O. R. TAMBO DISTRICT MUNICIPALITY

CONTRACT NO.: ORTDM SCMU 43-24/25

KING SABATA DALINDYEBO PRESIDENTIAL INTERVENTION BULK WATER SUPPLY

CONSTRUCTION OF 50ML/D HIGHBURY WATER TREATMENT WORKS & RAW AND CLEAR WATER PUMPSTATIONS: MECHANICAL & ELECTRICAL

VOLUME 2: SCOPE OF WORK & ANNEXURES

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KING SABATA DALINDYEBO PRESIDENTIAL INTERVENTION BULK WATER SUPPLY INFRASTRUCTURE:

CONSTRUCTION OF 50 ML/D HIGHBURY WATER TREATMENT WORKS & RAW AND CLEAR WATER PUMPSTATIONS: MECHANICAL & ELECTRICAL

Contents

C3: Scope of Work

Status

Should any requirement or provision in the parts of the Scope of Work conflict with any requirement of any Specification(s) forming part of this contract or any drawings, the order of precedence, unless otherwise specified, is:

- Project Specifications (including amendments to standard and particular specifications)
- BoQ
- Drawings
- Particular Specifications
- General Specifications
- Standard Specifications.

The above notwithstanding, any discrepancy shall be brought to the attention of the Engineer for clarification.

C3.1 Description of the Works

C3.1.1 Project Overview

As part of the implementation of a Presidential Intervention large-scale regional bulk water supply encompassing small towns and villages up to 40km outside Mthatha, a new 50Ml/d water treatment works at Highbury Village (Mthatha North) is being constructed to supply Mthatha North and three development corridors to the North and East of Mthatha.

All other areas of the KSD PI Bulk Water Scheme are to be supplied by the existing Thornhill WTW (the subject of various separate upgrading Contracts).

C3.1.2 Employer's Objectives

The Employer's objective is to appoint a Contractor to design, supply, install and commission all the mechanical and electrical power, control and instrumentation components required for the new 50Ml/d Highbury WTW and Clear Water Pumpstation and temporary Raw Water Pumpstation.

C3.1.3 Overview of this Contract

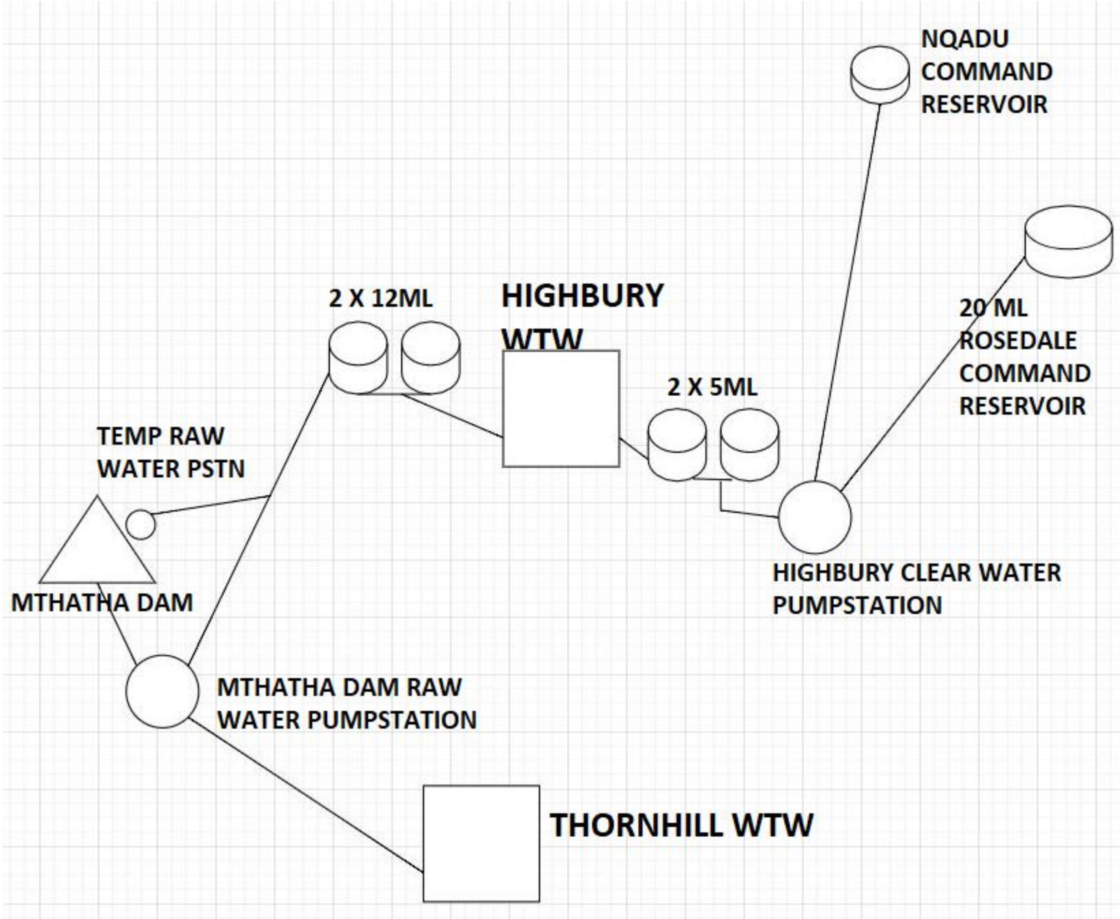
This Contract includes all mechanical and electrical components required to:

- Pump raw water from the side of Mthatha Dam to Highbury WTW (as an interim measure until the dam's outlet tower is upgraded and a permanent pumpstation below the dam is commissioned).
- Equip the new 50Ml/d Highbury Water Treatment Works.
- Pump the clear water from the above to two separate reservoirs.

Construction of the civil components of the new Highbury WTW are well advanced and the installation phase of this Contract is planned to 'dove-tail' with the completion of the civil works so that the Works as a whole can be commissioned without delay.

Construction of an overhead 11kV powerline to supply all the Highbury components from KSD Local Municipality's Thornhill Substation is currently underway and expected to be available by the time the equipment is ready for pre-commissioning testing.

A schematic layout of the raw water pumping, the two water treatment works and clear water pumping is given below.



C3.1.4 Scope of Works

The Scope of Works for this Contract can be summarised as the design, procure / fabricate / supply, install, test and commission the following mechanical equipment and electrical power and control equipment and instrumentation including all labour, materials, workmanship, machinery, equipment, transport, attendance on others, training of ORTDM operations staff and everything stated or implied which is, or may be, necessary in and for the entire completion of all the following works:

<u>Highbury WTW</u>

- Polyelectrolyte Dosing:
    - 4 x 10m^3 GRP polyelectrolyte bulk storage tanks, including steel portal frame canopy over and PVC filling pipework and supply pipework to a 'Day Tank'.
    - 1 x 60 litre GRP 'Day Tank' including GRP tank stand and pipework to dosing pumps.
    - 2 No. (Duty & Standby) wall-mounted polyelectrolyte dosing pumps including wall brackets, pulse-dampener and dosing and potable carrier water pipework to dosing point including HDPE underground sleeve between Dosing Building and Metering and Flow Control Structure.
    - 1 No. installed and one spare Streaming Flow Ion Detector in a wall mounted cabinet including all associated sampling and drainage pipework and signal cabling and control and HDPE underground sleeve back to Dosing Room for control of the polyelectrolyte dosing pumps.
    - 1 No. in-line static flash-mixer to be installed in incoming raw water pipework (remove temporary spool piece in pipework constructed under civil works and install flash-mixer).
    - Arrange and conduct testing of alternative sources of polyelectrolyte to determine the optimum dosing rate of each formulation, hence the most cost-effective (in terms of supply cost per Ml of raw water optimally flocculated).
    - Supply polyelectrolyte to fill bulk tanks (Prime Cost item)

- Inflow Metering and Control:
    - DN600 electro-magnetic flow meter to be installed in incoming raw water pipework (remove temporary spool piece in pipework constructed under civil works and install meter, including electrical earthing and insulating flange gaskets and stainless steel grounding rings each side).
    - DN600 rubber-lined solid ss disc butterfly valve with electrical actuator for local and remote control (remove temporary spool piece in pipework constructed under civil works and install valve).

- Highbury Raw Water Reservoirs
    - Supply and install 2 No. ultrasonic level sensor one in each raw water reservoir linked to SCADA

- Clariflocculator Equipment:
    - 4 No. rotating bridge sludge scrapers (304L stainless steel framework linking rubber scraper to bridge and epoxy-coated mild steel bridge) complete with outer drive wheel and inner support bearing incorporating slip-ring power supply;
    - 304L stainless steel V-notch weir plates to 4 No. clariflocculator launder channels
    - 4 No. desludge diaphragm valves (by specialist supplier as Prime Cost item) and associated electrical timer control and connection to potable water reticulation for valve actuating.

- Rapid Gravity Sand Filtration Equipment:
    - Precast fibre-reinforced panel false-floor on cast in-situ reinforced concrete stub-columns and slab topping as filter bed system for 8 No filters (each filter having two separate floors each side of launder channel) including all nozzle sleeves cast-in and screw-in 0.375mm gap size slotted wedge filter nozzles (plus 10% spare nozzles);
    - 8 No. 304L stainless steel manually-operated rising-gate weir gates (550mm weir vert travel, 600mm weir width) surface-mounted to inside of settled water inlet channels complete with pedestals and handwheels;
    - 8 No. DN300 rubber-lined solid ss disc butterfly valves electrically-actuated filter bed settled-water inlet valves linked to backwash control system (non-modulating actuator);
    - 8 No. DN400 rubber-lined solid ss disc butterfly valve electrically-actuated filtered-water outlets linked to backwash control system (modulating actuator for constant filter bed water level including ultrasonic level sensors) (remove temporary spool pieces in pipework constructed under civil works and install valves)
    - 8 No. DN400 rubber-lined solid ss disc butterfly valves electrically-actuated (non-modulating) filter backwash water inlets linked to backwash system (remove temporary spool pieces in pipework constructed under civil works and install valves)
    - 8 No. DN150 rubber-lined solid ss disc butterfly valve electrically-actuated air scour inlet valves linked to backwash control system (non-modulating actuator);
    - 8 No. DN400 rubber-lined solid ss disc butterfly valve electrically-actuated (non-modulating) spent backwash outlet linked to backwash system (including 304L stainless steel wall mounted frames for supporting valves over 620x620mm wall openings)
    - 3 No. (2 Duty, 1 Standby) backwash pumpsets in Filter Plant Room complete with:

        - mild steel suction and delivery manifolds and associated fittings and instrumentation designed to connect to existing ss puddle-pipes through wall (304L stainless steel and GRP suction and delivery pipework between Filter Buildings and Filter Plant Room by Stage 2 civil Contractor)
        - concrete plinths modified to suit pumpset frame
        - all associated electrical control and instrumentation equipment, including two DN400 electromagnetic flow meters on delivery line (in chambers constructed by civil contractor).
    - 2 No. (1 Duty, 1 Standby) 'Roots'-type air blowers for air scour of filter beds in Filter Plant Room complete with sound-attenuating hoods, pressure relief and isolating valves and buried and above-ground air delivery pipework (and associated supports and fixings) from blowers to each of 8 air scour inlet valves mentioned above.
    - Single-sized Quarzitic filter media (0.95mm nominal size) to 800mm depth for all 8 filter beds plus 10% spare
    - 2 No. manual gantry-beam trolleys and chain block (2 tonne rated capacity) installed on existing gantry beams in Filter Plant Building.

- Spent Backwash Water Recycle Tank Stirrers and Pumps:
    - Ultrasonic water level sensor linked to SCADA, stirrers and recycle pumps;
    - 2 No. vertical-spindle platform-mounted 3CR12 stirrers and motors and associated control linked to ultrasonic water level sensor (auto-on when water level rises above minimum operating level);
    - 3 No. recycle pumpsets (2 Duty, 1 Standby) complete with:
        - Concrete plinths to suit pumpsets
        - 304L cast-in suction bellmouths and insulating flange gaskets,
        - mild steel suction and delivery pipework and associated fittings and instrumentation inside pumproom
        - mild steel cast-in delivery puddle-pipe to uPVC rising main (rising main under civil contract)
        - all associated electrical control and instrumentation equipment and links to SCADA, including a DN100 electromagnetic flow meter on delivery line.

- Chlorine Gas Storage Room
    - 2 No. banks of 3 No. 1 tonne net content chlorine gas drums (1 Duty bank, 1 Standby bank) complete with:
        - Support cradles with load cells for read-out of remaining gas in adjoining dosing room;
        - On-drum emergency actuated gas shutoff valves and associated connections and remote control;
        - Flexible leads between drums and gas manifolds including connections and manual isolating valves
        - Wall-mounted gas manifold complete with liquid traps and heating tape;
        - Vacuum regulator
        - Vacuum change-over device between Duty and Standby banks
        - Gas dosing pipework from change-over device to chlorine dosing room.
    - 6 No. cradles for storage of 1 tonne net content chlorine gas drums complete with load cells for full / empty drum indication in adjoining dosing room.
    - 2 No. manual 5 tonne gantry trolleys with manual 2 tonne chain-block pulleys and chlorine drum lifting beams
    - Space heater with thermostat to keep gas storage room at about 20°C.
    - Nitrile or Butyl rubber sealing strips at bottom of existing doors to gas storage room
    - Supply of 12 full drums for commissioning and operation (Prime Cost item)

- Chlorine Dosing Room
    - 2 No. wall-mounted manually-adjusted gas dosing regulators (for two separate dosing points) drawing-off from single gas dosing pipeline from gas storage room, including pipework and isolating valves to venturi gas injectors.
    - 2 No. wall-mounted venturi gas injectors including associated connections off dedicated 90mm PN20 HDPE potable water pipeline and potable water mechanical flow meter for each offtake (no booster pumps required; dedicated water supply at ~14Bar off clear water rising main to outside Chlorine Dosing Building provided by civil contractor);
    - All uPVC dosing pipework from gas injectors to each Filter Building (2 separate dosing lines), including distributors at inflow point to Filter Building Chlorine Contact Tanks.

- Gas leak warning and scrubber system:
    - Gas leak detection device in chlorine dosing room with sensor in chlorine gas storage room including visual and audible alarms and all associated piping and connections and control wiring and links to SCADA
    - Dry scrubber system outside gas storage room on reinforced concrete slab (slab by civil contractor to M&E Contractor requirements) complete with:
        - automatic activation link to leak detector;
        - uPVC suction manifold at floor level in gas storage room;

      - GRP scrubber unit loaded with chlorine gas neutralising balls sufficient to neutralise 1 tonne of chlorine gas;
      - Extraction fan with exhaust stack;
      - All necessary electrical connections.

- Chlorine Safety Equipment:
  - Emergency shower and eye-wash station next to chlorine dosing room including pipework and connections to potable water reticulation.
  - 3 No. full PPE kits (full-face cartridge respirator and gloves) designed for gaseous chlorine environment in wall-mounted cabinets (2 cabinets in Chlorine Dosing Room, 1 cabinet in polyelectrolyte Dosing Building).
  - 3 spare sealed cartridges.

- Clear Water Pumpstation: Mechanical
  - 3 No. (2 Duty, 1 Standby) horizontally-split pumpsets to Rosedale Command Reservoir via existing DN1200 Clear Water Rising Main complete with:
    - Adjustment to concrete plinths built under the civil works contract (if necessary) to suit pumpsets;
    - Mild steel suction and delivery manifold and associated fittings and instrumentation inside pumproom;
    - Flanged connection to DN800 steel pipeline from clear water reservoirs complete with insulating flange gasket and DN900 steel delivery manifold welded connection to external isolating and scour valve chamber pipework (pipeline to pumpstation and isolation valve chamber on delivery side by civil Contractor);
    - All associated VSD electrical control and instrumentation equipment and links to SCADA, including a DN800 electromagnetic flow meter on suction line.
  - 2 No. (1 Duty, 1 Standby) multistage pumpsets to Nqadu Corridor Rising Main complete with:
    - Concrete plinths to suit pumpsets;
    - Mild steel suction and delivery manifold and associated fittings and instrumentation inside pumproom;
    - DN250 flanged connection to suction manifold and DN200 delivery manifold flanged connection to external isolating and scour valve chamber pipework (chamber on delivery side by civil Contractor);
    - All associated VSD electrical control and instrumentation equipment and links to SCADA,
    - DN200 electro-magnetic flow meter to be installed in existing isolation and scour chamber pipework (remove temporary spool piece in pipework constructed under civil works and install meter, including electrical earthing and insulating flange gaskets and ss grounding rings each side).
    - Cabling for above flow meter back to pumpstation MCC.
  - Electric Overhead Travelling (EOT) crane to pump hall (including fixed runway beams);
  - HVAC ducted axial-flow fans to transformer room

- Clear Water Pumpstation: Electrical
  - Install-only KSD Local Municipality 11kV incomer metering equipment in dedicated meter room (municipality supplied equipment).
  - MV isolating switchgear to connect to KSD Local Municipality point-of-supply terminals
  - Three 11KV/400V dry-type transformers.
  - 3 No. Rosedale Clear Water Pump LV VSDs/ MCCs.
  - 2 No. Nqadu Clear Water Pump LV VSDs/ MCCs.
  - LV reticulation, ducting, and cable trays.
  - Low voltage (LV) distribution boards.
  - HVAC and fire detection and suppression systems
  - Earthing and lightning protection.
  - Small power and lighting.
  - Security and access control.
  - Instrumentation & control systems (PLC, marshalling, HMIs, SCADA).
- Rosedale Reservoir
  - Supply and install 1 No. ultrasonic level sensor linked to Scada

- Standby Generator (in Clear Water Pumpstation Building): Mechanical:
  - 14kℓ diesel storage tank (alongside the building) (bund and canopy over by civil contractor);
  - Fuel delivery system and ancillaries;
  - HVAC, fire detection and suppression system.

- Standby Generator: Electrical:
  - 1 No. 2500kVA / 400V diesel-powered generator and ancillaries.
  - LV switchgear and cabling

- Sludge Holding Tank:

  - Ultrasonic water level sensor linked to SCADA and stirrers;
  - 4 No. vertical-spindle platform-mounted 3CR12 stirrers and associated control linked to ultrasonic water level sensor (auto-on when water level rises above minimum operating level).

- Sludge Dewatering and Dried Sludge Handling Equipment (whole package designed by Contractor to suit proprietary system):
  - Positive-displacement sludge feed pumps (min 50% standby capacity) with VSD or multiple Duty pumps drawing from above ground from flanged tee on sludge holding tank outlet; capacities to suit operating one or both dehydrating units simultaneously;
  - 2 No. volute dehydrators (each with double volutes) complete with liquid polymer flocculent dosing system (drawing from 25l containers of polymer) and associated sludge feed, potable flush water connections and filtrate drainage pipework to collector drainage manhole (manhole and drainage to filtrate recycle system by civil Contractor);
  - 2 No. manually-positioned 180º swing arc electrically-driven dried sludge stacking conveyors
  - All associated electrical control system and monitoring links to SCADA;
  - Design of housing for local SMME civil contractor to build;
  - Supply of polymer in 25l containers as per Engineer's instruction (Prime Cost item);
  - Pay for I year contract for providing and transporting waste skips and disposal of sludge (Prime Cost item);
  - Supply suitable skip loading machine ('Bobcat' or similar as agreed with Engineer). (Prime Cost item)

- Sludge Supernatant Recycle Water Pumpstation
  - Ultrasonic water level sensor in sludge pond intake sump linked to pump control;
  - 2 No. recycle pumpsets (1 Duty, 1 Standby) complete with:
    - Concrete plinths to suit pumpsets
    - mild steel suction and delivery manifold and associated fittings and instrumentation inside pumproom and connections to DN160 gravity main and DN100 Rising Main (mains by civil contractor)
    - all associated electrical control and instrumentation equipment and links to SCADA, including a DN80 electromagnetic flow meter on suction line.

- General Site: Electrical
  - Mast area lighting around WTW Site;
  - Electrical power reticulation from Clear Water Pumpstation Main DB to all building DBs and associated small power and lighting within all buildings
  - Earthing
  - Lightning and surge protection
  - Conduits, Cable Trays, Powerskirting, Trunking and other Wireways
  - Wiring and Connections
  - Intertripping and Control Wiring
  - Fibre-optic Data and Intercommunication Systems,
  - Security Systems
  - Smoke Detection
  - Thermal Survey before and after commissioning
  - Electrical Switchroom for KSDLM Electrical Authority (local SMME to build)

- Supply of water sampling and testing instruments and equipment and materials for Dosing Building laboratory as agreed with the Engineer (Prime Cost item).

- Liaison with Civil Contractor regarding installation planning and requirements

- Liaison with KSD Local Municipality – Electrical Department (Supply Authority)

<u>Interim Raw Water Pumpstation from Mthatha Dam</u>

- Construction of a platform excavated in rock for pumps close to the edge of the dam, complete with reinforced concrete plinths, gabion wave barrier wall, GMS gantry above pumps and motors and a concrete-roofed brick electrical and guardroom building.

- Supply and install 3 No. end-suction pumpsets to transfer water from the dam to Highbury WTW, including 30m long parallel DN400 steel suction pipes (complete with intake bellmouth and non-return valve to be mounted on a steel skid), GMS delivery pipework (complete with non-return and isolation valves), electrical control and instrumentation (electrical equipment housed in above-mentioned building).

- Rising Main to connect into exiting Highbury Raw Water Rising Main at a nearby AV chamber, (760m long DN500 GRP PN10 SN5000 pipe laid to an air valve chamber on an existing DN1200 rising main, including modifications to air valve chamber and fittings).

- Power cabling from KSDLM 800kVA minisub to pump control panel (minisub supplied by KSD Local Municipality).
- Gravel access road
- Security fencing.

Telemetry & SCADA

- Integrate Highbury WTW local control and monitoring with OR Tambo District Municipality's existing SCADA (currently covering only Thornhill WTW and its three associated receiving reservoir sites);
- The design of the above shall allow for a future extension of the telemetry network and SCADA to include remote monitoring of all KSD PI Bulk Water Supply Scheme Primary Bulk Infrastructure reservoirs, pumpstations and bulk flow meters.

General

- Performance acceptance testing
- Liaison and cooperation with Civil Contractor to access the Highbury WTW site
- Training programs for local residents by approved Accredited Service Providers.
- Signage
- O&M Manuals and selected spares.
- Liaison with local community.
- Environmental compliance and management including rehabilitation after construction.
- OSHA compliance and management.
- Full-time (24/7) operational support, training of OR Tambo District Municipality Operations and Maintenace staff and maintenance of all equipment installed for four-months Trial Operating Period from date of successful commissioning. Employer's staff to take over the operation of the Works at end of Trial Operating Period when the Taking-Over Certificate is issued). (1 Senior Technician and 3 Junior Technicians to share 3 No. 8h shifts 24h/7 days a week).
- On-Site monitoring of all operations and technical assistance for further 8 months after Trial Operations Period (1 Senior Technician x 8h shift per day, 5 days a week)
- Defects Notification Period of 8 months after the issue of the Taking-Over Certificate including rectification, maintenance and servicing of all of the above equipment over this period.

C3.1.5 Location of the Works

The site is located on the Northern outskirts of Mthatha town. Mthatha is situated within the King Sabata Dalindyebo Local Municipality which forms part of the OR Tambo District Municipality of the Eastern Cape Province. It is located approximately 230 km from East London on the N2 National Highway between East London and Kokstad.

The coordinates of the site are: 31°32'24.63"S; 28°45'02.61"E

C3.1.6 Description of Site and Access

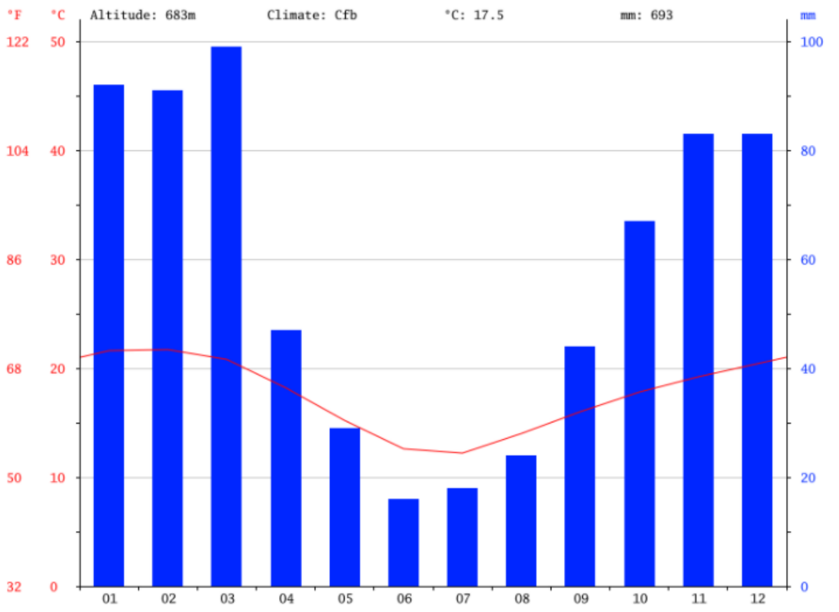
The Highbury WTW Site is accessed off Nqadu Street, a 3.8km road (first 2.7m is surfaced and the last 1.7km is gravel) off the N2 towards Kokstad (approximately 3km North of Mthatha CBD).

The Mthatha Dam Raw Water Pumpstation is some 2km beyond Highbury WTW (to the West). Access from the Highbury WTW side is via a small bridge that crosses the Mthatha Dam spillway; this bridge is not to be used by heavy machinery. There is an alternative route below the dam wall which can be used by any road vehicle.

The general climatic conditions for Mthatha are as follows :

Altitude above sea level	: ~670 masl
Maximum temperature	: 40 ºC
Minimum temperature	: -2 ºC
Annual Average Temperature	: 17,5ºC
Annual Average Rainfall	: 693mm
Rainfall season	: Summer

CLIMOGRAPH MTHATHA



Precipitation is the lowest in June, with an average of 16 mm. With an average of 99 mm, the most precipitation falls in March.

C3.1.7 Temporary Works

Temporary works include access for rigging equipment, barricades around work-in-progress, traffic management of heavy vehicles approaching and leaving the site.

C3.1.8 Geotechnical Conditions

According to the 1:250 000 geological map (3128) for Mthatha as published by the Council of Geosciences, the site is underlain by sedimentary rocks of the Beaufort Group belonging to the Karoo Supergroup.

The site lies within the Katberg formation, belonging to the Tarkastad subgroup of the greater Karoo Supergroup. The Tarkastad subgroup is characterised by a greater abundance of both sandstone and red mudstone. Although no dolerite dykes or sills were encountered in the trial pit excavations, such intrusions are common in the area.

The trial pit profiles show (from ground surface going down):

- A consistent upper layer of agricultural-grade soft soil material varying in depth from 1,4m (upper clariflocculators at the upper end of the Site) to 0,8m (lower end of the Site).
- A weathered mudstone layer of about 0,4m under the soil layer (which quickly decomposes to mud when excavated and exposed to water).
- A less-weathered mudstone layer of about 0,6m. This can be excavated by a 30t excavator equipped with a rock bucket.
- Below this is hard, unweathered mudstone, siltstone and sandstone which requires a heavy-duty hydraulic breaker or expanding grout to excavate (blasting is not allowed due to the proximity of existing structures).

All Geotechnical information is included in Annexure C3.5.1 (on CD) and all trial pit locations are shown on Drawing No.J31067/LAY_112.

The site has an average slope of 10% falling towards the north-eastern direction.

The Tenderer is at liberty to inspect existing open excavations on the Stage 1 Civils site, provided that he has made prior arrangement with the Employer's Agent.

Many of the structures constructed under Stage 2 have been backfilled to Natural Ground Level pending the commencement of Phase 2 Civils. Excavation for interlinking pipework will therefore be in soft backfill materials close to structures, but in hard rock beyond the Stage 1 excavations for the structures.

No blasting will be allowed anywhere.

C3.1.9 Site Facilities

C3.1.8.1 Location of Contractor's Camp and Depot

There are several empty platforms within the existing perimeter security fence that may be used by the Contractor. The Civil Works Contractor will have a Site Camp within this perimeter.

C3.1.8.2 Water Supply

The OR Tambo District Municipality is the Water Supply Authority. Although the adjacent Highbury Village does have reticulated water at a basic level of service (served from the nearby 3Ml/d Rosedale Water Treatment Plant), this supply is very limited and water quality and level of assurance of supply from this works tends to be erratic. The Contractor shall therefore make his own arrangements for ensuring an adequate supply of water for construction; including provision of on-site storage of sufficient capacity to allow uninterrupted construction. Water for non-potable water needs can be abstracted free of charge from the Mthatha Dam (eg dust suppression and pressure-testing pipelines).

The Contractor shall make his own arrangements for filling the various water retaining structures and pipelines for any equipment testing. The water can be sourced free of charge from the Mthatha Dam. For clear water pipelines and, the initial testing may be done using raw water but, at commissioning stage, such pipelines and reservoirs shall be cleaned-out afterwards using potable water sourced from the ORTDM system and the applicable charges paid or from clean water generated during the commissioning stage. No separate BoQ item is provided for conveyance of raw water from the dam (temporary pumping system or tankering) or for cleaning using potable water.

C3.1.8.3 Power supply

King Sabata Dalindyebo Local Municipality is the Electrical Supply Authority. There is a limited (single-phase domestic) power supply infrastructure in the area. The Contractor shall make his own arrangements for a metered offtake for the supply of electricity for construction purposes.

C3.1.8.4 Ablution facilities

There are no existing ablution facilities for the Contractors use on site. The construction and use of temporary septic tanks and soakaways (or the like) will not be permitted. Temporary conservancy tanks will be permitted.

C3.1.8.5 Accommodation

No accommodation for the Contractor's employees will be permitted on site. The Contractor shall make his own arrangements to house his employees and transport them to and from Site.
No informal housing or squatting will be allowed.

C3.2 Engineering

C3.2.1 Design Services and Activity Matrix

The Employer is responsible for concept, feasibility, basic engineering and layout for the full scope of works to tender stage of the project.

The design responsibility for the Works is as per Clause 4.2 of SANS 1921-1 and GCC 4.1.1. Where conflict arises, the Contractor shall refer the matter to the Employer's Agent for resolution. The Design Responsibilities are as follows:

Design Process	Responsibility
Concept, feasibility and overall process	Employer Responsible
Basic engineering and detail layout to tender stage for full scope of works	Employer/ Employer's Agent Responsible
Final design to Engineer's approval for fabrication and installation for all mechanical and electrical Works	Contractor Responsible
Temporary works	Contractor Responsible
Preparation of as-built drawings	Contractor Responsible

The extent of the Employer's Agent's design is shown on the respective drawings and specifications.

Before final award of Contract, the preferred Bidder shall submit full details of all equipment

C3.2.2 Contractor's Designs and Duties

The Contract includes the following duties in respect of the Works:

- Design
- Manufacture
- Supply
- Deliver
- Install
- Test
- Commission
- Provision of Operating & Maintenance Manual
- Training
- Trial Operation Period
- Upholding during the Defects Notification Period (DNP) including servicing of all supplied equipment.

The equipment provided under this Contract shall comply with the Project Specifications design, materials of construction and performance requirements and relevant Data Schedules. For any aspect of these not adequately covered by the Project Specifications and Data Schedules, the requirements of the standard (non-project specific) Particular Specifications shall apply.

The proposed equipment shall be designed to fit into the existing structures without major modification unless notification of required alterations were given with the tender and such alterations have been approved by the Engineer.

The Contractor will be responsible for the design of all temporary works and all construction methods, all rigging, shoring and lateral support that may be required. The Contractor will also be responsible for the preparation of method statements before commencing with installation.

The Contractor is also responsible for the preparation of record drawings and shop fittings of all installations.

C3.2.3 Construction Operations

Although almost all construction / installation is within the already-constructed Highbury Water Treatment Works boundary fence or Mthatha Dam Raw Water Pumpstation Site, special care must be taken with the safe control of vehicle movements coming to / leaving the site in that the Works adjoins the Highbury Village and Highbury Junior School.

C3.2.4 Drawings, Samples and Inspections

<u>Drawings Issued by the Engineer</u>

The work shall be carried out in accordance with the latest available revision of the drawings to be issued by the Engineer for construction. At commencement of contract, the Engineer shall deliver to the Contractor three sets copies of the construction drawings and any instructions required for the commencement of the works.

From time to time thereafter during the progress of the works, the Engineer may issue further drawings or revisions for construction purposes as may be necessary for adequate construction and completion of the works and defects correction.

<u>Contractor's Drawings, Samples and Inspections</u>

The Contractor shall timeously provide general layout drawings, workshop drawings, Technical Data Sheets and/or samples of the following items for the Engineer's review and approval:

- All polyelectrolyte storing, handling, control, dosing and flash-mixing equipment
- All clariflocculator tank travelling bridge structure and drive
- All filter floor structural details and components (including nozzles)
- Filter air scour blowers (and sound attenuation hood)
- All pumps and motors and all frames and suction and delivery pipework and supporting systems (eight pumping duties in six pumpstations)
- All pump and motor protection instrumentation and control equipment
- All spent backwash water & sludge tank stirrers
- All sludge dewatering and conveyor equipment
- All chlorine gas handling and dosing and dry-scrubber equipment
- All chlorine and dosing pipelines
- All Motor Control Centres / variable speed drives
- All Distribution Boards
- All flow meters, ultrasonic level sensors and other instrumentation not included above
- All HVAC equipment
- All permanent overhead hoisting equipment
- All standby generator (diesel engine, alternator, controller, fuel system, sound attenuators and cowlings etc)
- All busbar trunking in Clear Water Pumpstation
- All 11kV/400V transformers in Clear Water Pumpstation
- All MV Switchgear in Clear Water Pumpstation
- All Uninterruptible Power Supply (UPS) in Clear Water Pumpstation
- Standby diesel-powered generator and fuel system
- All powerskirting
- All Socket Outlets, Switches and Accessories.
- All line and wiring diagrams
- All cable run and sleeves
- All piping and instrumentation diagrams
- Equipment and instrument lists

Manufacture and delivery of these items shall not proceed without the Engineer's written instruction to proceed.

The Contractor shall timeously advise the Engineer of inspections at the manufacturer's premises to enable the Engineer to perform said inspections.

<u>As-Built Drawings</u>

The Contractor will be required to mark up one complete set of prints of the construction drawings with as-built information and submit these to the Employer's Agent at the end of construction, prior to issue of the Certificate of Practical Completion.

C3.3 Procurement

C3.3.1 Subcontracting

C3.3.2.1 Scope of Participation by local SMME's

A Prime Cost Sum for ring-fenced civil works to be undertaken by local SMMEs has been included in the BoQ.

Details of the ring-fenced work are given in an unpriced BoQ plus drawings [labelled 'CIV'] issued with the Tender Documents. The Main Contractor shall package the SoW into separate Requests for Quotes, obtain quotes, manage and supervise multiple SMMEs and make monthly payments for work certified for payment by the Employer's Agent. Payment to SMMEs shall be made within 5 working days of receiving payment from the Employer. Retention as per Main Contractor's work shall also apply to the SMMEs on the monthly certificates. A separately-calculated Contract Price Adjustment will apply to ring-fenced work (see Contract Data).

The Main Contractor shall make allowance for procuring, managing and supervising the ring-fenced civil work as soon as possible once the Contract has commenced; even though site establishment for the installation of mechanical and electrical equipment only happens much later.

All the Main Contractor's costs associated with the increased Performance Guarantee premium, procurement, management, supervision of execution of ring-fenced work and making monthly payments to the SMMEs are deemed to be included in tendered fixed cost and time-related P&G items. Fixed and time-related P&G items have been included in the Main BoQ for management, establishment and supervision costs of SMMEs over the initial period when not yet on Site for own Works.

C3.3.2.2 Subcontractor Requirements

All subcontractors (local and non-local) appointed by the Contractor shall be:

- Registered with the CIDB
- Allocated work within the category and value limits designated by their CIDB grading
- Be in good standing with the Department of Labour
- Registered on the Central Supplier Database.
- CSD compliant

Proof of the above is to be provided to the Employers Agent before appointment of the subcontractor.

C3.4 Construction

C3.4.1 Works Specifications

C3.4.1.1 Applicable National and International Standards

The Contractor is expected to provide for him/herself the necessary ISO and DIN applicable to the equipment, as well as the standards referred to in the Particular Specification bound in this document. The latest publication shall apply.

The following specifications apply to this project, but are not included in this document.

These specifications may be obtained or viewed at SA National Standards (SANS)

The latest published issue of each standard at tender closing date shall apply.

a) Applicable SANS 1200 Standardised Specifications

The following SANS 1200 Standardised Specifications for Civil Engineering Construction are applicable:

- SANS 1200 A - 1986 General
- SANS 1200 AB - 1986 Engineer's Office
- SANS 1200 C - 1980 Site Clearance (As amended 1982)
- SANS 1200 D - 1988 Earthworks (As amended 1990)
- SANS 1200 DB - 1989 Earthworks (Pipe Trenches)
- SANS 1200 DK - 1996 Gabions and pitching (First Revision)
- SANS 1200 G - 1982 Concrete (Structural)
- SANS 1200 HA - 1990 Structural Steelwork (Sundry items)
- SANS 1200 HC - 1988 Corrosion Protection of Structural Steelwork
- SANS 1200 L - 1983 Medium-Pressure Pipelines
- SANS 1200 LB - 1983 Bedding (Pipes)
- SANS 1200 LC - 1981 Cable ducts

Refer to the *Variations and Additions to the Standard SANS 1200 Specifications: General, Civil and Structural Works* in Annex C3.9.

b) Other Applicable SANS Specifications: Civil

- SANS 462 Welded Wire Fabric Gabions and Gabion Mattresses (metallic-coated or polyvinyl chloride (PVC) coated)
- SANS 974-1 Rubber Joint Rings (non-cellular) Part 1 : Joint Rings for Use in Water, Sewer and Drainage Systems
- SANS 1083 Aggregates from Natural Sources – Aggregates for Concrete

c) Other Applicable SANS Specifications: Electrical

SANS 156	Moulded-case circuit-breakers
SANS 164-1 to 7	Plug and socket-outlet systems for household and similar purposes for use in South Africa
SANS 337	Stove couplers
SANS 529	Heat-resisting wiring cables
SANS 556-1	Low-voltage switchgear
SANS 767-1	Earth leakage protection units
SANS 780	Distribution transformers
SANS 950	Unplasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations

SANS 1063	Earth rods and couplers
SANS 1085	Wall outlet boxes for the enclosure of electrical accessories
SANS 1195	Busbars
SANS 1213	Mechanical cable glands
SANS 1239	Plugs, socket-outlets and couplers for industrial purposes
SANS 1411-1	Materials of insulated electric cables and flexible cords – Part 1: Conductors
SANS 1433	Electrical terminals and connectors
SANS 1473-1	Low-voltage, switchgear and control gear assemblies – Part 1: Type-tested, partially type-tested and specially tested assemblies with a rated short-circuit withstand strength above 10 kA
SANS 1507	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SANS 1574	Electric cables – Flexible cords and flexible cables
SANS 1619	Small power distribution units (ready boards) for single-phase 230 V service connections
SANS 1765	Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA
SANS 1777	Photoelectric control units for lighting
SANS 10098	Public lighting
SANS 10108	Classification of hazardous locations
SANS 10114	Interior lighting
SANS 10142 - Part 1	The wiring of premises; low voltage insulations
SANS 10142 - Part 2	The wiring of premises; medium voltage installations above 1kV a.c. not exceeding 22kV a.c. and up to and including 3000 kW installed capacity
SANS 10198	The selection, handling and installation of electric power cables of rating not exceeding 33 kV
SANS 10199	The design and installation of earth electrodes
SANS 10292	Earthing of low-voltage (LV) distribution system
SANS 10313	The protection of structures against lightning
SANS 10389	Exterior lighting
SANS 60269/IEC 60269	Low-voltage fuses
SANS 60309/IEC 60309	Plugs, socket-outlets and couplers for industrial purposes
SANS 60439-4/IEC 60439-1	Low-voltage, switchgear and control gear assemblies – Part 1: Type-tested and partially type-tested assemblies
SANS 60439-2/IEC 60439-2	Low-voltage switchgear and control gear assemblies – Part 2: Particular requirements for busbar trunking systems (busways)
SANS 60439-4/IEC 60439-4	Low-voltage, switchgear and control gear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS)
SANS 60598-1/IEC 60598-1	Luminaires: General requirements and tests
SANS 60529/IEC 60529	Degrees of protection provided by enclosures (IP Code)
SANS 60570/IEC 60570	Electrical supply track systems for luminaires
SANS 60598-2-23/IEC 60598-2-23	Luminaires – Part 2-23: Particular requirements – Extra low voltage lighting systems for filament lamps
SANS 60669/IEC 60669	Switches for household and similar fixed-electrical installations
SANS 60730-2 Part 7	Electronic controls
SANS 60906/IEC 60906	IEC systems of plugs and socket-outlets for household and similar purposes

SANS 60947/IEC 60947	Low-voltage switchgear and control gear
SANS 60950/1/IEC 60950-1	Information technology equipment – Safety – Part 1: General requirements
SANS 61000-4-5/IEC 61000-4-5	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
SANS 61000-4-7/IEC 61000-4-7	Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and inter harmonics measurements and instrumentation, for power supply systems and equipment connected thereto
SANS 61008/IEC61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
SANS 61024	The protection of structures against lightning
SANS 61084/IEC 61084	Cable trunking and ducting systems for electrical installation
SANS 61238-1/IEC 61238-1	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) – Part 1: Test methods and requirements
SANS 61312/IEC 61312	Protection against lightning electromagnetic impulse
SANS 61386/IEC 61386	Conduit systems for electrical installations
SANS 61558/IEC 61558	Safety of power transformers, power supply units and similar
SANS 61643-1/IEC 61643-1	Surge protective devices connected to low-voltage power distribution systems – Part 1: Performance requirements and testing methods
SANS 62305	Lighting protection

d) Certification by recognised bodies

Wherever possible items and materials for construction of the works shall comply with the relevant South African Bureau of Standards Specifications and with the British Standards where these are applicable in the absence of local standards.

The Contractor, when using materials conforming to a Standard Specification shall if called upon furnish the Engineer with certificates of tests showing that the materials do so conform.

C3.4.1.2 Detailed Project Specifications

See:
- C3.6: Project Specifications: Pumping Equipment
- C3.7: Project Specifications: Waterworks Equipment
- C3.8: Project Specifications: Electrical Equipment

C3.4.1.3 Particular Specifications

See:
- C4: Environmental Management Plan
- C5: OH&S Specification and Baseline Assessment

C3.4.1.4 General Specifications

See C3.10: General Specifications

C3.4.2 Plant and Materials

C3.4.2.1 Materials Supplied by the Employer
No materials will be supplied by the Employer.

C3.4.2.2 Materials, Samples and Shop Drawings
The Contractor is required to provide proof of compliance with the materials specification, as well as to provide samples of materials and finishes.

Unless otherwise instructed in writing by the Employer's Agent, all proprietary materials are to be used, mixed, applied, fixed etc strictly in accordance with the manufacturer's recommendations.

Materials and/or equipment are to be ordered timeously to meet the construction programme. Extension of time for non-availability of materials will only be considered subject to the Contractor satisfying the Employer's Agent of timeous ordering thereof.

C3.4.3 Construction Equipment

C3.4.3.1 Requirements for Equipment

All equipment must comply with the requirements as stipulated in the Environmental regulations and specifications and contained in the OHS Act.

All construction plant and equipment used on this contract shall be in good working order, well maintained, of adequate size and fit for purpose. No plant or equipment that leaks oil, fuel or hydraulic fluids may be used on site.

Any plant or equipment that, in the opinion of the Employer's Agent, is not of adequate size or fit for use shall be removed from the site and replaced with acceptable plant and equipment, all at the Contractor's cost.

C3.4.3.2 Equipment Provided by the Employer

No equipment shall be provided to the Contractor by the Employer.

C3.4.4 Existing Services

C3.4.4.1 General

C3.4.4.2 Known Services

The positions of the abovementioned infrastructure is indicated on the drawings or will be pointed out to the Contractor on site.

The Contractor shall take all reasonable steps to ensure that any existing services are protected during construction.

The Contractor shall take all necessary steps to ascertain the location of existing services before commencing any section of the works. Prior to the commencement of work in any area the Contractor shall carefully excavate to locate and mark the positions of all existing underground services affected by the works. He shall take all necessary precautions to protect any existing works whatsoever against damage which may arise and shall bear the full cost of the repairs to any damage caused as a result of his operations on site. Any damage to a service shall immediately be reported to the responsible authority and to the Engineer. The Contractor must liaise with all relevant authorities to satisfy himself that all existing services have been located.

C3.4.4.3 Treatment of Existing Services

The Contractor shall ensure that none of the existing services are damaged during the implementation of this Contract.

C3.4.4.4 Proving Underground Services

Where services can reasonably be expected to exist where excavations are to take place, the Contractor shall, without instructions from the Employer's Agent, carefully excavate by hand to expose and prove their positions.

The Contractor may use detection equipment to locate underground services prior to exposing such by hand.

C3.4.4.5 Damage To Services

The Contractor shall exercise care in the vicinity of existing services, and shall take all necessary measures to protect such services. Should any service be damaged by the Contractor in carrying out the works and should it be found that the procedure as laid down in this clause has not been followed then all costs in connection with the repair of the service will be to the Contractor's account.

C3.4.4.6 Reinstatement of Services and Structures Damaged During Construction

In the event of a service being damaged, the Contractor shall immediately notify the authority concerned, as well as the Employer's Agent. Where the authority concerned elects to effect the repair, the Contractor shall co-operate with and allow such authority reasonable access and sufficient space and time to effect the repair. The Contractor shall otherwise reinstate all damaged structures and services to their original state.

C3.4.5 Site Establishment

C3.4.5.1 Services and Facilities Provided by the Employer

The OR Tambo District Municipality is the Water Supply Authority.

No services or facilities will be provided by the Employer. The Contractor is to provide his own services and facilities, and to make allowance for the cost thereof in Section 1 of the Schedule of Quantities.

C3.4.5.2 Facilities Provided by the Contractor

The Contractor is to provide the facilities indicated in the Schedule of Quantities and as specified in Section C3.9: SANS 1200 AB.

Note that office facilities for the Employer's Representative are required from the commencement of the local CPG subcontractor's ring-fenced civil works (which is to commence as soon as possible after the contract is signed and the Site is handed over).

The Main Contractor may wish to provide limited site establishment facilities (to monitor and supervise the above civil works) until the commencement of his own installation activities on Site.

The Contractor shall provide, for the exclusive use of the Engineer and his staff, offices and a toilet as specified in PSAB 3.2. Survey equipment according to clause PSAB 5.6 shall be supplied and maintained for the Engineer's use.

The Contractor shall provide, for the exclusive use of the Labour Desk Committee, one office and a toilet (refer to section PSAB).

The main construction camp location shall be within the existing fenced Highbury WTW boundary.

The construction camp is to be removed upon completion of the work, and the site returned to the condition in which it was found, to the satisfaction of the Environmental Control Officer and Engineer.

C3.4.5.3 Storage Facilities

The Contractor is to provide all facilities for his operations; including temporary pipeyards for the pipes to be supplied under this Contract. The Contractor is responsible for maintaining the pipe yard on a regular basis.

General storage areas are to be contained within the Contractor's designated, fenced off construction camp(s).

C3.4.5.4 Other Facilities and Services

The Contractor is responsible for the provision of all necessary temporary facilities which are not provided by the Employer, including power, water, telecommunications, security services, medical, fire protection, sanitation and toilets and solid waste disposal.

The Contractor shall make his own provisions for the collection, storage and disposal of all construction waste (i.e. whether it be in the camp or on the construction site); all in conformance with the Environmental Management Plan and with approval of the Employer's Agent, the Local Authority and the Environmental Officer. Payment for the clearing, loading, transport, dumping fees and any other requirement or costs incurred shall be included in the scheduled rates.

The Contractor shall provide suitable and adequate portable chemical latrines for his employees and his sub-contractors. Latrines shall be maintained by the Contractor in a clean and sanitary condition to the Employer's Agent's satisfaction. The use of latrines shall be enforced and fouling of the site will not be tolerated.

The Contractor is not permitted to house any of his employees or sub-contractors within the site camp.

The Contractor is to comply with all requirements contained in law or local bylaws, as well as any other requirements set by the local authority.

C3.4.5.5 Notice Boards

The Contractor is to provide notice boards as indicated in the Schedule of Quantities, the layout of which is to match the template issued in the Tender Document.

The boards are to be erected at locations approved by the Employer's Agent. The Employer's Agent reserves the right (at no cost to the Employer) to have any sign, notice or advertisement moved to another location, or to have such removed from the site entirely, should such signs, notices or advertisements prove in any way unsatisfactory, or an inconvenience or danger to the general public.

These boards are to be maintained for the duration of the Contract. Any damage to the boards shall be repaired within fourteen (14) days of a written instruction issued by the Employer's Agent.

The notice boards and supporting structures are to be removed fourteen (14) days prior to the issue of the Final Approval Certificate.

C3.4.6 Site Usage

The Contractors primary site is the Highbury WTW. Access to site shall be limited to the Contractor and his personnel.

The Contractor shall be responsible for the control of unauthorized entry to the site and shall inform the Employer's Agent of any breach of such rules. The site shall be managed and used for its intended purpose. The Contractor is required to keep a visitors log and ensure full compliance with site safety standards.

The Contractor is to take note that the Civil Contractor is responsible for the control of unauthorized entry to the site as well as maintaining the site and when access is granted the M&E Contractor shall be responsible for his portion of the work and the upkeep of the work area.

C3.4.7 Security

The Contractor may be exposed to criminal actions, including theft and vandalism, and shall make all his own necessary security arrangements for the duration of the Contract.

The Contractor shall be responsible for taking all reasonable measures to ensure that effective access control and integrity of the site perimeter fence is maintained for the full duration of construction.

C3.4.8 Permits and Way Leaves

While the Engineer is responsible for obtaining all the necessary wayleaves, permissions and permits applicable to working near any existing services or other infrastructure on Site, the Contractor is responsible for abiding by the safety and other conditions imposed by such wayleaves, permissions and permits.

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

C3.4.9 Alterations, Additions, Extensions and Modifications to Existing Works

The Contractor is to satisfy himself as to the dimensional accuracy, alignment, levels and setting out of existing structures or components thereof to ensure compatibility with the proposed works. Any concerns are to be raised timeously with the Employer's Agent.

C3.4.10 Inspection of Adjoining Properties

In the event that blasting is required on site, inspection of potentially affected buildings and properties is to be conducted with the owners of such buildings/properties, along with representatives of the local authority. This is to be completed before commencing with blasting.

The Contractor shall record the condition as well as photograph all adjoining structures before commencing with blasting.

C3.4.11 Water for Construction Purposes

The Contractor is responsible for procuring, transporting, storing any water needed for construction purposes. The adjoining Highbury Village has a small-bore water reticulation system fed from a 3Ml/d treatment works nearby.

Raw water from Mthatha Dam may be used for water tightness testing of all pipelines and reservoirs (clear water systems to be cleaned and sterilised just before commissioning).

C3.4.12 Survey Control and Setting Out of the Works

Control points in the form of benchmarks and pegs have been established at the Highbury Waterworks. There is a Provisional Sum item in the BoQ for surveying and installation of additional benchmarks as required.

C3.4.13 Dealing with Water

The Contractor shall manage and dispose of water, whatever its origin, on the site so that the works are kept sufficiently dry for their proper execution and to ensure that no local person can drown in any excavation undertaken under this Contract.

The Contractor shall ensure that:

- Where it is not practically possible to make deep excavations free-draining, diversion berms are constructed to divert stormwater runoff from entering the excavations and all standing water will be removed as soon as possible after each rain event.
- Keep all completed works properly drained.

- Not inhibit surface drainage
- Protect all parts of the Works against damage and erosion caused by rain and surface water.

C3.4.14 Workmanship and Quality Control

The onus to produce work that 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 suitably qualified and experienced Employer's Agents, 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 cost of supervision and process control will 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 required. The Contractor shall, at his own discretion, increase this frequency where necessary to ensure adequate control.

On completion and submission of every part of the work to the Employer's Agent for examination and measurement, the Contractor shall furnish the Employer's Agent with the results of the relevant tests, mix designs, measurements and levels to demonstrate the achievement of compliance with the Specifications.

C3.4.15 Features Requiring Special Attention

C3.4.15.1 Trial Operation Period

Before the Taking-Over certificate can be issued, the Contractor is to required to operate all the systems provided under this Contract for a period of 4 months commencing with the successful commissioning of the Works and production of water for supply to consumers.

The purpose of the Trial Operating Period is to identify and resolve all 'teething problems'; effect repairs / adjustments etc where necessary and establish the reliable operation of the whole system (as far as it is possible withing the Contractor's control). A full-time Operator shall be provided by the Contractor (3 shifts a day, 7 days a week).

The role of the Contractor-supplied Operator is take responsibility for all water treatment processes and pumping and, at the same time, instruct, train and guide OR Tambo District Municipality's Operations staff so that, over this period, they become fully conversant and familiar with the correct operating procedures. The Duty Operator's role is to include:

- the identification of teething issues, malfunctions and breakdowns and arrange for the relevant Contractor's specialist to speedily resolve same;
- Monitor chemical and consumable usage and arrange for deliveries as necessary;
- Monitor run-time vs service requirements for all equipment and arrange for servicing by the Contractor as required.

The cost of call-outs of Contractor's specialist staff (eg Electrical Control Technician) to speedily attend to all malfunctions and breakdowns of everything supplied under this Contract is deemed to be included in the tendered rates.

The cost of supply and delivery to Site of process chemicals required for production of any product of the Works (such as coagulants and chlorine), shall be paid for separately under a Provisional Sum item.

The cost of labour component of servicing as required is deemed to be included in the tendered rates. The cost of all servicing consumables will be paid-for under a Provisional Sum item (with % tendered mark-up).

The Trial Operating Period is for a set period of 4 months but, if at the end of the 4 months there are still unresolved issues preventing the reliable production and delivery of potable water to consumers, the Trial Operating Period shall be extended until such time as the Engineer deems the Works fit for issue of the Taking Over Certificate.

C3.4.15.2 Monitoring the Works Operation beyond Trial Operation Period

Further to the Trial Operating Period, the Contractor is required to continue monitoring operations up to the end of the Defects Liability Period whereby OR Tambo District Municipality's Operations staff carry-out all day-to-day operations of the water treatment and pumping processes but monitored by a 5 days a week, 8 hours a day Operator appointed by the Contractor.

The role of the monitoring Operator is to verify that the Operating Staff understand and are following the correct operating and servicing procedures and provide further mentoring of ORTDM staff where necessary, thereby preventing the inadvertent misuse of equipment by ORTDM staff while the Defects Liability Period is still running.

C3.4.15.3 Defects Liability Period

In recognition of the fact that all the equipment under this Contract will be in full operation from the commencement of the Trial Operating Period and that the Taking Over Certificate will only be issued at the end of the Trial Operating Period, the Defects Liability Period has been set as 8 months from issue of the Taking-Over Certificate.

C3.4.15.4 Interaction between Stage 2 WTW Civil Contract and M&E Contract

It is the aim of the Employer to be able to commission the Highbury WTW as soon as possible. The intention is that the M&E Contractor (this Contract) will commence installation of all his equipment as soon as the Stage 2 Civils Contract has reached the stage where only minor finishing-off is required and the interior finishes of buildings are effectively complete such that the M&E Contractor can work unhindered. While the M&E Contractor may need some assistance from the Stage 2 Civil Contractor, this will not be extensive and shall be to the M&E Contractor's account, or, if unforeseen at time of tender, measured for payment under Dayworks under the Civil Contract at the Engineer's discretion.

The only civil works design that is dependent on the appointed M&E Contractor's particular equipment is the sludge dehydrating equipment building. At the commencement of this Contract, the particular requirements for the size and design of the building housing the equipment will be provided to the Engineer who will then, in turn, complete the necessary civil and structural drawings for issue to the Civil Contractor.

C3.4.15.5 Installation of Critical Equipment and Warranties

Given the variety and complexity of the system and equipment to be installed under this Contract, it is essential that suitably qualified, trained, competent and experienced personnel are on-site full-time during the installation phase (and any off-Site pre-assembly work) to directly supervise the installation of each piece of critical equipment to ensure that such equipment is correctly handled, mounted and with appropriate fit-for-purpose interface connections and fittings, adjusted, aligned, balanced, calibrated, programmed, operating and protection parameters correctly set-up, cleaned, primed, lubricated, pre-commissioning tested and commissioned and, once put into operation, confirming that all such equipment is functioning correctly, all within appropriate tolerances and in full accordance with the manufacturer's requirements for maintaining the validity of the manufacturer's warranty and also in full conformity with all the latest relevant SANS and international standards and codes of practice and OH&S regulations.

To this end, notwithstanding any related requirements set-out in the Particular and /or Project Specifications, the Contractor shall, well before installation commences, satisfy the Employer's Agent and the Employer's technical staff that all the various persons the Contractor (or their suppliers / subcontractors) intends to directly supervise off-Site pre-assemblies, acceptance testing and on-site installation, pre-commissioning and commissioning are, indeed, suitably qualified, trained, competent and experienced in each of their roles.

To satisfy the Employer's Agent of the suitability, the Contractor shall furnish the Employer's Agent with the contact details of the relevant manufacturers' in-house (or authorised Agent) technical specialist (for addressing technical queries), the names, qualifications, training and experience of the persons proposed to directly supervise the work and also a letter from the equipment manufacturer (or Accredited Agent) confirming that they approve of the named proposed person who is to directly supervise the installation of their equipment.

In addition to the above, before the commissioning process is allowed to commence, the Contractor shall first deliver certification from each relevant equipment manufacturer (or their accredited Agent) to the Employer's Agent that the installation conditions required for retaining the validity of their respective warranties have been met and that they have approved of the Contractor's arrangements for pre-commissioning and commissioning.

'Critical equipment' in this clause means the following:

- Clariflocculator bridges
- Filter false floor system
- Filter PLC control system
- All valve electrical actuators
- All horizontal split-casing and multi-stage pumps
- Chlorine gas handling and dosing system
- Emergency chlorine gas scrubber system
- Sludge dehydrating system
- All Low and Medium Voltage equipment
- All electrical control and instrumentation systems
- Standby generator and fuel system

- SCADA and communication system

The costs of using such persons as set out in this clause shall be deemed to be included in the tendered rates for the various items of equipment.

Any installation carried out without being directly supervised full-time by a person (or persons) approved by the manufacturer (or their Accredited Agent) will not be accepted and payment for installation will not be certified for payment.

C3.4.15.6 Supporting Documents

The Contractor will be required to provide a detailed labour forecast of the numbers of each category of worker which he intends to employ or utilise in the execution of the Works, together with the definition of the particular tasks on which it is intended that they will be engaged and the periods during which they will be so engaged.

C3.4.15.7 Monthly Reporting

It is a specific requirement of this Contract that the Contractor shall collect and record all relevant information for the completion of monthly and bi-annual labour, progress and cashflow reports (using Employer-issued templates) and submit these by due date every month to the Engineer without fail. The labour template follows the standard Expanded Public Works reporting. The reporting includes (but is not necessarily limited to):

Monthly Reports:-

- EPWP DWA Labour Schedule
- Amatola Water Monthly Progress Report
- KSD PI – Monthly Progress Report
- Decent & Temporary Jobs Schedule

C3.4.15.8 Prevention of accidents to local residents; especially children

Particular care must be taken to proactively eliminate (as far as realistically possible) the risk of local individuals of all ages gaining access to construction areas during and outside working hours and coming to harm (In particular, drowning and falling into open excavations). As part of this risk mitigation / elimination, the Contractor shall employ and post a 24/7 guard at the access gate and shall hold regular meetings with the social facilitator and local community leadership to discuss and refine measures to mitigate risks to local residents.

C3.4.15.9 Accommodation of Traffic

The Contractor will be required to make provision for the accommodation of traffic along all public roads for the full duration of construction.

C3.5 Management

C3.5.1 Management of the Works

C3.5.1.1 Applicable SANS 1921 Standards

- SANS 1921-1:2004 Part 1 General Engineering and Construction Works
- SANS 1921-2:2004 Part 2 Accommodation of Traffic on Public Roads Occupied by the Contractor
- SANS 1921-3:2004 Part 3 Structural Steelwork
- SANS 1921-5:2004 Part 5 Earthworks Activities which are to be Performed by Hand
- SANS 1921-6:2004 Part 6 HIV/AIDS Awareness

C3.5.1.2 Particular Specifications (refer to Annex C3.6)

Refer to C3.6 – Annexures for particular (purpose written) specifications.

C3.5.1.3 Planning and Programming

The Contractor shall submit a detailed programme within fourteen (14) days of the acceptance of the tender as stipulated in the General Conditions of Contract 2015.

The Contract period shall include all Saturdays, Sundays, non-working days (public holidays), special non-working days, as well as an allowance for anticipated inclement weather (as per Clause 5.12.2.2: Extension of Time) during normal working hours.

Should the Contractor wish to work outside normal working hours (as defined in the Contract Data) for any reason, he shall first seek permission to do so from the Employer's Agent. Attending to emergency situations or making-safe the Works are exempt from requiring prior approval, but notification shall still be sent to the Employer's Agent.

The programme shall be agreed between the Employer and the Contractor prior to the implementation of the construction works.

The programme shall be updated monthly, for discussion at the monthly progress (site) meeting, to indicate planned versus actual progress.

The Contractor shall review his progress each month and should progress lag behind the latest accepted programme, by more than 2 weeks, he shall submit a revised programme and method statement of how he proposes to make up the lost time. If, in the opinion of the Employer's Agent, such revised programme will not make up the lost time, the Employer's Agent shall have the right to request the Contractor to reorganize his work in a manner which will ensure an acceptable programme. Claims for additional payment to meet any costs incurred due to such reorganisation will not be accepted.

If during the course of the contract, the execution of the work deviates in any manner from the programme, the Contractor shall, on instruction by the Employer's Agent, within one week of such instruction submit a revised programme.

C3.5.1.4 Programme Format and Content

Programmes shall be submitted in Microsoft Project format in hardcopy and softcopy. The Contractor is to provide the detailed programme such that it is legible.

The programme of construction shall be submitted to the Engineer within the time period stipulated in these documents. The programme shall clearly show all activities related to the works and shall indicate which activities are on the critical path.

The Contractor shall take cognisance of the following when programming his activities:

- Based on the tendered Time for Completion, the Due Completion Date for the issue of the Taking Over Certificate is calculated from the date of the Contractor receiving a copy of the signed Agreement Document. (see amendment to Contract Data sub-clause 1.1.1.14).
- A Time for Completion not exceeding 20 months (87 working weeks or 435 working days based on a 5 day working week) – or as tendered if less than 20 months.
- Site handover and commencement of execution of the Contract will only take place once all the necessary documentation (details given in Contract Data) has been submitted and approved and Construction Permit from DoL obtained. Before any site work is undertaken, an introductory meeting with the local community has to be held. The latter is arranged by the Employer's Agent
- The time required to order and deliver the required steel pipes and fittings and pipe specials.
- The deferring of construction of the sludge dehydrating equipment building and surrounding concrete platform until details of same have been confirmed with the appointed M&E Contractor (assume no later than 10 months from commencement of the Works)

- Requirements and effects of subcontracting to QMEs / SMMEs.
- Establishment and de-establishment times.
- All other activities required in terms of this document

The Contractor's programme shall show:

- The various activities, related to a time scale, for each element of the Works, including those of Subcontractors, in sufficient detail to be able to assess construction progress
- Critical path activities and their dependencies
- Key dates in respect of information to be provided by the Employer's Agent and/or others.

C3.5.1.5 Methods And Procedures

Where otherwise requested in writing by the Employer's Agent, the Contractor shall submit Method Statements for constructing specific aspects of the Works. Such work shall not be started until the Contractor receives approval of the Method Statement in writing from the Employer's Agent.

C3.5.1.6 Quality Plans and Control

The Contractor is required to have in place, and follow, an approved Quality Assurance System for the execution of this Contract. To this end, the Contractor shall submit his proposed Quality Management Plan (QMP) to the Employer's Agent for approval along with his up-front documentation required before the commencement of the Works. The QMP shall include the Contractor's proposed Quality Control Plan (QCP) which shows how conformance to the QMP is to be documented.

In addition to this, the Contractor is required to follow the Employer's Agent's Site Quality Control procedures which entails the following:

- Contractor's submission of Request for Inspection of Work;
- Employer's Agent's signing-off of 'hold points' at each stage of the work (thereby authorising the Contractor to proceed with the next stage of the work). This may take several iterations should the Employer's Agent require further work before signing-off. Work may not proceed on the next stage until the previous stage has been signed-off.

Claims for particular items of completed work for each interim Payment Certificate will not be certified for payment where the required sign-offs have not been obtained.

No claims for extension of time, nor any other form of compensation, will be entertained for delays in receiving the Employer's Agent sign-offs on 'hold points' where, in the opinion of the Employer's Agent, insufficient notice has been given to inspect and approve the Works. The default notice required is 48 hours.

The Contractor shall submit copies of all his conformance documentation to the Employer's Agent on a monthly basis and proof of recent calibration of all measuring devices that are to be used.

C3.5.1.7 Environment

The Contractor shall comply with the Construction Environmental Management Plan (attached in Annexures). The Environmental Control Officer shall liaise directly with the Contractor on general environmental matters. Where such matters affect construction works, the Environmental Control Officer will be required to address such concerns with the Employer's Agent.

The Contractor shall plan the work in such manner that wind-blown dust is kept to a minimum. Earthworks shall commence immediately after a section is cleared and approved. The Contractor will have a water truck or other means of dust suppression on standby for spraying the cleared areas. The cost of this process will be deemed to have been included in the clearing and excavation rates entered in the Schedule of Quantities.

Burning of any materials on site will not be allowed.

The Contractor is required to progressively and systematically finish and tidy the work as it proceeds. This will be monitored against the latest approved programme. The Employer's Agent shall have the right to not certify full payment of particular scheduled items where such items are largely complete, but finishing and tidying is deemed still outstanding.

Under no circumstances shall spoil, rubble, materials or equipment be allowed to unnecessarily accumulate on Site. If, in the opinion of the Employer's Agent, this is occurring, the Employer's Agent shall have the right to make an allowance for the estimated cost of rectifying the above by reducing particular measured quantities from claims being processed for payment.

C3.5.1.8 Sub-letting of the Works

The Contractor shall sub-let to Local Highbury Subcontractors as much of the Works as possible.

The sub-letting shall be done in accordance with the provision of Particular Specification PA: Sub-letting of the Works.

C3.5.1.9 Testing and Quality Control

(i) Contractor to submit details of his proposed fabricator of all steel pipe specials and other items fabricated from steel

The Specifications pertaining to testing and quality control require the Contractor to undertake his own confirmation testing for conformance with the specifications. To this end, the Contractor is to submit details of his proposed fabricator's Quality Management Plan and Quality Control Procedures for the fabrication of steel specials to the Engineer for approval before ordering any such fabricated specials.

The Contractor shall be responsible for ensuring that his fabricator carrying out of all such testing specified in the Contract, at not less than the frequencies and in the manner specified. The Contractor shall promptly provide the Employer's Agent with copies of the results of all such testing carried out by the independent laboratory.

(ii) Additional testing required by the Employer's Agent

There is a Prime Cost Sum in the BoQ for payment of the Employer's own independent inspectorate. This independent inspectorate is to review the proposed fabricator's QMP and QCP for materials, all weld testing and testing of fabricated pipe special coatings and linings (Dry Film Thickness of epoxy and di-electric integrity) and report on his findings to the Engineer. Based on the report, the Engineer shall approve / reject the proposed fabricator.

The Independent Inspectorate will inspect all fabricated specials and report on his findings to the Engineer. Based on the report, the Engineer shall approve / reject each special. Only approved specials may be incorporated into the Works.

The Employer's Agent shall be entitled at times during the Contract to require that the Contractor arrange with the independent inspectorate to carry out any such tests, additional to proving compliance (subclause C3.4.2.2), at such times and at such locations in the Works as the Employer's Agent shall prescribe. The Contractor shall promptly and without delay arrange with the independent laboratory for carrying out all such additional testing as required by the Employer's Agent, and copies of the test results shall be promptly submitted to the Employer's Agent.

(iii) Costs of testing

(a)Tests in terms of subclause C3.4.2.2

The costs of all compliance testing carried out by the independent inspectorate in accordance with the requirements of subclause C3.4.2.2, above shall be borne by the Contractor and shall be deemed to be included in the tendered rates and prices for the respective items of work as listed in the Bill of Quantities and which require testing in terms of the Specifications. No separate payments will be made by the Employer to the Contractor in respect of any testing carried out in terms of subclause C3.4.2.2.

Where, as a result of the consistency of the materials varying or as a result of failure to meet the required specifications for the work, it becomes necessary to carry out additional tests (e.g. re-tests on rectified work and/or replacement materials), the costs of such additional testing shall be for the Contractor's account.

(b)Additional tests required by the Employer's Agent

The costs of any additional tests required by the Employer's Agent in terms of subclause C3.4.2.2: Additional testing required by the Employer's Agent, shall be reimbursed to the Contractor against substitution of the Provisional Sum allowed therefore in the Bill of Quantities; provided always that the costs of any such additional tests ordered by the Employer's Agent, the results of which indicate that the quality of the materials utilised and/or the standard of workmanship achieved are/is not in accordance with the specifications, shall not be reimbursable to the Contractor.

C3.5.1.10 Recording of Weather

The Contractor is to provide and correctly install a rain gauge and maximum/minimum thermometer at the construction camp. The Contractor shall record and keep a record of the daily rainfall and maximum/minimum temperatures, and supply the data to the Employer's Agent on a daily basis. Readings are to be recorded daily at 08:00 unless otherwise agreed to by the Employer's Agent.

The Contractor shall take all necessary precautions to ensure that the rain gauge cannot be interfered with by unauthorised persons.

C3.5.1.11 Extension of Time Resulting from Abnormal Weather (installation and commissioning phase only)

Extension of time will not be considered for normal adverse weather conditions. For abnormal rainfall or saturated conditions will be calculated as follows:

- The Contractor shall, in his programme, allow for the expected number of working days on which work on critical path activities could be delayed – as given in the Schedule below.
- Extension of time will be calculated for each calendar month or part thereof over the full period for the completion of the Work, plus any approved extension thereof, as follows:

  - A delay caused by abnormal weather conditions will only be accepted for extension of time if, in the opinion of the Employer's Agent, it delays an item or items which lie on the critical path determined by the Contractor's approved programme (irrespective of actual rainfall).

  - An extension of time will be granted for the number of days, as approved, on which adverse weather conditions delay critical path activities, less the anticipated number of days given in the Schedule below.

  - The net extension of time determined for each month, which may be negative, shall accumulate algebraically to determine the net number days for extension of time due to abnormal weather conditions, but a negative total at the end of the Completion Period will not be taken into account.

  - Where a portion of a month is involved, a pro rata number of days shall be calculated.

The anticipated number of working days on which work on critical path activities will be delayed as a result of adverse weather conditions are as follows:

Month	Days	Month	Days
January	3	July	0
February	3	August	1
March	4	September	2
April	2	October	2
May	1	November	3
June	0	December	3

C3.5.1.12 Format of Communications

All requests for information or requests for inspections are to be recorded in writing.

All instructions are to be issued in writing as a Site Instruction.

C3.5.1.13 Key Personnel

The Contractor is to compile and submit to the Employer's Agent a schedule of Key Personnel, including titles, names, designations and contact numbers of such personnel. This document is to be updated immediately in the event of any changes.

C3.5.1.14 Management Meetings

Formal project meetings will be held on site in the Employer's Agent's office (or similar suitable office). Representatives of the Employer, Employer's Agent and Contractor will be required to attend. The representatives are to have the necessary authority in respect of aspects such as planning and health and safety. The Contracts Manager and Construction Manager (Site Agent) are required to attend all such meetings.

The Contractor shall attend the following meetings during the Contract:

a) An inaugural site meeting at the GIBB offices or as called by the Employer's Agent
b) Monthly site meetings, at GIBB's Mthatha offices and on Site or as called by the Employer's Agent, from the commencement of the Works until the issue of the Practical Completion Certificate (or where necessary as determined by the Employer's Agent).
c) Monthly technical meetings called by the Employer's Agent (or where necessary as determined by the Employer's Agent).
d) Meetings during the Defects Notification Period called by the Employer's Agent (only if warranted)
e) The following reports shall be submitted by the Contractor before the monthly Site Meetings:
   - Progress Report
   - Plant & Labour returns
   - Updated Programme vs Baseline Programme
   - Updated cashflow projection.

The cost of these requirements shall be included in the rates tendered for Time Related Items.

C3.5.1.15 Forms for Contract Administration

The Employer's Agent's Representative will have a full set of contract administration forms for use on site. This includes forms for recording test results, claims, inspections and the like. The Contractor may use such as a basis for his documentation should he not have adequate similar templates.

C3.5.1.16 Electronic Payments
The Employer will make payments by electronic means only.

C3.5.1.17 Daily Records (installation and commissioning phase only)
The Contractor is required to keep daily records of resources (people and construction equipment) as well as of work performed on the site. A signed copy of the previous day's record must be provided to the Employer's Agent on a daily basis.

Information relating to construction equipment shall be recorded in the Daily Site Diary. In addition, the Contractor shall deliver to the Employer's Agent, on a monthly basis, a detailed schedule of construction equipment present on the site for that month. Full particulars are to be recorded, identifying each piece of equipment, including whether the equipment is in working order or out-of-order. This schedule is to be submitted by the first day of the month following the month to be reported.

C3.5.1.18 Bonds And Guarantees
Bonds and guarantees are to be submitted to the Employer from whom they can be collected once they are released, in accordance with the contract.

C3.5.1.19 Payment Certificates
Measurements for interim and final certificates must be agreed with the Employer's Agent prior to the issuing of a Tax Invoice by the Contractor.

The Contractor is to provide all invoices, vouchers and receipts in respect of payments made by him in connection with provisional or prime cost items when he requires payment for such.

The Contractor is to provide all invoices or receipts in respect of materials purchased and delivered to the site when he requires payment for such. Invoices or receipts are to clearly identify the material, the unit rate thereof, and the quantity/number purchased.

It is a specific requirement of this Contract that the Contractor shall collect and record all relevant information for the completion of end-of-month documentation to be submitted with each payment claim. The Payment Certificate (prepared by the Employer's Agent) will not be accepted by the Employer unless accompanied by the following:

- Local Labour Schedule (in EPWP format; ie giving employee names, IDs, gender, age group and disability status if applicable)
- Contract Participation Goal expenditure to date vs target (details of labour wages and salaries paid and payments to Targeted Enterprises vs value of work certified to date)
- Monthly Progress Report (from Site Meeting).

C3.5.1.20 Proof of Compliance with the Law
The Contractor shall insure his employees against accident in terms of the Compensation for Occupational Injuries and Diseases Act (Act 130 of 1993), as amended. A Letter of Good Standing with the Compensation Fund, as issued by the Department of Labour, must be submitted as part of the Tender.

Where the Letter of Good Standing expires during the contract period, the Contractor will be required to submit new, valid documentation. Failing to do so will result in work being stopped.

C3.5.1.21 Insurance Provided by the Employer
No insurance will be provided by the Employer.

C3.5.2 Health and Safety

C3.5.2.1 Health and Safety Requirements and Procedures
The Contractor is to comply in all respects with the Occupational Health and Safety Act (Act 85 of 1993), as amended, as well as with the Construction Regulations 2014, the Electrical Machinery Regulations, and the Employer's OH&S Particular Specification given in Part C3.6.

The Health and Safety Officer appointed by the Employer shall liaise directly with the Contractor on safety matters but shall be required to channel safety matters affecting construction work through the Employer's Agent.

With reference to the Baseline Risk Assessment given in the Employer's OH&S Particular Specification, the Contractor shall take special care of the following during construction:

- Covid-19 prevention measures and compliance with all relevant regulations
- Flooding of trenches or excavations
- Possibility of collapse of excavations in sandy soils

- Protection of existing services
- Accommodation of traffic and pedestrians
- Proper storage and stacking of materials
- Good housekeeping and site tidiness
- Provision of welfare facilities
- All power supplies, power lines and cables shall be treated as live until proven otherwise
- Care shall be exercised and all necessary precautions taken while working under power lines or near cables with construction plant and when carrying or working on ladders in the vicinity of power lines.

The Baseline Risk Assessment provided is not necessarily fully comprehensive and the Contractor is responsible for carrying out his own Baseline Risk Assessment.

The Contractor's Health and Safety plan is to be approved and the Contractor's Safety Officer is to be appointed prior to the commencement of any construction activities. It is specifically noted that the person officially appointed as the Contractor's Safety Officer shall be properly qualified and experienced and be based full-time at the site while activities are taking place.

Time lost due to delayed commencement or suspension of the work as a result of the Contractor's failure to submit the safety plan timeously, shall not be used as a reason to claim for extension of time or standing time and related costs.

The rates and prices tendered by the Contractor shall be deemed to include all costs for conforming to the requirements of the complete Act. Particular attention however needs to be made to the Construction Regulations of the Act and this specification as applicable to this Contract.

C3.5.2.2 Protection of the Public

The Contractor shall at all times ensure that his operations do not endanger any member of the public.

No excavation may left open during the builder's holiday. Excavations left open over other non-working days shall be adequately safeguarded at all times.

C3.5.2.3 Barricades and Lighting

The Contractor is responsible for the safety of the site and shall provide all necessary watching, barricading and lighting. This is especially significant at excavations.

C3.5.3 Community Participation

C3.5.3.1 Community Liaison Officer

The employment of local labour shall be through a Community Liaison Officer.

A Provisional Sum allowance has been made for the short-term employment of CLOs in accordance with the following Terms of Reference (ToR):

a) Candidates for the CLO will be selected by the local leadership.
b) The accepted CLO will responsible for liaising with a Project Steering Committee (PSC) for each area.
c) The CLO is to be appointed for the period of on-site activity, plus a period of 14 days prior to this period.
d) Remuneration for the CLO will be R 5 000 wages plus R300 cell phone allowance per month for the period of employment.

The CLO will liaise with the Contractor in performing the following activities:

- Organise and assist the contractor in explaining to all workers the labour-based construction model
- Ensure labourers understand their task and the principles behind task work
- Ensure labourers are informed of their conditions of temporary employment
- Attend all site meetings and briefing for work procedures
- Keep written record of interviews and community liaison which should be summarised and included in the monthly progress reports
- Collect monthly welfare reports and submit to social facilitators
- Ensure that contractor's workers are paid what is due to them and in time
- Assist in the recruitment of labour
- Promote and maintain sound relations with community stakeholders and other role players

- Screen the supplied labour by the community through Project Steering Committees to ensure compliance with the agreed upon recruitment policy and the government's labour employment targets
- Inform local labour about their conditions of temporary employment, to ensure their timeous availability and inform them timeously when they would be relieved, where the rotation of labour is applicable
- Keep the labour register of labour and manage records of project local labourers and be able to provide reports on employment statistics
- Consult on all decisions regarding local problems and any matters of importance that, in any way will be of relevance to the Contract.
- To be on site on a daily basis
- To register concerns / perceptions and raise them in the PSC meetings
- Attend site and PSC meetings to present monthly report on the local community labour involvement and site matters
- Identify possible labour dispute and any disciplinary matter and advise the site agent / foreman and assist in the resolution, where necessary must call for the assistance of the Social Consultant for the resolution of the conflicts
- Assist the contractor in preparing records of project employees. Assist the contractor in making task measurements and the records thereof
- Monitor the production of individual task workers and arrange replacement of those workers who fail to produce a reasonable task output
- Attend disciplinary proceedings to ensure that hearings are fair and reasonable
- Communicate daily with the contractor to determine additional labour requirements with regard to numbers and skills and pass this to the PSC
- Attend weekly meetings with the contractor and make a weekly written report which shall be a prerequisite to being paid.

The CLO will liaise with the Social Facilitators in performing the following activities:

- Assist in convening of workshops
- Disseminate information to PSC members
- Articulate implementing agency policies to PSC members
- Communicate labour requirements
- Attend induction training programmes for workers and induct labourers
- Submit monthly welfare reports to the social facilitators PSC
- Communicate labour and skills requirements to the PSC
- Assist in the recruitment and engagement of work force
- Verify labour records and ensure all engaged qualify as per the Contract requirements
- Investigate and report all labour dispute matters to the PSC, advise site agent on resolution.

The community is represented by a PSC. All liaisons with the community and the committees are the responsibility of the Social Facilitator in conjunction with the OR Tambo District Municipality, the Employer and the Project Steering Committee. The Contractor will be required to liaise through them for any matters pertaining to the community.

C3.5.3.2 Employment of the Local Community

The Contractor is to limit the import of labour to skilled personnel only. Semi-skilled (where possible) and all unskilled labour is to be sourced from the local community.

It is a requirement that, at least, all unskilled labour taken-on by the Main Contractor and his sub-Contractors are sourced from the immediate local community (Highbury Village but extending to Ward 30 where necessary) and that such employment is arranged through the CLO and PSC.

Employment of all temporary labour, whether employed directly or through a Subcontractor, shall comply in all respects with the National Government Department of Labour's regulations; including the minimum wage applicable to construction work in the Eastern Cape.

C3.5.3.3 Certificate of Service

An employee shall, upon termination of his services, be entitled to a Certificate of Service showing the full names of his employer (i.e. the Contractor) and the employee, the type of work done by the employee, the date of commencement, a record of training received and the date of termination of his services.

C3.6 Project Specification: Pumping Equipment

Table of Contents

1 SCOPE

This project-specific specification covers the performance and mechanical specifications for all raw and clear water pumping equipment to be supplied under in this Contract. This specification also covers the requirements for an electric travelling crane for the Clear Water Pumpstation.

Although high-level control and instrumentation requirements are given in this specification, the electrical power supply and control and sensor and instrumentation specifications are covered under Project Specifications: Electrical Equipment.

Where not otherwise specified hereunder, the following General Specifications shall apply to all pumping equipment in this Contract:

- GIBB 002: General Mechanical
- GIBB 003: General Pumping Equipment
- GIBB 007: Painting and Corrosion Protection

The control philosophy in this specification only serves as a basic overview on the control requirements for the pumpsets listed. The Contractor shall develop the detailed functional design in collaboration with the Engineer.

The pumping installations covered are as follows:

1) **Temporary Raw Water Abstraction from Mthatha Dam**

   In that the 50Ml/d Highbury WTW will be ready for commissioning before all aspects of the permanent raw water supply infrastructure are in place and operational, a temporary pumping installation on the banks of the Mthatha Dam is to be provided. This will allow the Highbury WTW to operate at up to its design capacity (ie 50Ml/d) (with until such time as the permanent raw water supply is operational.

2) **Highbury WTW**

   At the Highbury WTW, there are four separate pumpstation buildings as follows:

   (a) Filter Plant Room – This houses 2 Duty, 1 Standby end suction centrifugal pump and motor sets to backwash the sand filter beds from water drawn from clear water sumps below the filter beds.

   (b) Spent Backwash Recycling Pumpstation – This houses 2 Duty, 1 Standby end-suction centrifugal pump and motor sets to recycle spent backwash water collected in an adjoining tank back to the head of the waterworks.

   (c) Sludge Supernatant Recycle Water Pumpstation – This houses 1 Duty and 1 Standby end-suction centrifugal pump and motor sets to recycle sludge supernatant water from a sump between the two adjacent sludge storage ponds to the head of the waterworks.

   (d) Highbury Clearwater Pumpstation – The pumpstation building (situated below the 2 No. 5Ml Clear Water Reservoirs) houses pumps for two independent systems; namely the Rosedale System and the Nqadu System.

2 TEMPORARY RAW WATER ABSTRACTION FROM MTHATHA DAM

2.1 Overview and Concept Design

As noted above, the 50Ml/d Highbury WTW will be ready for commissioning before all aspects of the permanent raw water supply infrastructure are in place and operational. A temporary pumping installation on the banks of the Mthatha Dam is therefore to be provided under this Contract.

The size of the Mthatha Dam storage volume and catchment area, relative to the annual volume of water supplied from it, is such that the dam typically overflows every wet season and seldom drops more than about 300mm by the end of the dry season. Any temporary pumps installed on the dam's waters edge will, however, need to be able to continue operating down to FSL -3m as the Department of Water & Sanitation (dam owner) will, at some stage, have to artificially lower the dam level in order to carry out essential upgrading of the dam outlet tower and repairs to the spillway chute downstream.

An end-suction type centrifugal pump situated close to the dam water edge (pump inlet at about 1m above FSL) with a suction pipe extending to a foot-valve inlet at or below FSL -4m is therefore indicated. A 2m high gabion wall will be constructed between the dam and the pumps to protect the later from direct wave action in stormy weather.

The concept design is therefore to install two Duty, and one Standby end-suction centrifugal pumpsets side by side on a concrete plinth, each with their own suction pipe but delivering into a common temporary rising main via isolating valves and non-return valves and priming bypasses.

The pumps shall be sized for two pumps to deliver at least 25Ml/d over 20h with the dam water level at FSL -3m and the Highbury Raw Water Reservoir levels more-or-less full. Pump control is based on keeping the water level in the Highbury Raw Water Reservoirs within 500mm of being full.

All civil works for the installation is included in this Contract but is ring-fenced for local SMME Contractors to undertake.

A 400V power supply (11kV/400V 800kVA minisub and meter next to the pumpstation Site) is being arranged through by the Supply Authority (KSD Local Municipality).

In that this temporary pumpstation may need to operate for an extended period (depending on DWS progress on upgrading the dam outlet tower), the system must be able to physically deliver close to 50Ml/d under minimum static head conditions; albeit at lower efficiency. This can be achieved by operating all three pumps in manual mode and keeping the raw water reservoirs as low as possible to minimise the pumping head. The electrical supply (800kVA minisub) is therefore sized for 3 pumps running with the dam full and the raw water reservoirs empty. The pump motors need to be sized for the lowest pumping head condition (one pump running with dam full and reservoirs empty).

Refer to drawings: **PID 101** and **MECH 650-01** to **-05**.

2.2 Control Philosophy

The pumps shall be PLC controlled off a signal from an ultrasonic level sensor mounted in one of the Highbury Raw Water Reservoirs activating the stop and start sequences. It shall also be possible to operate the pumps by manual start / stopping at the local control panel.

Each pump has a dedicated DN400 suction line with a foot-valve with bellmouth inlet The suction pipework extends into the dam to a level where the inlet bellmouth is below FSL-4m. The length of the pipe is approximately 30m (to be confirmed). Each pump discharges into a common delivery manifold connected to a temporary Rising Main and conveys raw water to the existing DN1200 steel rising main.

No / low flow switches in the suction pipework will serve as an interlock and pump controlled stop condition signalling the dam level is too low.

The pump interlocks, trips, start and stop sequences shall be locally controlled in AUTO mode.

OFF and RUN push buttons are to be provided for operating each pump in MANUAL mode.

An AUTO-OFF-MANUAL selector switch for each pump shall be provided.

It shall be possible to operate all three pumps in Manual mode.

Being a temporary pumping installation, no alarm signals need be relayed back to the Highbury WTW SCADA.

All instrumentation, piping, valves and equipment is shown on piping an instrumentation diagram **J31067-PID-101.** All instrumentation to control and protect the pumps are described in more detail in section 2.5.

An electromagnetic flow meter on the temporary Rising Main will provide an accurate record of volumes of raw water abstracted (required by DWS) and flow rates.

2.3 Layout and General Arrangement

The preferred arrangement of the temporary end-suction pumps and the associated pipework to connect into the existing system is shown on drawings **J31067/MECH/650**.

The layout of the pumps and pipework above have been prepared based on a particular pump model. The Contractor shall prepare the final civil, mechanical and electrical layout drawings to suit the particular pump units supplied under the contract. The drawings provided are indicative and may require minor changes. These changes shall be deemed inclusive in the tendered price.

The scope of work for the temporary raw water abstraction system shall include the design, supply and installation of the following:

- Three Pumpsets complete with suction pipes and delivery manifold (including isolating valves and non-return valves)
- Electromagnetic flow meter
- MCC for each pump
- Pump and motor instrumentation.
- Power and Instrument cabling for pump and MCC.
- Baseplates, plinths, shaft seals and guards, holding-down bolts and anchors.
- Emergency Stops, trips and alarms.
- Ultrasonic Water Level sensor and transmitter on each of 2 raw water reservoirs at the WTW
- Power supply and telemetry system for above to communicate with pump MCC
- Testing and Commissioning.

2.4 Pump Operating Parameters and Design Details

2.4.1 Required Duties

Table 1: Temporary end suction pump set required duties

Configuration & Operating Parameters RAW WATER PUMPS	
Required flow rate	25ML/d over 20-hour period
Number of pumps	3
Duty configuration	2 Duty / 1 Standby

Suction Conditions		
Dam Full Supply Level (FSL)		693.0 masl
Design Lowest Dam Operating Level (FSL – 3m) ****** will be applicable when repairs to dam spillway commences ******		690.0 masl
Dam Level typical seasonal variation		FSL +0.1m to FSL -0.3m
Pump inlet level (centerline) (FSL +1m)		694.0 masl
Suction Conditions		Each pump: DN600xDN400 downward-facing bellmouth on DN400 pipework with wafer-type double-door spring-loaded non-return valve (no strainer as negligible debris / vegetation in the dam at point of abstraction). Bellmouth at FSL -4m. DN400 bare mild steel pipes to pumps.
Delivery Conditions		
Receiving Reservoir Top Water Level (TWL)		755.58 masl
Receiving Reservoir Minimum Operating Level (MOL) (floor level +1m)		748.8 masl
Reservoir Inlet Elevation		748.35 masl (Note: Below MOL)
Receiving Reservoir Normal Operating Range under automatic control		Pump OFF at TWL (=755.58 masl) Pump 1 ON at TWL – 0.3m (=755.28masl) Pump 2 ON at TWL – 0.5m
Water Levels for Specified Pump Duty Point		Dam at FSL -3.0m Reservoir at TWL -0.3m
Static head variation	Max	Dam at FSL -3m (690.0masl) Reservoir at TWL (755.58masl) = 65.58
	At Specified Pump Duty Point	Dam at FSL -3m (690.0masl) Reservoir at TWL -0.3m (755.28masl) = 65.28
	Min	Dam at FSL +0.1m (693.1masl) Reservoir at MOL (748.8masl) =55.70m
Delivery Conditions		DN500 GRP pipework 360m long (this Contract) tying into a 830m long DN1200 steel pipeline to the Highbury WTW Raw Water Reservoirs (existing)
Indicative Dynamic Head Losses		One pump running: 2.6m to 11.3m

(min to max static head)	Two pumps running: 6.5m to 14.9m Three pumps running: 12.1m to 17.3m
Indicative Range of Delivery Capacity (min to max static head)	One pump (20h/d): 13.7Ml to 16.3Ml Two pumps (20h/d): 25Ml to 30Ml Three pumps (24h/d): 38Ml to 49.5Ml

Pump System Specifications RAW WATER PUMPS	
Water to be pumped	Settled dam water (negligible settleable solids, but high colloidal turbidity)
Specified Pump Duty Point for pump selection @ Best Efficiency Point) **(2 Duty Pump Scenario)**	**1258m³/h (=629m³/h per pump) @ 70.6m total pumping head**
Pump type	End-suction centrifugal
Pump model (indicative)	KSB ETA B 200-50 (01 Stk)
Impeller material	Cast-Iron
Nominal Speed (rpm)	1490 rpm (4 Pole)
Min pump efficiency at Duty Point	81%
Pump housing	Cast iron
Internal Coating	Factory standard
External Coating	Factory standard
Baseplate / Frame	GMS
Indicative maximum pump absorbed power (worst case is one pump running at lowest static head)	~164 kW
Motor rating, kW (estimate)	185 kW
Motor	400V 50Hz 2-pole TEFC motor The insulation rating of the motor shall be Class F rated to run at Class B and supply rated output at deviations of up to ±5% of the rated frequency and voltage. The cable termination shall be bottom-entry with IP68 gland suitable for outdoor, fully exposed service.
Pump-to-motor coupling	Flexible (rubber tyre type)
Starter	The motors shall be soft-starter controlled.
Suction Pipework	Each pump: DN600xDN400 downward-facing bellmouth on DN400 pipework with wafer-type double-door spring-loaded non-return valve (no strainer as negligible debris / vegetation in the dam at point of abstraction).

Pump System Specifications RAW WATER PUMPS	
	Bellmouth and 90º elbow bolted to GMS support frame with skids (see drg MECH 650-05) DN400 bare mild steel pipes, minimum 4.0mm wall thickness, site-jointed by means of min. 4mm thick x 200mm long wrapper fillet-welded over plain ends, loose-laid on dam floor. Each pipe to have 1kg zinc sacrificial anode attached near inlet. It is proposed that the suction pipes are incrementally launched from the bank with pipes site-welded as this process proceeds. The pipes are extended until a temporary (detachable) monitoring rope attached to the bellmouth indicates that the bellmouth is at 4m below dam FSL.
Delivery Pipework	Hot-dip galvanised mild steel frame, uncoated , unlined Grade B mild steel pipes (minimum 4mm wall thickness), flanges to SANS1123 1000/3.
Pipework fittings	Flanged butterfly valve (solid ss disc with rubber-liner) isolation valves (with gearbox) on delivery side of pumps, flanged nozzle-type non-return valves , all flanges to SANS1123 1000/3
Pipework instruments	Suction pipework: Nil Delivery pipework: • 1000kPa glycerine-filled 100mm dia dial pressure gauges c/w isolating stop-cocks immediately before each pump NRV and on common delivery manifold • No / low flow sensor immediately before each pump NRV Rising Main: DN400 electromagnetic flowmeter (see Elec Spec).
Plinth and Base Plate	Min 25MPa/20 concrete plinth and GMS baseplate

2.4.3 System curves

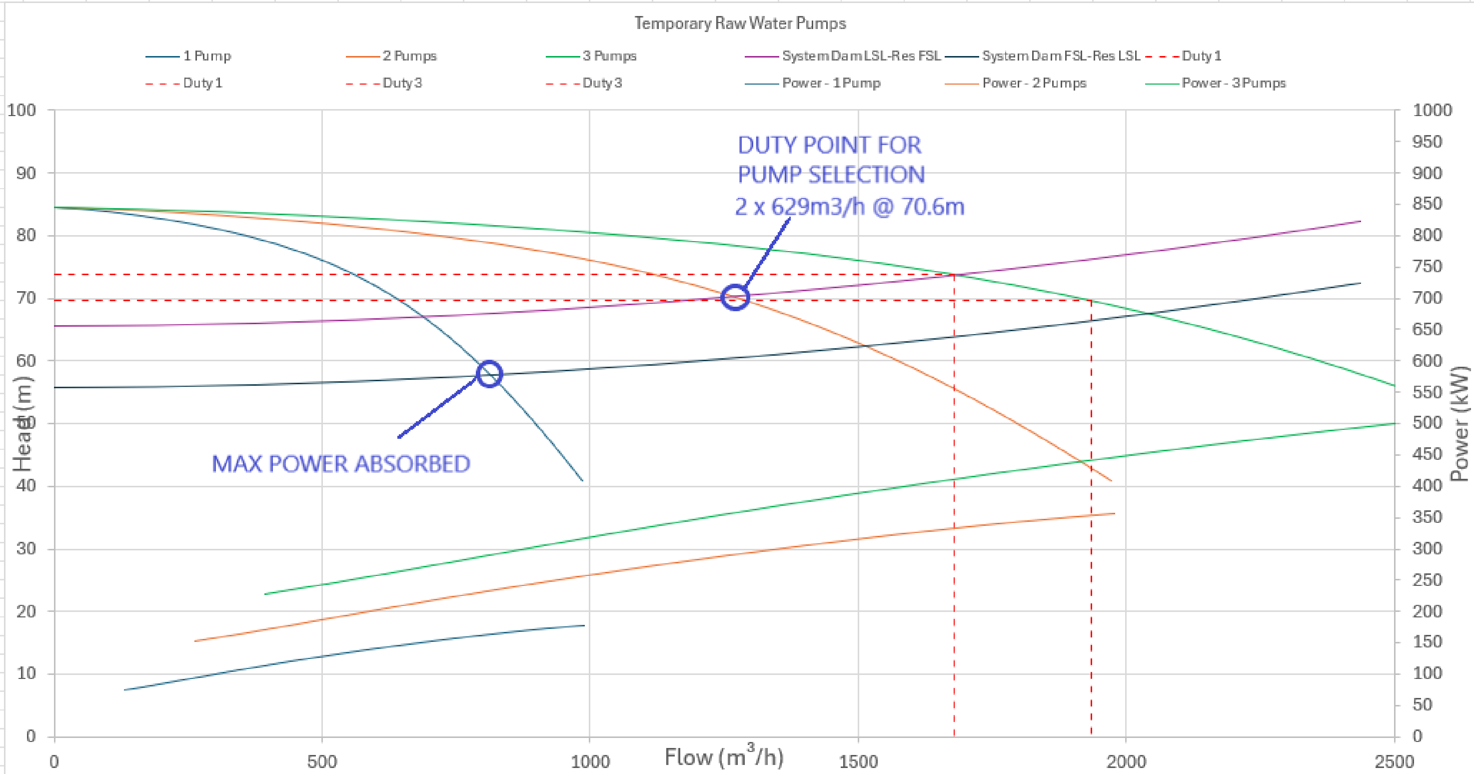


Figure 2-1: System and performance curves

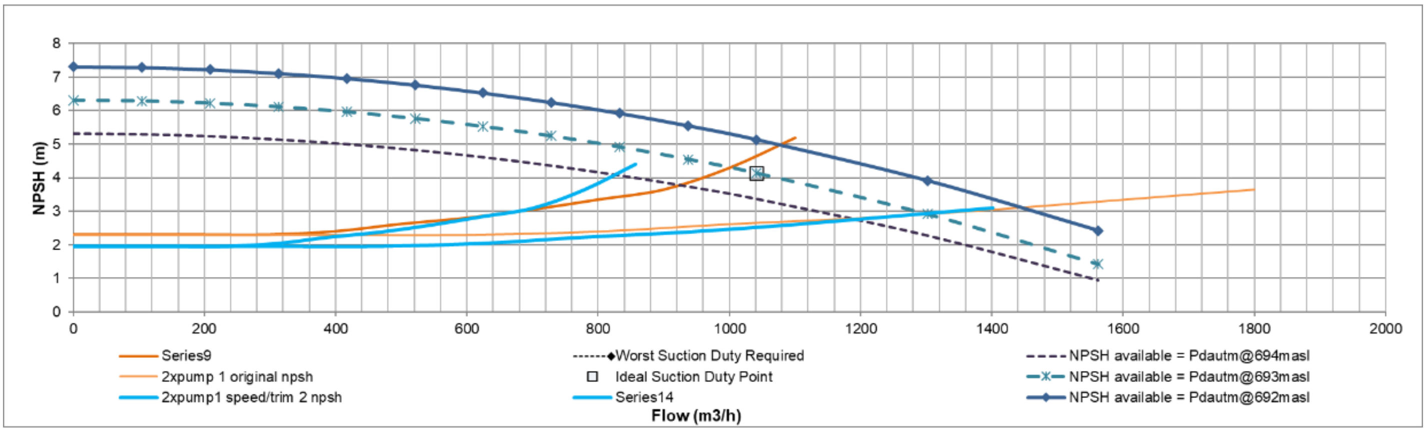


Figure 2-2: NPSH curves

2.5 Control, Monitoring and Instrumentation

Pump Start (Auto Mode) RAW WATER PUMPS
SUCTION No water level inputs required for starting (it is assumed that Operator is monitoring the dam water level and that suction pipe is primed)

Pump is protected from prolonged dry running or air entrainment by low-flow switch
DISCHARGE
On activating AUTO Mode PLC receives signal from ultrasonic water level sensor in Highbury Raw Water Reservoir • IF Level is less than (TWL – 0.3m) THEN initiate STAGGERED START signal for both Duty Pumps (preset delay on 2nd pump so only starts after 1st pump has reached stead-state condition). After preset time-out from START, PLC checks that no-flow switch FOR EACH DUTY PUMP registers greater than minimum set flow and initiates TRIP for any DUTY PUMP if less than minimum set flow and activates Low-Flow Trip light on panel for the particular pump. Protection for motors: Motors to trip on: • Over-current detection • Thyristors for windings temperature (no vibration sensors or bearing temperature monitoring) E-Stop active on all motors
Pump Start (Manual Mode)
SUCTION As per Auto Mode
On activating Manual Mode Operator initiates pumping for any one pump by pressing the respective START button. Operator to delay starting next pump until running pump has reached steady state. All three pumps can be operated manually. After preset time-out from START, PLC checks that no-flow switch FOR EACH DUTY PUMP registers greater than minimum set flow and initiates TRIP for any DUTY PUMP if less than minimum set flow and activates Low-Flow Trip light on panel for the particular pump. Reset push-button to be provided. Protection for motors: Motors to trip on preset parameters for: • Over-current detection • Thyristors for windings over-temperature (no vibration sensors or bearing temperature monitoring) E-Stop active on all motors
Pump Stop (Auto Mode)
PLC receives continuous signal from ultrasonic water level sensor in Highbury Raw Water Reservoir

• IF Level reaches TWL, THEN initiate PUMP OFF signal for 1st Duty Pump. • After preset delay, PUMP OFF signal for 2nd pump is initiated. No-flow sensors active for each pump over running period.
Pump Stop (Manual Mode)
Operator initiates PUMP OFF for each pump in turn by pressing the respective STOP button. Operator to stopping next pump until running pump has reached steady state. Pump will not shut down when reservoir is full. No-flow sensors active for each pump over running period. Motor protections still active in Manual Mode.
Emergency stop button
• Pump shut down (no ramp down just disconnect power). • Signal “Emergency Stop” light and lockout until manual reset.
Duty - Standby Pump cycling (Auto Mode only)
• The PLC is to cycle which pump starts 1st among all three pumps. • If any pump has tripped and the reset button not pushed, or any pump manually isolated, no cycling is required.
Monitoring and Instrumentation
Instruments on each Pump suction Pipe
• -100kPa to 0kPa (sub-atmospheric) glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cock
Instruments on each Pump Discharge Pipe
• 1000kPa pressure gauge with isolating stop-cock (between pump and non-return valve) • No / low flow sensor
Instruments on common discharge pipe
1000kPa pressure gauge with isolating stop-cock
A Magflow meter to be installed on the discharge line in a lockable chamber (chamber to be 5m beyond last pipe bend exiting the pumpstation). The signal from this is to be fed into the MCC. The signal is to provide flow rate and totalizer readings (to be displayed on the MCC)

3 HIGHBURY WTW: FILTER BACKWASH PUMPSETS

3.1 Overview

Details of the Rapid Gravity Sand Filters are given in Project Specification: WATERWORKS EQUIPMENT. This section covers only the backwash water pumps. These are very low head, high volume pumps and fine adjustment of flow will be my means of Variable Speed Drive speed adjustment (See also Project Specification: ELECTRICAL EQUIPMENT) and possibly also orifice plates to artificially raise the pumping head (reducing the motor speed too much makes the motor cooling fan ineffective).

3.2 Layout and General Arrangement

The Filter Plant Building layout and the configuration of the suction and discharge pipework and mechanical equipment arrangement is shown on drawings **J31067/MECH/240-01 & -02**. All instrumentation, brief controls and equipment is shown on piping and instrumentation diagram **J31067-PID-306**

The layout of the pumps and pipework above have been prepared based on a particular pump model. The contractor shall prepare the final layout drawings to suit the pump units supplied under the contract, which may require minor changes in pipework position and dimensions to suit the pump house structural constraints. These changes, if necessary, will be deemed to have been included in the tendered price should alternative pumpsets be accepted.

The scope for the spent backwash recycle pumpstation shall include the design and installation of the following:

- Three Pumpsets complete with suction pipes and delivery manifold (including isolating valves and non-return valves and possibly orifice plates)
- VSDs and MCC (see Electrical Specification)
- Motor instrumentation.
- Power and Instrument cabling for pumps, VSDs and MCC.
- Baseplates, plinths, shaft seals and guards, holding-down bolts and anchors.
- Emergency Stops
- Testing and Commissioning.

3.3 Pump Operating Parameters and Design Details

BACKWASH WATER PUMPS (Filter details given in Project Spec: WATERWORKS EQUIPMENT)	
Parameter	**Description**
Number of pumps	3 No. (2 Duty; 1 Standby)
Duty Flow **(2 Duty pumps running)**	**1426 m^3/h (713 m^3/h per pump)**
Pump Flow during combined water and air backwash **(one Duty Pump running)**	Approximately 1000m^3/h (may need to lower speed on VSD when only 1 pump running)
Static Head	**TWL in chlorine contact tank:** 742.17masl (does not vary) **Spent backwash launder weir invert:** 743.80 masl **Static Head:** 1.63m
Total Dynamic Head at Duty Flow **(2 Duty pumps running)**	4.98m
Static Suction Head at pump impellor level	TWL in chlorine contact tank: 742.17masl (= constant operating level) Pump Impellor level: 738.57masl Static Head at pump inlet: 3.6m
Medium	Filtered clear water from upstream of chlorine contact tank
Preferred Pump type	End-suction centrifugal
Pump speed	4-pole or 8-pole motor (depending on pump characteristics) with VSD for setting accurate backwash flow rate

Pumpset Specifications: FILTER BACKWASH PUMPSETS	
Specified Pump Duty Point (One Pump)	713 m^3/h @ 4.98m (or artificially higher with orifice plate added to delivery pipework)
Preferred Pump type	End suction centrifugal
Pump model (indicative)	WILO 15-15 MVF or WILO FD 300-300-315 with orifice plate
Minimum efficiency	The pump efficiency at the guaranteed duty point shall not be less than 65%.
Suction size (indicative)	DN400mm
Discharge size (indicative)	DN400mm or DN300
Seal Type	Mechanical seal
Bearing	Sleeve Bearings
Impeller material	Bronze
Volute casing	Ductile Iron
Shaft	Chrome Steel
Shaft Sleeves	316 stainless steel
Internal Coating	Factory Standard
External Coating	Factory Standard
Motor to Pump coupling	Close-coupled
Motor Speed	4 or 8 pole
Motor rating, kW (estimate)	15kW (or higher with orifice plate)
Motor	3 phase, 400V, 50 Hz, AC supply The insulation rating of the motor shall be Class F rated to run at Class B and supply rated output at deviations of up to ±5% of the rated frequency and voltage. The cable termination shall be bottom-entry with IP68 gland suitable for outdoor, fully exposed service.
Motor Cooling	TEFC
Motor Bearings	Sealed-for-life roller bearings
Starter	VSD
Pipework (General)	GMS (unpainted) with insulating flange gasket kit between GMS and SS puddle-pipes in wall. No threaded sockets welded to pipework allowed (must have DN50 flanged penetrations for sensors / instruments)
Suction Pipework	DN500 min wall thickness: 4.0mm (flanges to SANS1123 1000/3) PN10 DN500 EPDM lined solid ss disc flanged butterfly valves with gearbox and handwheel
Delivery Pipework	DN400 min wall thickness: 4.0mm (flanges to SANS1123 1000/3). DN400 wafer double-door non-return valves, PN10 DN400 EPDM lined solid ss disc flanged butterfly

Pumpset Specifications: FILTER BACKWASH PUMPSETS	
	valves with gearbox and handwheel all flanges to SANS1123 1000/3
Pipework instruments	Suction pipework: • No / low flow sensor Delivery pipework: • 100kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks immediately before each pump NRV and on common delivery manifold
Plinth and Base Plate	Min 25MPa/20 concrete plinth and GMS baseplate

4 HIGHBURY WTW: SPENT BACKWASH RECYCLE PUMPSETS

4.1 Overview

As no liquid waste streams should be discharged from the Highbury WTW, all spent backwash water from the filters is to be recycled back to the head of works immediately downstream of the incoming raw water flow meter. The spent backwash water contains less than 0.1% dry solids, so is effectively the same as pumping raw water with respect to density and viscosity.

The spent backwash water from the filters drain to a 600m^3 holding tank for pumping back to the head of the Works. The holding tank has been sized to allow at least two filter backwashes in quick succession or all eight filters backwashed at even intervals over a 24h period.

Two Duty and one Standby end suction centrifugal pumpsets are to be provided. One Duty pump set will typically operate most of the day (depending on Works daily throughput and frequency of filter backwashes) and the second Duty pump set kicks in when the holding tank contents exceeds 60% of its capacity and cuts out when the contents drops below 50% capacity.

4.2 Control Philosophy

Each pump has DN100 steel suction pipe with a downward-facing DN200 bellmouth. A box-out between the tank and the pump room has been provided for each pump. The discharge manifold is connected to a 200mm uPVC rising main (constructed by others under Stage 2 Civils) to the Head of Works.

An ultrasonic level sensor (fitted above the pump sump which is 1.2m deeper than the main tank) in the storage tank controls the pumps (ON/OFF sequence) in Auto Mode based on the main tank levels. The following logic for **Auto Mode Operation** applies:

Logic Description	Tank volume % (depth)	Triggers ON
Lo Lo	Tank 0% (0m) (pump sump still has 1.2m water depth as main tank empties)	Pump 1 Off
Lo	Tank 10% (0.244m)	Pump 1 Turns ON

Hi	Tank 60% (1.44m)	Pump 1 already ON Pump 2 Turns ON
Hi Hi	Tank 100% (2.4m)	Pump 1 ON Pump 2 ON Alarm & overflow to emergency pond
	Tank water level drops below 50% capacity when two pumps running	2nd Duty Pump OFF

In Manual Mode, the Operator can push START or OFF buttons no matter what the water level in the tank. Dry run protection is to remain active in Manual Mode.

Large variations in surface elevation between the raw water reservoir and the storage tank means the static head of the pumps varies between 7.8m and 17m. The dynamic head is also affected as the supernatant recycling pumpstation also conveys medium to the Head of Works via the same Rising Main. Each pump is fitted with a “Maric’ flow limiting device and set-up such that each pump delivers a fixed design flow no matter what the operating conditions. The Rising Main does not need priming for dry start-up (pumps protected from high flow rate by Maric flow controller).

Instrumentation

A DN150 electromagnetic flowmeter in a dedicated chamber outside the backwash pumpstation shall record the flow rate and totalized flow of the recycled backwash water for record keeping and monitoring of waterworks performance.

No / low flow sensors on each pump delivery pipe will serve to initiate pump trip after a preset period to protect the pumps from prolonged dry running (eg pump isolating valves closed).

If the Head of Works flow into the waterworks is shut down for any reason, the backwash recycle pumps can operate as normal (the pumped recycle flow will back-up into the Raw Water Reservoir).

Each pump delivery line is to be fitted with a pressure gauge and no-flow sensor before the non-return valve. The common delivery manifold shall also be fitted with a 250kPa pressure gauge.

The pump interlocks, trips, alarms, start and stop sequences shall be controlled in AUTO mode via the PLC.

All instrumentation, piping, valves and equipment is shown on piping an instrumentation diagram **J31067-PID-308.** All instrumentation to control and protect the pumps are described in more detail in section 3.4

4.3 Layout and General Arrangement

The building layout and the configuration of the suction and discharge pipework and preferred mechanical equipment arrangement is shown on drawings **J31067/MECH/330-01 to J31067/MECH/330-05.** All instrumentation, brief controls and equipment is shown on pipping an instrumentation diagram **J31067-PID-302/308.**

The layout of the pumps and pipework above have been prepared based on a particular pump model. The contractor shall prepare the final layout drawings to suit the pump units supplied under the contract, which may require minor changes in pipework position and dimensions to suit the pump house structural constraints. These changes, if necessary, will be deemed to have been included in the tendered price should alternative pumpsets be accepted.

The scope for the spent backwash recycle pumpstation shall include the design and installation of the following:

- Three Pumpsets complete with suction pipes and delivery manifold (including isolating valves, non-return valves and Maric flow controller)
- Electromagnetic flow meter (see specifications under Electrical)
- MCC
- Pump and motor instrumentation and water level sensor.
- Power and Instrument cabling for pumps, water level sensor and MCC.
- Baseplates, plinths, shaft seals and guards, holding-down bolts and anchors.
- Emergency Stops, trips and alarms.
- Testing and Commissioning.

4.4 Pump Operating Parameters and Design Details

Configuration & Operating Parameters: SPENT BACKWASH RECYCLE PUMPSETS		
Number of pumps		3
Duty configuration		2 Duty 1 Standby
Suction Conditions		
Tank floor level (= Min Operating Level)		738.50masl
Tank top water level (TWL)		741.00masl
Pump centerline level		738.05masl
Tank sump floor level under bellmouth		737.30masl
Inverted 200mm bellmouth entrance level		737.40masl (100mm off floor)
Suction Pipework		DN150 mild steel with inverted DN200 bellmouth
Delivery Conditions		
Hydraulic Gradeline Elevation variation at Head of Works		Minimum Raw Water Reservoir Operation Level 748.8masl Raw Water Reservoir TWL 755.58masl
Static head (m)	Lowest	Backwash Tank full (TWL 741.00) to Raw Water Reservoir MOL (748.80) = 7.80m
	Highest	Backwash Tank at MOL (738.50) to Raw Water Reservoir TWL (755.58) = 17.08m
Delivery Pipework		DN100 branches into DN150 delivery manifold, ~10m of 160mm uPVC + ~ 20m of 200mm uPVC + ~200m of 315mm uPVC rising main to head of

	Works (315 pipe also part of spent backwash rising main)
Specified Duty Point Flow	13.3l/s one pump
Flow Controller	Wafer-type PVC in-line 'Maric' precision flow limiter fitted to DN100 delivery side of each pump (rated flow: 800l/min). **Maric Order Code: 100WPP800**
Pumping Head	Fixed due to Maric controller. Minimum Maric headloss is 14m at Specified Duty Flow (where static head + dynamic head are less than max, Maric headloss increases accordingly so flow is always 13.3l/s (one pump running) or 26.6l/s (two pumps running). Duty Point Head is therefore 14m (Maric) + 17.1m max static + 3m max dynamic head (two pumps running) = 34m Total Pumping Head
Indicative pumpshaft-to-water at assumed 75% pump efficiency	5.9kW (constant under all operating conditions due to Maric)
Indicative motor rating	7.5kW

Pumpset Specifications: SPENT BACKWASH RECYCLE PUMPSETS	
Water to be pumped	Spent backwash water from storage tank containing less than 0,1% by mass dry solids
Specified Pump Duty Point (One Pump)	13.3l/s @ 34m
Preferred Pump type	End suction centrifugal
Pump model (indicative)	KSB ETANORM 65-50-160 GG AI 10
Minimum efficiency	The pump efficiency at the guaranteed duty point shall not be less than 74%. Please note that all performance information provided as well as any testing is to be at Grade 1E of SANS 9906 only.
Suction size (indicative)	DN65mm
Discharge size (indicative)	DN50mm
Seal Type	Mechanical seal
Bearing	Sleeve Bearings
Impeller material	Bronze
Volute casing	Ductile Iron
Shaft	Chrome Steel
Shaft Sleeves	316 stainless steel
Internal Coating	Factory Standard
External Coating	Factory Standard

Pumpset Specifications: SPENT BACKWASH RECYCLE PUMPSETS	
Motor to Pump coupling	Close-coupled
Motor Speed	2930 rpm (2 Pole)
Motor rating, kW (estimate)	7.5 kW
Motor	3 phase, 400V, 50 Hz, AC supply The insulation rating of the motor shall be Class F rated to run at Class B and supply rated output at deviations of up to ±5% of the rated frequency and voltage. The cable termination shall be bottom-entry with IP68 gland suitable for outdoor, fully exposed service.
Motor Cooling	TEFC
Motor Bearings	Sealed-for-life roller bearings
Starter	DOL
Suction Pipework	Fusion-Bonded Epoxy (FBE) coated and lined DN100 mild steel with DN200 bellmouth (minimum 4mm wall thickness), flanges to SANS1123 1000/3.
Delivery Pipework	Fusion-Bonded Epoxy (FBE) coated and lined DN100 mild steel into DN150 manifold (minimum 4mm wall thickness), flanges to SANS1123 1000/3.
Pipework fittings	PN10 DN100 Resilient-seal gate valves each side of pumps, DN100 wafer double-door non-return valves, all flanges to SANS1123 1000/3, in-line DN100 wafer MARIC flow controller on each pump delivery pipe as specified above,
Pipework instruments	Suction pipework: Nil Delivery pipework: • 600kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks immediately before each pump NRV and on common delivery manifold • No / low flow sensor immediately before each pump NRV Rising Main: DN150 electromagnetic flowmeter (see Elec Spec).
Plinth and Base Plate	Min 25MPa/20 concrete plinth and GMS baseplate

5 HIGHBURY WTW: SLUDGE SUPERNATENT RECYCLE PUMPSETS

5.1 Overview

As noted for the filter spent backwash water, no liquid waste streams should be discharged from the Highbury WTW.

The other significant waste stream to be recycled back to the head of the Works is the filtrate water and flushing water draining from the sludge dehydrators and the decanted supernatant water from any waste stream that ends up in the emergency sludge ponds (any Spent Backwash Tank or Sludge Holding Tank overflows and tank scours drain to the emergency sludge ponds). As a last resort, any excess inflows to the sludge ponds overflow into the stormwater system.

The sludge supernatant recycle pumpstation is located at the bottom of the works below the sludge storage ponds. Pumps are to be provided to return all recycled water back to the Head of Works. The Duty Pump draws from a central inlet / outlet sump (situated between the two emergency sludge ponds) via a 160mm uPVC 90m long pipeline. Sludge filtrate and flushing water from the sludge dehydrators is piped directly into this sump. Any clarifier sludge overflow or spent backwash tank overflow discharges directly into the emergency ponds where the sludge will settle and the clear supernatant can be decanted (via manually operated weir sluice gates) or overflow into the central inlet / outlet sump for recycling.

The pumpstation building and suction and delivery pipework outside the building is included in the Stage 2 Civil Works Contract. The 110mm uPVC pipe Supernatant Rising Main combines with the 200mm Spent Backwash Rising Main and becomes a 315mm PVC Rising Main to the Head of Works.

5.2 Control Philosophy

The rate of generation of water to be recycled is highly variable. The emergency ponds provide balancing storage so that the water to be recycled can be returned to the Head of Works at a constant rate spread-out over the day.

In essence, the Auto Mode control system is to pump away any accumulating recycle water from the central intake/outlet sump.

The pumps shall be controlled off a signal from an ultrasonic water level sensor mounted in the sludge inlet/ outlet sump, with the signal being relayed to the MCC. The signal will activate the stopping and starting sequence of the pumps.

A START / OFF push button MANUAL mode shall be provided whilst keeping the no-flow protection active.

<u>Instrumentation</u>

The flowmeter is housed outside the recycle pumpstation in a dedicated manhole.

No/ low fl ow switches in the suction pipework will protect the pumps from prolonged dry running.

The delivery manifold will have 250kPa pressure gauges on each pump before the non-return valve and a further pressure gauge on the common side of the delivery manifold.

All instrumentation, piping, valves and equipment is shown on piping an instrumentation diagram **J31067-PID-309.**

5.3 Layout and General Arrangement

The Sludge Pond Inlet / Outlet Sump is shown on drawing **J31067/DET/300**. The building layout and the configuration of the suction and discharge pipework and preferred mechanical equipment arrangement is shown on drawings **J31067/DET/340-01 to J31067/DET/340-02**.

All instrumentation, brief controls and equipment is shown on pipping an instrumentation diagram **J31067-PID-302/309.**

The layout of the pumps and pipework above have been prepared based on a particular pump model. The contractor shall prepare the final layout drawings to suit the pump units supplied under the contract, which may require minor changes in pipework position and dimensions to suit the pumpstation structural constraints. These changes, if necessary, will be deemed to have been included in the tendered price should alternative pumpsets be accepted.

The scope of work shall include the design and installation of the following:

- Two Pumpsets complete with suction pipes and delivery manifold (including Maric flow controllers, suction & delivery isolating gate valves and wafer-type double-door non-return valve for each pump)
- DN100 Electromagnetic flow meter
- MCC
- Pump and motor instrumentation and water level sensor.
- Power and Instrument cabling for pump, water level sensor and MCCs
- Baseplates, plinths, shaft seals and guards, holding-down bolts and anchors.
- Emergency Stops, trips and alarms.
- Commissioning and testing.

5.4 Pump Operating Parameters and Design Details

Configuration & Operating Parameters: SLUDGE SUPERNATENT RECYCLE	
Maximum daily recycle volume from dehydrators (2 units operating max 8h/d)	Sludge Filtrate: 2 dehydrators operating: 2x8l/s feed rate = 58m^3/h
	Flush water: 0.5m^3/h
	Total: 58.5m^3/h x 8h = 468m^3/d
Allowance for overflow volume to be returned in one day over 24h (over and above sludge filtrate)	1322m^3/d less whatever dehydrator filtrate water is generated (Up to 854m^3/d)
Required pump rate	15.3 l/s (55.1m^3/h)
Number of pumps	2
Duty configuration	1 Duty, 1 Standby
Suction Conditions	
Minimum Operating Water Level in sump	730.5masl
Top Water Level in sump	734.0masl
Pump centerline level	730.58masl
Suction Pipework	160 mm uPVC approx. 90m long from sludge inlet/outlet collection box at the emergency sludge ponds
Delivery Conditions	

Hydraulic Gradeline Elevation variation at Head of Works		Minimum Raw Water Reservoir Operating Level 748.8masl Raw Water Reservoir TWL 755.58masl
Static head (m)	Lowest	Inlet / Outlet Sump full (TWL 734.00) to Raw Water Reservoir MOL (748.80) = 14.80m
	Highest	Inlet / Outlet Sump at MOL (730.50) to Raw Water Reservoir TWL (755.58) = 25.08m
Flow Controller (required due to large variation in static head)		Wafer-type PVC in-line 'Maric' precision flow limiter fitted to DN100 delivery side of each pump (rated flow: 960l/min). **Maric Order Code: 100WPP960**
Delivery Pipework		~150m of 110mm uPVC + ~200m of 315mm uPVC to head of Works
Pumping Head at Duty Point Flow		Fixed due to Maric controller. Minimum Maric headloss is 14m at Specified Duty Flow (where static head + dynamic head are less than max, Maric headloss increases accordingly so flow is always 16l/s). Duty Point Head is therefore 14m (Maric) + 25m max static + 3m dynamic head = 42m Total Pumping Head
Specified Pump Duty Point		$55m^3/h$ @ 42.0 m
Indicative pumpshaft-to-water at assumed 75% pump efficiency		8.4kW (constant under all operating conditions due to Maric)
Indicative motor rating		11kW

Pumpset Specifications: SLUDGE SUPERNATENT RECYCLE	
Pumping Medium	Sludge dehydration filtrate and decanted supernatant liquor from sludge storage ponds (negligible solids content) at ambient temperature
Preferred Pump type	End suction centrifugal
Pump model (indicative)	KSB ETANORM 065-050-160 GB10 PO
Suction size (indicative)	65 mm NB
Discharge size (indicative)	50 mm NB
Seal	Mechanical seals
Bearing	Sleeve Bearings
Impeller material	Bronze
Volute casing	Ductile iron
Shaft	Chrome Steel
Shaft Sleeves	316 stainless steel
Nominal Speed (rpm)	2953 rpm (2 Pole)
Motor to Pump coupling	Close-coupled or rubber tyre - type

Pumpset Specifications: SLUDGE SUPERNATENT RECYCLE	
Motor rating, kW (estimate)	11 kW
Motor	3 phase, 400V, 50 Hz, AC supply The insulation rating of the motor shall be Class F rated to run at Class B and supply rated output at deviations of up to ±5% of the rated frequency and voltage. The cable termination shall be bottom entry with IP68 gland suitable for outdoor, fully exposed service.
Motor Cooling	TEFC
Motor Bearings	As per pump supplier
Starter	DOL
Minimum pump efficiency	The pump efficiency at the guaranteed duty point shall not be less than 74%.
Internal Coating	Factory Standard
External Coating	Factory Standard
Plinth and Base Plate	Min 25MPa/20 concrete plinth and GMS baseplate
Suction & Delivery Pipework	Fusion-Bonded Epoxy (FBE) coated and lined mild steel (minimum 4mm wall thickness), flanges to SANS1123 1000/3. Suction side to connect onto below-ground 160mm uPVC pipe from emergency pond inlet / outlet structure, reduce to DN100 above ground to pump inlets. Delivery side DN100 to outside pumpstation, increasing to DN150 to connect to existing 160mm uPVC Rising Main
Pipework fittings	PN10 DN100 Resilient-seal gate valves each side of pumps, wafer double-door non-return valves, all flanges to SANS1123 1000/3, in-line wafer MARIC flow controller on each pump delivery manifold as specified above
Pipework instruments	Suction pipework: • 60kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks between pumps and isolating valves Delivery pipework: • 600kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks immediately before each pump NRV and MARIC flow-controller and on common delivery manifold • No / low flow sensor immediately before each pump NRV • DN100 electromagnetic flowmeter (see Elec Spec).

6 HIGHBURY CLEAR WATER PUMPSTATION: ROSEDALE PUMPSETS

6.1 Overview

The Rosedale pumpsets (housed in the Clear Water Pumpstation) convey treated water from the Highbury clear water reservoirs at the WTW via a 1.6km long DN1200 steel Rising Main to the Rosedale Command Reservoir (which supplies Northern Mthatha, Libode and Ngqeleni Corridors)

The Rosedale System will ultimately take up to 100Ml/d (allowing for a future doubling-up of the waterworks) for which 4 Duty and 2 Standby horizontally split pumps will be required. This Contract provides for half this capacity to be installed now (2 Duty, 1 Standby). The pumpstation building is sized for the current and future pumpsets.

The Rosedale pumps receive potable water from a DN800 steel suction line to a DN800 steel suction manifold. When the WTW is later upgraded to 100Ml/d, further clear water reservoirs and an additional DN800 suction line (feeding into the suction manifold from the opposite end to form a closed loop) will be provided.

The suction manifold for this Contract (which connects to the suction line outside the pumpstation building provided under the Civil Contract) has four offtakes (to the three Rosedale pumpsets and one common offtake to the two Nqadu multi-stage pumps).

6.2 Control Philosophy

In essence, the control philosophy is to maintain the Rosedale Command Reservoir as full as possible (more specifically within 500mm of the Top Water Level with one Duty Pump and bring-in the second Duty Pump when the level drops below 500mm of TWL).

The Works Operator monitors the daily demand and adjusts the steady waterworks throughput once a day accordingly using the 2 x 5Ml WTW Reservoirs as balancing storage. Being a new system extending up to 40km away, the extent of the daily fluctuation of draw from the Rosedale Command Reservoir is unknown. If the Operator sets the daily Works throughput at a rate which exceeds the demand, any overflows of excess treated water must occur from the 2 x 5Ml clear water reservoirs at the WTW. The Rosedale Command Reservoir must not be allowed to overflow as the area below it is rapidly being developed with houses.

Ultrasonic water level sensors in the 2 x 5Ml reservoirs serve as an interlock and pump controlled stop condition when the reservoir level falls below a preset Low-Low (Minimum Operating Level).

An ultrasonic water level sensor mounted in the Rosedale Reservoir provides the signal for controlling the Duty Pumps to keep it as full as possible.

The pump interlocks, trips, alarms, start and stop sequences shall be controlled in AUTO mode via the PLC.

It shall be possible to operate the pumps in MANUAL mode.

All instrumentation, piping, valves and equipment is shown on piping an instrumentation diagram **J31067-PID-307.** All instrumentation to control and protect the pumps are described in more detail in section 5.4.

6.3 Layout and General Arrangement

The building layout and the configuration of the suction and discharge pipework and preferred mechanical equipment arrangement is shown on drawings **J31067/MECH/320-01 to J31067/MECH/320-10**. All instrumentation, brief controls and equipment is shown on P&ID diagram **J31067-PID-307.**

Under this contract, three pumpsets are required (2 Duty + 1 Standby)

The pumphall and delivery pipework has been sized for installing 3 additional pumps for a future doubling-up to Rosedale Command Reservoir (ie 4D + 2S arrangement). Two additional 5Ml clear water reservoirs and 800mm gravity main (to tie into the end of the current suction main) will be added in future.

The layout of the pumps and pipework above have been prepared based on a particular pump model. The contractor shall prepare the final layout drawings to suit the pump units supplied under the contract, which may require minor changes in pipework position and dimensions to suit the pumphall structural constraints. These changes, if necessary, will be deemed to have been included in the tendered price.

The scope shall also include the design and installation of the following:

- Three pumpsets;
- MCC with soft starters for each pump;
- Suction and Delivery manifolds, including all fittings, sensors and instrumentation and pipe supports and anchoring and connections to supply and rising main pipelines constructed by others;
- DN800 electro-magnetic flow meter on Delivery Manifold (see Electrical Specification);
- All electrical power, control and instrument cabling (see Electrical Specification);
- Emergency Stops, trips and alarms;
- Ultrasonic Water Level sensor and transmitter on Rosedale Command Reservoir;
- Power supply and telemetry system for above to communicate with pump PLC;
- Testing and commissioning.

6.4 Pump Operating Parameters and Design Details

6.4.1 Required Duty

Table 2: Rosedale Clear Water Pump Operating Parameters

Configuration & Operating Parameters ROSEDALE CLEAR WATER PUMPS	
Required delivery capacity	46.6 ML/d over 20h
Number of pumps	3
Duty configuration	2 Duty 1 Standby
Suction Conditions	
Maximum Operating Level (TWL) Clear Water Reservoir	741.9 masl
Minimum Operating Level	736.7 masl
Reservoir Floor Level	735.7 masl
Pump level (impeller eye)	733.98 masl
Suction Pipeline dia & length	DN800 Steel approx. 108m

<table>
<tr><td colspan="2">(reservoir to suction manifold)</td><td></td></tr>
<tr><td colspan="2">Reservoir live storage (max to min operating level)</td><td>8750m³ (both reservoirs on-line)</td></tr>
<tr><td colspan="2">Overflow level</td><td>742.27 masl</td></tr>
<tr><td colspan="3">Delivery Conditions</td></tr>
<tr><td colspan="2">Maximum Reservoir Level (TWL)</td><td>855.75 masl</td></tr>
<tr><td colspan="2">Reservoir inlet discharge level</td><td>853.75 masl</td></tr>
<tr><td colspan="2">Reservoir floor level</td><td>847.75 masl</td></tr>
<tr><td colspan="2">Reservoir live storage</td><td>20 Ml</td></tr>
<tr><td rowspan="2">Static head (m)</td><td>Lowest</td><td>111.85m (highest suction = 741.9 masl;
lowest delivery = 853.75 masl)</td></tr>
<tr><td>Highest</td><td>119.05 m (lowest suction = 736.7 masl
highest delivery = 855.75 masl)</td></tr>
<tr><td colspan="2">Delivery Pipework</td><td>DN800 Steel pipework in pumphall 15m long
DN1200 steel pipeline 1191m long</td></tr>
</table>

6.4.2 Parameters

Table 3: Rosedale clear water pumpset Parameters

Pump System Specifications ROSEDALE CLEAR WATER PUMPS	
Medium	Potable water
Specified Pump Duty Point (each pump)	1165m^3/h (324l/s) @ 122m total pumping head
Preferred Pump type	Single-stage, double-entry, horizontally-split centrifugal units
Pump model (suggested)	KSB Omega 250-600 split casing pump and motor
Suction size (mm) and pressure rating	500 mm NB PN10
Discharge size (mm) and pressure rating	400 mm NB PN25
Seal Type	Mechanical seals Face materials shall be silicon carbide on silicon carbide.
Seal Flush Water	Potable water
Bearing	Rollerball each end
Impeller material	Stainless steel with a ceramic coating or similar approved (Minimum Grade 316)
Casing wear rings & impeller wear rings	Stainless steel or non-ferrous material with tungsten carbide coating
Volute casing	Ductile iron (Minimum Grade EN-GJS-400-18)
Shaft	Chrome Steel or stainless steel (Minimum Grade 431)

Pump System Specifications ROSEDALE CLEAR WATER PUMPS	
Shaft Sleeves	Chrome Steel
All fasteners, mechanical seals and all auxiliary steel components	Unless otherwise stated Stainless steel (Minimum Grade 316). Bolts, nuts and washers (where applicable) shall be to suit the material to which they are affixed
Nominal Speed	1490 rpm (4 Pole)
Indicative maximum Pumpshaft-to-water absorbed power over full operating range (each pump)	475kW (max absorbed power when only 1 pump running).
Motor rating (estimate)	500kW The maximum absorbed power must not exceed 95% of the rated power of the motor
Motor	Rated for operation on a 3 phase 400V 50 Hz supply and complying with the details provided in the Electrical specification schedules The insulation rating of the motor shall be Class F rated to run at Class B and supply rated output at deviations of up to ±5% of the rated frequency and voltage. The cable termination box shall be side-mounted above cable channel
Starter	The motors shall be Soft Starter controlled.
Motor Cooling	Motor cooling shall be of the TEFC configuration.
Motor Bearings	Bearings shall be provided with temperature sensors.
Minimum efficiency	The pump efficiency at the specified duty point shall not be less than 83%. Please note that all performance information provided as well as any testing is to be at Grade 1E of SANS 9906 only.
Internal Coating	The internal coating of the pump casing shall be to the manufacturer’s standard for tropical applications.
External Coating	External coating shall be to the manufacturer’s standard for tropical applications.
Plinth and Base Plate	25MPa/20 concrete plinth (by civil contractor) and painted mild steel baseplate
Suction & Delivery Branch Pipework (SANS 719 Grade B)	FBE coated and lined mild steel (minimum 4.5mm wall thickness), flanges to SANS1123 1000/3 (suction) and 2500/3 (delivery).
Suction and Delivery Manifold (DN800 SANS 719 Grade B)	Epoxy coated and lined (2 coats to min DFT of 300 microns) mild steel (min 6.4mm wall thickness), flanges to SANS1123 1000/3 (suction) and 2500/3 (delivery).
Pipework fittings	Heavy-Duty flanged butterfly valves (with gearbox and handwheel) each side of pumps, nozzle-type non-return

Pump System Specifications ROSEDALE CLEAR WATER PUMPS	
	valves, fully-restrained dismantling joints on pump side of isolating valves, flanges as specified for the manifolds.
Pipework instruments	Suction pipework: • 60kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks between pumps and isolating valves Delivery pipework: • 1600kPa glycerine-filled 100mm dia dial pressure gauges c/w isolating stop-cocks immediately before each pump NRV and on common delivery manifold • No / low flow sensor immediately before each pump NRV Delivery Manifold: DN800 electromagnetic flowmeter (see Elec Spec).
General Materials	The materials selected for the pump components shall generally comply with the general pump particular specification, as amended above.

6.4.3 Filling an Empty Rising Main

For filling the DN1200 Rosedale Rising Main from empty, the main isolating valve (in the Isolating Valve, Bypass and Scour Chamber outside the CW Pumpstation Building) shall be manually closed and the bypass opened before manually starting one pump. The priming rate will be automatically controlled by 1 No. DN300 Maric-type flow control device on the bypass pipework. The Maric device automatically limits the flow rate to a maximum of 8854l/min (= 531 m^3/hr) irrespective of backpressure from water in the rising main. This has been supplied by the Civil Contractor.

6.4.4 System Curve

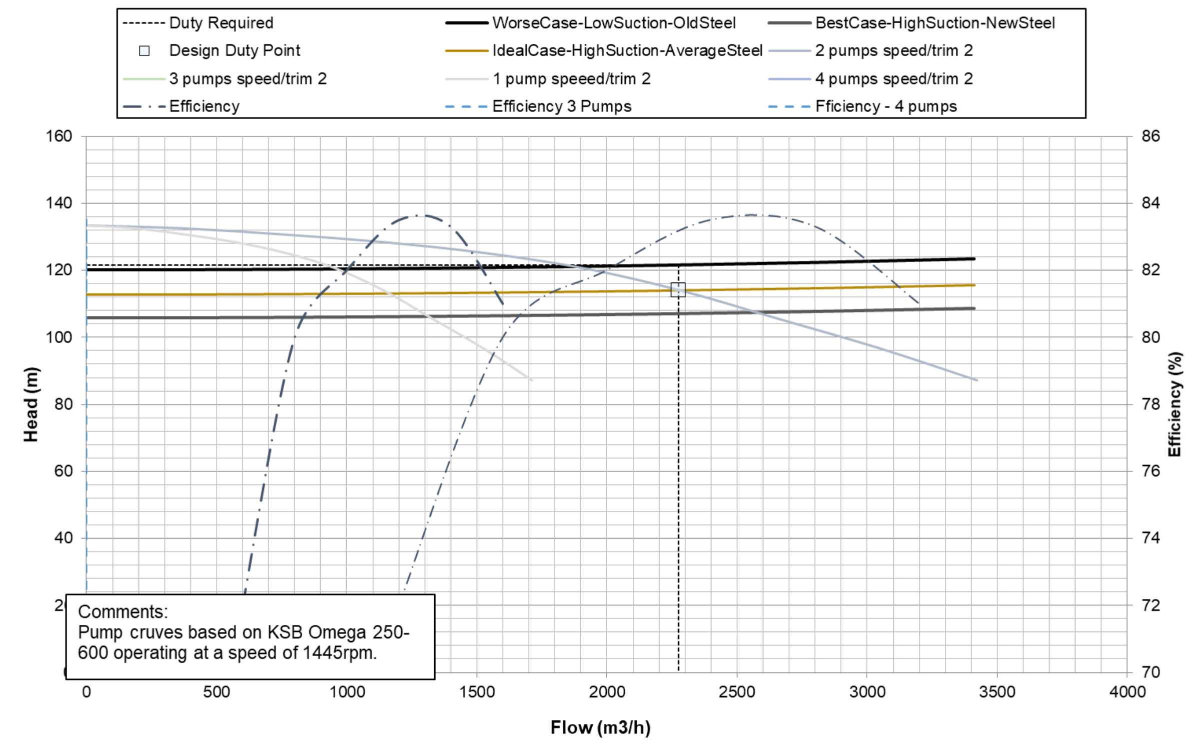


Figure 6-1: Rosedale Pump set system and performance curves

6.5 Motor Control Details

See Electrical Specification.

7 HIGHBURY CLEAR WATER PUMPSTATION: NQADU PUMPSETS

7.1 Overview

The Nqadu pumpsets (housed in the Clear Water Pumpstation) convey treated water from the Highbury clear water reservoirs at the WTW via a 13.3 km DN300 GRP / 355mm oPVC Rising Main to the Soyini Reservoir (TWL 911.25 masl) and Ngungululu Reservoir (946.43 masl) (which supplies the Nqadu Corridor North of Umtata). The Soyini Reservoir automatically draws from an offtake on the Rising Main during pumping, but with a flow limiter and pressure sustaining valve such that it does not significantly affect the pumping head experienced by the Duty Nqadu pumpset and not empty the Rising Main when the pump is not running. The pressure-sustaining valve on the Soyini inlet will be set to ~ 1 Bar lower than the static head when the Rising Main is fully-primed.

The Nqadu System will take up to 3.9Ml/d for which 1 Duty and 1 Standby multi-stage pumps will be required. There is no provision for increasing the supply in the future.

7.2 Control Philosophy

As receiving radio telemetry signal from a remote location (Ngungululu Reservoir) is not considered sufficiently reliable for controlling the Duty Pump, the ‘Duty Pump Off’ control (when the reservoirs are full) is to be based on sensing a preset decline of flow on the WTW-based Nqadu flow meter as the control valve at the Ngungululu Reservoir starts to close.

As pump protection against a burst or significant leak developing in the Rising Main, the Duty Pump is also shut down should the flow meter sense an increase in flow beyond a preset limit.

Ultrasonic level sensors in the clear water reservoirs at the WTW will serve as an interlock and pump controlled stop condition when the reservoir level is Low.

The PLC shall automatically start the Duty Pump (the two pumps alternating duty) after a preset time delay from last ‘Pump Off’ condition.

The pump interlocks, trips, alarms, start and stop sequences shall be controlled in AUTO mode via the PLC.

There shall be a MANUAL push button provided.

An AUTO-OFF-MANUAL selector switch shall be provided controlling the multistage pumps.

All instrumentation, piping, valves and equipment is shown on piping an instrumentation diagram **J31067-PID-307.** All instrumentation to control and protect the pumps are described in more detail in section 9.5

7.3 Layout and General Arrangement

The building layout and the configuration of the suction and discharge pipework and preferred mechanical equipment arrangement is shown on drawings **J31067/MECH/320-01 to J31067/MECH/320-07**. All instrumentation, brief controls and equipment is shown on P&ID drawing **J31067-PID-307.**

The layout of the pumps and pipework above have been prepared based on a typical multistage pump. The contractor shall prepare the final layout drawings to suit the pump units supplied under the contract, which may require minor changes in pipework position and dimensions to suit the pump house structural constraints. These changes, if necessary, will be deemed to have been included in the tendered price.

The scope shall include the design and installation of the following:

- 2 No. pumpsets;
- MCC with soft starters for each pump;
- Pump and motor vibration and temperature sensors, transmitters and instrumentation;
- Suction and Delivery manifolds, including all fittings, sensors and instrumentation and pipe supports and anchoring and connections to suction and delivery pipelines;
- All electrical and instrument cabling;
- Emergency Stops, trips and alarms;
- Testing and commissioning.

7.4 Pump Operating Parameters and Design Details

7.4.1 Required Duty

Table 4: Nqadu Pump design requirements

Configuration & Operating Parameters NQADU CLEAR WATER PUMPS	
Required flow	3.9Ml/d over 20h
Number of pumps	2

Duty configuration		1 Duty 1 Standby
Suction Conditions		
Supply Reservoir TWL		741.9 masl
MOL (Minimum Operating Level)		735.5 masl
Pump centerline level		733.98 masl
Suction Pipework		DN800 Steel pipework approx. 108m
Delivery Conditions		
Gungululu Reservoir Minimum Water Level		940.85 masl
Gungululu Reservoir TWL		946.43 masl
Static head (m)	Max	946.43-735.5 = 210.93m (lowest suction \ highest delivery)
	Min	940.85-741.9=198.95m (lowest suction \ highest delivery)
Delivery Pipework		DN200 Delivery Manifold to Isolation Valve Chamber DN300 GRP Isolation Valve Chamber to SV1666m DN350 PVC pipeline 11 650m long DN200 diaphragm valve in reservoir
Specified Pump Duty Point		195m^3/h @ 212m

The Tenderer shall consider whether the specified pump performance parameters are technically acceptable for the pumps offered with respect to the suction conditions (flow speed in suction pipework, NPSHavailable and NPSHrequired etc.) as well as over the full operating range for the pumps.

The pumps shall comply with the general pump particular specification, unless stated otherwise in this specific specification.

7.4.2 Parameters

Table 5: Nqadu clear water pumpset Specifications

Pump System Specifications NQADU CLEAR WATER PUMPS	
Medium	Potable water
Specified Pump Duty Point	195m^3/h @ 214m total pumping head
Preferred Pump type	Multi-stage centrifugal units and shall be mounted with horizontal shafts. Side entry and side exit
Pump model (suggested)	KSB Multitec 150 11.1 pump and motor
Suction size (mm)	200 mm NB
Discharge size (mm)	150 mm NB
Seal Type	The seals shall be of the balanced bellows type.

Pump System Specifications NQADU CLEAR WATER PUMPS	
	Face materials shall be silicon carbide on silicon carbide.
Seal Flush Water	Mechanical seals
Bearings	To manufacturer's design
Impeller material	Bronze or stainless steel
Casing wear rings & impeller wear rings	Stainless steel or non-ferrous material with tungsten carbide coating
Volute casing	Ductile iron with internal abrasion resistant coating (Minimum Grade EN-GJS-400-18)
Shaft	Chrome Steel
Shaft Sleeves	316 stainless steel
Nominal Speed (rpm)	1450 (4 Pole)
Frequency (hz)	50
Est absorbed power at Duty Point	164 kW
Est absorbed power at Lowest Pumping Head (= max flow)	180kW
Minimum motor rating, kW (estimate)	200 kW
Motor	The rated power of the motor shall be selected to be not less than 10 % in excess of the designed power requirement of the driven equipment at an ambient temperature of 45 ºC. and suitably de-rated for altitude.
Motor Cooling	TEFC
Motor Bearings	As per pump supplier
Starter	Soft starters
Minimum efficiencies	The pump efficiency at the guaranteed duty point shall not be less than 72%. Please note that all performance information provided as well as any testing is to be at Grade 1E of SANS 9906 only.
Internal Coating	As per pump supplier
External Coating	As per pump supplier
Plinth and Base Plate	25MPa/20 concrete plinth (by civil contractor) and painted mild steel baseplate
Suction & Delivery Pipes	PN10 Suction & PN40 Delivery: FBE coated and lined DN200 (SANS 719 Grade B minimum 4.5mm wall thickness)
Pipework fittings	Heavy-Duty flanged butterfly valves (with gearbox and handwheel) each side of pumps, nozzle-type non-return valves, fully-restrained dismantling joints on

Pump System Specifications NQADU CLEAR WATER PUMPS	
	pump side of isolating valves, flanges as specified for the manifolds.
Pipework instruments	PN10 Suction pipework: • 60kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks between pumps and isolating valves PN40 Delivery pipework: • 4000kPa glycerine-filled 100mm dia dial Bourdon pressure gauges c/w isolating stop-cocks immediately before each pump NRV and on common delivery manifold • No / low flow sensor immediately before each pump NRV Delivery Manifold: DN800 electromagnetic flowmeter (see Elec Spec).

The materials selected for the pump components shall generally comply with the general pump particular specification, as amended above.

7.4.3 Filling an Empty Rising Main

For the filling an empty DN300 Nqadu Rising Main, the priming rate shall be controlled by closing the main isolating valve (in the Isolating Valve, Bypass and Scour Chamber outside the Clear Water Pumpstation Building) and forcing the Duty Pump to pump through a bypass with a DN100 Maric-type flow control valve which limits the flow rate to a maximum of 21l/s (76m^3/h) irrespective of backpressure from water in the rising main.

7.4.4 System Curve

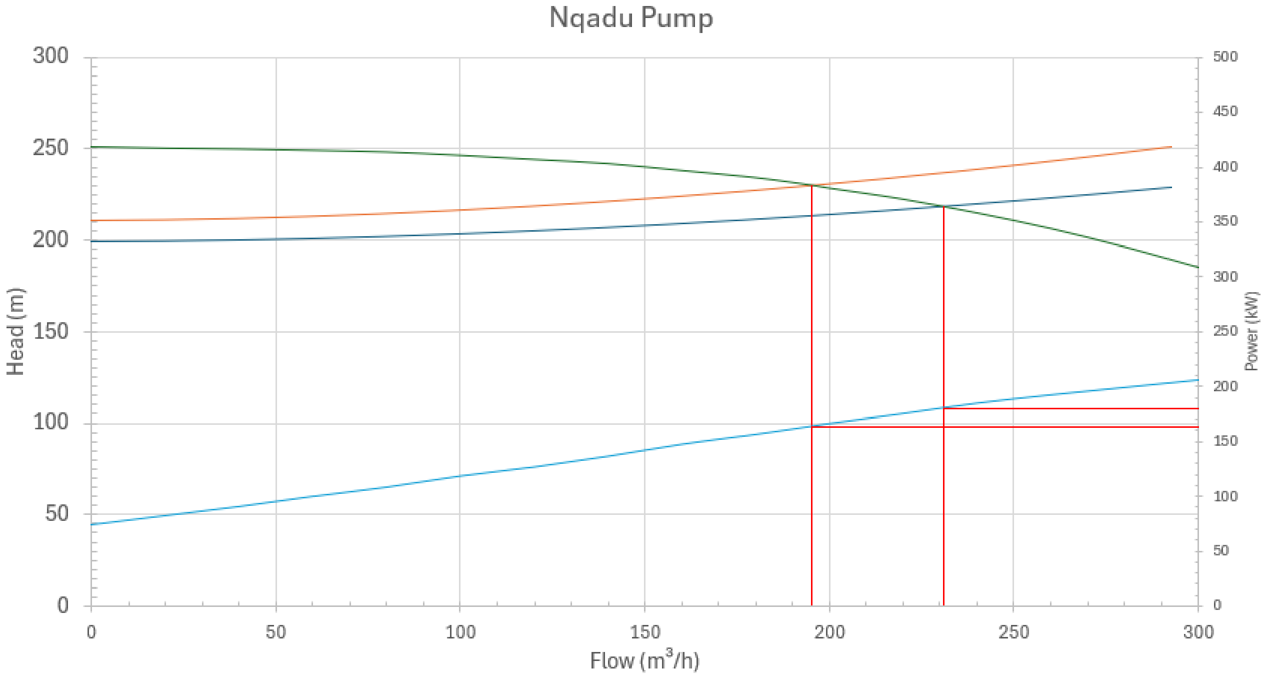


Figure 7-1: Nqadu Pump system and performance curves

7.5 Motor Control Details

See Electrical Specification.

8 PUMP TESTING

All pumpsets and piping supplied under this Contract shall be tested in accordance with GIBB 003 General Pumping Equipment: clauses 10.1, 10.2, 10.3.1 and 10.3.3. In addition, all three Rosedale Clear Water Pumps and both Nqadu Clear Water Pumps shall be tested in accordance with clause 10.3.2 (Manufacturer's factory test). Witnessing of the Factory Acceptance Tests by the Employer's Agent will only be necessary if the results of unwitnessed factory tests show cause for concern.

All pumps supplied under this Contract must be manufactured in accordance with approved in-house QCPs. Proof of compliance with the respective QCPs shall be submitted to the Employer's Agent before the pumps are installed.

The Contractor is contractually obliged to replace equipment / make-good any failure to meet specified requirements.

9 TRAVELLING CRANE: CLEAR WATER PUMPSTATION

9.1 Scope

An electrically-powered traveling crane is required for the Clear Water Pumpstation pump hall.

The crane runway beam and rail has been designed by others but shall be supplied and installed under this Contract. The Civil Contractor has cast-in 4No. M20 Grade 8.8 anchor bolts (fitted to 150 x 150 x 12mm mild steel base plate). The alignment (conforming to BS466

Appendix F) has been certified by an independent Surveyor. See details on Drawings MECH 620-01 to -07.

The power supply is specified separately under the Electrical Project Specification.

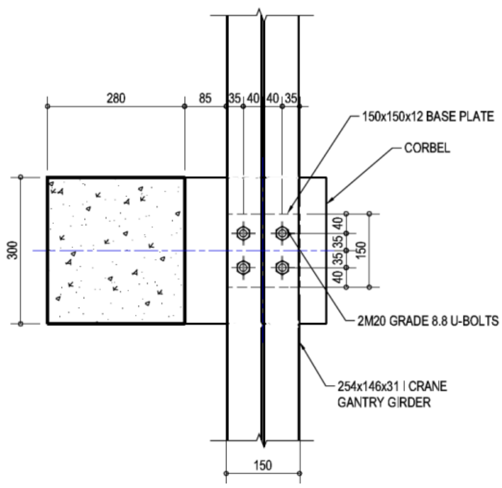
The scope of work includes the following:

- Design of motorised 5T x 8.48m span single girder crane with low headroom motorised 2-wheeled end-carriages each side.
- Submit in-house QCP and shop drawings for approval before fabrication.
- Supply of compound crane runway beam each side of pump hall.
- Supply of motorised cross-travel trolley with 5T motorised wire rope hoist.
- All electrical cabling and control equipment from an agreed fixed power supply box.
- Crane factory test, transport to Site, installation, load testing certification and commissioning.
- O&M Manual
- Training of ORTDM Operations Staff
- All maintenance and servicing until issue of Performance Certificate (proof of cost of consumables claimed under Provisional Sum item).

9.2 Layout and General Arrangement

See Drawings MECH 620-01 to -07.

9.3 Design Parameters

Design Parameters: CLEAR WATER PUMPSTATION CRANE	
Minimum Rated Lifting Capacity	5.0 Tonnes
Span (wheel c/c)	8.48m
Long Travel Length	Approx 36m
Runway beam & rail dimensions	PFC200x75 welded to 254x146x31kg/m PF I-beam with 40x40mm (or 50 x 50mm) rail on 200x75 channel
Runway beam anchor bolts and base plate (already installed by others)	
Minimum Hook to Deck Clearance	Approx.1.8m
Maximum Hoist Travel Length	Approx. 3.95m

Design Parameters: CLEAR WATER PUMPSTATION CRANE	
Clearance from top of crane travelway rail to soffit of concrete roof beams	554mm (suggest top of girder level with top of end carriage)
Crane Control	Pendant + radio remote control (2-step push button)
Ambient operating range	0ºC to 40ºC
Weather Rating	Indoor installation
IP Rating	Elec cubicles: IP54 Elec motors: IP55
Indicative Crane Travelling Speeds (to be agreed)	2-speed: 32m/min & 8m/min
Indicative Hoisting Speeds (to be agreed)	2-speed: 5m/min & 0.83m/min
Indicative Trolley Traversing Speeds (to be agreed)	2-speed: 20m/min & 5m/min
Power supply	400V Three Phase power 50Hz
Motor protection (all motors)	Thermal cut-out Overload limiting device Limit switches
Safety	Disc brake on all motors
Corrosion protection	Factory standard painting system (to be agreed)
Warranty Period	12 months from acceptance

10 MEASUREMENT AND PAYMENT

See C2.1: Pricing Instructions in Volume 1 for measurement and payment clauses pertaining to:

- General
- Preliminary & General
- Design
- Fabricate / manufacture / procure / supply and deliver
- Storage off-site
- Installation, O&M Manual, Pre-commissioning tests and Commission
- Commission the Works as a Whole and Finalise O&M Manual
- Trial Operating Period
- Monitoring the Works Operation beyond Trial Operation Period up to end of Defects Liability Period
- Consumables
- Spares
- Miscellaneous items

- Service and Adjustment Visits

All electrical components associated with the pumping equipment are measured for payment separately to the mechanical pumping and waterworks components EXCEPT proprietary packages (such as sludge dehydration package and chorine dry scrubber package). These include:

- Electromagnetic flow meters
- Electrically powered sensing and transmitting instruments
- All power and signal cabling

C3.7 Project Specification: Waterworks Equipment

Table of Contents

1 SCOPE

This project-specific specification covers the design parameters, performance requirements and control and instrumentation functionality requirements for all waterworks equipment to be supplied under in this Contract.

This specification also includes overall waterworks commissioning and Trial Operation Period requirements and measurement and payment clauses for all mechanical works and overall commissioning and Trial Operating Period.

The waterworks equipment covered by this Specification is as follows:

- Inflow Metering & Control
- Chemical Dosing Equipment (coagulation & flocculation)
- Clariflocculator Equipment
- Filtration Equipment
- Chlorine Dosing and Chlorine Gas Scrubber Equipment
- Vertical Shaft Mixers: Spent Backwash Recycle Tank and Sludge Holding Tank
- Sludge Dewatering Equipment
- Miscellaneous sensors and fittings in remote tanks and chambers

All pumping equipment is covered under a separate project-specific pumping specification (excluding filter backwash pumps which is covered in this specification).

All electrical power, control, monitoring and communication and SCADA equipment is covered under a separate project-specific electrical specification.

This specification takes precedence over all the provisions in the Particular Specifications listed in C3.6.2. The provisions of the Particular Specifications shall apply where not covered or otherwise provided for in this specification.

As a special note:

- All cable connections to sensors and actuators and motor terminal boxes and the like in below-ground chambers and outdoors provided under this Contract shall be bottom-entry and use sealing glands rated for IP68 water penetration resistance.

- All sensors and instruments installed outdoors shall be shaded from direct sunlight by means of a stainless steel or aluminium plate suitably fixed to withstand all weather conditions.

- All motors and actuators installed outdoors shall be either designed for satisfactory operation in permanently-exposed all-weather conditions or be fitted with a shade plate as described above.

- Only stainless steel cable ties shall be used where cables are exposed to direct sunlight. Plastic cable ties will only be acceptable as a temporary measure.

2 RAW WATER SOURCE & QUALITY

The Mthatha Dam will be used as a sole source of raw water for the Highbury Water Treatment Works. This dam has a capacity of 253.7 million m^3 and a yield of 145 million m^3/annum.

The dam catchment is largely open and undeveloped. Pollution levels are very low. The water has a low organic carbon content.

Raw water samples were collected in March 2012 and December 2013 from the Mthatha Dam and were analysed at the CSIR laboratory in Durban. When the analysis results where compared with SANS 241 (2005 and 2011), most parameters were well within Class 1 of the standard except for colour and turbidity. The table below present the comparative analysis for turbidity and colour.

Table 2-1: Comparative Analysis of Turbidity and Colour

Determinant	Units	Class I 2015	SANS 241: Standard limits 2015	Thornhill Test: 21-12-2011	Test Results: 13-03-2012	Test Results: 13-12-2013
Colour	Mg/L Pt-Co	< 20	< 15	-	>500	>500
Turbidity	NTU	< 1	< 1	155	268	139

The high turbidity and high colour values of the raw water are the result of the presence of a significant colloidal clay content which is easily removed in the treatment process. The high colloidal clay content is the result of the highly erodible nature of the soils in the Mthatha Dam's catchment area and, given the large size of the dam, is largely constant through the year's seasons. Because the raw water is drawn directly from the intake tower in the dam wall (i.e. far away from the sand and silt laden incoming rivers), all the sand and silt has settled in the dam before the water reaches the intake tower.

The colour and turbidity of the treated water ex Thornhill Water Treatment Works (which also draws from the Mthatha Dam) is well within the SANS 241 limits. No special treatment processes are therefore required for achieving SANS 241 Class 1 water from the Highbury Works. Although no special desilting processes are required, the high colloidal clay content will generate significant volumes of sludge which need to be dewatered and disposed of.

Previous tests for corrosivity of the treated water (ex Thornhill Waterworks) show the following:

Table 2-2: Results of Corrosivity Tests

Parameter	Value
pH	7.1
TDS	480 mg/l
Alkalinity	412 mg/l as CaCO3
Corrosiveness Index	approximately 0.38
Calcium Hardness	310 mg/l as CaCO3

The treated water is mildly aggressive towards cement-based products.

3 PROCESS DESIGN

The design philosophy principles applied to the Highbury WTW are as follows:

- The technology and processes employed shall take cognisance of the general operation and maintenance constraints associated with a general shortage of suitably trained and experienced personnel available in South Africa (ie of robust nature that can continue to deliver drinking water despite operating conditions being occasionally sub-optimal).
- The Works output shall be capable of meeting Class 1 of the South African National Drinking Water Standard SANS 241: 2015

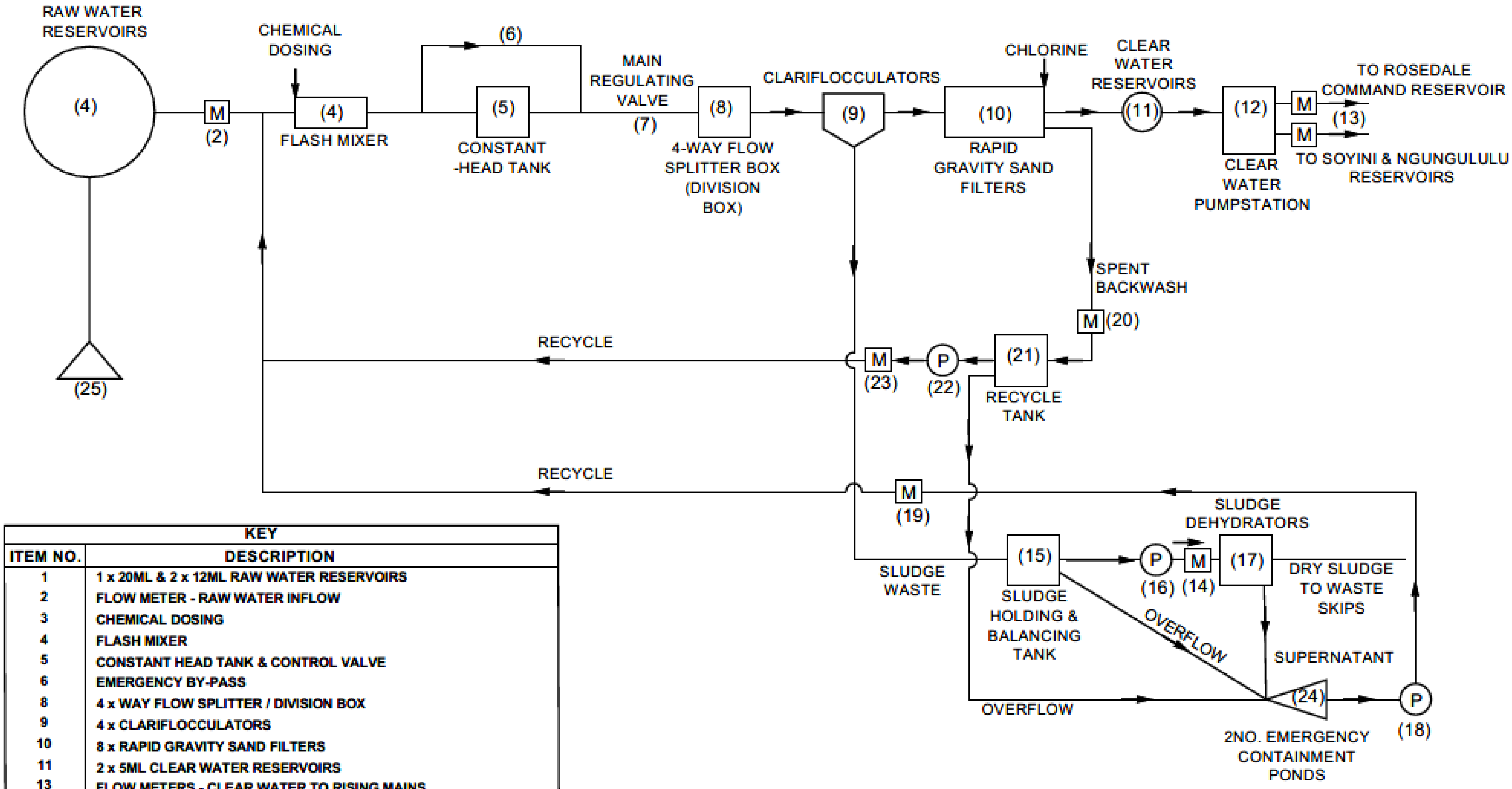
- All spares and consumables shall be readily available from South African vendors.

A simplified Process Flow Diagram is given overleaf. Detailed P&ID Diagrams are given in the drawings section. Water is abstracted from Mthatha Dam and is pumped up to 2 No.12Ml raw water reservoirs at the treatment works. The treatment process adopted for Highbury is as follows:

- Destabilization (coagulation) of the suspended solids (colloids) by flash-mixing a polyelectrolyte coagulant and flocculent into the regulated incoming raw water stream.
- Flocculation (flocculation zone of clariflocculator tanks)
- Settling (settling zone of clariflocculator tanks)
- Filtration (rapid gravity sand filters)
- Disinfection (dosing with gaseous chlorine and allowing a minimum chlorine contact time at elevated chlorine concentrations)
- Delivery to consumers.

The process is designed for largely continuous and steady conditions and adjustments to the rate of flow through the Works (to match changes in day-to-day demand) will be, as far as possible, be limited to once a day to ensure stable (laminar) steady-state flow conditions in the settling zones of the clariflocculators. The rate of flow through the works is regulated by the Operator by means of an electrically-actuated control valve in the pipeline between a constant-head-tank (the latter fed from the raw water balancing tanks via a diaphragm valve) and the division box at the clariflocculators. The overall process is all under gravity flow from the raw water balancing tanks at the top of the waterworks site to the clear water pumpstation at the bottom of the waterworks site.

Although a standby generator for maintaining the Works operation (at up to 25Ml/d capacity) is provided, the Operating Authority (OR Tambo District Municipality) may prefer to only use it for prolonged power outages (has a high operating cost and the clear water storage reservoirs are normally sufficient for maintaining a supply to consumers over short power outages).



KEY	
ITEM NO.	**DESCRIPTION**
1	1 x 20ML & 2 x 12ML RAW WATER RESERVOIRS
2	FLOW METER - RAW WATER INFLOW
3	CHEMICAL DOSING
4	FLASH MIXER
5	CONSTANT HEAD TANK & CONTROL VALVE
6	EMERGENCY BY-PASS
8	4 x WAY FLOW SPLITTER / DIVISION BOX
9	4 x CLARIFLOCCULATORS
10	8 x RAPID GRAVITY SAND FILTERS
11	2 x 5ML CLEAR WATER RESERVOIRS
13	FLOW METERS - CLEAR WATER TO RISING MAINS
14	FLOW METERS - SLUDGE WASTE DISCHARGE
15	TRANSFER PUMP TO DEHYDRATOR
18	SUPERNATANT RECYCLE PUMPS
19	FLOW METER - RECYCLED WATER FROM DEHYDATOR
20	FLOW METER - TOTAL SPENT BACKWASH WATER
21	RECYCLE WATER COLLECTION SUMP
22	RECYCLE PUMPS
23	FLOW METER - TOTAL RECYCLED BACKWASH WATER
24	EMERGENCY SLUDGE CONTAINMENT PONDS (1 DUTY, 1 STAND-BY)
25	RAW WATER RESERVOIR SCOUR CONTAINMENT POND

4 INFLOW METERING & CONTROL

4.1 General Description

This section covers the incoming raw water electromagnetic flow meter and the electrically-actuated butterfly valve used to control the rate of raw water inflow.

As noted above, the rate of raw water inflow to the works is regulated by the Operator by means of an electrically-actuated control valve in the pipeline between a constant-head tank in the Meter and Flow Control Chamber and the division box to the clariflocculators. In order to fine-tune the desired constant inflow rate, the Operator refers to the incoming raw water flow rate on SCADA and makes small adjustments to the valve position accordingly. There will be a lag of a minute or so (depending of degree of flow change) from changing the valve position to the diaphragm valve (which maintains a preset water level in the constant-head tank) reflecting the change.

Should the Works Operator wish to temporarily shut-down the raw water inflow to the Works for any reason, he/she can manually close the ¼-turn ball valve on constant-head-tank diaphragm valve control pipework (or constant-head-tank bypass isolating valve if that is open). ***Note:*** Fully-closing the electrically-actuated flow-regulating valve is ***not*** recommended as having to reopen the valve to return to previous flow throttling position will take while to stabilize).

The design of the system shall allow for the Works Operator to remotely adjust the rate of inflow from the SCADA system and also locally at the actuator. The Contractor shall therefore provide a wall-mounted local flowmeter display unit in the chamber next to the actuated flow-regulating valve.

Refer to the following drawings for details of the Meter and Flow Control Chamber:

J31067-PID_301 Highbury WTW: P&ID: Raw Water Reservoir & Inlet Works

J31067/MECH/280-01 Meter and Flow Control Chamber: Concrete Work

J31067/MECH/280-02 Meter and Flow Control Chamber: Pipework

4.2 Scope of Equipment

The equipment to be supplied is as follows:

- DN600 PN10 flanged electro-magnetic flow meter to be installed in incoming raw water pipework (remove temporary spool piece in pipework constructed under civil works and install meter, including electrical earthing and insulating flange gaskets and ss grounding rings each side).
- DN600 PN10 flanged rubber-lined solid ss disc butterfly valve with non-modulating electrical actuator for local and remote raw water inflow control (remove temporary spool piece in pipework constructed under civil works and install valve).

4.3 Functional Requirement

The Contractor shall design and provide everything necessary to meter and regulate the raw water inflow as outlined hereunder.

All necessary ducting for power and signal cables for the flow meter and the actuated valve shall be provided.

4.4 Design Parameters, Layout and General Arrangement

FLOW METERING & REGULATION		
Description: Continuous gravity flow to Clariflocculators, manually adjusted once a day by Operator		
Flow Meter	DN600 PN10 flanged electromagnetic unit (c/w insulating gaskets and stainless steel grounding rings linked to earth each side) linked to SCADA and with wall-mounted display unit next to flow regulating valve. Min 0.5% accuracy at 0.5m/s flow	
Flow regulating valve and actuator	Flow throttling by electrically actuated DN600 PN10 flanged butterfly valve linked to SCADA.	
	Butterfly valve to have EPDM lining and solid stainless steel disc.	
	Valve spindle to be installed horizontally and gearbox to be on the accessible side of the chamber	
	Actuator to suit occasional small adjustments to valve position over entire range of valve position.	
	Forward / reverse controller to be integral part of actuator (with indicator lights) and to allow local and remote (on SCADA) adjustment of valve position.	
	Actuator anti-condensation heater to be powered from internal connection. Internal circuits to protect motor from dropped phase and include auto phase rotation correction.	
Design Flow	ℓ/s Ml/d	580 50
Max flow	ℓ/s Ml/d	690 (Design Flow + 20%) 60
Min flow	ℓ/s Ml/d	58 5

4.5 Testing and Commissioning

Commissioning Stage

The Contractor shall demonstrate to the Employer's Agent at the commissioning stage that the flow meter reading is stable and accurate and that the valve positioning can be successfully adjusted both locally and remotely.

Final Acceptance Stage

All operating issues and defects identified over the Defects Notification Period satisfactorily resolved.

5 CHEMICAL DOSING EQUIPMENT (COAGULATION & FLOCCULATION)

5.1 General Description

This section covers all the equipment required to store and dose a single liquid polyelectrolyte for the coagulation and flocculation of the incoming raw water.

Liquid polyelectrolyte for coagulation and flocculation shall be delivered via road truck to four 10m^3 bulk storage tanks. The storage tanks shall be positioned outside the chemical dosing building in a dedicated bunded area. A manifold station with a drip tray shall be used to connect the road tanker to the relevant storage tank. The road tanker transfer pump will be used to transfer the chemical to the selected bulk storage tank.

The bulk storage tanks shall feed four Duty 200 litre day tanks / break-pressure tanks. The function of the day tanks is only to provide the dosing pumps with a liquid surface at or slightly lower than the dosing pump intake such that an unintended gravity flow through the dosing pumps is not possible. Transfer between the bulk storage tanks and the day tanks shall be under gravity and manually-filled by the Operator. The inlet piping shall be sized to allow rapid filling of Day Tank (min 50mm dia pipework) (so Operator is less inclined to leave open inlet valve unattended).

From the day tank, the undiluted polyelectrolyte shall be dosed via a dedicated dosing pump (duty/standby) arrangement into carrier water for delivery directly into an in-line static flash mixer in the incoming raw water pipeline inside the meter and flow control chamber. Immediately following the in-line static flash mixer is a constant-head tank diaphragm control valve which completes the flash-mixing process (the headloss through this device varies between 10m and 2m depending on the level in the raw water storage reservoirs).

The duty dosing pump shall be controlled by means of a signal from a streaming-flow ion current detector (SCD) installed in a cabinet on the outside wall of the flow division box (downstream of the metering and flow control chamber and upstream of the clariflocculators). The raw water from Mthatha Dam always has a significant colloidal clay turbidity and any change in ion charge in response to heavy rain in the dam catchment will be gradual and small.

The SCD is fed with a continuous flow of destabilized raw water under gravity from the flow distribution box (the inflow rate of sampling flow being regulated by a manual isolating ball valve). The discharge side of the SCD is to drain to the nearby waste sludge drainage chamber.

As the Works is designed to operate at a steady continuous rate (with occasional small raw water inflow adjustments to cater for changes in day-to-day overall water demand by consumers), the required polyelectrolyte dosing rate change in response to an adjustment of inflow rate by the Operator is to be accommodated by the SCD picking-up the small change in ion-charge and controlling the Duty dosing pump accordingly.

In the event of a power failure (or ESKOM load shedding), a UPS system housed in the Dosing Building dedicated to the chemical dosing pumps and SCD) shall provide at least 30 minutes of uninterrupted operation which gives the Works Operator sufficient time to manually shut-down the raw water inflow (or for the standby generator to kick-in).

Should the Operator wish to shut-down the Works for any reason, the Duty dosing pump (and clariflocculator desludging control system) will need to be switched-off. The dosing pump operation and clariflocculator desludging control system shall therefore be linked to a dedicated no-flow switch installed on the in-line static flash mixer provided under this Contract.

All instrumentation, controls and equipment are shown on P&ID drawing J31067-PID-202.

Refer to the following drawings for details of the Dosing Building, Meter and Flow Control Chamber and the Division Box to Clariflocculators:

J31067-PID_302 Highbury WTW: P&ID: Chemical Dosing

J31067/BUI/430- Chemical Dosing Building

J31067/MECH/280-01 Meter and Flow Control Chamber: Concrete Work

J31067/MECH/280-02	Meter and Flow Control Chamber: Pipework
J31067/MECH/290	Division Box to Clariflocculators

5.2 Scope of Equipment

The equipment and materials to be supplied is as follows:

- 4 x 10m^3 GRP/FRP polyelectrolyte bulk storage tanks, including steel portal frame canopy over (Prime Cost item), single filling point with quick-release coupling and isolating ball valve to suit road tanker delivery hose and inlet manifold to each tank (bottom flanged entry c/w isolating ball valves) and outlet manifold (bottom flanged outlet c/w isolating ball valves) and delivery manifold to flanged inlet to 'Day Tank'.
- Liquid level sensor in each bulk tank linked to SCADA for monitoring poly remaining.
- 4 No.x 200 litre GRP/FRP 'Day Tank/ Break Pressure Tank' on a drip trays and bottom outlet fixed uPVC pipework to dosing pumps via single measuring cylinder with isolating ball valves for pump rate testing and connection to potable water supply for periodic flushing of piping to drain point.
- 2 No. (1 Duty, 1 Standby) wall-mounted polyelectrolyte dosing pumps including wall brackets, pulse-dampeners, pressure relief valves, isolating ball valves and dosing pipework and potable carrier water pipework to dosing point including underground sleeve between Dosing Building and Metering and Flow Control Structure.
- Potable water system to include 15mm domestic-type flow meter and isolating ball valves and non-return valve.
- Emergency eye-wash station next to poly dosing system in dosing room (incl connection to potable water supply).
- 1 No. installed and one spare Streaming Flow Ion Detector (in wall mounted cabinet on division box) including all associated sampling and drainage pipework and signal cabling and control and HDPE underground sleeve back to Dosing Room for control of the polyelectrolyte dosing pumps.
- DN600 PN10 flanged In-line static flash-mixer to be installed in incoming raw water pipework (remove temporary spool piece in pipework constructed under civil works and install flash-mixer). Flash-mixer unit to include no-flow switch and associated cabling to dosing pumps and desludge control system.
- Arrange with suppliers for conducting testing of alternative sources of polyelectrolyte to determine the optimum dosing rate of each formulation, hence the most cost-effective (in terms of supply cost per Ml of raw water optimally flocculated).
- From the commencement of Contract until the end of the Defects Notification Period, collect raw water samples and send them to an accredited laboratory for building-up a data set of water quality tests as directed by the Engineer (Prime Cost item).
- Supply polyelectrolyte to fill bulk tanks (Prime Cost item).
- Quarterly service and adjustments visits.
- All hazardous material handling and safety signage

5.3 Functional Requirement

The Contractor shall design and provide everything necessary for a fully functional and effective single liquid polyelectrolyte (for coagulation and flocculation) storage and dosing system as outlined hereunder.

All chemical feeding and storage equipment shall be provided complete with all piping, valves, brackets, fixings and all equipment necessary for the chemicals specified.

All materials used in the construction of the equipment shall in themselves be resistant to the chemicals to be used or shall be suitably protected from the action of these chemicals.

Electric motors forming part of the feeding equipment shall be securely sealed against penetration by the chemicals in use. They shall be readily accessible for repair and maintenance.

Chemical pipes and hoses shall be of non-flame propagating materials suitable for the chemicals in use. They shall be arranged for easy dismantling for cleaning, and, if screwed joints or joints formed by solvent welding are proposed, enough flanged or flexible joints shall be provided to enable the pipework to be removed in sections without working from one end to the other of a particular run. Tees and cocks shall also be provided at convenient points for the connection of a pressure water supply to flush pipework through as required.

All necessary chemical delivery piping, fittings, support racks or trays and brackets and ducting between the Dosing Building and the metering and flow control chamber to serve the plant supplied shall be provided.

All necessary drainage pipework for the SCD outflow to the nearest sludge drainage manhole shall be provided.

All necessary ducting for power and signal cables between the SCD unit and the dosing pumps shall be provided.

Valves shall be of the ball or diaphragm type, with bodies or linings suitable for undiluted and diluted polyelectrolyte.

5.4 Design Parameters, Layout and General Arrangement

See layout drawings of Dosing Building, Metering and Flow Regulation Chamber, Flow Division Box, P&ID of dosing system.

POLYELECTROLYTE HOLDING TANKS		
Item	**Capacity**	**Description & Design Criteria**
Bulk Tank	4 x 10 000ℓ	**Position:** Housed outdoors next to Dosing Building accessible by delivery tanker. Mounted on concrete pedestal with 40m^3 bund under (plinth and bund by Civil Contractor). Base elevation to allow gravity-flow to Dosing Equipment Day Tank. Bulk tank and bund to be protected from sun by overhead steel shelter (Prime Cost item; quotes to be arranged). **Material of construction and capacity:** Fibre-reinforced plastic designed for contents with Specific Gravity of 1,6. Must have UV-stabilised opaque walls with translucent vertical strip for visual indication of liquid level. Flanged inlets and outlets with isolating ball valves. Top of tank to be domed with access hatch (sealed bolt-on blank-flange). **Instrumentation:** Top of tank to include flanged portal for mounting ultrasonic or other appropriate liquid level sensor (which is to be linked back to SCADA for monitoring of poly remaining in each tank) **Overflow Pipe & Tank Venting:** Overflow pipe to discharge at tank base level into bund. Overflow also acts as tank vent for filling and draining. **Scour (tank draining) valve:** DN100 ball valve on flanged tank connection.
Day Tanks / Break-Pressure Tanks	4 x 200ℓ	**Position:** On fibre-reinforced trip-trays on low plinths inside Dosing Room. **Material of construction and capacity:** Fibre-reinforced translucent plastic designed for contents with Specific Gravity of 1,6. Flanged inlets and outlets. Liquid level to be visible through wall. Cover to be tight-fitting (bolt-on) so venting is via overflow only. Overflow to drip tray at base level in a position clearly visible to Operator. **Inlet Control:** Manually-filled from Duty bulk tank via separate DN50 PVC ball valves at each tank at convenient height for Operator but bottom-inlet discharge into each tank. No automatic shutoff when Day Tank is full. **Outlet Pipework:** Fixed uPVC with single removable glass measuring cylinder on outlet manifold and linked to potable water supply for periodic flushing. PVC Isolating ball valves to be fitted on each Day Tank outlet. **Flush water pressure:** Between 3 and 6 Bar (potable water reticulation to Dosing Building by civil Contractor)

SCD UNIT (STREAMING CURRENT DETECTOR or ION-CHARGE ANALYSER)	
Parameter	**Description**
Number of Units	1 Duty, one spare in storage
Output signal	4 – 20 mA analogue signal to dosing pump controller
Type	Ion charge analyser in sampling pot
Sampling flow	**Position:** Gravity flow drawing from centre of flow division box to clariflocculators
	Sampling flow rate: Manually regulated gravity flow to about 6 litres/min (or to suit unit supplied)

POLY DOSING PUMPS	
Parameter	**Description**
Number of Pumps	1 Duty & 1 Standby Housed in existing chemical dosing building Manual & Auto modes Controller to be compatible with SCD
Pumped liquid	Undiluted polyelectrolyte (SG up to 1.6)
Type	Solenoid actuated reciprocating diaphragm or other approved pumping action with built-in controller for proportional dosing according to SCD 4-20mA analogue signal (residual ion charge of dosed raw water).
	The unit shall be designed to operate in auto mode and manual mode
	Delivery pressure rating to suit pulse-dampener design and downstream operating conditions (see backpressure at dosing point below)
Dosing Rate (widest operational Range)	Min: 1/100th of max
	Max: 20mg/l for 55Ml/d continuous raw water inflow = ~30 l/h (720 litres over 24h)
Delivery pipework	Fixed wall-mounted uPVC within buildings, but HDPE in HDPE duct between Dosing Building and Meter & Flow Regulation Chamber. Delivery pipework to include pulse dampener and pressure relief valve protection (between pump outlet and isolating ball valve before connection to common delivery pipe to dosing point) against accidental closure of downstream isolating valve. ***Pipework pressure rating:*** 6 Bar (max potable carrier water pressure). ***Backpressure at dosing point:*** Depends on level in raw water reservoir (TWL is at elevation of 755.58 masl and Min Operating Level is at 748.3 masl. Dosing Building floor level is 748.75 masl)
Carrier water	Delivery pipework to include connection off potable supply for carrier water so that flow rate in delivery pipework to dosing point is ***not less than*** 1m/s. Carrier water regulation by manual adjustment of ball valve. Monitoring of flow rate by in-line domestic flow meter. Carrier water system to include non-return valve
Dosing Point	Directly into in-line static flash mixer in meter and flow regulating chamber.
Flash Mixer	DN600 purpose-fabricated PN10 flanged uPVC (max pressure 20m water head) In-line baffled static flash mixer 990mm long f/f designed for up to

POLY DOSING PUMPS	
Parameter	**Description**
	55Ml/d (637l/s) steady flow and approx. 500mm head-loss as mixing energy. Flash mixer to be retrofitted to pipework constructed by Civil Contractor (remove temporary spool piece and insert flash mixer). Flash Mixer to include tapping for no-flow switch (linked to dosing pumps and clariflocculator desludging control system). **Note:** Diaphragm flow control valve (by Civil Contractor) immediately downstream provides additional flash mixing.

5.5 Testing and Commissioning

Commissioning Stage

Before commencing trial commissioning operations of the Works, the Contractor shall arrange for the various polyelectrolyte suppliers to conduct jar tests using their products on samples of water taken from Mthatha Dam to determine optimum dosing rates for their products.

Of those products that are found to successfully coagulate the raw water and produce readily-settleable floc sizes, the Contractor shall then carry out a cost benefit analysis to determine which of the range of products is the most cost-effective in terms of delivered poly cost per m^3 of raw water treated.

On written approval of the Employer's Agent, the Contractor shall procure sufficient of the approved poly to fill one $10m^3$ bulk tank ready to commence trial commissioning tests on the Works.

Further poly shall be procured as and when needed during the commissioning phase, trial operation phase and Defects Notification Period. All bulk tanks shall be filled for final handover of the Works (ie at issue of Final Approval Certificate). A Prime Cost item in the BoQ with Contractor's markup shall cover the poly procurement cost and cost of arranging optimisation tests for determining the most appropriate poly to use.

The Contractor shall be responsible for the design and setting-up and proper functioning of the dosing system. The system shall only be deemed ready for Employer Taking Over once it has been demonstrated to the Employer's Agent that the dosing system is operating optimally, effectively and reliably.

Final Acceptance Stage

The final Performance Certificate shall only been issued once the Employer's Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that the dosing system is operating optimally, effectively and reliably.

5.6 Spares

The Contractor shall provide the following spares:

- One SCD sensor and controller unit (excluding sampling pot and associated plumbing fixtures) suitably packaged for storing in the Dosing Building.

6 CLARIFLOCCULATOR EQUIPMENT

6.1 General Description

This section covers all the equipment required to shift settled sludge from the gently-sloping floor area of four clariflocculators to the central hoppers and to automatically periodically drain the thickened sludge from the hoppers to a drainage, holding and dewatering system (following sections).

It also includes the specifications for V-notch peripheral weir plates to be supplied and installed on the clariflocculator launder channel walls.

Refer to the following drawings for the general clariflocculator arrangement:

J31067-PID_303 Highbury WTW: P&ID: Clariflocculators

J31067-MECH_210-01 Clariflocculator Tank (Sheet 1 of 5)

J31067-MECH_210-02 Clariflocculator Tank (Sheet 2 of 5)

J31067-MECH_210-03 Clariflocculator Tank (Sheet 3 of 5)

J31067-MECH_210-04 Clariflocculator Tank (Sheet 4 of 5)

J31067-MECH_210-05 Clariflocculator Tank (Sheet 5 of 5)

The clariflocculator tanks have already been constructed. A 63mm HDPE sleeve for the bridge electrical power supply has been incorporated into the structure (see drawings for position of sleeves).

The top-of-walls (on which the rotating bridge drive wheels run) has been hand-ground to produce a reasonably flat, smooth, void-free durable concrete finish.

The tank sloping floors have not been screeded. Screeding to be done once bridges are in place. The actual supply and placing of screed as been 'ringfenced' for work to be done by local subcontractors (as par of Contract Participation Goal work). The Main Contractor will need to supervise this and operate the travelling bridge as the screed guide.

6.2 Scope of Equipment

The equipment to be supplied is as follows:

- 4 No. rotating half-bridge sludge scrapers complete with electrical slip-ring arrangement and centre bearing;
- 304L V-notch weir plates to 4 No. clariflocculator launder channels
- 4 No. desludge diaphragm valve systems (by specialist supplier as Prime Cost item);
- 4 No. sets of local timer-controlled electro-mechanical equipment and small-bore pipework and connections to potable water reticulation for pressurizing / de-pressurizing diaphragm; including 4 No. spare 3-way solenoid valves (also by specialist supplier as part of the desludge system Prime Cost)
- PLC and power supply and control cables under ELEC SPEC
- Quarterly service and adjustments visits.

6.3 Functional Requirement

The Contractor shall design and provide everything necessary for a fully functional and effective sludge collection and desludging system as outlined hereunder.

The rotating bridge and scraper assemblies shall be seen to operate reliably, smoothly and steadily while successfully shifting settled sludge to the centre hoppers under all operational conditions over the full period from end of the Trial Operating Period to final inspection preceding the issue of the Final Performance Certificate.

Similarly, the desludging equipment and control system shall be seen to operate reliably in discharging the desired rates of flows and durations and frequencies of opening (as determined by commissioning trials and agreed with the Employer's Agent) under all operational conditions over the full period from end of the Trial Operating Period to final inspection preceding the issue of the Final Performance Certificate.

The Contractor is required to satisfactorily resolve any functional issues identified at any stage up to the issue of the Final Performance Certificate.

6.4 Design Parameters, Layout and General Arrangement

CLARIFLOCCULATOR DIMENSIONS & LOADING	
Parameter	**Description**
Number of Units	4
Type of Technology	Clariflocculators (but ***without*** slow-mixers in central flocculation well)
Tank Details & Dimensions	***See drawings (MECH 210-01 to 05)*** Inside diameter of main tank wall: 25.00m
	Main tank wall thickness: 300mm
	Centre of tank to centre of perimeter wall (bridge span): 12.65m
	Top-of-perimeter wall to floor (at wall): 4765mm
	Top-of-perimeter wall to floor (at central hopper): 5669mm
	Central sludge hopper volume: 10m^3 Hopper diameter at top: 3421mm
	Diameter of desludge pipe under tank: 200mm
Hydraulic Load per tank	Max: 15 Ml/d (174 ℓ/s) At Design Capacity: 12.75 Ml/d (both at assumed recycle flow rate of 2%)
Design maximum raw water solids concentration (dry mass per litre)	175mg/ ℓ
Estimated sludge load	Max: 2 200kg/d dry solids per clariflocculator at 12.5Ml/d raw water inflow
	Max daily volume to desludge at 1% solids concentration (worst case scenario): ~220m^3 per tank
	Target desludge rate: Min 60 ℓ/s (=2m/s velocity in desludge pipe under tank)

CLARIFLOCCULATOR ROTATING BRIDGE (4 No)	
Parameter	**Description**
Central Bridge Slew Bearing & Trunnion Plate Arrangement	Central bearing shall be designed for long-life continuous rotation with central electrical duct and 9-strip electrical slip-ring for powering bridge drive motor etc. Slew bearing to be based on long service life greaseless system (Teflon pad on highly-polished stainless steel plate or similar approved). Trunnion plate connection to bridge to allow for uneven perimeter wall. **NOTE:** There is a 63mm HDPE cable duct with ski-rope draw (for the bridge power and signal cable) cast into the Central bridge support slab and column under; this follows the inlet pipe under the tank and exits above ground level above the inlet pipe.
Rotating Half-Bridge Structure	The bridge shall be fabricated from mild steel and designed to support a continuous line live load of 1kN/m without the mid-span deflecting more than 10mm.
	The bridge shall be pre-chambered to give a residual 10mm mid-span under full dead load (bridge, scrapers and scraper support frame and tank empty).
	If the design of the bridge span has one or more bolted joints (for purposes of transport), the jointing faces shall incorporate fixed locating pins (or other locking mechanisms) such that, if the bolts come lose, the bridge will not sag.
	GMS handrails both sides of bridge and step for access onto bridge from clariflocculator wall
	GRP floor grating with ss clips
Scum baffle / scraper	Not required
Vertical shaft paddle stirrers on bridge for central floc chamber	Not required
Scraper support frame below bridge	The bridge drive, the drive torque limiter and the bridge structure to be designed to provide sufficient rigidity to hold scraper blades in firm alignment relative to tank floor whilst pushing through sludge that has been allowed to accumulate and consolidate for 7 days without the bridge turning or desludge valve opened. **Material of construction:** All frame components below bridge to be fabricated from 304L or duplex stainless steel.
Floor scraper blades	Multiple straight blades not less than 200mm high attached directly to the support frame and angled to effectively and progressively shift settled sludge from the outer floor edge to the central concentration hopper. Blades to be fitted with adjustable rubber wipers set to just touch tank floor at circumferential high points ***(floor to be screeded by local SMME under this Contract once scraper mechanism is in place)***
	Circumferential high points on floors to be checked with the Employer’s Agent once bridges are operational but before scraper blades are fixed in place.

CLARIFLOCCULATOR ROTATING BRIDGE (4 No)	
Parameter	**Description**
	Material of construction: 304L or duplex ss
	Note: A single curved blade arrangement will not be accepted.
Bridge outer support	Double wheel carriage rigidly attached to bridge structural members.
Bridge Drive Mechanism	Electrically-driven trailing wheel through reduction gearbox c/w torque-limiter device and steel guard plate ahead of leading wheel between tank wall and bridge carriage.
	Local 'Auto-Off-Manual' selector switch, On/Off push-buttons and Run/Stop/Trip lights in cabinet with weather-proof door mounted on handrailing
	Stainless steel Emergency Stop pull-cable along handrail to run full length of bridge
Bridge Speed of Rotation	1.63 revs per hour (+/- 5% of this)
Bridge Drive Wheels	Solid urethane coated steel rims on solid mild steel shaft with ***sealed-for-life*** bearings either side (bearing housing bolted to bridge end carriage with precision-alignment for wheels to track the tank wall centreline without scuffing).

CLARIFLOCCULATOR DESLUDGE SYSTEM (4 No.)	
Parameter	**Description**
Desludge System by Specialist Supplier (Prime Cost item)	Specialist supply and installation includes: • DN200 tank scour valve with extn spindle • DN200 flow regulating valve with extn spindle • DN200 diaphragm de-sludge valve (complete with control pipework and solenoid valve system and connection to potable water supply). • EXCLUDED: PLC and signals and power to each chamber – see Elec Specs for these.
Desludge control	Diaphragm valve closes by being pressurised with potable water off site reticulation (max 5 Bar at elevation of control equipment). Valve opens when diaphragm pressure is vented to atmosphere.
	Automatic Mode: Pressurising / de-pressurising frequency and duration by PLC-controlled DN32 PN10 3-way 24V AC solenoid-actuated ball valve. ***In event of power failure, valve must default to pressurising position (no sludge flow).***
	Manual desludging / tank draining by operating DN32 ¼-turn lever ball valves.
	PLC in MCC in Dosing Building.
	Solenoid valve to be housed in cabinet with weather-proof door mounted above-ground on wall of desludge chamber.

CLARIFLOCCULATOR LAUNDER CHANNEL V-NOTCH WEIR PLATE	
Parameter	**Description**
V-notch Weir Plate	See drg **MECH 210-05** for dimension details The weir plates shall be sealed against the concrete launder channel wall by means of a UV-resistant marine grade silicone-rubber sealant only after accurate alignment (levelling) marks have been made on the concrete wall and the anchor bolts are in position ready to tighten.
	Material: 304 Stainless steel (minimum 2mm thick) with ss anchor bolts
	Weir plates to be installed level all around within +/- 1mm tolerance (ie max allowable variation over whole circumference of 2mm). V-invert to be set 10mm above highest point on launder channel concrete wall (Contractor to survey wall to identify highest point).

6.5 Testing and Commissioning

Commissioning Stage

Acceptance testing of bridge drive and bridge / frame stiffness to include successful starting-up and rotation (without driver torque-limiter cutting-in or frame visibly deflecting) through sludge that has been allowed to accumulate for 7 days without the bridge turning or desludge valve being opened.

The rotating bridge and scraper assemblies shall be seen to operate reliably, smoothly and steadily while successfully shifting settled sludge to the centre hoppers.

The desludging equipment and control system shall be seen to operate reliably in discharging the desired rates of flows and durations and frequencies of opening.

As soon as the Works is operating steadily, the Contractor shall work with the Employer's Agent to optimise the frequency and duration and rate of desludging settings to match sludge production and to maximise sludge thickness to be dewatered.

Final Acceptance Stage

The final Performance Certificate shall only be issued once the Employer's Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that the sludge collection and desludging system is still operating optimally, effectively and reliably.

6.6 Spares

The Contractor's Specialist Supplier shall provide the following spares:

- 4 No. 3-way solenoid valves suitably-packaged and labelled and stored in Dosing Building Store Room.

7 FILTRATION EQUIPMENT

7.1 General Description

The Works comprises two independent 25Ml/d clarification and filtration modules; each module comprising two clariflocculators and one filter building. There is no cross-connection of inflow between the two modules. There is a separate filter plant building (containing bashwash pumps and air blowers) serving both filter buildings.

This section covers all the filtration and backwash equipment required to equip the two filter buildings and associated filter plant building. All the building work is already complete. Apart from all actuated valves and sluice gates, most of the filtered water outlet & backwash water inlet manifold pipework has already been installed and all backwash water pipework between the two Filter Buildings and the Filter Plant Building is currently being installed.

Refer to the following drawings for the general filter arrangement:

J31067-PID_304 ME	Highbury WTW: P&ID: Filter Building No1
J31067-PID_305 ME	Highbury WTW: P&ID: Filter Building No2
J31067-PID_306 ME	Highbury WTW: P&ID: Filter Plant Room & Clear Water Reservoirs
J31067/MECH_220-01	Rapid Gravity Sand Filter1 - Sheet 1 of 10
J31067/MECH_220-02	Rapid Gravity Sand Filter1 - Sheet 2 of 10
J31067/MECH_220-03	Rapid Gravity Sand Filter1 - Sheet 3 of 10
J31067/MECH_220-04	Rapid Gravity Sand Filter1 - Sheet 4 of 10
J31067/MECH_220-05	Rapid Gravity Sand Filter1 - Sheet 5 of 10
J31067/MECH_220-06	Rapid Gravity Sand Filter1 - Sheet 6 of 10
J31067/MECH_220-07	Rapid Gravity Sand Filter1 - Sheet 7 of 10
J31067/MECH_220-08	Rapid Gravity Sand Filter1 - Sheet 8 of 10
J31067/MECH_220-09	Rapid Gravity Sand Filter1 - Sheet 9 of 10
J31067/MECH_220-10	Rapid Gravity Sand Filter1 - Sheet 10 of 10
J31067/MECH/216-01	Filter Backwash delivery and suction pipework fitting details (Sheet 1 of 4)
J31067/MECH/216-02	Filter Backwash delivery and suction pipework fitting details (Sheet 2 of 4)
J31067/MECH/216-03	Filter Backwash delivery and suction pipework fitting details (Sheet 3 of 4)
J31067/MECH/216-04	Filter Backwash delivery and suction pipework fitting details (Sheet 4 of 4)
J31067/MECH/221	Blower Pipework and Fitting Details (Indicative)
J31067-MECH_240-01	Filter Pump Room (sheet 1 of 2)
J31067-MECH_240-02	Filter Pump Room (sheet 2 of 2)

7.2 Scope of Equipment

The equipment to be supplied is as follows:

- Precast false-floors with nozzle sleeves cast-in and screw-in filter nozzles for 8 No. filters (**Note:** An alternative filter floor system such as pipe laterals will NOT be accepted);
- Single-sized Silica-Quartz filter media (0.95mm effective size) to 900mm depth for all 8 filter beds;
- 8 No. manually-operated rising-gate weir sluice gates to filter inlets;
- 8 No. DN300 electrically-actuated settled water inlet valves linked to backwash control system (non-modulating actuator for open/close duty only);
- 8 No. DN400 electrically-actuated filtered-water outlet valves linked to backwash control system and ultrasonic level sensors (continuously-modulating actuator for maintaining constant filter bed water level);
- 8 No. DN150 electrically-actuated air scour inlet valves linked to backwash control system (non-modulating actuator for open/close duty only);
- 8 No. DN400 electrically-actuated backwash water inlet valves linked to backwash control system (non-modulating actuator for open/close duty only);
- 8 No. 600mm dia electrically-actuated spent backwash water valves with 3CR12 backing plate wall-mounted over 600x600mm opening at end of washout launder channel and linked to backwash control system (non-modulating actuator for open/close duty only);
- 8 No. float switches (on adjustable–height cables) hanging in filters for initiating auto backwash sequence.
- 3 No. (2 Duty, 1 Standby) backwash pumpsets in Filter Plant Building complete with:
  - GMS suction and delivery manifolds and associated fittings and instrumentation designed to connect to existing 304L stainless steel puddle-pipes through wall (DN500 suction and DN400 delivery) (pipework between Filter Buildings and Filter Plant Building by Civil Contractor)
  - Concrete plinths modified (if necessary) to suit particular pumpset frame supplied under this Contract
  - All associated electrical control and instrumentation equipment, including two DN500 electromagnetic flow meters on delivery line (to be retro-fitted in chambers constructed by civil contractor) (see Electrical Specification)
- 2 No. (1 Duty, 1 Standby) ‘Roots’-type air blowers installed in Filter Plant Building complete with inlet and outlet silencers, sound-attenuating hoods with motor-cooling forced-ventilation fans, pressure-relief valves, isolating valves, clogged air filter indicators and cut-out switches.
- Design, supply and install all air delivery pipework (buried and above-ground and all associated supports and fixings and holes through walls) from blowers to each of the 8 air scour inlet valves mentioned above.
- 4 No. Backwash Control HMIs wall-mounted next to doors between filters (for monitoring status, initiating backwash and monitoring progress). (see Electrical Project Specifications).
- All sensors, instrumentation, MCC panel (with built-in HMI and PLCs), signal and power cables (including ducting, cable trays, connections to SCADA etc) required to complete the filter system (see Electrical Project Specifications).
- 2 No. manual gantry-beam trolleys and chain block (2 tonne rated capacity) installed on existing fixed gantry beams in Filter Plant Building.
- Service and adjustments as necessary.
- Spare filter nozzles as detailed in Section 7.6

In addition to the above scope of supply, a BoQ item has been included to thoroughly clean the following (to remove all dust, silt and debris that can get wedged in the inside of the filter nozzle slits when backwashing for the first time) immediately prior to fitting the filter nozzles in the false floors:

- The chlorine contact tank roof slabs, walls and floors;
- All backwash pump suction pipework between the chlorine contact tanks and the pumps;
- All backwash pump delivery pipework between the pumps and the central plenums in all 8 filters;
- All 8 central plenums under the spent backwash water launder channel;
- All 16 plenums under the filter bed false floors .

7.3 Functional Requirements

The Contractor shall design and provide everything necessary for a fully functional and effective filtering and backwashing system as outlined hereunder.

In particular, the design of the backwash control system shall be such that, should a fault develop with any of the water level sensors or valve or sluice gate actuators whereby backwashing of the affected filter cannot proceed until the fault is rectified, the affected filter shall be automatically taken off-line without affecting the automatic backwashing of the other filters.

Settled Water Inflow Distribution and Control

Each Filter Building has 4 No. rapid gravity sand filter beds. The incoming settled water from the clariflocculators is evenly split between the four filters by means of manually-adjusted rising weir gates installed in an inflow channel. Separate electrically-actuated butterfly valve inlets (immediately downstream of the rising-weir sluice gates) allows the inflow to a particular filter bed to be temporarily halted for backwashing.

Filtered Water Outflow Control

The water level in each filter bed is maintained at a preset level (irrespective of rate of inflow to filter) by means of a constantly-modulating electrically-actuated filtered water outlet valve linked to an ultrasonic water level sensor. As the filter bed becomes progressively clogged, the outlet valve opens more and more to keep the water level above the filter sand at a preset constant level (default value: 50mm above spent-backwash water outlet launder).

The driving head for filtration (water level in filter to water level in filtered water sight-box) (which overflows a 1150mm wide weir into the chlorine contact tank) is approximately 850mm (depends on rate of flow). The sight-box overflow weir crest is approximately 145mm lower than the top of filter media, so sub-atmospheric conditions in the media is avoided.

Once the filtered outlet valve is fully-open, the water level in the filter will start to rise. At a preset High Water Level (default value: 250mm above spent-backwash water outlet launder), a PLC-controlled backwash sequence is automatically initiated.

The PLC shall automatically initiate a backwash sequence after a pre-set time since last backwash (default setting: 48h) if not first initiated by a rising water level.

The Operator can manually initiate a backwash sequence at any time.

Source of Backwash Water

The two Filter Buildings each have a chlorine contact tank below the filter beds into which the filtered water is discharged. The chlorine contact tanks stay permanently full as they each have a bellmouth outlet draining treated water to the clear water reservoirs. The tanks are interconnected only by means of the backwash pump suction pipework.

Backwash water will be drawn from the upstream end of the chlorine contact tanks (before chlorine is added). The tanks can be individually isolated from the backwash pump suction pipework by means of sluice gates. Under normal operation, both sluice gates are left fully open.

Automatic Backwash Modes

Two alternative automatic backwash modes are to be programmed into a PLC (Operator to select Mode applicable to all filters on HMI):

- **Mode 1:** Air scour followed by water backwash
- **Mode 2:** Air scour, then combined air and water, then water-only

The Works Supervisor shall be able (with password access to control settings) to adjust elapsed time periods of each of the relevant backwashing steps. The most effective elapsed time settings for each mode to be determined by the Contractor and Employer's Agent at commissioning stage.

The backwash control PLC shall not allow more than one filter to be backwashed at a time under any circumstances.

Backwashing Sequence: Mode 1

The backwashing sequence comprises:

- Close settled water inlet valve
- Allow water level to drop to 300mm above the top-of-sand level (controlled by ultrasonic level sensor), then close filtered water outlet valve
- Open spent-backwash water launder channel outlet sluice gate
- Open air scour inlet valve
- Start duty air blower and run for preset period (default period: 5 minutes)
- Stop duty air blower
- Close air scour inlet valve
- Open backwash water inlet valve
- Start duty-1 and duty-2 backwash pumps (~2 second staggered start) and run for preset period (default period: 10 minutes)
- Stop duty backwash pumps
- Close backwash water inlet valve
- Close spent-backwash water launder channel outlet sluice gate
- Open settled water inlet valve
- Allow water level to rise to 50mm above the top of spent-backwash water launder channel (controlled by ultrasonic level sensor), then open filtered water outlet valve in continuously-modulating mode

Backwashing Sequence: Mode 2

The backwashing sequence comprises:

- Close settled water inlet valve

- Allow water level to drop to 300mm above the top-of-sand level (controlled by ultrasonic level sensor), then close filtered water outlet valve
- Open spent-backwash water launder channel outlet sluice gate
- Open air scour inlet valve
- Start duty air blower
- After 2 minutes has elapsed, open backwash water inlet valve
- Start duty-1 backwash pump
- After 5 minutes has elapsed, stop duty air blower
- Close air scour inlet valve
- Start duty-2 backwash pump
- After 5 minutes has elapsed, stop both duty backwash pumps
- Close backwash water inlet valve
- Close spent-backwash water launder channel outlet sluice gate
- Open settled water inlet valve
- Allow water level to rise to 50mm above the top of spent-backwash water launder channel (controlled by ultrasonic level sensor), then open filtered water outlet valve in continuously-modulating mode

Manual Backwash

It shall be possible to manually initiate a backwash of a particular filter from the local HMI at any time, provided that no other filter is currently running through a backwash sequence.

It shall also be possible to manually open and close any of the actuated valves via open / close buttons on the actuator itself.

PLC and HMIs for Filters

The filters are to be controlled via a PLC in the Filter Plant Building MCC. Setting adjustments are to be made on an HMI in the abovementioned MCC.

Local basic HMIs (one per two filters) in positions in Upper Filter Gallery are to be provided to (for the particular filter selected):

- Display the status of each actuated valve / sluice gate (open / shut / xx% open in the case of the filtered water outlet valve)
- Display hours since last backwash;
- Initiate backwash sequence;
- Display where backwash process is in terms of the backwash stages;
- Display countdown of current stage time remaining

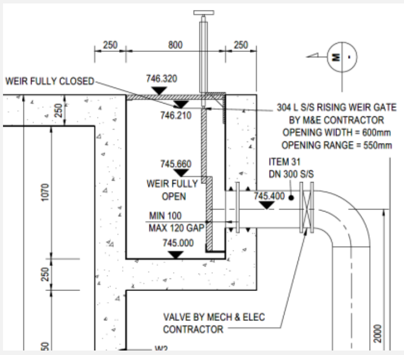
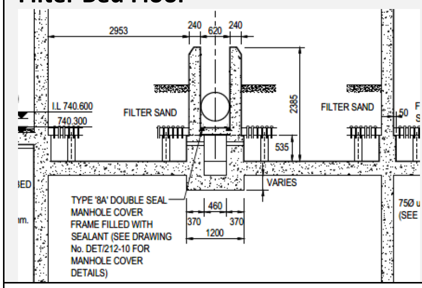
Backwash Pump Duty Head

The Contractor shall be responsible for determining the Duty Pumping Head required to backwash the filters at the minimum specified rate of flow. The calculation shall be based on which of the 8 filters requires the most pumping head given the suction and delivery pipework geometry. The motors shall be controlled by means of VSDs to allow for fine-tuning of backwash flow rate.

Air Blower Delivery Pipework

The Contractor shall be responsible for designing (sizing, routing, piping supports etc), supplying and constructing all aspects of the pipework from the air blowers in the Filter Plant Building to the existing DN150 PN10 flanged connection points on the filter inlet manifolds. An indicative routing and choice of pipe materials is given on drawing J31067/MECH/221 ME. The Contractor's design shall be submitted to the Employer's Agent for approval before any materials are ordered.

7.4 Design Parameters, Layout and General Arrangement

FILTER DETAILS	
Parameter	**Description**
Number of Filters	4 + 4 No. (2 No. Filter Buildings)
Type	Constant-flow rising-head Rapid Gravity Sand Filter
Inflow Control to Filter Beds 	**Equal division of incoming flow between on-line filters** 8 No. 304L ss manually-actuated weir gates (550mm weir vertical travel, 600mm weir width) surface-mounted to inside of 800mm wide settled water inlet channels complete with GMS pedestal and handwheel. Gap between channel wall and lower (fixed) part of weir gate to be not less than 100mm but not more than 120mm (water overflowing weir has to be able to flow into DN300 pipe into filter)
	Isolating filter inflow for backwashing: 8 No. DN300 electrically-actuated filter bed inlet butterfly valves linked to backwash control system (non-modulating actuator). **Note 1:** DN300 GMS downpipes into filters already in place; above valves to be retro-fitted **Note 2:** An extension spindle is to be fitted to each of the valves such that electrical actuator is physically positioned above the inlet channel walkway where it can be easily accessed for manual opening / closing
Filter Bed Floor 	**Filter Bed dimensions:** 2 950mm x 11 500mm x 2 No per filter (two connected sides separated by launder channel) ***Contractor to confirm exact 'as built' dimensions and squareness on-site and fit false floor accordingly***
	Monolithic false-floor (prefabricated fibre-cement panels supported on each corner with 535mm high reinforced concrete stub columns with reinforced concrete topping (minimum 25MPa) and cast-in sleeves for screw-in nozzles)
	Floor surface with cast-in sleeves to be cast to level variation not exceeding 2.0mm lowest point to highest point
Design settled water flow rate for all 8 filters on-line	53Mℓ/d continuous flow
Total sand bed area each filter	67.85m^2
Design flow rate per filter (all filters on-line)	276m^3/h
Loading rate at Design Flow (all filters on-line)	4.07m/h
Loading rate at Design Flow (1 of 4 filters off-line for backwashing)	5.42 m/h
Filter nozzles	**Material:** Caps and nozzles fabricated in polypropylene
	Spacing: Min 43 nozzles per m^2 (= ~150mm c/c spacing)
	Slot width: 0,3mm Slots to be of the non-clogging tapered / wedge type (progressively wider slot width from outer to inner face)

FILTER DETAILS	
Parameter	**Description**
	Headloss through nozzle stem at full water-only backwash: Between 150mm and 300mm. Stem also designed for equal air scour-only distribution and combined water and air backwash) NOTE: Only 1 of 2 backwash pumps operate simultaneously with air
Filter media and depth	High quality natural single-graded silica quartz sand; D_{10} effective size of 0.95mm +/- 0.05mm (10% by mass less than 0.95mm) [Test Method: ASTM C136]
	Uniformity Index (D60/D10): Less than 1.4 [Test Method: ASTM C136]
	Grain Density: 2 600 to 2 700 kg/m^3 [Test Method: ASTM C128-93]
	Acid solubility [Test Method: AWWA B100]
	Silica content: Greater than 95.0% [test Method AWWA B100]
	Required depth of media in filters: 900mm +30/-0mm from surface of false floors after all fines have been rinsed out
	Volume of sand (all 8 filters): 489m^3
Washout weir freeboard above top-of-sand	~785mm
Backwash water upflow rate through sand bed	21m/h -0/+4m/h (VSD used to adjust pump speed)
Backwash water flow rate (2 Duty pumps running)	1426 m^3/h
Duration of water backwash	**Mode 1:** Nominal 10 minutes (must be adjustable)
	Mode 2: Nominal 5 minutes with air & 5 minutes water-only
Backwash water volume from the backwashing of one filter	Approx 238m^3 (both Mode 1 and Mode 2)
Auto initiation of backwashing	Once every 48h or when filter water level rises to pre-set limit (whichever occurs first)
Access to plenum under false floor	One DN450 access port (with blank flange cover) per half bed (ie 2 per filter) has been provided for access to plenum if needed for inspection / flushing etc.
Access to central plenum under launder channel	One 400x600 cast-iron double-seal manhole cover and frame with ss holding-down bars has been provided for access into the plenum. The cast-iron double seal needs to be re-sealed with an elastomer sealant (to be air-tight when the air blower is running) every time it is opened.
Filtered Water Outlet Control Valve	8 No. DN400 electrically-actuated filtered-water outlet butterfly valves linked to ultrasonic level sensors and backwash control PLC (continuously-modulating actuator for maintaining constant filter bed water level)
	Actuator internal modulating control system to be linked directly to ultrasonic level sensor (not via PLC) for positioning valve to keep filter water level constant. Actuator to incl integral diagnostic function.
	An extension spindle is to be fitted to each of the valves such that electrical actuator is physically positioned above the top

FILTER DETAILS	
Parameter	**Description**
	of concrete pipework channel where it can be easily accessed for manual opening / closing (extension height ~3m) and cannot get flooded.
	Preset constant level: 50mm above spent-backwash water outlet launder **Preset backwash initiation level:** 195mm above spent-backwash water outlet launder
	Remove temporary spool pieces in pipework constructed under civil works and install valves.
Backwash Water Inlet Valve	8 No. DN400 electrically-actuated backwash water inlet butterfly valves linked to backwash control system (non-modulating actuator for open/close function only)
	An extension spindle is to be fitted to each of the valves such that electrical actuator is physically positioned above the top of concrete pipework channel where it can be easily accessed for manual opening / closing (extension height ~3m) and cannot get flooded.
	Remove temporary spool pieces in pipework constructed under civil works and install valves.
Air Scour Inlet Valve & air delivery pipework	8 No. DN150 electrically-actuated air scour inlet butterfly valves linked to backwash control system (non-modulating actuator for open/close function only)
	Contractor to design and construct air delivery pipework from Duty & Standby air blowers to existing DN150 PN10 connections on filter inlet manifolds.
Spent backwash water sluice gate	8 No. 304L ss electrically-actuated surface-mounted DN600 butterfly valves on 3CR12 backing plates over 600x600mm opening with rising spindle with electrical actuator physically positioned above the top of the backwash channel wall where it is accessible for manual operation and cannot get flooded.
	Actuator to be non-modulating for open/close function only.
All valve and sluicegate electrical actuators	All of the electrical actuators for the above to include the following: • Forward / reverse controller to be integral part of actuator (with indicator lights) and to allow local adjustment of valve position in event of PLC failure • Actuator anti-condensation heater to be powered from internal connection. • Internal circuits to protect motor from dropped phase and include auto phase rotation correction. • IP68 cable sealing glands • Robust GMS extension pedestals for mounting actuators at required heights above valves where the weight of the pedestal and actuator does not bare on the valve body

AIR BLOWERS	
Parameter	**Description**
Number of Blowers	2 No. (1 Duty; 1 Standby)
Type	V-Belt-driven Roots (rotary double-lobe positive displacement) c/w rubber mounting, replaceable paper-element air filter, clogged air filter indicator and cut-off switch, inlet silencer, outlet silencer, Kunkle pressure-relief valve, non-return valve, isolating valve, pressure gauge, force-ventilated acoustic hood with removable access panels.
Site Altitude for blower sizing	742masl
Air scour loading rate at 1013mBar & 20°C	Min 30 m/hour (2100m^3/h)
Motor	400V Class H, IP55, IE1 efficiency, DOL-starting air-cooled electric motor
Air blower design max operating pressure (max pressure experienced on commencement of air scour)	Minimum 30kPa or sufficient to easily displace water in inlet pipework and filter plenum and with water in filter at spent-backwash water launder channel weir level (743.015 masl), whichever is the higher. **Note:** lowest point for air to push through in flooded delivery pipework has crown elevation of 741.56masl.
Pressure-relief valve setting at Blower outlet	Sufficiently-high to not vent under steady-state operating conditions. Contractor to determine steady-state operating head when supplying filter bed furthest away from blower units (depends on Contractor's delivery pipework design).
Max noise level outside acoustic hood	Less than 75dBa measured 3m away from hood

BACKWASH WATER PUMPS (more details given in Project Spec: PUMPING EQUIPMENT)	
Parameter	**Description**
Number of pumps	3 No. (2 Duty; 1 Standby)
Duty Flow (2 Duty pumps running)	**1426 m^3/h (713 m^3/h per pump)**
Pump Flow during combined water and air backwash (one Duty Pump running)	Approximately 1000m^3/h (may need to lower speed on VSD when only 1 pump running)
Static Head	**TWL in chlorine contact tank:** 742.17masl (does not vary) **Spent backwash launder weir level:** 743.80 masl **Static Head:** 1.63m
Total Dynamic Head at Duty Flow (2 Duty pumps running)	4.98m

7.5 Testing and Commissioning

Commissioning Stage

The Contractor shall be responsible for the design and setting-up and proper functioning of the filtering and backwashing system. The system shall only be deemed ready for Employer Taking Over once it has been demonstrated to the Employer's Agent that the filtering and backwashing systems are operating optimally, effectively and reliably.

Having verified that the false floor has been constructed in accordance with the Project Specifications and the Contractor's approved design and similarly that all mechanical and electrical equipment supplied and installed complies with the manufacturer's installation requirements and Project Specifications and the Contractor's approved design and list of materials and equipment approved at Contract Award stage, acceptance testing at commissioning stage shall comprise demonstrating that:

- An even bubble-pattern across the entire bed area of all 8 filters is achieved when the Duty air blower is operating (with water level about 300mm above the surface of the sand).
- The backwash water flow rate on all 8 filters is not less than the flow specified for water-only stage.
- The automatic and manual initiation of backwashing functions reliably and the full backwash cycles under Mode 1 and Mode 2 function reliably in all 8 filters as per the approved design.
- All actuated valves and sluice gates operate smoothly, steadily and reliably and close drop-tight.

As soon as the Works is operating steadily, the Contractor shall work with the Employer's Agent to optimise the duration of air scour, combination of wash water and air scour and water-only stages of the two operating modes.

Final Acceptance Stage

The final Performance Certificate shall only been issued once the Employer's Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that the filtering and backwashing system is operating optimally, effectively and reliably.

7.6 Spares

The Contractor shall provide the following spares:

- 500 No. filter nozzles in labelled wooden crate in Workshop Building Storeroom.

8 CHLORINATION EQUIPMENT

8.1 General Description

This section covers all the chlorine gas storage and dosing and emergency scrubbing equipment required to disinfect two separate and independent filtered water streams. All the building work is already complete.

The design of the Chlorine Building allows for an unventilated room for housing two banks of 3 No. chorine drums (one bank on-line and one on automatic change-over standby) and 6 cradles for the storage of spare full drums or empty drums. The Building has a separate adjoining room (with fixed glass windows for viewing the gas room) for the chlorine gas regulating and dosing equipment and chlorine gas leak detection equipment. An emergency dry scrubber unit is positioned outside alongside the Chlorine Building. The latter is linked to the gas leak detector and, at a preset chlorine ppm level, shall automatically start drawing air from the gas room through the scrubber.

A dedicated 90mm HDPE high pressure pipeline from an offtake on the Rosedale Clear Water Rising Main is provided for supplying carrier water for dosing the filtered water with chlorine at the head of the chlorine contact tanks (no booster pumps needed).

Chlorine dosing is to be entirely manually controlled by the Works Operator who will take periodic samples of the residual chlorine concentration in the final clear water leaving the waterworks and adjust the two gas chlorinators accordingly.

Under normal circumstances, the two 25Ml/d clariflocculator / filter modules will always operate at the same rate of flow and will therefore be dosed with the same kg/h of chlorine. If one clariflocculator is taken off-line for any reason (thereby halving the flow through that clariflocculator / filter module), the Works Operator will need to adjust the kg/h chlorine dosing to both modules in proportion to different flows (in this example, 33% : 67%).

The Highbury WTW has been designed to eventually accommodate 4 x 25Ml/d clariflocculator / filter modules. The Chlorine Building is to ultimately serve all four modules. The Contractor is to bare this in mind when designing the chlorine gas piping and layout of equipment and make due allowance for the future addition of two more chlorine dosing streams off the Duty / Standby chlorine gas manifolds to be provided under this Contract.

Refer to the following drawings for the general chlorine dosing and gas scrubber arrangement:

J31067-PID_310 ME Highbury WTW: P&ID: Chlorine Dosing & Scrubber

J31067-MECH_400-01 ME Chlorination Building (Sheet 1 of 4)

J31067-MECH_400-02 ME Chlorination Building (Sheet 2 of 4)

J31067/MECH_220-01 ME Rapid Gravity Sand Filter1 - Sheet 1 of 10 (chlorine dosing point)

8.2 Scope of Equipment

The equipment to be supplied is as follows:

- Chlorine Gas Storage Room
    - 2 No. banks of 3 No. 1 tonne net content chlorine gas drums (1 Duty bank, 1 Standby bank) complete with:
        - Support trunnion cradles with load cells for read-out of remaining gas in adjoining dosing room;
        - Flexible leads between drums and gas manifolds including connections and manual isolating valves
        - Two wall-mounted gas manifolds complete with liquid traps and heating tape and gas filters and manifold isolating ball valves;
        - Vacuum regulator (2 No. if not integral with change-over device)
        - Pressure relief vent valve on manifold (2 No. if regulator not integral with change-over device).
        - Vacuum change-over device between Duty and Standby banks (separate or integral with vacuum regulator)
        - Gas dosing pipework from change-over device to both gas dosing regulators in chlorine dosing room complete with isolating valves.
    - 6 No. cradles for storage of 1 tonne net content chlorine gas drums.
    - 2 No. manual 5 tonne gantry trolleys; each with manual chain-block pulley (SWL of 3 tonnes) and 2 No. chlorine drum lifting beam (SWL of 3 tonnes).
    - 2 No. wall-mounted panel heaters with thermostat to keep gas storage room at about 20^{o}C (minimum rating 425W).
    - Nitrile or Butyl rubber sealing strips at bottom of existing doors to gas storage room
    - Supply of 12 full drums for commissioning and operation (Prime Cost item)
    - Supply of three spare flexible connections between chlorine drums and manifolds (including spare washers where appropriate).

- Chlorine Dosing Room
    - 2 No. 5kg/h wall-mounted manually-adjusted gas dosing regulators (for two separate dosing lines), each delivering gas under sub-atmospheric pressure to wall-mounted venturi gas injectors (2 more gas dosing regulators to be added in future when Works upgraded to 100Ml/d).
    - Water supply to injectors from dedicated 90mm PN20 HDPE potable water pipeline immediately outside chlorine building (no booster pumps required; dedicated water supply at ~12Bar off clear water rising main provided by civil contractor). Water connection to include bifurcation, each with isolating ball valve, in-line strainer, adjustable pressure reducing valve (with pressure gauges each side) to manually regulate rate of flow and mechanical flow meter;

  - All uPVC dosing pipework from gas injectors to each Filter Building (2 separate dosing lines), including trenching and backfilling, drilling holes through reinforced concrete walls in Filter Buildings and Chlorinator Building and distributors at inflow point to Filter Building Chlorine Contact Tanks.

- Gas leak warning and scrubber system:
  - Gas leak detection device in chlorine dosing room with sensor in chlorine gas storage room including visual (strobe light) and audible alarms (siren) and all associated piping and connections and control wiring and links to SCADA
  - Dry scrubber system installed outside the gas storage room on a reinforced concrete slab (slab by civil contractor to M&E Contractor requirements) complete with:
    - automatic activation link to leak detector;
    - uPVC suction manifold at floor level in gas storage room;
    - GRP scrubber unit loaded with chlorine gas neutralising balls sufficient to neutralise 1 tonne of chlorine gas;
    - Extraction fan with exhaust stack;
    - All necessary electrical connections.

- Chlorine Safety Equipment:
  - 1No. Emergency shower and eye-wash station next to chlorine dosing room including pipework and connections to potable water reticulation.
  - 3No. full PPE kits (full-face cartridge respirator and acid-resistant suit, shoes and gloves) designed for gaseous chlorine environment in separate cabinets in polyelectrolyte Dosing Building.
  - 3No. spare sealed cartridges for respirator in sealed packets.
  - 2No. OH&S ‘Regulation 7’ first-aid boxes
  - 1No. UV-resistant orange windsock (conical tube with wind vane tail of robust design capable of resisting strong winds) mounted on a 1.5m high aluminium pole on the South-Eastern corner of the roof of the Chlorine Building.

- All modifications to Chlorination Building structure (cutting-out / drilling holes through walls and subsequent re-sealing etc) necessary for installing the chlorine equipment shall be included in this Contract the cost of which is to be covered by the BoQ item rates as scheduled.

- General
  - Provide all tools necessary for changing over gas drum connections.
  - Quarterly service and adjustments visits.
  - All hazardous material handling and safety signage

8.3 Functional Requirements

<u>Generally:</u>

The Contractor shall design, provide and install everything necessary for a fully functional, fit-for-purpose and effective chlorine storage, dosing and scrubbing system, including all emergency gear and safety signage which complies with SANS 10298: 2009, all as outlined in the Scope of Works and hereunder.

<u>Gas Drum Room:</u>

All equipment and materials supplied for installation in the gas drum room shall designed to be appropriately corrosion-resistant for occasional exposure to low concentrations (up to 5ppm for up to 1 hour) of free chlorine gas.

All units and pipework to be wall-mounted.

All penetrations through the wall between the gas drum room and chlorine dosing room for pipes and cables shall be properly sealed after installation of equipment.

Gas Dosing Room:

All equipment in the chlorine dosing room shall be wall mounted.

Dosing Pipework:

The Contractor shall be responsible for the design and supply of all materials and construction / installation of all delivery pipework and fittings to both dosing points. Only uPVC pipework rated to at least 12Bar (or other approved wet chlorine resistant material – NOT HDPE) shall be used.

Pipework between buildings shall be buried at least 1.0m deep below finished ground level.

Pipework emerging from below ground and attached to the walls of the Filter Buildings shall be fully protected from external impact damage by being installed between two back-to-back 50x50x4mm GMS angles anchor-bolted to the concrete wall. All uPVC pipe shall also be protected from direct sunlight.

The entry point through the wall of the Filter Buildings to the dosing points inside shall be at least 100mm higher than the TWL of the chlorine contact tank inside and shall be permanently sealed after installation of the pipework through the walls.

The sparge rings discharging the chlorinated water at the entrance to the two separate chlorine contact tanks shall be robustly attached to the concrete floor, walls and ceiling on all four sides using non-metallic anchors that are resistant to highly-chlorinated water.

Emergency Chlorine Gas Scrubber:

The emergency chlorine gas scrubber shall be of the dry chemical type which is ready for immediate automatically-initiated extraction and neutralising of leaking chlorine gas (upon detection of a chorine gas concentration in the gas drum room exceeding 5 ppm) and of sufficient capacity to neutralize the contents of a full 1-tonne chlorine gas drum.

All equipment making-up the complete emergency chlorine gas scrubber system, including media, blower assembly, blower control and starter panel, and appropriate connections for external duct work shall be provided by the manufacturer. The extraction pipework inside the gas drum room shall be mounted just above floor level along the full length of the wall separating the drum room and the chlorine dosing room and shall be fabricated from solvent-welded uPVC.

Local Agent: The system offered shall have a local (RSA) agent who can service it and supply replacement chemicals and parts where necessary. The local agent shall also be able to provide a media sampling service to determine the extent to which the media has been used-up following a gas leak event. The local agent shall also be required to certify that the system has been correctly-installed and test its functionality and train the operations staff on how it works and how to look after it.

Sampling: The Emergency Chlorine Gas Scrubber (ECGS) shall be configured to allow discrete sampling of the entire height/length of the media column/bed to determine the extent of spent media, and to allow replacement of the spent media without removing and replacing the entire media column/bed. Discrete beds may be preferred for ease of operations and maintenance.

Blower: The blower shall be sized to draw a minimum of 4000 cfm initial airflow through the scrubber system, under ambient air conditions and for 100% saturated air at 100ºC; and to assure sufficient air/Cl2 mixture flow, under maximum Cl2 release conditions, to maintain a partial vacuum throughout the Cl2 storage room. The manufacturer shall verify that the blower size is sufficient based on the attached drawings, and recommend any changes to the sizing. Blower static pressure rating, on air, and at standard conditions, should be sufficient to achieve the intended minimum mixture flow rate, based on operational test results.

Discharge Requirements: The ECGS shall be designed and verified by testing to assure that discharge air contains less than 1 ppm Cl_2, while operating at design Cl_2 loading rates.

Major components of the scrubber system, starting at the air inlet end, shall include:

- Corrosion Resistant Inlet Plenum with 18" circular duct connection;
- Corrosion Resistant Media Support Grids and Media Bed(s);
- Corrosion Resistant Housing;
- Corrosion Resistant Discharge Plenum with 18" circular discharge duct connection;
- Dry Adsorbent Media
- Blower-Motor Assembly
- Control/Motor Starter Panel.

Shipping: The ECGS system shall be factory assembled prior to shipping. If necessary, the ECGS system can be manufactured in pieces to facilitate installation through the pre-fabricated opening into an existing scrubber room. If the unit is provided in pieces, then detailed assembly instructions shall be included with the unit.

Materials of Construction: Scrubber housing and major structural members shall be fabricated of corrosion resistant and chlorine resistant material suitable for the application. Materials of construction shall be bid as alternates and may include: Temperature resistant Fiberglass Reinforced Plastic (FRP).

FRP shall be constructed in accordance with ASTM D-3299 standard specifications. The resin used shall be suitable for continuous exposure to a wet chlorine/air mixture with maximum operating temperature of 200°F. A certified letter of suitability for all resins must be submitted with the bids. A corrosion barrier on the inner surface shall be a Hetron 922 vinyl ester resin measuring a minimum of 10-20 millimeters. The resin shall be composed of reinforced non-continuous glass fibre strands applied in two plies of chopped strand mat equivalent to three oz/ft. The inner resin layer shall not exceed 10% + 15% "C" glass by weight. Filament wound laminates shall have an average glass concentration of 50-55% by weight. Hand Layup laminates when used on the vessels and equipment shall be fabricated to meet the physical properties in accordance with PS 15-69 product standard. Press moulded or compression mould flanged nozzles are acceptable up to and including 6 inch nominal size. All cut-walls shall be reinforced as required by ASTM D-3299.

Jointing: Scrubber housing and all components which will hold a chlorine release shall be fabricated without caulked, screwed or riveted joints, but rather seamless materials, welded construction, or gasketed joints (gasket material must be compatible with chlorine).

Media Containment Section: If discrete media beds are used, each media bed shall be contained between separate corrosion resistant support grids and perforated sheet material to provide media support while imposing a minimum resistance to air flow. The media containment section(s) shall be designed for bulk placement of new media into the unit through latched access hatches; and removal from the unit by vacuuming or manual handling, through media unload doors. The media containment section(s) shall be separated to assure filling and removal of individual beds as required. Specially designed fill chutes shall allow for media settling, but shall preclude bypass of contaminated air.

Blower (Extractor fan): The fiberglass blower shall be an externally mounted, belt driven, with backward inclined blades, sized to deliver 4000 cfm of airflow while adsorbing chlorine at the design rate. Blower must be located to cause air (gas) to be drawn through the scrubber, thus maintaining the scrubber internal atmosphere at a slight vacuum.

Differential pressure gauge: A gauge shall be included with the scrubber to permit local read-out of pressure loss through the system.

Blower control: The controls shall include low voltage signals to allow remote and local operation of the blower (i.e. on/off). The control panel shall allow for reception of a signal from the chlorine leak sensor in the chlorine storage room to automatically activate the blower. The blower shall only be turned off manually.

Adsorption media: The media shall be suitably impregnated with chemicals to enhance the capacity for removal of chlorine and to chemically-react to produce solid reaction products within the media. Activated carbon shall not be used due incompatibility with chlorine. Impregnants shall be applied during pellet formation, such that the impregnate is uniformly distributed throughout the pellet volume. The media shall be capable of absorbing and removing chlorine throughout the entire pellet volume and shall be totally non-flammable. The media will not dissociate in water

8.4 Design Parameters, Layout and General Arrangement

CHLORINATION EQUIPMENT	
Parameter	**Description**
No. of Dosing Points	2 No.
Max Filtered Water Flow Rate	55Ml/d over 24h split equally = 2 x 1145m^3/h
Max dosing rate	3.5mg/l
Normal dosing rate	1.5mg/l
Max chlorine demand	4.0kg/h per dosing stream
Normal chlorine demand	1.72kg/h per dosing stream
Max draw rate from Duty gas bank	8.0kg/h
No of 1 tonne gas drums (if all connected)	Duty Bank: 3 No. Standby Bank: 3 No.
Required minimum rated capacity for chlorinator vacuum regulator and change-over unit	10kg/h
Required minimum rated capacity for chlorine gas flow regulators and venturi injectors	5kg/h

CHLORINATION EQUIPMENT	
Parameter	**Description**
Dosing water flow rate and pipe size	To suit venturi offered (Contractor's design).
Drum cradles	Two rows of six cradles specifically designed for 2 Tonne Chlorine drums, six with load cells for accurate read-out of chlorine content remaining in the drums (for Duty and Standby drums) and six indication read-outs (Full / Empty for storage cradles)
Chlorine Gas Dry Scrubber Unit	Single Unit with minimum neutralisation capacity of 1 Tonne of chlorine gas
	Minimum air flow for extractor fan: 4000 cfm (American units). 1 No. Duty fan only.
	Minimum resolution of gas leak detection: 0.1 ppm
	Minimum range of gas detection 0.1 - 5 ppm

8.5 Testing and Commissioning

Commissioning stage

Before 'going live', the Contractor shall satisfy the Engineer that all pipework and connections have been pressure / vacuum tested (as appropriate) and that all safety protocols are in place and that a Certificate of Compliance is submitted.

Final Acceptance Stage

The final Performance Certificate shall only been issued once the Employer's Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that the chlorination system is operating safely, optimally, effectively and reliably.

The Contractor shall arrange and pay for the manufacturer's local agent for the emergency chlorine gas scrubber system to sample and test the adsorption media, just before the end of the Defects Notification Period, and confirm that it is still has capacity to neutralize 1 tonne of chlorine gas. Any reduction of neutralising capacity shall be made good at the Contractor's expense (unless there has been a leak event not related to faulty equipment or installation).

8.6 Spares

See Scope of Works – spares listed not measured separately for payment.

9 VERTICAL-SHAFT STIRRERS

9.1 General Description

This section covers the provision of 2 No. vertical shaft stirrers / mixers for the spent backwash holding tank and 4 No. vertical shaft stirrers for the sludge holding tank.

9.2 Scope of Equipment

The equipment to be supplied is as follows:

- Ultrasonic water level sensor linked to SCADA, stirrers and recycle pumps;

- 2 No. vertical-shaft platform-mounted 3CR12 stirrers and associated control linked to ultrasonic water level sensor (auto-on when water level rises above minimum operating level);
- Ultrasonic water level sensor linked to SCADA and stirrers;
- 4 No. vertical-spindle platform-mounted 3CR12 stirrers and associated control linked to ultrasonic water level sensor (auto-on when water level rises above minimum operating level).
- Quarterly service and adjustments visits.

9.3 Functional Requirements

The Contractor shall design and provide everything necessary for a fully functional and effective tank stirring systems for both the spent backwash holding tank and sludge holding tank as outlined hereunder.

All equipment offered shall be IP68 rated with respect to cable entries to terminal boxes and be suitable for unprotected outdoor conditions.

The stirrer requirements are the same for both spent backwash tank and sludge holding tank.

Slow-speed stirrers are required to prevent the excessive accumulation of settled sludge on the flat tank bottom. The stirrers shall be designed to impart sufficient mixing energy to re-suspend any settled sludge within a radius of at least 3m of the stirrer shaft.

The stirrers shall be designed to be operate with as low as practically possible minimum submergence and therefore as close as practically possible to the tank floor.

The stirrers shall be linked to an ultrasonic water level sensor and designed to operate continuously while the water level is above the minimum operating submergence. The stirrer motor shall automatically start once the water level in the tank rises 500mm above the minimum submergence level and stop when the level drops to the minimum submergence level.

Each stirrer shall have its own external weather-proof control box mounted on the handrails (with manual / auto selector switch and On / Off push-buttons behind a weather door) and external weather-proof emergency stop. The control panel shall also house LED Green (Run), Blue (Standby) and Red (trip) lights. The control panels shall be energised from isolation switches on the spent backwash recycle pumpstation MCC (spent backwash tank stirrers) or Sludge Dehydration Building (sludge holding tank stirrers).

9.4 Design Parameters, Layout and General Arrangement

SPENT BACKWASH WATER HOLDING TANK STIRRER DETAILS	
Type of tank	Rectangular
Internal Dimensions	See drawing
Max depth of liquid	2.5m
Top of Conc to floor height	3.0m
Max suspended solids concentration	2% dry mass (thin waterworks sludge)
No of Stirrers	2 No. vertical shaft stirrers with motor and reduction gearbox on concrete platform 0.5m above TWL
Type of stirrer	Low-shear blades (minimum 3 No.)
Stirrer diameter & speed	~ 1.5m dia, Max 60 rpm

SPENT BACKWASH WATER HOLDING TANK STIRRER DETAILS	
Motor size & speed	7.5kW rating, 4-pole
Reduction gearbox minimum service factor	3.5 x motor rating

SLUDGE HOLDING TANK STIRRER DETAILS	
Type of tank	Open-topped circular reinforced concrete with flat bottom (but with local sump in floor for emptying completely with dehydrator feed pump)
Internal Diameter	9m
Max depth of liquid sludge	3.0m
Top of Conc to floor height	3.5m
Max suspended solids concentration	1% dry mass (spent backwash water)
No of Stirrers	4 No. vertical shaft stirrers with motor and reduction gearbox on concrete platform 0.5m above TWL
Type of stirrer	Low-shear blades (3 No.)
Stirrer diameter & speed	~ 1.5m dia, Max 60 rpm
Motor size & speed	7.5kW 4-pole
Reduction gearbox minimum service factor	3.5 x motor rating

9.5 Testing and Commissioning

Commissioning Stage

The stirrers shall operate free of vibration or wobble and accurately vertically aligned.

Final Acceptance Stage

The final Performance Certificate shall only been issued once the Employer's Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that the stirrers are operating effectively and reliably.

9.6 Spares

Nil

10 SLUDGE DEWATERING EQUIPMENT

10.1 General Description

This section covers the provision of all equipment for drawing clariflocculator sludge from a holding tank, dewatering it and stockpiling the dehydrated product for disposal off-site.

The Contractor shall be responsible for the sourcing and selection of suitable proprietary equipment from a RSA agent.

10.2 Scope of Equipment

The equipment to be supplied is as follows:

- 2 No. progressive-cavity sludge feed pumps (2 Duty, one for each dehydrator unit) and all associated pipework from feed pumps (civil works pump enclosure constructed and measured for payment separately under local Highbury SMME subcontractor).
- 2 No. Dehydrator Units (each operating independently) comprising:
  - A polyelectrolyte dosing and mixing zone;
  - A coagulation zone;
  - Two proprietary pre-fabricated multiple-screw volute dehydrator units (of imported manufacture, but with a local RSA agent whom can provide spares and a repair service);
  - At least one Duty and one Standby poly dosing pumps per Dehydrator Unit;
  - All connects off waterworks service water reticulation to sprayer systems and all downstream drainage piping and pressure regulators (if necessary);
  - A hopper for each dewatering unit to catch the emerging dewatered sludge solids;
- 2 No. polyacrylamide flocculent powder-to-liquid make-up Units (each operating independently) and all connections to service water pipeline.
- 2 No. screw conveyors (one for each dewatering unit) to lift the sludge solids from the dehydrator discharge hoppers and stockpile the sludge in a ~150^{o} semi-circular manually-adjusted slewing arc on a concrete loading platform.
- Local MCC and DB in dehydrator building and all electrical control equipment and cabling required for equipment listed above (incoming power cable to MCC isolator measured elsewhere).
- 1 No. mini skid-steer wheel loader (‘Bobcat’ or similar) for transferring stockpiled sludge into skips (Prime cost item; quotes to be called).
- Contractor to conduct trials to determine most cost-effective polyacrylamide flocculent and supply all dry powder poly required over 12 months Defects Notification Period (Prime Cost item).
- Training of operations staff on the operation and maintenance of the whole dehydration system.
- Quarterly service and adjustments visits.

The Contractor is required to provide a layout design for an appropriate building to house the two dehydrator units, powder to liquid poly make-up units, MCC and dehydrated sludge conveyers. All civil work associated with housing the dehydrator equipment and pipework from sludge holding tank to sludge feed pumps and filtrate water drainage shall be carried out under the Highbury Stage 2 Civil Works Contract.

10.3 Functional Requirements

The Contractor shall design, provide and install everything necessary for a fully functional, fit-for-purpose and effective sludge dehydration system, all as outlined in the Scope of Works and hereunder.

10.4 Design Parameters, Layout and General Arrangement

DEYDRATOR UNIT DETAILS	
Nature of sludge	Sludge drained from waterworks clariflocculator where polyelectrolyte used as coagulant / flocculent. Raw water has high colloidal clay content year round.
Required operating range of settled sludge concentration (ex clarifiers) (% Total Dry Solids in sludge by mass)	1% to 3%
Type of Dehydrator Required	Mechanical multi-disc volute screw press

DEYDRATOR UNIT DETAILS	
	dehydrator
Number of Dehydrator Units required	2 No. Duty
Maximum anticipated daily volume of sludge (at 1% TDS concentration) (or slightly higher % if recycled solids in dehydrator filtrate returned to head of Works is taken into account)	928 m^3/d
Anticipated maximum dry solids per day (excluding solids recycled to Head of Works in dehydrator filtrate water)	9275 kg/d
Required dehydrated sludge solids concentration (by mass) based on 1% sludge concentration	Not less than 12%
Estimated max volume of dehydrated sludge per day	77m^3 (at 12% solids conc) 62m^3 (at 15% solids conc)
Minimum Dry Solids effective processing capacity PER UNIT excluding solids recycled to Head of Works in dehydrator filtrate water (based on 1% sludge concentration and max operating period of 18h/day)	258 kg/h dry solids mass
Minimum hydraulic processing capacity PER UNIT (based on 1% sludge concentration and max operating period of 18h/day at max capacity) ***Note:*** *Sludge feed pumps need VSD or similar to give turn-down ratio of up to 1:3 to cope with sludge concentration varying between 1% and 3% dry solids*	26m^3/h
Target dehydrator polyacrylamide flocculent dosing rate (kg poly per t dry solids)	Less than 8 kg/t
Anticipated max dehydrator polyacrylamide flocculent usage per day at anticipated max solids loading	74kg/d dry mass
	37m^3/d at 0.2% dilution
Poly Dosing Pumps	At least 1 Duty + 1 Standby per Dehydrator Unit
Poly dosing rate per unit	*(Contractor to confirm maximum dosing rate required when dehydrator working at its most efficient sludge feed concentration)*
Minimum suspended solids removal efficiency at 1% sludge feed concentration and optimised poly dosing (Note: the solids that escape with the filtrate water drains to the sludge supernatant recycle pumpstation for return to Head of Works)	85%
External spray water (periodic bursts to clean outside of screw press) **Note:** Assumed values; actual spray requirements to supplier's design	Available service water pressure at Dehydrator Building: Max 5.6 Bar Min 3.0 Bar
	Max water usage per dehydrator unit: 0.4m^3/h
	Max water usage per day (both units running 18h/d): 14.4m^3/d

POLYACRYLAMIDE FLOCCULANT POWDER-TO-LIQUID MAKE-UP UNITS	
Number of Make-up Units required	2 No. Duty
Assumed minimum make-up capacity required ***(Contractor to confirm maximum dosing rate required when dehydrator working at its most efficient sludge feed concentration)***	1500 l/h each make-up unit
Anticipated maximum dry powder used per day	37kg/d each make-up unit
Range of dilution required	0.1% to 0.2%

DEYDRATED SLUDGE CONVEYOR DETAILS	
Number of Dehydrated Sludge conveyors required	2 No. Duty
Type	Discharge-end motorized centreless spiral screw conveyor with slewing ring and wheels on circular concrete beam
Typical example of conveyor	
Maximum anticipated daily volume of sludge (at 1% TDS concentration)	928 m^3/d
Estimated max volume of dehydrated sludge per day PER UNIT	39m^3 (at 12% solids conc)
Minimum slew angle	150º of arc
Minimum discharge height above stockpiling slab	4.0m
Minimum reach from centre of slewing ring	9.0m in plan

10.5 Testing and Commissioning

Commissioning Stage

The Contractor will need to carry out tests to establish the most cost-effective polyelectrolyte to use and demonstrate that a ‘spadeable’ dehydrated sludge can be consistently and reliably achieved. Once the system is operational, the Contractor shall adjust the sludge concentration in the sludge holding tank to approximately 1.0% dry solids content and then demonstrate that minimum solids handling and hydraulic capacities can be achieved on each unit.

As part of the clarifier de-sludging, optimising of the duration and frequency of the drain valves is also required at commissioning stage in order to maximise the solids concentration of the sludge to be dehydrated (target sludge concentration drained from Clariflocculators is 2.0%). Having established

The Contractor shall train the operations staff on the running and maintenance of the whole dehydration system.

Final Acceptance Stage

The final Performance Certificate shall only been issued once the Employer's Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that the sludge dehydration system is operating optimally, effectively and reliably.

10.6 Spares

Nil

11 SENSORS & FITTINGS IN TANKS & CHAMBERS

11.1 General Description

This section covers the provision of various water level sensors in reservoirs and tanks; equipment for controlling the rate of filling empty clear water rising mains and flowmeters in clear water rising main isolation chambers.

Highbury WTW Raw Water Reservoirs

The two open-topped 12Ml raw water reservoirs need to be fitted with ultrasonic water level sensors linked to the Mthatha Dam Raw Water Pumpstation, the temporary raw water pumpstation next to Mthatha Dam (both via telemetry) and the Highbury WTW SCADA (via signal cable).

Highbury WTW Clear Water Reservoirs

The two 5Ml clear water reservoirs need to be fitted with ultrasonic water level sensors linked to the Highbury Clear Water Pumpstation and the Highbury WTW SCADA (via signal cable).

Rosedale Clear Water Command Reservoir

The 20Ml command reservoir needs to be fitted with ultrasonic water level sensor linked to the Highbury Clear Water Pumpstation and the Highbury WTW SCADA (via telemetry).

Nqadu Clear Water Receiving Reservoir

The Nqadu Corridor 1.5Ml command reservoir needs to be fitted with ultrasonic water level sensor linked to the Highbury Clear Water Pumpstation and the Highbury WTW SCADA (via telemetry).

Spent Backwash Water Holding Tank

The 600m^3 spent backwash water holding tank needs to be fitted with ultrasonic water level sensor linked to the Recycle Backwash Water Pumpstation and the two vertical shaft mixers and the Highbury WTW SCADA (via signal cable).

Waste Sludge Holding Tank

The 600m^3 waste sludge holding tank needs to be fitted with ultrasonic water level sensor linked to the Sludge Dehydration sludge feed pump, the four vertical shaft mixers and the Highbury WTW SCADA (via signal cable).

Sludge Pond Outlet Box

The outlet box between the two sludge holding ponds needs to be fitted with ultrasonic water level sensor linked to the Sludge Supernatant Recycle Pumpstation and the Highbury WTW SCADA (via signal cable).

Rosedale and Nqadu Clear Water Rising Main Isolating Chambers

Although the Civil Works Contractor is responsible for constructing the two rising main isolation valve chambers (both immediately downstream of the Highbury Clear Water Pumpstation), the M&E Contractor is responsible for retro-fitting electromagnetic flowmeters and pressure transducers and isolating valve position sensors and flow-limiting devices (for automatic control of flow for filling the two empty clear water rising mains) under this Contract.

Refer to the following drawings for layout details:

- J31067 MECH 500
- J31067 MECH 600

11.2 Scope of Equipment

The equipment to be supplied is as follows:

- Ultrasonic Water Level Sensors:
    - One each to 2 No. Highbury WTW Raw Water Reservoirs;
    - One each to 2 No. Highbury WTW Clear Water Reservoirs;
    - Spent Backwash Water Holding Tank
    - Waste Sludge Holding Tank
    - Sludge Pond Outlet Box
    - Rosedale Clear Water Command Reservoir
    - Nqadu Clear Water Command Reservoir
- Rosedale Clear Water Rising Main Isolating Chamber
    - 1 No. DN600 electromagnetic flowmeter
    - 1 No. DN300 MARIC flow limiting control device on isolating valve bypass
    - 1 No. Pressure transducer and bourdon-type pressure gauge (with stop-cock) downstream of isolating valve
    - Equipment to sense position of isolating valve to be shown on SCADA
- Nqadu Clear Water Rising Main Isolating Chamber
    - 1 No. DN200 electromagnetic flowmeter
    - 1 No. DN150 MARIC flow limiting control device on isolating valve bypass
    - 1 No. Pressure transducer and bourdon-type pressure gauge (with stop-cock) downstream of isolating valve
    - Equipment to sense position of isolating valve to be shown on SCADA

11.3 Functional Requirement

Water Level Sensors

Ultrasonic non-contact sensor and transmitter for liquid level with Integrated temperature compensation, process temperature range: 0 to 40°C, Measuring range: To suit tank (see table in Section 11.4), Measuring accuracy: ±0.2 % of end value or ±6 mm, Beam Angle: 3°

Signal output: 4 to 20 mA / 2-wire

Housing 316L S/S, IP68 NEMA 4X/6P

The sensor shall be positioned such that the beam is not affected by the containing structure.

Pressure Transducers

As per electrical specifications

Bourdon-Type Pressure Gauges

As per standard mech spec.

MARIC Flow Limiting Devices

These are proprietary wafer disc devices manufactured in Australia (and obtainable from a local agent) that fit between pipework flanges. The discs are fitted with specially-designed rubber grommets which deflect under increasing flow and effectively restrict the through-flow to not exceed a predetermined rate of flow no matter what the upstream pressure is. Fitted to a rising main bypass around a manually-closed isolating valve, one of the clear water Duty pumps may be safely operated to fill (or re-fill) the rising main without the pump being damaged through insufficient backpressure.

Once the rising main is largely full, the Operator can open the rising main isolating valve for

11.4 Design Parameters, Layout and General Arrangement

WATER LEVEL SENSORS OPERATING RANGE		
	Floor to Top of Structure (= min sensing range)	**Floor to Top Water Level (= max operating range)**
Highbury Raw Water Reservoirs	8.05m	7.75m
Highbury Clear Water Reservoirs	6.74m	6.20m
Spent Backwash Water Holding Tank	3.00m	2.50m
Waste Sludge Holding Tank	3.55m	3.00m
Sludge Pond Outlet Box	5.10m	4.50m
Rosedale Command Reservoir	9.30m	8.50m
Nqadu Command Reservoir	4.85m	4.10m

11.5 Testing and Commissioning

<u>Commissioning Stage</u>

The sensors and flow meters included in this section shall be demonstrated to be fit-for-purpose and operating correctly over the full required operating range. Manufacturer’s Certificates of Calibration shall be provided.

<u>Final Acceptance Stage</u>

The final Performance Certificate shall only been issued once the Employer’s Agent is satisfied that all issues identified during the Defects Notification Period have been successfully resolved and that all sensors covered by this section are operating optimally, effectively and reliably.

11.6 Spares

Nil

12 MEASUREMENT AND PAYMENT

See C2.1: Pricing Instructions in Volume 1 for measurement and payment clauses pertaining to:

- General
- Preliminary & General
- Design
- Fabricate / manufacture / procure / supply and deliver
- Storage off-site
- Installation, O&M Manual, Pre-commissioning tests and Commission
- Commission the Works as a Whole and Finalise O&M Manual
- Trial Operating Period
- Monitoring the Works Operation beyond Trial Operation Period up to end of Defects Liability Period
- Consumables
- Spares
- Miscellaneous items
- Quarterly Service and Adjustment Visits

All electrical components associated with the pumping equipment are measured for payment separately to the mechanical pumping and waterworks components EXCEPT proprietary packages (such as sludge dehydration package and chorine dry scrubber package). These include:

- Electromagnetic flow meters
- Electrically powered sensing and transmitting instruments
- All power and signal cabling

C3.8 Project Specification: Electrical Equipment

C3.8 PROJECT SPECIFICATION: ELECTRICAL EQUIPMENT

CONTENTS LIST

PSE 1. GENERAL

PSE 1.1. Employer's Objectives

The objectives of the employer for this contract (in respect of the electrical aspects) are:

(a) To provide electrical equipment for the proposed new 50 Ml/day Highbury Water Treatment Works which will be constructed on a Greenfields site upstream of the Mthatha Dam. Under this contract, the treatment capacity of the new works will be 50 Ml/day. In the future the treatment capacity will be increased to 100 Ml/day.

(b) To test and commission the Works.

PSE 1.2. Extent Of Works

The description of work given is merely an outline and does not limit the extent of the works to be carried out.

The Contract shall comprise the design, supply of all labour, materials, workmanship, machinery, equipment, transport, attendance on others and everything stated or implied which is, or may be, necessary in and for the entire completion of all the electrical requirements for the following works:

- Establishment of Site.
- Liaison and coordination with the Contractor awarded the Civil Works Contract
- All Medium voltage cable work.
- Cable ladders, trenching etc.
- Utility kiosks and Outstations.
- Instrumentation as detailed in these documents.
- Area lighting.
- Fibre Optic installation.
- Building lightning protection.
- Electrical installation for buildings on site as detailed in this document.
- Electrical and control cabling for all electro-mechanical devices including pump and air blower motors, meters, probes, actuators etc.
- Motor control centres, variable speed drives and electrical panels.
- Control and monitoring system with mimics and interface to external SCADA system.
- Commissioning and guarantee of the installed equipment for a period of 12 months including training of the Employer's staff to take over the operation of the Works.
- Removal of site establishment and cleaning of the site after completion.
- Site visits and technical assistance for a period of 12 months after the certificate of Completion.
- LV Distribution Cabling and Switchgear
- Excavation and Backfilling of Trenches for Underground Cables
- Standby Generator Plant
- Earthing
- Lightning and Surge Protection
- Distribution Boards
- LV Busbar Trunking
- Metering
- Interior Lighting
- Exterior Lighting
- Lighting Control System
- Socket Outlets, Switches, Isolators, Cover Plates and Other Accessories
- Conduits, Cable Trays, Power skirting, Trunking and other Wireways
- Wiring and Connections
- Inter-tripping and Control Wiring
- Wireways and Distribution Boards for Telephones, Clocks, Data, Intercommunication Systems, Security, Television, Smoke Detection, Public Address Systems
- Electrical Signs Notices and Labelling
- Cutting of Chases and Rough Filling
- Workshop Drawings and Samples
- Chasing of Conduits
- Managing Subcontractors and Suppliers to the Electrical Contract
- Provision of own Hoisting and Lifting
- Provision of own Scaffolding

- Removal of own Waste
- Thermal Survey
- Commissioning and guarantee of the installed equipment for a period of 12 months including training of the Employer’s staff to take over the operation of the Works.
- Trial Operating Period of 4 months after commissioning of the Works
- Removal of site establishment and cleaning of the site after completion.
- Site visits and technical assistance over the Defects Liability Period for a further 8 months after completion of the Trial Operating Period and issue of the Taking-over Certificate.

The Contractor will be required to construct the works in conformity with design criteria specified in the Project Specification and/or shown on the drawings.

PSE 1.3. Work Measured elsewhere

The following work is included in the Scope of Work to be carried out under this contract, but will be not be measured under the electrical BoQ items:

- Floor Slabs and Screeds, Foundations, Walls, and Ceilings
- Plinths (unless otherwise specified in this document)
- Provision of Openings in Walls, Floors, Ceilings and Roofs
- Sealing of Openings/Penetrations through Walls, Floors, Ceilings and Roofs
- Cutting Away and Making Good
- Provision of Ducts, Hand holes and Manholes
- Flashing of Conduits Passing Through Roofs and/or Membrane Waterproofing
- Access Doors

The cost of assisting with the setting out, co-ordination and compliance with the specification and drawings of the above activities related to the electrical installation shall be included in the electrical BoQ items.

PSE 1.4. Definitions

Supply	:	To purchase or procure and deliver complete with all necessary and additional specified accessories.
Erect	:	To place or mount and fix in position.
Install	:	To erect, connect and commission, complete with related accessories.
Indicated, Shown, Noted	:	As indicated or shown on drawings.
Approved, Alternative	:	Approved in writing by the Engineer.
Similar, Equal	:	Equal or better in efficiency of performance, construction, and compatibility with installation.
Tenderer	:	After contract award, Tenderer shall also mean Electrical Contractor where applicable.
Electrical Contractor	:	Where the tender/subcontract document is based on an Electrical Subcontract, Electrical Contractor in this extent of work shall mean the Electrical Subcontractor.

PSE 1.5. Description Of Site And Services

The proposed 50 Ml/day Highbury Water Treatment Works is a new plant that will be constructed on a Greenfields site upstream of the Mthatha Dam. Under this contract, the treatment capacity of the new works will be 50 Ml/day. The treatment capacity will be increased to 100 Ml/day in the future.

Note that the numbers in brackets below refer to those on Drawing J31067/LAY/100:

Raw water to be treated will be abstracted from the Mthatha Dam by a Temporary Raw water pump station and conveyed via a 500mm and 1200mm dia. pipeline to 2 x 12 Ml Raw Water Reservoirs (9) on the site of the treatment works. From this reservoir, water will be gravitated via a meter and flow control chamber (13), to the inlet works of the Water Treatment Works.

The Water Treatment Works comprises an Inlet Works, a Dosing Building (2), a Division Box (4-way Flow Splitter (10), 4 x 25 m diameter Clari-Flocculation Tanks (11), a Filter Plant Room (17), 2 x Rapid Gravity Sand Filter Blocks (four filters each) (12), a Chlorination Building (5), Backwash Recycle Pump Station (15), a Sludge Dewatering Facility (14) and a Supernatant Recycle Pump Station (23). In addition, there will also be an Administration Building (1), a Guard House (6), Staff Accommodation (4), Electrical Building (3) and Workshop and Storage (8) Buildings. There shall also be 2 x 5Ml Clear Water Reservoirs (16) and a Clear Water Pump Station (7) provided downstream of the treatment works. However, the Civil and Structural works associated with these items have been constructed under a separate contract.

This Specification addresses the design, supply, installation, testing, and commissioning of all the electrical, instrumentation, and control equipment needed for the successful operation of the Water Treatment Works components.

PSE 1.6. Water To Be Treated

The water is drawn from the Mthatha Dam and has been found to have a turbidity of between 130 and 270 NTU (Nephelometric Turbidity Unit). The raw water is mildly aggressive towards cement-based products.

Parameter	Value
pH	7.1
TDS	480 mg/l
Alkalinity	412 mg/l as CaCO3
Corrosiveness Index	approximately 0.38
Calcium Hardness	310 mg/l as CaCO3

PSE 1.7. Operator Training, Tools And Operating Manuals For Maintenance Of Plant And Equipment

Details of the contents and format of submission of the Operating and Maintenance Manual are specified in the main Project Specification.

Operating manuals shall include wiring diagrams of all electrical equipment and equipment used in hard copies as well as AutoCAD format.

On the completion of all tests to the Engineers satisfaction, the Contractor shall provide adequate instructions to the Employer’s staff for the proper operation and maintenance of the equipment.

The Contractor shall provide one complete set of special tools and software required for testing (Laptop etc.), of all plant and equipment supplied by him as well as a list of spare parts which it is recommended should be kept by the Employer. Spares, which the employer decides to order, shall be delivered simultaneously with the rest of the equipment and shall be separately packed and appropriately marked.

PSE 1.8. Intent Of Drawings And Specification

The electrical Drawings and Specifications supplied with the Tender Document are not intended to be either complete in detail or to prescribe rigidity the equipment to be offered in the general layout of the Works but are intended only as a guide to Tenderers. The Specification details the Employer's minimum requirements, and Tenderers must provide everything necessary, whether mentioned or not, to provide a satisfactory, efficient, and functional plant.

Should there be a conflict between the specification and drawings, then sections shall be considered in the following order of priority:

1) Detailed Specifications
2) Extent of Work
3) Drawings
4) Schedule of Requirements and Guarantees
5) Schedule of Quantities
6) South African National Standard Specifications

7) General Technical specifications

Should the Contractor note an inconsistency between the Specification and drawings, he shall be responsible for notifying the Engineer and obtaining clarification or instructions prior to ordering or installing equipment.

Should Tenderers consider that deviations from or additions to the equipment as specified by the Employer are necessary, these must be described and accounted for in detail.

Any exclusions by the Tenderer to the installation as specified shall be itemised and described in detail.

PSE 1.9. Workshop Drawings, Samples And Inspections

The Electrical Contractor shall timeously provide workshop drawings, catalogues and/or samples of the following items for the Engineer's review:

- Distribution Boards, Kiosks and Outstations
- Meters
- Luminaries
- High Mast Light Structures
- Standby Generator, NER, and Neutral Contactor
- Standby Generator control system
- Busbar Trunking
- Uninterruptible Power Supply (UPS)
- Power skirting
- Socket Outlets, Switches and Accessories
- Instrumentation equipment and loop diagrams
- Transformers and Miniature Substations
- MV Switchgear
- MCC, PLC and Control drawings and diagrams
- Control Philosophy
- IT Equipment (PC's, Laptops, Servers, Switches and Routers)
- MV and LV Cables
- Fibre Cable and Equipment
- Telemetry

Manufacture and delivery of these items shall not proceed without the Engineer's written instruction to proceed.

The Electrical Contractor shall timeously advise the Engineer of inspections at the manufacturer's premises to enable the Engineer to perform said inspections.

PSE 1.10. List Of Drawings

1	J31067/ELE/101	Electrical Site plan Layout
2	J31067/ELE/110	Electrical Sleeve Layout for Instrumentation and Fibre optic cables
3	J31067/ELE/120	High Mast Layout
4	J31067/ELE/220	Rapid Gravity Sand Filter: Lighting and Power Layout
5	J31067/ELE/240	Filter Plant Room : Lighting and Power Layout
6	J31067/ELE/320	Clear water Pump station & Electrical Building: Lighting and Power Layout
7	J31067/ELE/330	Backwash Recycle Pump station Building: Lighting and Power Layout
8	J31067/ELE/340	Sludge Supernatant Recycle Pump station Building: Lighting and Power Layout
9	J31067/ELE/350	Workshop: Lighting and Power Layout
10	J31067/ELE/400	Chlorination Building: Lighting and Power Layout
11	J31067/ELE/410	Administration Building: Lighting and Power Layout
12	J31067/ELE/420	Guard House: Lighting and Power Layout
13	J31067/ELE/430	Dosing Building: Lighting and Power Layout
14	J31067/ELE/440	Staff Member Type A: Lighting and Power Layout
15	J31067/ELE/441	Staff Member Type B: Lighting and Power Layout
16	J31067/ELE/150	Instrumentation and PLC Diagram Page 1
17	J31067/ELE/151	Instrumentation and PLC Diagram Page 2
18	J31067/ELE/160	Single Line Diagram Sheet 1
19	J31067/ELE/161	Single Line Diagram Sheet 2
20	J31067/ELE/161A	Single Line Diagram Sheet 3
21	J31067/ELE/162	Switchgear Panel
22	J31067/ELE/163	PLC Network Architecture
23	J31067/ELE/164	GA of Typical Out-station
24	J31067/ELE/165	GA of Power Kiosk
25	J31067/ELE/166	Typical MCC Panel
26	J31067/ELE/167	Typical Schematic Diagram
27	J31067/ELE/100	RAW Water Pumps Station: Lighting and Power Layout

PSE 2. Electricity Connection

The Supply Authority is the King Sabata Dalindyebo Local Municipality.

The supply voltage is nominally 11kV phase-phase at 50 Hz in three phases.

The maximum current fault/level at the point of supply (consumer main switch) is 20kA.
The 11 kV switchgear and transformers in the Municipal 11 kV Switch room, Highbury 11 kV Switchgear room and Transformer Room respectively, will be supplied, installed, and commissioned under this contract. The supply, delivery and installation of the cable and terminations from the new overhead line to the new Municipal 11 kV switchgear, from the Municipal to the Highbury 11 kV switchgear and from the Highbury 11 kV switchgear to the transformers, will be supplied under this contract.

PSE 3. MV Installation

To accommodate the new motors to be installed, the power supplying the new MCC will need to be provided by three 2500KVA transformers, which will provide n+1 redundancy. Two of the transformers will be supplied under this contract. The third transformer will be supplied when the works is extended to 100 Ml/day.

The Electrical Contractor shall supply, install, test and commission the 11kV switchgear as indicated in relevant schedules.

Each 11kV switch room will be provided with one set of operating tools as determined by the switchgear installed.

The Electrical contractor shall supply, install and commission a 110Vdc battery tripping unit as indicated in the relevant schedules.

The Electrical Contractor shall supply and install 11 kV cable as indicated on the drawings.

The Electrical Contractor shall supply and install an MV earth grid at each MV switching station and a MV and LV earth Mat at each transformer room.

The Electrical contractor will measure and record the earth mat resistance of each earth mat installed.

The Electrical Contractor shall supply and install a LV and MV earth bar in the transformer room, to which all earth bars are to be connected.

The Electrical Contractor shall connect to the earth bars where applicable:

- 11 kV Switchgear, transformer, and LV switchgear frames
- 11 kV and LV Switchgear earth bars
- Transformer/s neutral points
- Generator neutral point through NER
- Incoming Supply Authority earth
- Power system earth mat

Only cadmium plated, high tensile bolts in conjunction with spring washers may be used for connections to earth bars.

The Electrical Contractor shall provide statutory substation signage.

The Electrical Contractor shall provide a wall-mounted first aid kit in each indoor substation room.

PSE 4. MV Switchgear

The Electrical Contractor shall be responsible for the timeous ordering, delivery, offloading on-site, storage and handling, installation, testing and commission of the MV switchgear. Refer to general and project specification SE12 under the General Specification section.

PSE 5. Distribution Transformers

The Electrical Contractor shall be responsible for timeous ordering, delivery, offloading on site, storage, handling, installation, and commissioning of the transformers.

All transformers are to be stationed in the new transformer room to be constructed.

The scope includes design/engineering, manufacture, testing and supply of 2 x enclosed as per specification, resin cast dry type transformer of rating 2500 KVA, 11kV/415V, 50 Hz Dyn11 with required spares and accessories, as per the technical specification.

The following tests as per SANS 60076, shall be carried out on the transformers.

PSE 5.1. Routine Test:

The test shall be as below:

a) Measurement of Resistance of windings.
b) Measurements of voltage ratio at all taps and check of voltage vector relationship.
c) Check test for polarity.
d) Measurement of impedance voltage (principal tap), short circuit impedance and load loss at rated current.
e) Measurement of No-Loads loss and current.
f) Separate source voltage withstand test.
g) Induced over voltage withstand test.
h) Measurement of insulation resistance.
i) HV test on auxiliary & control wiring.
j) Calculation of the regulation and efficiency at rated load on unity P.F and 0.8 P.F lag.

PSE 5.2. Special Test:

a) Partial Discharge test.
b) Measurements of acoustic sound level.
c) Measurements of zero sequence impedance.

PSE 5.3. Type Test:

These tests shall be performed on one of the transformers (as selected by the purchaser during FAT) from the lot.

a) The Temperature rise test as per IEC 60076-2 [6]

If a transformer fails in any of the tests specified, the purchaser shall have the option to reject complete lot. Additional test shall be performed to determine the reason of failure and after necessary modifications; all the tests shall be repeated to prove that the modified transformer meets with the requirements of the specification in all respects. The cost, if any, for the modification, testing including any additional test required for verification of the transformer performance shall be to the account of the bidder.

PSE 6. Battery Tripping unit

Two 110 Vdc battery tripping unit with low maintenance and Ni cad batteries shall be supplied, installed, and commissioned for the operation of the Highbury WTW 11kV switchgear. The battery charger must be equipped with boast charge facility, ammeter, voltmeter, spare fuses, and circuit diagram.

Each of the battery tripping unit must be capable of supporting the standing load of the 11kV switchgear for a period of no less than 12hrs. The contractor will calculate the standing load on the battery tripping unit based on the 11kV equipment supplied and there after size the cells accordingly. Refer to general and project specification SE12 under General Specification section.

PSE 7. MINIATURE SUBSTATION

PSE 7.1. General

The miniature substation shall comply with SANS 1029 and Eskom Std. 34-1621 (Unique Identifier 240-56062752).

The miniature substation sizes shall be 315 kVA. The system voltage of the miniature substation is 11 kV / 420 V and the vector group Dyn 11. The miniature substation shall be equipped with a non-extendable “2 Switched-Disconnector; 1 Circuit-Breaker” Ring Main Unit where the circuit breaker shall supply the transformer. The ring main unit shall comply with SANS1874. The miniature substation kiosk shall be Avocado Green, C12 of SANS 1091. The miniature substation transformer shall have aluminium windings and comply with SANS780. No IRTU (Integrated remote terminal unit) is required.

The minisub shall comprise of the following:

a) a medium voltage compartment housing the ring main unit (RMU) and earth fault indicator.
b) a transformer compartment housing the transformer.
c) a low voltage compartment housing the street lighting / metering equipment with door.
d) a low voltage compartment housing the LV equipment with doors for access to the busbar and the main LV MCB.
e) screw locking mechanism on all doors equal to Eskom & City Power specification.

Drawings must be submitted to the Engineer for approval. For inspection in the factory, the roof must be removed to enable easy access.

The concrete plinth walls shall be at least 300 mm in thickness, protruding 50 mm above ground level. The ground around the Miniature Substation shall be raised and shaped to prevent accumulation of water around the MSS. Please see Figure 7-1 and Figure 7-2 for more details.

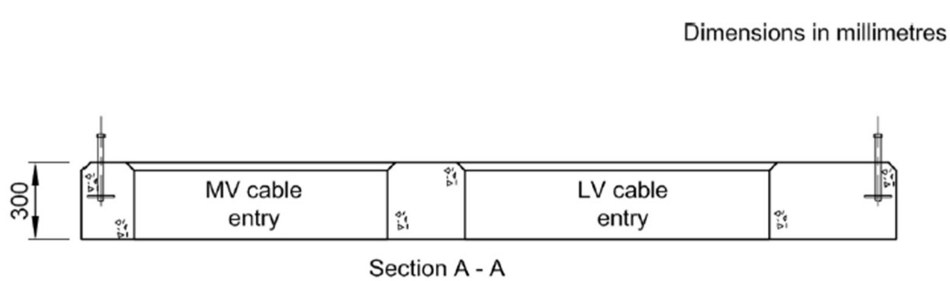


Figure 7-1: SANS 1029:2016 Type B MSS Plinth details: Section A-A

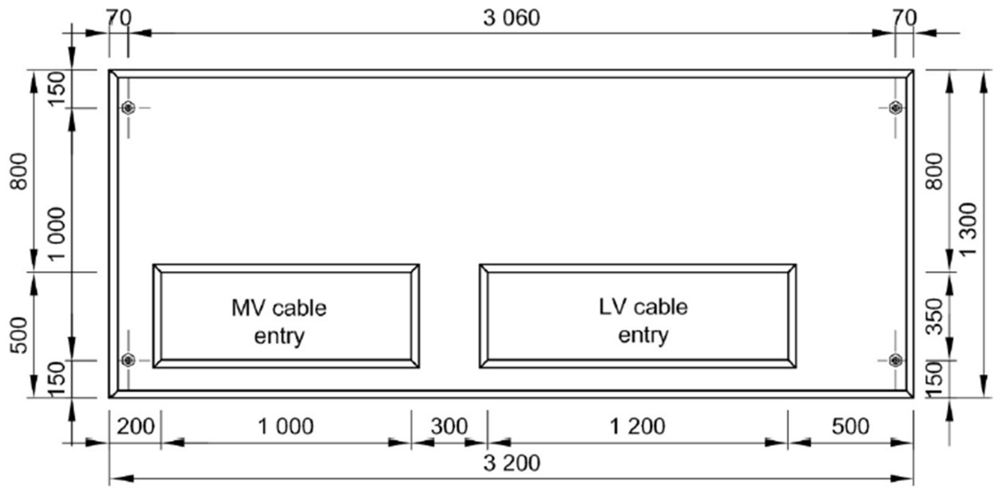


Figure 7-2: SANS 1029:2016 Type B MSS Plinth details: Plan view.

The earthing configuration for the MSS shall make provision for a separate MV and LV earthing system. The MV and LV earthing system shall consist of 8 x Copper Cladded Steel (CCS) earth rods/spikes with a conductivity equal to 16 mm dia. bare copper earth rods, 1.5 m in length and installed in the excavated trench spaced 3 m on either side of the MSS and connected with 70 mm² copper earth wire / electrode. The 70mm2 copper earth wire / electrode bonded to the LV system shall be insulated for the first 5 m in a 180° opposite direction that the medium voltage earth electrode. The combined MV & LV electrode resistance shall be less than 10 Ω, if the MV earthing system is tested separately it shall measure less than 30 Ω. Please see Figure 7-3 to
Figure 7-5 for more details.

Dedicated holes shall be provided for the following connections:

- The LV neutral bar, LV earth bar and gland plate shall be insulated and connected via a 70 mm² insulated copper earth wire to the LV earth system.
- The LV neutral and earth bars shall be bonded by means of a suitably rated bare copper wire.
- The LV earth bar and gland plate shall be bonded by means of a suitably rated insulated copper earth wire.
- A LV neutral surge arrestor shall be installed between the LV neutral bar and the MV earth bar.

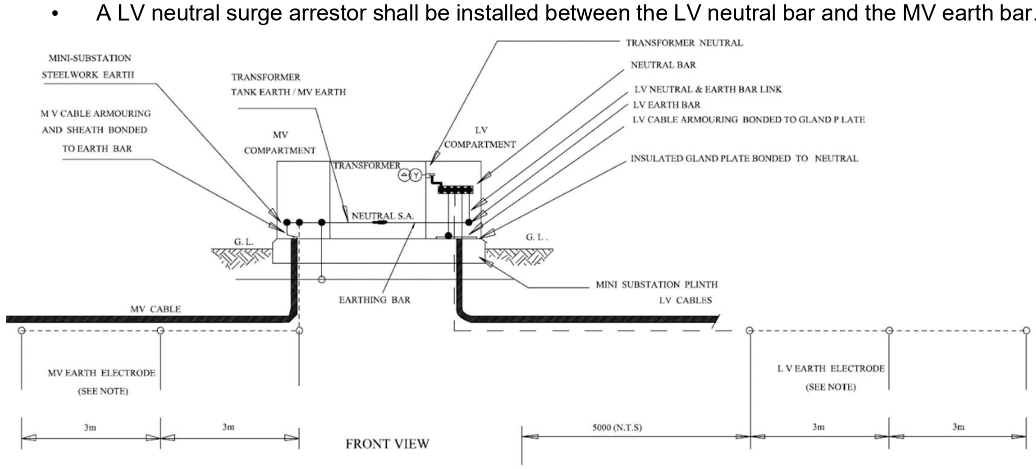


Figure 7-3: Earthing arrangement - Top View

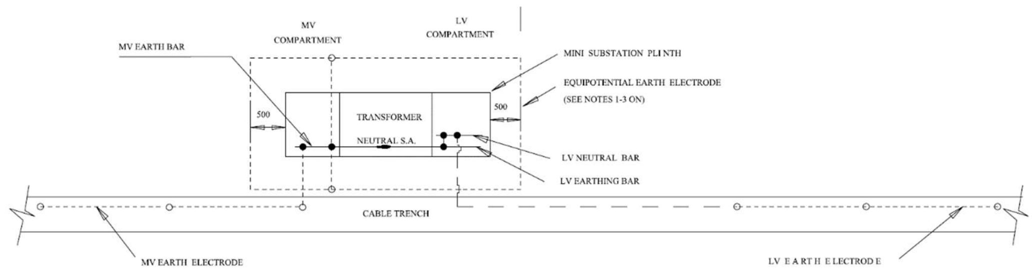


Figure 7-4: Earthing arrangement - Front View

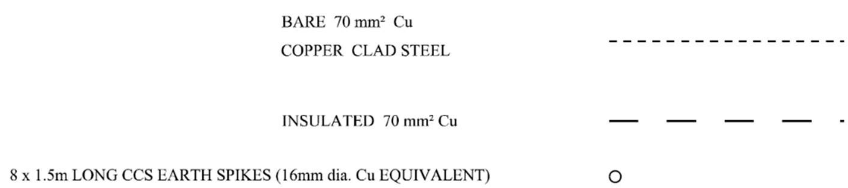


Figure 7-5: Earthing arrangement - Legend.

Transformer overload protection and shunt trip facility in the transformer compartment. Thermistor to be set at tripping the breaker with shunt trip coil at oil temperature of 110 °C. Earth fault indicator in RMU compartment.

The tenderer will also be responsible for arranging Factory Acceptance Tests (FAT) including training at the OEM and on site, which will be attended by the Maintenance Personnel of the Employer and the Engineers Representative.

The tenderer shall make all the necessary arrangements for two (2) Engineer representatives and two (2) Employer representatives and one (1) contractor representative to witness the FAT at the manufacturer. The cost thereof shall be for the account of the tenderer.

PSE 7.2. LV Compartment of Minisubs

The LV compartment of the minisub shall be equipped with the following:

- 1 x 400-630 A, 3 pole main MCCB.
- 4 x 100-200 A, 3 pole MCCB: Feeders
- 3 mm² thick galvanised gland plates
- LV auxiliary circuit with three pin socket outlets protected by a 20 A, earth leakage unit, with overload protection.

PSE 7.3. Lighting and Metering Compartment

The metering compartment of the MSS shall be equipped with the following:

- Streetlight Feeder with 3P 50A MCB
- 1 x day night switch
- 1 × 60A, 4 pole contactor.
- 1 × 5A single phase MCB for contactor coil circuit.
- 1 x 3 Phase kWh meter

PSE 7.4. Additional equipment

The following additional equipment is required:

- 3 x 500 / 5 max demand ammeters
- 3 x 500 / 5, Class 1, metering CT" s
- 1 x 0-500 V voltmeter with selector switch
- 1 x 3 Phase kWh meter
- 1 x Enerium E50

PSE 7.5. SCHEDULE OF MINISUBS

MS1 – (315 kVA) for Staff accommodation and Admin Building
MS2 – (315 kVA) for Temporary Raw Water Pump Station

PSE 8. Metering

Bulk municipal metering for the Highbury WTW shall be recorded by the King Sabata Dalindyebo Municipality at the Municipal Highbury Switching station.

PSE 9. Motor Control Centres – MCC's

The distribution panel and Motor Control Centre shall be of a free floor standing type with access, both from the front, rear sides, and bottom. The maximum height of the panel shall not exceed 2.0 meters.

The protection rating of this panel must have an IP 54 rating and shall be of a modular design manufactured from 1,2 mm 3CR12 steel, powder coated in SIGNAL RED, colour A11 of SANS 1091.

The boards shall comply fully with the latest IEC 61439-1 & 2 standard and the manufacturer shall provide proof of compliance and the Original Manufacturer shall be responsible for the Design verifications and electrical tests as listed in IEC 61439-2.

Tenderers shall submit their own diagrams complete with terminal numbers and all equipment indicated.

Damaged paintwork will not be repaired on site but will be returned to the factory for re-painting. It remains the Contractor's responsibility to protect the panels during transit and on site against damage until the final acceptance thereof on site. Sufficient provision shall be made for heat dissipation and ventilation of the board.

The single line diagrams are only an indication of the system required and the Contractor shall submit a design from the MCC manufacturer indicating how cascading and discrimination will be achieved with the equipment offered. Tenderer shall after award of contract submit his own design which must be approved by the Engineer before manufacturing.

PSE 9.1. RAW WATER ABSTRACTION FROM MTHATHA DAM

PSE 9.1.1. MCC 8: MTHATHA DAM RAW WATER PUMP STATION

Motor starters shall be provided in MCC 8 for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design and shall have an IP66 protection rating.

Fault level is 65 kA and single line diagram is shown on drawing J31067/ELE/161A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, suitably sized and marked with phase colours for distribution in the panel.

b) Set of 3 phase, neutral and earth busbars, rated for 1250 A and 25 kA fault level, from the transformer LV terminals up to the MCC Panel Incomer 1 and marked with phase colours. The Busbars shall be encapsulated.

c) 1 x 1250 A, 4 pole, 25 kA, ACB Draw-out Low Voltage circuit breaker as Incomer 4 with over current and earth fault protection. Including auxiliary contacts (Open, Close and Trip) for indication to the PLC. The breaker shall have a lockout mechanism when switched off and remote trip/close facility.

j) Lightning arresters (25 kA rating) on the busbars suitable for electronic component protection on each Incomer.

k) 1 x Multifunction energy meter with protection fuses and suitable CTs with a communications module for communication to PLC, on each Incomer.

l) 1 x Under voltage, Phase reversal control relay on each Incomer.

m) 1 x Under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit on each Incomer.

n) All breakers must have lockout facilities.

o) The single line diagram is only an indication of the system required and the Contractor shall submit a design from the MCC manufacturer indicating how cascading and discrimination will be achieved with the equipment offered.

p) Motor starters shall be provided in MCC 8 for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule.

q) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

b) Auxiliary supplies for PLC, Control circuits, etc.

r) 1 x Under voltage, Phase reversal control relay interlocked with control circuit.

s) Lamp test wiring and relays.

t) Where a Motor is marked “Future” the panel should be provided but with no equipment.

u) 1 x Single phase 415/220 V Control Transformer.

v) Supply for RAW Water Magflow and HMI on MCC, showing Flow Rate and Totalizer readings from Magflow.

SCHEDULE OF ELECTRICAL MOTORS MCC 8

No	Tag	Description	Control	Rating
1	01-TEP-01	RAW Water Pump 1	SS	200kW
2	01-TEP-02	RAW Water Pump 2	SS	200kW
3	01-TEP-03	RAW Water Pump 3	SS	200kW

PSE 9.1.2. RAW WATER PUMPSETS 1 – 3 (3 starter cubicles required) 200kW MOTORS

The control of the pump sets is described as follows:

The pumps shall be PLC controlled off a signal from an ultrasonic level sensor mounted in one of the Highbury Raw Water Reservoirs activating the stop and start sequences. It shall also be possible to operate the pumps by manual start / stopping at the local control panel.

Each pump has a dedicated DN400 GMS suction line with a foot-valve with bellmouth inlet inside a coarse-mesh GMS screen. The suction pipework extends into the dam at the same gradient to a level where the inlet bellmouth is below FSL-4m. The length of the pipe is approximately 30m (to be confirmed). Each pump discharges into a common delivery manifold connected to a temporary Rising Main and conveys raw water to the existing DN1200 steel rising main. The common discharge manifold as well as each pump suction and delivery line will have equipment and instrumentation to control and protect the pumps.

No / low flow switches in the suction pipework will serve as an interlock and pump trip condition signalling the dam level is too low.

The pump interlocks, trips, start and stop sequences shall be locally controlled in AUTO mode.
OFF and RUN push buttons are to be provided for operating each pump in MANUAL mode.

An AUTO-OFF-MANUAL selector switch for each pump shall be provided.

It shall be possible to operate all three pumps in Manual mode.

Manual Control:

- Operator initiates pumping for any one pump by pressing the respective START button. Operator to delay starting next pump until running pump has reached steady state.
- All three pumps can be operated manually.
- After preset time-out from START, PLC checks that no-flow switch FOR EACH DUTY PUMP registers greater than minimum set flow and initiates TRIP for any DUTY PUMP if less than minimum set flow and activates Low-Flow Trip light on panel for the particular pump.
- Reset push-button to be provided.
- E-Stop active on all motors

Auto Control:

Start - PLC receives signal from ultrasonic water level sensor in Highbury Raw Water Reservoir

- IF Level is less than (TWL – 0.3m) THEN initiate STAGGERED START signal for both Duty Pumps (preset delay on 2nd pump so only starts after 1st pump has reached stead-state condition).
- After preset time-out from START, PLC checks that no-flow switch FOR EACH DUTY PUMP registers greater than minimum set flow and initiates TRIP for any DUTY PUMP if less than minimum set flow and activates Low-Flow Trip light on panel for the particular pump.
- E-Stop active on all motors

Stop - PLC receives continuous signal from ultrasonic water level sensor in Highbury Raw Water Reservoir

IF Level reaches TWL, THEN initiate PUMP OFF signal for 1st Duty Pump.
After preset delay, PUMP OFF signal for 2nd pump is initiated.
No-flow sensors active for each pump over running period.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker (and fuses if required) with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- 1 x Multifunction energy meter with protection fuses and suitable CTs.
- Suitably sized Soft Starter with Motor protection and communication.
- Soft starter HMI on the cubical door.
- 1 x Running hour meter.
- 1 x Control Circuit MCB.
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to soft starter with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- Motor and pump temperature and vibration monitors.
- All PLC inputs and outputs to be wired to PLC cabinet.
- Clear water reservoir low level LEDs -High and Low

PSE 9.2. HIGHBURY CLEAR WATER PUMP STATION MCC 5A AND 5B

PSE 9.2.1. MCC 5A: HIGHBURY CLEAR WATER PUMP STATION

Motor starters shall be provided in MCC 5A for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design.

Fault level is 65 kA and single line diagram is shown on drawing J31067/ELE/160/A.

The panel shall consist of the following equipment as indicated.

d) Set of 3 phase, neutral and earth busbars, suitably sized and marked with phase colours for distribution in the panel.

e) Set of 3 phase, neutral and earth busbars, rated for 4000 A and 65 kA fault level, from the transformer LV terminals up to the MCC Panel Incomer 1 and marked with phase colours. The Busbars shall be encapsulated.

f) 1 x 4000 A, 4 pole, 65kA, ACB Draw-out Low Voltage circuit breaker as Incomer 1 with over current and earth fault protection. Including auxiliary contacts (Open, Close and Trip) for indication to the PLC. The breaker shall have a lockout mechanism when switched off and remote trip/close facility.

g) Transformer protection CTs for Incomer 1.

h) <u>Provision for future</u> Set of 3 phase, neutral and earth busbars, rated for 4000 A and 65 kA fault level, from the transformer LV terminals up to the MCC Panel Incomer 2 and marked with phase colours. The Busbars shall be encapsulated.

i) 1 x 4000 A, 4 pole, 65kA, ACB Draw-out Low Voltage circuit breaker as Incomer 2 with over current and earth fault protection. Including auxiliary contacts (Open, Close and Trip) for indication to the PLC. The breaker shall have a lockout mechanism when switched off and remote trip/close facility.

j) Transformer protection CTs for Incomer 2.

k) 1 x 4000 A, 4 pole, 65kA, ACB Draw-out Low Voltage circuit breaker as Bus Section 1 with over current and earth fault protection. Including auxiliary contacts (Open, Close and Trip) for indication to the PLC. The breaker shall have a lockout mechanism when switched off and remote trip/close facility.

l) Set of 3 phase, neutral and earth busbars, rated for 4000 A and 65 kA fault level, from MCC 5A to MCC 5B and marked with phase colours. The Busbars shall be encapsulated.

m) The Incomers and Bus Sections must be connected to the SCADA control system. The contractor must also ensure that all mechanical and electrical interlocking is working to prevent the transformers from being paralleled.

n) For Incomers and Bus couplers Interlocking must be provided to ensure the following conditions are always maintained:

- No two transformers can be paralleled at any time.
- The breaker interlocking must be done as far as possible using mechanical interlocks. If electrical interlocking is used, it must be fail-safe so that it will trip any breakers in the event of an unknown condition. The Engineer must approve the Electrical interlocking.

j) Lightning arresters (65 kA rating) on the busbars suitable for electronic component protection on each Incomer.

w) 1 x Multifunction energy meter with protection fuses and suitable CTs with a communications module for communication to PLC, on each Incomer.

x) 1 x Under voltage, Phase reversal control relay on each Incomer.

y) 1 x Under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit on each Incomer.

z) 1 x 600 A 3 pole circuit breaker feeder to Power Factor Correction – voltage rating to be at least 600 volts. (300 kVAr). The Power Factor correction must be interlocked with the Genset Incomers, if any Genset is operating, this breaker must be “off”.

aa) 300-kVAR power factor correction panel with 6 step controller.

bb) All breakers must have lockout facilities.

cc) The single line diagram is only an indication of the system required and the Contractor shall submit a design from the MCC manufacturer indicating how cascading and discrimination will be achieved with the equipment offered.

dd) Motor starters shall be provided in MCC 5A for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule.

ee) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

c) Auxiliary supplies for PLC, Control circuits, etc.

ff) 1 x Under voltage, Phase reversal control relay interlocked with control circuit.

gg) Lamp test wiring and relays.

hh) Where a Motor is marked “Future” the panel should be provided but with no equipment.

ii) 1 x Single phase 415/220 V Control Transformer.

SCHEDULE OF ELECTRICAL MOTORS MCC 5A

No	Tag	Description	Control	Rating
1	07-P-01	Rosedale Pump 1	SS	500kW
2	07-P-02	Rosedale Pump 2	SS	500kW
3	07-P-03	Rosedale Pump 3	SS	500kW
4	Future	Rosedale Pump 4	Future	500kW
5	Future	Rosedale Pump 5	Future	500kW
6	Future	Rosedale Pump 6	Future	500kW

Note : Cubicles without switchgear or equipment to be provided for 3 x future pumps.

PSE 9.2.2. ROSEDALE PUMPSETS 1 – 3 (3 starter cubicles required) 500kW MOTORS

The control of the pump sets is described in the following sections.

Pump Safety devices.

The following safety loops or devices are to be effective per pump in both automatic and manual operating modes:

- 2 x 5 Ml Clear Water Low reservoir level: When a low level is detected, the pumps will stop and can’t be started until the reservoir level has recovered above the low-level switch.
- Water delivery to Rosedale Command Reservoir: The level in Rosedale Command reservoir will be monitored with an ultrasonic level controller. When a “High-High” level is detected in the Rosedale Command reservoir, the pumps will stop.. The pump can be restarted manually or automatically without resetting the soft starter. The tripping must be disabled during starting.
- Motor overload/ high pump delivery: This function is to be implemented in the soft starter. When a motor overload occurs, the soft starter must stop the motor. The pump must not be able to be started until the soft starter has been reset.
- Motor fault protection: This function is to be implemented in the soft starter. When a motor fault is detected (earth fault, locked rotor) the motor must stop. The pump must not be able to be started until the soft starter has been reset.
- Pump and motor vibration: The pump is to be fitted with two vibration sensors and similarly the motor is also fitted with two vibration sensors. These vibration sensors are to be wired back to controllers located on the respective soft starter cubicle. When high vibration is detected on either the pump or

motor the motor must stop via a controlled stop. The pump must not be able to be restarted until the soft starter is reset.

- Pump bearing temperature: The pump bearings are fitted with temperature sensors. These sensors are to be wired back to controllers located on the respective soft starter cubicle. When high temperature is detected, the motors must stop via a controlled stop. The pump cannot be reset until the soft starter is reset.
- Motor winding temperature (PT100, RTD or Thermistor): The motor is to be supplied with 3 x temperature sensors. The soft starter should preferably make provision for these temperature sensors to be connected directly to it. When a high motor winding temperature is detected, the motors should be stopped via a controlled stop.
- Motor bearing temperature (Temperature Transmitter): The motor is to be supplied with 2 x temperature sensors. These temperature sensors are to be wired back to controllers located on the respective soft starter cubicle. When high motor bearing temperature is detected, the motors must stop via a controlled stop. The pump can’t be reset until the soft starter is reset.
- Each pump will be fitted with a Pressure sensor and flow sensor on the discharge side. If high pressure on no flow is detected the motor must be stopped via a controlled stop. The pump can be restarted manually or automatically without resetting the soft starter.

The definition of a controlled stop is one in which the soft starter ramps the motor speed down to standstill. An uncontrolled stop is one in which the soft starter turns off and the motor freewheels to a stop.

Automatic Control

The automatic controls are to be implemented by the soft starter. If one soft starter is out of service, it must not affect the remainder of the soft starters. (There must not be a master soft starter). The control of the soft starter may be done via Programmable Logic Controller (PLC) logic internal to each soft starter. When in automatic (determined by the position of the auto manual switch on the MCC starter cubical) the pumps will start and stop automatically. If a soft starter is removed or isolated the signals between and to the other soft starters must not be affected.

The control of the pumps will be as follows:

The controlling signal is the Rosedale Command water reservoir level, this level will be fed to a controller, the output will control the pump requirements. Thus low-low (operator adjustable) level requires maximum flow, which will equate to both duty pumps running. As the level rises to high level (operator adjustable), one duty pump will stop. At a high-high level (operator adjustable), both duty pumps will stop. As the level drops, one pump will start at high level and the second at low level (operator adjustable).

Logic Description	Level %	Triggers ON
Lo Lo	Reservoir 10%	Pump 1 RUN Pump 2 RUN
Lo	Reservoir 30%	Pump 1 RUN Pump 2 RUN
Hi	Reservoir 70%	Pump 1 RUN Pump 2 STOP
Hi Hi	Reservoir 100%	Pump 1 STOP Pump 2 STOP

The starting and stopping of the pumps must be such that the operating hours on the pumps are balanced as best as possible without recording and controlling the pumps on this parameter. Thus, the first pump to start will be the first pump to stop. Similarly, the last pump to stop will be the last pump to start. Following a complete plant stop or power failure pump 1 will start first. A maximum of two pumps will operate simultaneously and one will be a standby pump.

Should communication to the Rosedale Command water reservoir level sensor be lost, the rising main flow sensor will control the pumps. If the pumps stop for low delivery flow the pumps must remain off for duration of 10 minutes (operator adjustable) before automatically restarting. It would be preferred if the pump sequence could be continued from the condition prevailing just prior to the system stop.

Manual Control

When in manual (determined by the position of the auto manual switch on the MCC cubical) the pumps are started and stopped by the operator via the start stop buttons on the MCC cubical or the Outstation. If a pump stops on high-high level, low delivery flow or high delivery line pressure the pumps will be restarted manually by pressing the start button.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker (and fuses if required) with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- 1 x Multifunction energy meter with protection fuses and suitable CTs.
- Suitably sized Soft Starter with Motor protection and communication.
- Soft starter HMI on the cubical door.
- 1 x Running hour meter.
- 1 x Control Circuit MCB.
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to soft starter with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- Motor and pump temperature and vibration monitors.
- All PLC inputs and outputs to be wired to PLC cabinet.
- Pump delivery valve position LED – Open/Closed round semaphore.
- Pump discharge valve position LED – Open/Closed round semaphore.
- Pump alarm indication LED: The alarms will be high vibration, high pump temperature, high motor temperature, and high motor load.
- Clear water reservoir low level LED

PSE 9.2.3. POWER FACTOR CORRECTION AND HARMONIC FILTERS (PFC)

The Highbury Main Distribution Panel must be corrected to 0,98 lagging, it is estimated that the correction will be approximately 700 kVAr in total and 2 x 350 KVAr panels shall be provided as indicated in drawing J31067/ELE/160/A. The steps for corrections shall not be more than 100 kVAr per step.

The harmonic filters shall achieve individual harmonic voltages not exceeding 1 % and the total harmonic voltage distortion not exceeding 3 %.

The protection of the capacitors should be provided by delayed action fuses having current ratings of 1,7 times the rated current of the capacitors.

All power factor correction capacitors and reactive control systems shall meet the provisions of VDE Standards 0560, DIN 57560 and IEC 70.

PSE 9.2.4. Electrical low voltage interconnections

The method for electrical connection of the low voltage supply from the transformers to MCC 5A will be via bus bars. The bus bar capacities are shown in drawing number J310678B/ELE/160/A sheet 1

All other connections will be by means of copper cables. The cables schedule is attached in Appendix A at the end of Document PSE.

The Electrical Contractor will verify the rating prior to purchasing the cable, to ensure that the cables don’t have different specs than that originally used when doing the design.

PSE 9.2.5. MCC 5B: HIGHBURY CLEAR WATER PUMP STATION

Motor starters shall be provided in MCC 5A for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design.

Fault level is 65 kA and single line diagram is shown on drawing J31067/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, suitably sized and marked with phase colours for distribution in the panel.

b) Set of 3 phase, neutral and earth busbars, rated for 4000 A and 65 kA fault level, from the transformer LV terminals up to the MCC Panel Incomer 3 and marked with phase colours. The Busbars shall be encapsulated.

c) 1 x 4000 A, 4 pole, 65kA, ACB Draw-out Low Voltage circuit breaker as Incomer 3 with over current and earth fault protection. Including auxiliary contacts (Open, Close and Trip) for indication to the PLC. The breaker shall have a lockout mechanism when switched off and remote trip/close facility.

d) Transformer protection CTs for Incomer 3.

e) 1 x 4000 A, 4 pole, 65kA, ACB Draw-out Low Voltage circuit breaker as Bus Section 2 with over current and earth fault protection. Including auxiliary contacts (Open, Close and Trip) for indication to the PLC. The breaker shall have a lockout mechanism when switched off and remote trip/close facility.

f) The Incomers and Bus Sections must be connected to the SCADA control systems as proposed by the contractor. The contractor must also ensure that all mechanical and electrical interlocking is working to prevent the transformers from being paralleled.

g) For Incomers and Bus couplers Interlocking must be provided to ensure the following conditions are always maintained:

h) No two transformers can be paralleled at any time.

i) The breaker interlocking must be done as far as possible using mechanical interlocks. If electrical interlocking is used, it must be fail-safe so that it will trip any breakers in the event of an unknown condition. The Engineer must approve the Electrical interlocking.

j) Lightning arresters (65 kA rating) on the busbars suitable for electronic component protection on each Incomer.

k) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each Incomer.

l) Auxiliary supplies for PLC, Control circuits, etc.

m) 1 x Under voltage, Phase reversal control relay on each Incomer.

n) 1 x Under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit on each Incomer.

o) 1 x 63 A 3 pole, 60 kA MCCB feeder to Dosing Building MCC 1

p) 1 x 250 A 3 pole, 60 kA MCCB feeder to Filter Plant Room MCC 2

q) 1 x 80 A 3 pole, 60 kA MCCB feeder to Chlorination Building MCC 3

r) 1 x 100 A 3 pole, 60 kA MCCB feeder to Backwash Recycling Building MCC 4

s) 1 x 160 A 3 pole, 60 kA MCCB feeder to Sludge Dewatering MCC 6

t) 1 x 125 A 3 pole, 60 kA MCCB feeder to Supernatant Pump Station MCC 7

u) 1 x 250 A 3 pole, 60 kA MCCB feeder to Filter Plant Room 2 MCC 8. Feeder to future MCC, MCCB to be installed.

v) 1 x 100 A 3 pole, 60 kA MCCB feeder to Backwash Recycling Building 2 MCC 9. Feeder to future MCC, MCCB to be installed.

w) 1 x 160 A 3 pole, 60 kA MCCB feeder to Sludge Dewatering 2 MCC 10. Feeder to future MCC, MCCB to be installed.

x) 1 x 125 A 3 pole, 60 kA MCCB feeder to Supernatant Pump Station 2 MCC 10. Feeder to future MCC, MCCB to be installed.

y) 1 x 60 A 3 pole, 60 kA MCCB feeder to Workshop and Storage Building

z) 1 x 60 A 3 pole, 60 kA MCCB feeder to Admin Building

aa) All breakers must have lockout facilities.

bb) The single line diagram is only an indication of the system required and the Contractor shall submit a design from the MCC manufacturer indicating how cascading and discrimination will be achieved with the equipment offered.

cc) Motor starters shall be provided in MCC 5B for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule.

dd) 1 x Multifunction energy meter with protection fuses and suitable CTs with a communications module for communication to PLC, on each motor starter panel.

ee) Auxiliary supplies for Control circuits, etc.

ff) 1 x Under voltage, Phase reversal control relay interlocked with control circuit.

gg) Lamp test wiring and relays.

hh) 1 x Single phase 415/220 V Control Transformer.

ii) Audible alarm for the following:

- Clear water reservoir low water level audible alarm
- Clear water reservoir high water level audible alarm
- Pump tripped audible alarm.
- Rosedale Command reservoir low-level audible alarm
- Ngungululu Command reservoir low-level audible alarm

jj) Local DB complete with:

- 1 x 60 A, 3 pole circuit breaker.
- 1 x 30 A,3 pole MCB, Crane Hoist
- 1 x 60 A, 2 pole earth leakage unit.
- 2 x 20 A, 1 pole, MCB, for plugs.
- 3 x 10 A, 2 pole, MCB, for lights.
- 3 x 60 A, 2 pole earth leakage unit.
- 3 x 30 A, 3 pole, MCB welding socket outlet.
- 3 x 40 A, 3 pole, MCB utility kiosks and high mast lights.
- 3 x 60 A, 3 pole, MCB sub DB’s.
- 3 x 10 A, 2 pole, MCB, (outdoor lights)
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 5 x 10 A, 1 pole MCB's for instrumentation.

- 4 x lightening arrestors

SCHEDULE OF ELECTRICAL MOTORS MCC 5B

No	Tag	Description	Control	Rating
1	07-P-04	Nqadu Pump 1	SS	200kW
2	07-P-05	Nqadu Pump 2	SS	200kW
2		Transformer 1 Extraction Fan	DOL	1.5kW
4		Transformer 2 Extraction Fan	DOL	1.5kW
5		Transformer 3 Extraction Fan	DOL	1.5kW
6		Pump Hall Extraction Fan 1	DOL	1.5kW
7		Pump Hall Extraction Fan 2	DOL	1.5kW
8		Pump Hall Extraction Fan 3	DOL	1.5kW
9		Pump Hall Extraction Fan 4	DOL	1.5kW
10		Pump Hall Fresh Air Fan 1	DOL	1.5kW
11		Pump Hall Fresh Air Fan 2	DOL	1.5kW
12		Pump Hall Fresh Air Fan 3	DOL	1.5kW
13		Pump Hall Fresh Air Fan 4	DOL	1.5kW

PSE 9.2.6. NQADU Pumps 1 – 2 (2 starter cubicles required) 200 kW motors

The Nqadu pumpsets (housed in the Clear Water Pumpstation) convey treated water from the Highbury clear water reservoirs at the WTW via a 13.3 km DN300 GRP Rising Main to the Soyoni Reservoir (910 masl) and Ngungululu Reservoir (954 masl) (which supplies the Nqadu Corridor North of Umtata). The Soyini Reservoir automatically draws from an offtake on the Rising Main during pumping, but with a flow limiter and pressure sustaining valve such that it does not affect the pumping head experienced by the Nqadu pumpsets.
The Nqadu System will take up to 3.3Ml/d for which 1 Duty and 1 Standby multi-stage pumps will be required. There is no provision for increasing the supply in the future.

Pump Set Controls

The control of the pump sets is described in the following sections.

Pump Safety devices.

The following safety loops or devices are to be effective per pump in both automatic and manual operating modes:

- 2 x 5 Ml Clear Water Low reservoir level: When low level is detected the pumps will stop and can't be started until the reservoir level has recovered above the low-level switch.
- Water delivery to Ngungululu Reservoir: The level in Ngungululu reservoir will be monitored with an ultrasonic level controller. When a "High-High" level is detected in the Ngungululu reservoir, the pumps will stop. As a back-up system, a flow meter will be installed on the delivery line to Ngungululu reservoir. The soft starter must monitor this and when the flow drops below a specified minimum level for a short duration the soft starter must stop. The pump can be restarted manually or automatically without resetting the soft starter. The tripping must be disabled during starting.
- Motor overload/ high pump delivery: This function is to be implemented in the soft starter. When a motor overload occurs, the soft starter must stop the motor (preferably via a ramp down if possible, to reduce water hammer). The pump must not be able to be started until the soft starter has been reset.
- Motor fault protection: This function is to be implemented in the soft starter. When a motor fault is detected (earth fault, locked rotor) the motor must stop. The pump must not be able to be started until the soft starter has been reset.
- Pump and motor vibration: The pump is to be fitted with two vibration sensors and similarly the motor is also fitted with two vibration sensors. These vibration sensors are to be wired back to controllers located on the respective soft starter cubicle. When high vibration is detected on either the pump or

motor the motor must stop via a controlled stop. The pump must not be able to be restarted until the soft starter is reset.

- Pump temperature: The pump bearings are fitted with temperature sensors. These sensors are to be wired back to controllers located on the respective soft starter cubicle. When high temperature is detected, the motors must stop via a controlled stop. The pump cannot be reset until the soft starter is reset.
- Motor winding temperature (Temperature Sensors): The motor is to be supplied with 3 x temperature transmitter. The soft starter should preferably make provision for these temperature transmitters to be connected directly to it. When a high motor winding temperature is detected, the motors should be stopped via a controlled stop.
- Motor bearing temperature (Temperature Sensors): The motor is to be supplied with 2 x temperature transmitter. These temperature transmitters are to be wired back to controllers located on the respective soft starter cubicle. When high motor bearing temperature is detected, the motors must stop via a controlled stop. The pump can't be reset until the soft starter is reset.
- High discharge pressure: A pressure transmitter monitors the pressure in the rising main. The pressure transmitter is wired to an indicator in the local control panel. If the indicator indicates high pressure the motor must be stopped via a controlled stop. The pump can be restarted manually or automatically without resetting the soft starter. Each pump will be fitted with a Pressure sensor and flow sensor on the discharge side. If high pressure on no flow is detected the motor must be stopped via a controlled stop. The pump can be restarted manually or automatically without resetting the soft starter.

The definition of a controlled stop is one in which the soft starter ramps the motor speed down to standstill. An uncontrolled stop is one in which the soft starter turns off and the motor freewheels to a stop.

Control Philosophy

As receiving radio telemetry signal from a remote location (Ngungululu Reservoir) is not considered sufficiently reliable for controlling the Duty Pump, the 'Duty Pump Off' control (when the reservoirs are full) is to be based on sensing a preset decline of flow on the WTW-based Nqadu flow meter as the control valve at the Ngungululu Reservoir starts to close.

As pump protection against a burst or significant leak developing in the Rising Main, the Duty Pump is also shut down should the flow meter sense an increase in flow beyond a preset limit.

Ultrasonic level sensors in the clear water reservoirs at the WTW will serve as an interlock and pump trip condition when the reservoir level is Low.

The PLC shall automatically start the Duty Pump (the two pumps alternating duty) after a preset time delay from last 'Pump Off' condition.

Automatic Control

The automatic controls are to be implemented by the soft starter. If one soft starter is out of service, it must not affect the remainder of the soft starters. (There must not be a master soft starter). The control of the soft starter may be done via Programmable Logic Controller (PLC) logic internal to each soft starter. When in automatic (determined by the position of the auto manual switch on the MCC starter cubical) the pumps will start and stop automatically. If a soft starter is removed or isolated the signals between and to the other soft starters must not be affected.

The control of the pumps will be as follows:

The controlling signal is the Ngungululu water reservoir level, this level will be fed to a controller, the output will control the pump requirements. Low level (operator adjustable) will start the duty pump and high level (operator adjustable) will stop the duty pump.

The starting and stopping of the pumps must be such that the operating hours on the pumps are balanced as best as possible without recording and controlling the pumps on this parameter. Thus, the first pump to start will be the first pump to stop. Similarly, the last pump to stop will be the last pump to start. Following a complete plant stop or power failure pump 1 will start first. Only one pump will operate at any given time, and one will be a standby pump.

Should communication to the Ngungululu water reservoir level sensor be lost, the pump shall be controlled by the rising main flow sensor. If the pump stops for low delivery flow the pump must remain off for duration of 10 minutes (operator adjustable) before automatically restarting. It would be preferred if the pump sequence could be continued from the condition prevailing just prior to the system stop.

Manual Control

When in manual (determined by the position of the auto manual switch on the MCC cubical) the pumps are started and stopped by the operator via the start-stop buttons on the MCC cubical or the Outstation. If a pump stops on high level, low delivery flow or high delivery line pressure the pumps will be restarted manually by pressing the start button.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- 1 x Multifunction energy meter with protection fuses and suitable CTs.
- Suitably sized Soft Starter with Motor protection and communication.
- Soft starter HMI on the cubical door.
- 1 x Running hour meter.
- 1 x Control Circuit MCB.
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to soft starter with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- Motor and pump temperature and vibration monitors.
- All PLC inputs and outputs to be wired to PLC cabinet.
- Pump delivery valve position LED – Open/Closed round semaphore.
- Pump discharge valve position LED – Open/Closed round semaphore.
- Pump alarm indication LED: The alarms will be high vibration, high pump temperature, high motor temperature, and high motor load.
- Clear water reservoir low level LED

PSE 9.2.7. Extraction and Fresh Air Fans 1-11 (11 starter cubicles required) 5.5 kW motors

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- 1 x Multifunction energy meter with protection fuses and suitable CTs.
- Suitably sized DOL with Motor protection and communication.
- 1 x Running hour meter.
- 1 x Control Circuit MCB.
- Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to soft starter with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- Motor and pump temperature and vibration monitors.
- All PLC inputs and outputs to be wired to PLC cabinet.
- Pump delivery valve position LED – Open/Closed round semaphore.
- Pump discharge valve position LED – Open/Closed round semaphore.

PSE 9.2.8. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/166/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection.
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Cut-outs as required for HMI Panel.
Suitable panel lights.
Suitable for electronic IO marshalling.
Local HMI fitted to PLC cabinet.

PSE 9.2.9. Electrical low voltage interconnections

The method for electrical connection of the low voltage supply from the transformers to MCC 5B and will be via bus bars. The bus bar capacities are shown in drawing number J310678B/ELE/160/A sheet 1.

All other connections will be by means of copper cables. The schedule of cables is shown in The Schedule of Cables attached in Appendix A at the end of Document PSE.

The Electrical Contractor will verify the rating prior to purchasing the cable, to ensure that the cables don't have different specs than that originally used when doing the design.

PSE 9.3. SUPERNATANT PUMP STATION MCC 7

PSE 9.3.1. MCC 7: Supernatant Pump Station

Motor starters shall be provided in MCC 7 for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design.

Fault level is 10 kA and single line diagram is shown on drawing J310678B/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 10kA suitably sized and marked with phase colours for distribution in the panel.

b) 125 Amp, 3 pole, 10kA circuit breaker as the mains. The breaker shall have a lockout mechanism when switched off.

c) 4 x lightning arresters (65 kA rating) on the busbars suitable for electronic component protection.

d) 1 x Multifunction energy meter with protection fuses and suitable CTs with a communications module for communication to PLC, on each motor starter panel.

e) Auxiliary supplies for Control circuits, etc.

f) 1 x Undervoltage, Phase reversal control relay interlocked with control circuit.

g) 1 x Undervoltage, Phase reversal indicator lamp – Red LED

h) Lamp test wiring and relays

i) All breakers must have lockout facilities.

j) Local DB

- 1 x 60 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole, 30 mA earth leakage for plugs.

- 1 x 20 A, 1 pole MCB for plugs.
- 1 x 10 A, 1 pole MCB for lights.
- 1 x 60 A, 3 pole, 300 mA earth leakage for welding socket.
- 1 x 30 A, 3 pole, MCB welding socket outlet.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 1 x 10 A, 2 pole MCB for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 1 x 40 A, 3 pole MCB for Utility Kiosks
- 2 x 10 A, 1 pole MCB for instrumentation.
- 4 x Lightening arrestors

d) Where a Motor is marked “Future” the panel should be provided but with no equipment.

e) 1 x Single phase 415/220 V Control Transformer.

SCHEDULE OF ELECTRICAL MOTORS MCC 7 –Supernatant Pump Station

No	Tag	Description	Control	Rating
1	08-AP-01	Sludge storage Tank Mixer 1	DOL	7.5kW
2	08-AP-02	Sludge storage Tank Mixer 2	DOL	7.5 kW
3	08-AP-03	Sludge storage Tank Mixer 3	DOL	7.5kW
4	08-AP-04	Sludge storage Tank Mixer 4	DOL	7.5 kW
5	10-SRP-01	Supernatant Return Pump 1	DOL	11kW
6	10-SRP-02	Supernatant Return Pump 2	DOL	11kW

PSE 9.3.2. Motor starters MCC 7 – SUPERNATANT RETURN Pumps 1 – 2 (2 starter cubicles required) 11 kW motors

Mode of operation required:

Manual - Local/remote Manual start and stop with low level and no-flow protection.

Auto The Recycle Pump will check every 60 minutes (operator adjustable) if the ultrasonic level controller level in the emergency sludge pond inlet/outlet sump is higher than the Lo level (operator adjustable). If the level is lower than the Lo level, the pump will not start, and the 60-minute timer will reset. Should the level be higher than the Lo level, the pump will start. Should the sump reach the High level (operator adjustable), the pump will start without delay.
The pump will continue running until the Lo level is reached. The 60-minute timer will then reset.
The pumps shall alternate between duty and standby for each sequence if both pumps are healthy. If one pump is out of service or tripped, then one pump shall be the duty pump for each sequence.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- DOL starter with Electronic overload relay with communication to PLC.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control circuit MCB
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton

- 1 x Start pushbutton
- 1 x Emergency Stop
- "Run", "Stop" and "Trip", LED's - Green, Red and Yellow respectively "Run", "Stop" and "Trip", potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to electronic overload relay with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.3.3. Motor starters MCC 7 – SLUDGE STORAGE TANK MIXER 1 – 4 (4 starter cubicles required) 7.5 kW motors

Mode of operation required:

Manual - Local/remote Manual start and stop with low-level protection.

Auto The Sludge storage tank mixers/stirrers shall operate when the ultrasonic level controller level, in the sludge storage tank reaches a certain level (High) (operator adjustable) above the minimum submergence level and stop when the level drops to the minimum submergence level (Lo).

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- DOL starter with Electronic overload relay with communication to PLC.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control circuit MCB
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- "Run", "Stop" and "Trip", LED's - Green, Red and Yellow respectively "Run", "Stop" and "Trip", potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to electronic overload relay with isolation transformers.
- "Run", "Standby" and "Trip", LED's - Green, Blue and Red respectively at outstation.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.3.4. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/166/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection.
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Cut-outs as required for HMI Panel.
Suitable panel lights.
Suitable for electronic IO marshalling.
Local HMI fitted to PLC cabinet.

PSE 9.4. FILTER PLANT ROOM AND FILTED BUILDINGS MCC 2, MCC 2A AND MCC 2B

PSE 9.4.1. MCC 2: FILTER PLANT ROOM

Motor starters shall be provided in MCC 2 for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design.

Fault level is 20 kA and single line diagram is shown on drawing J310678B/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 20kA suitably sized and marked with phase colours for distribution in the panel.

b) 300 Amp, 3 pole, 20kA MCCB Low Voltage Isolator as the mains. The breaker shall have a lockout mechanism when switched off.

c) 4 x lightning arresters (65 kA rating) on the busbars suitable for electronic component protection.

d) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

e) Auxiliary supplies for PLC, Control circuits, etc.

f) 1 x under voltage, Phase reversal control relay

g) 1 x under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit.

h) Lamp test wiring and relays

i) 1 x 63 A 3 pole, 20 kA MCCB feeder to Filter Building 1 MCC 2A

j) 1 x 63 A 3 pole, 20 kA MCCB feeder to Filter Building 2 MCC 2B

k) All breakers must have lockout facilities.

l) Local DB

- 1 x 60 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole, 30 mA earth leakage for plugs.
- 1 x 20 A, 1 pole MCB for plugs.
- 1 x 10 A, 1 pole MCB for lights.
- 1 x 60 A, 3 pole, 300 mA earth leakage for welding socket.
- 1 x 30 A, 3 pole, MCB welding socket outlet.
- 1 x 30 A, 3 pole, MCB Crane Hoist
- 1 x 24 hr timer with bypass circuit for outside lights.
- 1 x 10 A, 2 pole MCB for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 1 x 40 A, 3 pole MCB for Utility Kiosks
- 2 x 10 A, 1 pole MCB for instrumentation.
- 4 x Lightening arrestors

m) 1 x Single phase 415/220 V Control Transformer.

SCHEDULE OF ELECTRICAL MOTORS MCC 2 –Filter Plant Room

No	Tag	Description	Control	Rating
1	05-FBP-01	Filter Backwash Pump 1	VSD	15 kW
2	05-FBP-01	Filter Backwash Pump 1	VSD	15 kW
3	05-FBP-01	Filter Backwash Pump 1	VSD	15 kW

4	05-BP-01	Blower Motor 1	DOL	30 kW
5	05-BP-01	Blower Motor 1 - Cooling Fan	DOL	0.37 kW
6	05-BP-02	Blower Motor 2	DOL	30 kW
7	05-BP-02	Blower Motor 2 - Cooling Fan	DOL	0.37 kW
8	03-BS-01	Clarifloculator Bridge Motor 1	DOL	0.55 kW
9	03-BS-02	Clarifloculator Bridge Motor 2	DOL	0.55 kW
10	03-BS-03	Clarifloculator Bridge Motor 3	DOL	0.55 kW
11	03-BS-04	Clarifloculator Bridge Motor 4	DOL	0.55 kW

PSE 9.4.2. RAPID GRAVITY SAND FILTER OPERATION

Mode of operation required:

Automatic Control

Each filter building has four rapid gravity sand filter beds. The water level in each filter bed is maintained at a preset level (irrespective of rate of inflow to filter) by means of a constantly modulating electrically-actuated filtered water outlet valve linked to a water level sensor. As the filter bed becomes progressively clogged, the outlet valve opens more and more to keep the water level above the filter sand at a preset constant level (default value: 50mm (operator adjustable) above spent-backwash water outlet launder).

Once the filtered outlet valve is fully open, the water level in the filter will start to rise. At a preset High-Water Level of 250mm above spent-backwash water outlet launder (operator adjustable), a PLC-controlled automatic backwash sequence is initiated. The PLC shall automatically initiate a backwash sequence after a pre-set time of 48 hours (operator adjustable) since last backwash, if not first initiated by a rising water level.

Two alternative automatic backwash modes are to be programmed into a PLC (Operator to select Mode applicable to all filters on HMI and/or Control Desk):

a) Mode 1: Air scour followed by water backwash.
b) Mode 2: Air scour, then combined air and water (one duty pump running), then water-only (Both duty pumps running)

Only the clarified water inlet valves into the filter bed shall be open when all four filter beds are operational. The backwash water outlet valves, backwash water inlet valves and the air scour valves shall all be closed. The air scour blower and the backwash pumps shall be switched off. The backwash control PLC shall not allow more than one filter to be backwashed at a time under any circumstances.

During backwashing, the conditions in the seven filter beds which are not being washed shall remain as stated above. It must be selectable to take any of the filters from the sequence for maintenance purposes. However, for the filter bed, which is being washed, the sequence of activities shall be as follows:

Backwashing Sequence: Mode 1

The backwashing sequence comprises:

1. Close settled water inlet valve

2. Allow water level to drop to 300mm above the top-of-sand level (controlled by ultrasonic level sensor), then close filtered water outlet valve
3. Open spent-backwash water launder channel outlet valve
4. Open air scour inlet valve
5. Start duty air blower and run for a preset period (default period: 5 minutes)
6. Stop duty air blower.
7. Close air scour inlet valve
8. Open backwash water inlet valve
9. Start duty-1 and duty-2 backwash pumps (~2 second staggered start) and run for preset period (default period: 10 minutes)
10. Stop duty backwash pumps.
11. Close backwash water inlet valve
12. Close spent-backwash water launder channel outlet valve.
13. Open settled water inlet valve
14. Allow water level to rise to 50mm above the top of spent-backwash water launder channel (controlled by ultrasonic level sensor), then open filtered water outlet valve in continuously modulating mode to maintain water level at 50mm above launder channel.

All times and levels will be operator adjustable.

Backwashing Sequence: Mode 2

The backwashing sequence comprises:

1. Close settled water inlet valve
2. Allow water level to drop to 300mm above the top-of-sand level (controlled by ultrasonic level sensor), then close filtered water outlet valve
3. Open spent-backwash water launder channel outlet valve
4. Open air scour inlet valve
5. Start duty air blower.
6. After 2 minutes has elapsed, open backwash water inlet valve.
7. Start duty-1 backwash pump.
8. After 5 minutes has elapsed, stop duty air blower.
9. Close air scour inlet valve
10. Start duty-2 backwash pump.
11. After 5 minutes has elapsed, stop both duty backwash pumps.
12. Close backwash water inlet valve
13. Close spent-backwash water launder channel outlet valve.
14. Open settled water inlet valve
15. Allow water level to rise to 50mm above the top of spent-backwash water launder channel (controlled by ultrasonic level sensor), then open filtered water outlet valve in continuously modulating mode to maintain water level at 50mm above launder channel.

All times and levels will be operator adjustable.

In Auto mode the selected filter should go through the whole selected backwashing sequence and when complete it should "rest" for 5 minutes before resuming filtering. If there is an

interrupt in the backwash sequence then, the system should stop, and all valves should return to filtering mode.

Manual Initiation of a Backwash Cycle

The Operator can manually initiate a backwash sequence at any time from the local HMI, provided that no other filter is currently running through a backwash sequence.

PSE 9.4.3. Motor starters MCC 2 – FILTER Backwash Pumps 1 – 3 (3 starter cubicles required) 15 kW motors

Mode of operation required:

Manual - Local/remote Manual start and stop with low level and no-flow protection.

Auto See Filter operation in PSE 13.1.1
The pump speed will be controlled to achieve an operator adjustable flowrate. This flowrate will be measured by the Backwash Water Supply flow meters.

MCC starter cubical controls to have the following minimum equipment:

- Full co-ordination required.
- Main fuses for VSD protection
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- Suitably sized Variable speed drive de-rated for altitude, as required with Motor protection and communication.
- VSD HMI on cubical door.
- Input and output line chokes if required.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control Circuit MCB.
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- Push buttons for manual speed control (up/down)
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to VSD with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.4.4. Motor starters MCC 2 – Air scour Blowers 1 – 2 (2 starter cubicles required) 15 kW motors

Mode of operation required:

Manual - Local/remote Manual start and stop.

Auto See Filter operation in PSE 13.1.1 for full auto and manual sequence initiation

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.

- DOL starter with Electronic overload relay with communication to PLC.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control circuit MCB
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to electronic overload relay with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.4.5. Motor starters MCC 2 – CLARIFLOCULATOR Bridge Motors 1- 4 (4 starter cubicles required) 0.55 kW motors

Mode of operation required:

Manual - Local/remote Manual stop/start

Auto Auto restart after power failure.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- DOL starter with Electronic overload relay with communication to PLC.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control circuit MCB
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Torque trip and reset indication on MCC cubical and Outstation.
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Remote Emergency Stop at bridge entry.
- Torque limiter input. (Limit switch)
- 1 x Ammeter at outstation connected to electronic overload relay with isolation transformers.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.4.6. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J31067/ELE/166/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection.
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.

Cut-outs as required for HMI Panel.
Suitable panel lights.
Suitable for electronic IO marshalling.

PSE 9.4.7. MCC 2A: FILTER BUILDING 1

Fault level is 10 kA and single line diagram is shown on drawing J310678B/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 10kA suitably sized and marked with phase colours for distribution in the panel.

b) 80 Amp, 3 pole, 20kA MCCB Low Voltage Isolator as the mains. The breaker shall have a lockout mechanism when switched off.

c) 4 x lightning arresters (65 kA rating) on the busbars suitable for electronic component protection.

d) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

e) Auxiliary supplies for PLC, Control circuits, etc.

f) 1 x under voltage, Phase reversal control relay

g) 1 x under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit.

h) Lamp test wiring and relays

i) All breakers must have lockout facilities.

j) Local DB

- 1 x 60 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole 30mA earth leakage unit for plugs.
- 3 x 20 A, 1 pole, MCB, for plugs.
- 3 x 10 A, 2 pole, MCB, for lights.
- 4 x 60 A, 2 pole 300mA earth leakage unit for welding socket.
- 4 x 30 A, 3 pole, MCB welding socket outlet.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 1 x 10 A, 2 pole, MCB, for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 3 x 10 A, 1 pole MCB's for instrumentation.
- 4 x lightening arrestors

k) 1 x Single phase 415/220 V Control Transformer.

SCHEDULE OF ELECTRICALLY ACTUATED VALVES MCC 2A – Filter Building 1

No	Tag	Description	Control	Rating
1	04-XV-BV01	Filter Bed 1 - Settled water inlet valve	FDR	0.75 kW
2	04-XV-BV02	Filter Bed 1 - Filter outlet valve	FDR	0.75 kW
3	04-XV-BV03	Filter Bed 1 - Backwash Valve	FDR	0.75 kW
4	04-XV-BV04	Filter Bed 1 - Blower Valve	FDR	0.75 kW
5	04-XV-GS01	Filter Bed 1 - Backwash Channel	FDR	0.75 kW
6	04-XV-BV05	Filter Bed 2 - Settled water inlet valve	FDR	0.75 kW

7	04-XV-BV06	Filter Bed 2 - Filter outlet valve	FDR	0.75 kW
8	04-XV-BV07	Filter Bed 2 - Backwash Valve	FDR	0.75 kW
9	04-XV-BV08	Filter Bed 2 - Blower Valve	FDR	0.75 kW
10	04-XV-GS02	Filter Bed 2 - Backwash Channel	FDR	0.75 kW
11	04-XV-BV09	Filter Bed 3 - Settled water inlet valve	FDR	0.75 kW
12	04-XV-BV10	Filter Bed 3 - Filter outlet valve	FDR	0.75 kW
13	04-XV-BV11	Filter Bed 3 - Backwash Valve	FDR	0.75 kW
14	04-XV-BV12	Filter Bed 3 - Blower Valve	FDR	0.75 kW
15	04-XV-GS03	Filter Bed 3 - Backwash Channel	FDR	0.75 kW
16	04-XV-BV13	Filter Bed 4 - Settled water inlet valve	FDR	0.75 kW
17	04-XV-BV14	Filter Bed 4 - Filter outlet valve	FDR	0.75 kW
18	04-XV-BV15	Filter Bed 4 - Backwash Valve	FDR	0.75 kW
19	04-XV-BV16	Filter Bed 4 - Blower Valve	FDR	0.75 kW
20	04-XV-GS04	Filter Bed 4 - Backwash Channel	FDR	0.75 kW

PSE 9.4.8. VALVE FEEDERS MCC 2A – ELECTRICALLY ACTUATED VALVES 1 (20 FEEDER CIRCUITS required)

Mode of operation required:

Manual – (Local) Manual operation with conditions as in PSE 9.4.2
Remote operation will be done on the Filter local control panel.

Auto See Filter operation in PSE 9.4.2

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with auxiliary contacts for control circuit isolation purposes.
- 1 x Control circuit MCB
- Heater circuit.
- Auto – Off – Manual key operated selector switch
- Filter 1-4 to be backwashed selector switch or push buttons (only one filter to be selected at any given time)
- Backwash sequence Mode 1-2 selector switch
- 1 x Start Backwash pushbutton
- 1 x Stop Backwash pushbutton
- Timer for adjusting Backwash time
- The following LED indication must be available in the form of a mimic panel. The indication LED's and controls must be laid out in a logical order such that no confusion can occur. A mimic must be painted on the panel, and the indication LED's suitably arranged.

  Filter Bed 1
  - Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Level of water is ready for backwash – Ready (Green)
  - Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Air scour blower On – Run (Green)
  - Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Backwash pump On – Run (Green)
  - Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

  Filter Bed 2
  - Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Level of water is ready for backwash – Ready (Green)
  - Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
  - Air scour blower On – Run (Green)
  - Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)

- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

Filter Bed 3
- Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Level of water is ready for backwash – Ready (Green)
- Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour blower On – Run (Green)
- Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

Filter Bed 4
- Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Level of water is ready for backwash – Ready (Green)
- Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour blower On – Run (Green)
- Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.4.9. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/166/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection.
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Suitable panel lights.
Suitable for electronic IO marshalling.

2 x Local HMIs mounted to the wall in the upper filter gallery with the following functionalities:
- Display the status of each actuated valve / sluice gate (open / shut / % open in the case of the filtered water outlet valve).
- Display hours since last backwash.
- Initiate backwash sequence.
- Display where backwash process is in terms of the backwash stages.
- Display countdown of current stage time remaining.

4 x Local Filter Control Desks mounted to the wall or floor standing in the upper filter gallery with the following functionalities:
- Display the status of each actuated valve / sluice gate (open / shut / % open in the case of the filtered water outlet valve).
- Display hours since last backwash.
- Initiate backwash sequence.
- Display where backwash process is in terms of the backwash stages.
- Display countdown of current stage time remaining

PSE 9.4.10. MCC 2B: FILTER BUILDING 2

Fault level is 20 kA and single line diagram is shown on drawing J310678B/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 20kA suitably sized and marked with phase colours for distribution in the panel.

b) 80 Amp, 3 pole, 20kA MCCB Low Voltage Isolator as the mains. The breaker shall have a lockout mechanism when switched off.

c) 4 x lightning arresters (65 kA rating) on the busbars suitable for electronic component protection.

d) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

e) Auxiliary supplies for PLC, Control circuits, etc.

f) 1 x under voltage, Phase reversal control relay

g) 1 x under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit.

h) Lamp test wiring and relays

i) All breakers must have lockout facilities.

j) Local DB

- 1 x 60 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole 30mA earth leakage unit for plugs.
- 3 x 20 A, 1 pole, MCB, for plugs.
- 3 x 10 A, 2 pole, MCB, for lights.
- 4 x 60 A, 2 pole 300mA earth leakage unit for welding socket.
- 4 x 30 A, 3 pole, MCB welding socket outlet.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 1 x 10 A, 2 pole, MCB, for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 3 x 10 A, 1 pole MCB's for instrumentation.
- 4 x lightening arrestors

k) 1 x Single phase 415/220 V Control Transformer.

SCHEDULE OF ELECTRICALLY ACTUATED VALVES MCC 2B – Filter Building 2

No	Tag	Description	Control	Rating
1	04-XV-BV17	Filter Bed 1 - Settled water inlet valve	FDR	0.75 kW
2	04-XV-BV18	Filter Bed 1 - Filter outlet valve	FDR	0.75 kW
3	04-XV-BV19	Filter Bed 1 - Backwash Valve	FDR	0.75 kW
4	04-XV-BV20	Filter Bed 1 - Blower Valve	FDR	0.75 kW
5	04-XV-GS05	Filter Bed 1 - Backwash Channel	FDR	0.75 kW
6	04-XV-BV21	Filter Bed 2 - Settled water inlet valve	FDR	0.75 kW
7	04-XV-BV22	Filter Bed 2 - Filter outlet valve	FDR	0.75 kW
8	04-XV-BV23	Filter Bed 2 - Backwash Valve	FDR	0.75 kW
9	04-XV-BV24	Filter Bed 2 - Blower Valve	FDR	0.75 kW
10	04-XV-GS06	Filter Bed 2 - Backwash Channel	FDR	0.75 kW
11	04-XV-BV25	Filter Bed 3 - Settled water inlet valve	FDR	0.75 kW
12	04-XV-BV26	Filter Bed 3 - Filter outlet valve	FDR	0.75 kW
13	04-XV-BV27	Filter Bed 3 - Backwash Valve	FDR	0.75 kW
14	04-XV-BV28	Filter Bed 3 - Blower Valve	FDR	0.75 kW
15	04-XV-GS07	Filter Bed 3 - Backwash Channel	FDR	0.75 kW

16	04-XV-BV29	Filter Bed 4 - Settled water inlet valve	FDR	0.75 kW
17	04-XV-BV30	Filter Bed 4 - Filter outlet valve	FDR	0.75 kW
18	04-XV-BV31	Filter Bed 4 - Backwash Valve	FDR	0.75 kW
19	04-XV-BV32	Filter Bed 4 - Blower Valve	FDR	0.75 kW
20	04-XV-GS08	Filter Bed 4 - Backwash Channel	FDR	0.75 kW

PSE 9.4.11. VALVE FEEDERS MCC 2B – ELECTRICALLY ACTUATED VALVES 1 (20 FEEDER CIRCUITS required)

Mode of operation required:

Manual – (Local) Manual operation with conditions as in PSE 9.4.2
Remote operation will be done on the valve local control panel.

Auto See Filter operation in PSE 9.4.2

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with auxiliary contacts for control circuit isolation purposes.
- 1 x Control circuit MCB
- Heater circuit.
- Auto – Off – Manual key operated selector switch
- Filter 1-4 to be backwashed selector switch or push buttons (only one filter to be selected at any given time)
- Backwash sequence Mode 1-2 selector switch
- 1 x Start Backwash pushbutton
- 1 x Stop Backwash pushbutton
- Timer for adjusting Backwash time
- The following LED indication must be available in the form of a mimic panel. The indication LED's and controls must be laid out in a logical order such that no confusion can occur. A mimic must be painted on the panel and the indication LED's suitably arranged.

<u>Filter Bed 1</u>
- Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Level of water is ready for backwash – Ready (Green)
- Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour blower On – Run (Green)
- Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

<u>Filter Bed 2</u>
- Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Level of water is ready for backwash – Ready (Green)
- Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour blower On – Run (Green)
- Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

<u>Filter Bed 3</u>
- Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Level of water is ready for backwash – Ready (Green)
- Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour blower On – Run (Green)
- Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

<u>Filter Bed 4</u>

- Settled water inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Level of water is ready for backwash – Ready (Green)
- Filtered water outlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Air scour blower On – Run (Green)
- Backwash pump inlet valve Position – Open/Closed round semaphore (Geen and Red)
- Backwash pump On – Run (Green)
- Spent backwash outlet valve Position – Open/Closed round semaphore (Geen and Red)

- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.4.12. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/166/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection.
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Suitable panel lights.
Suitable for electronic IO marshalling.

2 x Local HMIs mounted to the wall in the upper filter gallery with the following functionalities:

- Display the status of each actuated valve / sluice gate (open / shut / % open in the case of the filtered water outlet valve).
- Display hours since last backwash.
- Initiate backwash sequence.
- Display where backwash process is in terms of the backwash stages.
- Display countdown of current stage time remaining.

4 x Local Filter Control Desks mounted to the wall or floor standing in the upper filter gallery with the following functionalities:

- Display the status of each actuated valve / sluice gate (open / shut / % open in the case of the filtered water outlet valve).
- Display hours since last backwash.
- Initiate backwash sequence.
- Display where backwash process is in terms of the backwash stages.
- Display countdown of current stage time remaining

PSE 9.5. CHLORINE BUILDING DISTRIBUTION BOARDS

PSE 9.5.1. MCC 3: CHLORINE BUILDING

This will be a Distribution Board supplying the following:

Fault level is 10 kA.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 10 kA suitably sized and marked with phase colour.

b) Siren and Strobe light linked to the gas leak detector and PLC for high chlorine ppm level.

c) Local DB with as part of MCC complete with:

   - 1 x 80 A, 3 pole MCB - Mains
   - 1 x 60 A, 2 pole 30mA earth leakage unit for plugs.
   - 2 x 20 A, 1 pole, MCB, for plugs.

- 2 x 10 A, 2 pole, MCB, for lights.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 3 x 10 A, 2 pole, MCB, for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 1 x 40 A, 3 pole MCB for Utility Kiosks
- 15 x 10 A, 1 pole MCB's for instrumentation.
- 1 x 60A, 3 pole MCB for Chlorine Control panel (by others)
- 4 x lightning arrestors

SCHEDULE OF ELECTRICAL MOTORS IN CHLORINE BUILDING

No	Abbrev	Description	Rating
1	12-CHL-xx	Extractor fan on emergency Dry Scrubber	0.55 kW

PSE 9.5.2. PLC Cabinet

The PLC cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/160/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Cut-outs as required for various indicating instruments.
Suitable panel lights.
Suitable for electronic IO marshalling.
Local HMI fitted to PLC cabinet.

PSE 9.6. COAGULANT DOSING BUILDING MCC 1

PSE 9.6.1. MCC 1: COAGULANT DOSING BUILDING

Motor sfeeders shall be provided in MCC 1 for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design.

Fault level is 10 kA and single line diagram is shown on drawing J310678B/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 10 kA suitably sized and marked with phase colour.

b) 1 x 80 A, 3 pole, 10 kA MCCB Low Voltage Isolator as the mains. The isolator shall have a lockout mechanism when switched off.

c) 4 x lightning arresters (65 kA rating) on the busbars suitable for electronic component protection.

d) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

e) Auxiliary supplies for PLC, Control circuits, etc.

f) 1 x Undervoltage, Phase reversal control relay interlocked with control circuit.

g) 1 x Undervoltage, Phase reversal indicator lamp – Red LED

h) Local DB with as part of MCC complete with:

- 1 x 60 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole 30mA earth leakage unit for plugs.
- 3 x 20 A, 1 pole, MCB, for plugs.
- 1 x 10 A, 2 pole, MCB, for lights.
- 1 x 60 A, 2 pole 300mA earth leakage unit for welding socket.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 3 x 10 A, 2 pole, MCB, for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 2 x 40 A, 3 pole MCB for Utility Kiosks
- 3 x 10 A, 1 pole MCB's for instrumentation.
- 4 x lightening arrestors

SCHEDULE OF ELECTRICAL EQUIPMENT MCC – 1 DOSING BUILDING

No	Tag	Description	Control	Rating
1	11-DP-01	Coagulant Dosing Pump 1	FDR	0.37 kW
2	11-DP-02	Coagulant Dosing Pump 2	FDR	0.37 kW
3	02-XVF-BV04	Inlet Control Valve	FDR	0.75 kW

PSE 9.6.2. Motor starters MCC 1 – COAGULANT DOSING PUMP 1-2 (2 x Feeders required) 0.37 kW motors

Mode of operation required:

Manual - Local/remote Stop – Start for each pump with no-flow protection.

Auto Operator will select which pump must run; The duty dosing pump shall be controlled by means of a signal from a streaming-flow ion current detector (SCD). A dedicated no-flow switch shall stop the dosing pump.

PSE 9.6.3. VALVE FEEDERS MCC 1 – ELECTRICALLY ACTUATED INLET CONTROL VALVE (1 FEEDER CIRCUIT required)

Mode of operation required:

Manual - Local/remote The Operator can manually change the electrically-actuated valve position at any time from the local HMI in the Dosing building, SCADA in the Admin Building, or the remote outstation.

Auto The valve will control the inlet flow measured at the inlet flow meter. This flow is operator adjustable. This closed-loop control will be very slow to allow time for the constant-head hydraulic diaphragm valve (in the adjoining chamber) to adjust to the change in flow rate.

PSE 9.6.4. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/160/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Cut-outs as required for various indicating instruments.
Suitable panel lights.
Suitable for electronic IO marshalling.
Local HMI fitted to PLC cabinet

PSE 9.7. BACKWASH RECYCLING BUILDING MCC 4

PSE 9.7.1. MCC 4: BACKWASH RECYCLING BUILDING

Motor starters shall be provided in MCC 4 for all electrical motors listed in the Schedule of Electrical Motors. Motor starters shall be equipped as detailed in the Motor Starter Schedule and Type 2 co-ordination shall be used for design.

Fault level is 10 kA and single line diagram is shown on drawing J310678B/ELE/160/A.

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 10kA suitably sized and marked with phase colour for distribution in the panel.

b) 1 x 125 A, 3 pole, 10kA MCCB Low Voltage Isolator as the mains. The isolator shall have a lockout mechanism when switched off.

c) 4 x lightning arresters (65 kA rating) on the busbars suitable for electronic component protection.

d) 1 x Multifunction energy meter with protection fuses and suitable CTs with communications module for communication to PLC, on each motor starter panel.

e) Auxiliary supplies for PLC, Control circuits, etc.

f) 1 x under voltage, Phase reversal control relay

g) 1 x under voltage, Phase reversal indicator lamp – Red LED and audible alarm interlocked with control circuit.

h) Lamp test wiring and relays

i) All breakers must have lockout facilities.

j) Local DB

- 1 x 60 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole, 30 mA earth leakage for plugs.
- 1 x 20 A, 1 pole MCB for plugs.
- 1 x 20 A, 2 pole MCB for Roller Shutter Door plug.
- 1 x 10 A, 1 pole MCB for lights.
- 1 x 60 A, 3 pole, 300 mA earth leakage for welding socket.
- 1 x 30 A, 3 pole, MCB welding socket outlet.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 1 x 10 A, 2 pole MCB for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 1 x 40 A, 3 pole MCB for Utility Kiosks
- 2 x 10 A, 1 pole MCB for instrumentation.
- 4 x Lightning arrestors

k) 1 x Single phase 415/220 V Control Transformer.

SCHEDULE OF ELECTRICAL MOTORS MCC 4 –Backwash Recycling Room

No	Tag	Description	Control	Rating
1	08-RBP-01	Backwash Recycling Pump 1	DOL	7.5 kW
2	08-RBP-02	Backwash Recycling Pump 2	DOL	7.5 kW
3	08-RBP-03	Backwash Recycling Pump 3	DOL	7.5 kW
4	08-AP-01	Backwash Storage Tank Mixer 1	DOL	7.5 kW
5	08-AP-02	Backwash Storage Tank Mixer 2	DOL	7.5 kW

PSE 9.7.2. Motor starters MCC 4 – Backwash Recycling Pumps 1 – 3 (3 starter cubicles required) 7.5 kW motors

Mode of operation required:

Manual - Local/remote Manual start and stop with low level and no-flow protection.

Auto

The Backwash Recycle Pumps will operate based on the level in the storage tank. The starting and stopping of the pumps must be such that the operating hours on the pumps are balanced as best as possible without recording and controlling the pumps on this parameter. Thus, the first pump to start will be the first pump to stop. Similarly, the last pump to stop will be the last pump to start. Following a complete plant stop or power failure pump 1 will start first. A maximum of two pumps will operate simultaneously and one will be a standby pump.

Logic Description	Storage Tank level % (depth)	Triggers ON
Lo Lo	Tank 0% (0m)	Pump 1 Off Pump 2 Off
Lo	Tank 10% (0.244m)	Pump 1 Turns ON
Hi	Tank 60% (1.44m)	Pump 1 ON Pump 2 Turns ON
Hi Hi	Tank 100% (2.4m)	Pump 1 ON Pump 2 ON Alarm

As the delivery pipework on each pump will be fitted with a 'MARIC' in-line hydro-mechanical flow limiter, the pumps operate at a fixed pumping head no matter what the variations in static head are. There is therefore no need for any electrical flow-regulating systems.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- DOL starter with Electronic overload relay with communication to PLC.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control circuit MCB
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- "Run", "Stop" and "Trip", LED's - Green, Red and Yellow respectively "Run", "Stop" and "Trip", potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to electronic overload relay with isolation transformers.
- "Run", "Standby" and "Trip", LED's - Green, Blue and Red respectively at outstation.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.7.3. Motor starters MCC 4 – Backwash Storage Tank Mixers 1-2 (2 starter cubicles required) 7.5 kW motors

Mode of operation required:

Manual - Local/remote Manual start and stop with low level protection.

Auto The Backwash storage tank mixers/stirrers shall operate when the level in the spent backwash storage tank reaches a certain level (operator adjustable) above the minimum submergence level and stop when the level drops to the minimum submergence level.

MCC starter cubical controls to have the following minimum equipment:

- Type 2 co-ordination required.
- 1 x Motor Protection Circuit breaker with lockable front panel rotary handle, door interlocked and auxiliary contacts for control circuit isolation purposes.
- DOL starter with Electronic overload relay with communication to PLC.
- 1 x ammeter
- 1 x Running hour meter.
- 1 x Control circuit MCB
- Heater circuit.
- Local – Remote Selector switch.
- Auto – Off – Manual key operated selector switch
- 1 x Stop pushbutton
- 1 x Start pushbutton
- 1 x Emergency Stop
- “Run”, “Stop” and “Trip”, LED’s - Green, Red and Yellow respectively “Run”, “Stop” and “Trip”, potential free contact outputs to PLC
- Remote Stop, Start, Emergency Stop at outstation.
- 1 x Ammeter at outstation connected to electronic overload relay with isolation transformers.
- “Run”, “Standby” and “Trip”, LED’s - Green, Blue and Red respectively at outstation.
- Necessary control contacts, -wiring and terminals as required for instrumentation and power.
- Lamp test wiring and relays.
- All PLC inputs and outputs to be wired to PLC cabinet.

PSE 9.7.4. PLC Cabinet

The PLC cabinet shall form part of the MCC, and the cabinet shall be 1200 mm wide x 2000 mm high as indicated on drawing J310678B/ELE/166/A.

The cabinet shall include the following:

1 x 20 A, 2P MCB suitable for electronic equipment protection.
1 x 20 A, 2P MCB suitable for 24-volt DC protection.
Din rails for mounting of terminal strips.
Terminals as required.
Cut-outs as required for HMI Panel.
Suitable panel lights.
Suitable for electronic IO marshalling.
Local HMI fitted to PLC cabinet.

PSE 9.8. SLUDGE DEWATERING MCC 6

PSE 9.8.1. MCC 6: SLUDGE DEWATERING

Here we will only require a Floor standing IP65 Distribution Board with the following:

Fault level is 15 kA .

The panel shall consist of the following equipment as indicated.

a) Set of 3 phase, neutral and earth busbars, 15 kA suitably sized and marked with phase colour.

b) DB complete with:

- 1 x 80 A, 3 pole MCB - Mains
- 1 x 60 A, 2 pole, 30 mA earth leakage for plugs.
- 1 x 20 A, 1 pole MCB for plugs.
- 1 x 10 A, 1 pole MCB for lights.

- 1 x 60 A, 3 pole, 300 mA earth leakage for welding socket.
- 1 x 30 A, 3 pole, MCB welding socket outlet.
- 1 x 24 hr timer with bypass circuit for outside lights.
- 1 x 10 A, 2 pole MCB for outside lights.
- 1 x 5 A, 1 pole, MCB, feeding the photocell.
- 1 x 1 pole contactor
- 1 x 40 A, 3 pole MCB for Utility Kiosks
- 2 x 10 A, 1 pole MCB for instrumentation.
- 1 x 60A, 3 pole MCB for SLUDGE DE-WATERING MCC (Supplied by others)
- 4 x Lightening arrestors

PSE 10. INSTRUMENTATION

PSE 10.1. Ultrasonic Water Level Sensors

The level sensors, supply and control cables shall be supplied under this contract. The level sensors shall be complete with a control unit and must operate from 230 V supply and have a 4-20 mA HART interface. All 4 – 20 mA signal cables shall be 1,5 mm^2 Multiple Shielded twisted pair (Served Wire Armour) cable. The sensor heads shall be ordered with the applicable cable length. The Ultrasonic non-contact sensor and transmitter for liquid level shall have integrated temperature compensation.

The Ultrasonic level transmitter shall comply with the following requirements:

- Measuring accuracy of ±0.2 % of end value or ±6mm.
- Measuring range of up to 12 m
- Process temperature range: 0 to 40°C.
- Beam Angle: 3°
- Housing 316L S/S, IP68 NEMA 4X/6P
- FM, CSA, ATEX, IECEX Hazardous area approval.
- 4-20 mA, HART communication.
- 2 wire, 24 V dc loop powered.
- Automatic temperature compensation.
- Fault monitoring and Self Checking.
- Configurable display.
- Configurable locally via display.
- If the sensor is submerged, the output will remain constant and shall not fluctuate.

The control unit shall comply with the following requirements:

- Panel mounting control units.
- 4-20mA HART compatible input.
- Five fully field programmable relays
- Programmer wizards to assist configuration and set-up for level, pump control and flow.
- Pre-configured flow curves for weirs and flumes in accordance with ISO / BS standards.
- 4-20 mA output, 5 x SPDT relay contacts on controllers.
- FM, CSA, ATEX, IECEX Hazardous area approval.
- 4-20 mA, HART communication.
- Data logging of up to 7000 events plus totalized flow.

PSE 10.2. Level Switches (Suspended Float Switches)

Suspended Float level switches with adjustable heights shall be used in the filter beds to initiate automatic backwash sequence. The switches shall be supplied under this contract as well as the control cables.

The flow switches shall comply with the following requirements:

- Cable length 10 m
- Ingress protection of IP68
- Adjustable height

PSE 10.3. Magnetic Flow Meter

The magnetic flow meter tube and transmitters shall be supplied under this contract. The magnetic flow meters shall be flanged complete with the transmitter integral mount and must operate from 230 V supply. The supply to the sensors shall be supplied under this contract as well as the control cables. All 4 – 20 mA signal cables shall be 1,5 mm^2 Multiple Shielded twisted pair (Served Wire Armour) cable. The Magnetic flow meter will have a 4-20 mA output HART, compatible. The flow tube sensor will be flange ANSI150.

The magnetic flow meter shall comply with the following requirements:

- Flange mounted.
- Reference accuracy of ± 0.25 % over 40:1 flow turndown.
- FM, CSA, ATEX, IECEX Hazardous area approval.
- Fault monitoring.
- Configurable display.
- Configurable locally via display.
- 4-20 mA, HART communication.

PSE 10.4. Flow Switches

Flow switches shall be used to protect the delivery side of each pump. The sensors shall be supplied under this contract as well as the control cables.

The flow switches shall comply with the following requirements:

- High accuracy under low flow conditions.
- Range Adjustment.
- Set Point Adjustment (±15 % to 9 % of measuring range).
- Linearity Deviation of < 5 %.
- Repeatability of < 2 %.
- Hysteresis of ± 10 %

PSE 10.5. Pressure Transmitter

Pressure transmitters shall be used to monitor suction and discharge pressures. The transmitters shall be supplied under this contract as well as the control cables. The Pressure transmitters will have a 4-20 mA output HART, compatible. All 4 – 20 mA signal cables shall be 1,5 mm^2 Multiple Shielded twisted pair (Served Wire Armour) cable.

The pressure transmitters shall comply with the following requirements:

- Measuring accuracy of ± 0.055 %
- Measuring range of 0 to 4000 kPA
- Process temperature range: -10°C to 60°C
- FM, CSA, ATEX, IECEX Hazardous area approval.
- Fault monitoring.
- Configurable display.
- Configurable locally via display.
- 4-20 mA, HART communication.

PSE 11. Standby Generator Plant and Equipment

A nominated generator manufacturer and installer shall be appointed by the Electrical Contractor to complete the supply, delivery, installation, programming, testing, and commissioning of the generator plant and associated equipment into service. Provision has been made in the schedule of quantities of this tender for the above.

Suitable louvres and attenuators are to be installed in the openings of the Generator Plant Room to allow for adequate cooling and ventilation of the Gensets and to ensure that the sound level is below 85 dBA noise rating limit external to the building when the Genset is operational.

The option of synchronising the Gensets power with municipal power with, seamless transfer capabilities will not be permissible as the sum of the combined power will result in kA fault levels outside of safety parameters when generating and synchronising the Gensets and municipal power at 11 000 V. Seamless transfer to be added depending on 11kV fault levels.

PSE 11.1. New 2500 KVA Generator Plants

A new standby diesel generator is to be provided, placed in the generator room to be constructed near the pumps station. The generator is to have the following specifications:

Capacity: 2500 KVA

Voltage: 11 000 V 3 phase

PF: 0.8 lagging

Poles: To suit engine

Engine: To be confirmed

Controls: See control specifications

Change over system: Part of Genset

Day fuel tank: 1000l

The Contractor shall allow for the complete supply, delivery, handling, off-loading, installation, testing, commissioning, and handing over in working order of the specified installation and system in such a way that the whole forms a complete working system without any further material, apparatus or labour being required to make it so.

The current rating and number of poles shall be as indicated on the name plate.

PSE 11.2. New Generator room additional equipment installation

Louvres and attenuators are to be fitted to the new generator building. The contractor must ensure that these are correctly designed to reduce the noise level below 85db at the outside of the building.

PSE 11.3. Generator Automation

PSE 11.3.1. Generator Control

Only one generator will be installed at this stage.

PSE 11.3.2. Off / Automatic/ Manual/ Maintenance control switch

This switch will be a three-position switch with a locking facility for each position, the response of the generator to each position will be as follows:

- Off – The generator will not start for a power failure if the manual start button is pressed.
- Automatic – the generator will start and stop in response to power failures. The Gensets will synchronize with each other and share load.
- Manual – the generator will start when the start button is pressed and will only stop when the stop button is pressed. The generator will synchronize and share load in manual.
- Maintenance – When in this position the generator starting/ stopping and control will be done at each generator and the operation of the transformer, couplers and generator breakers will be done manually.

PSE 11.3.3. Manual Start button

This button will only be active when the selector switch is set to manual. When the start button is pressed the generator will all synchronise onto the generator bus bar. The controls will then disconnect the WTW from the mains by opening breaker “Incomer 1” – 11 kV bus and closing “Genset 1.

PSE 11.3.4. Manual Stop Button

This button will only be active when the selector switch is set to manual. When the stop button is pressed when the generator are running, the controls will disconnect the WTW from the generator by opening the Generator breakers Genset 1.The generator will then run down and stop.

PSE 11.3.5. Emergency Stop Button

When pressed this button must via hard wiring disable generator 1.

PSE 11.3.6. Local HMI

The system must have a local HMI which will indicate the status of the system, alarms, and power flows.

PSE 11.3.7. Synchroscope

The master panel must have a synchroscope for the generator. This unit must also prevent closing of the breaker if the units are not in synch with the bus bar.

PSE 11.3.8. Interface signals

The following signals must be used in the control of the breakers:

- 11 kV Incomer 1 breaker racked in
- 11 kV Incomer 1 breaker fault tripped.
- 11 kV Incomer 1 breaker status open or closed.
- Genset 1 breaker racked in
- Genset 1 breaker tripped.
- Genset 1 breaker status

If the breaker is removed from the carriage, it must still give a breaker racked out indication.

PSE 11.3.9. Automatic start control description

The master control station must sense the 11kV supply voltage on the 11 kV Incomer. The generator must only start if the main control switch is in automatic, and a loss of voltage is detected for longer than a settable period (5 seconds to 60 minutes).

The master controller will then check the following before starting a generator:

- 11 kV supply off and 11 kV Incomer 1 open.
- Generator breakers racked in.
- No trip on generator breakers
- No trip on Transformer breakers
- Transformer breakers TRF 1,2 and 3 are open.
- 400 V bus couplers 1 and 2 are open.

If these conditions are met, then the master controller will perform the following sequence of operations:

- **Sequence 1:**

a. If Genset breakers are racked in and ready for operation move to next sequence

- **Sequence 2:**

a. Start first machine Genset 1.
b. Close Genset 1 breakers.

- **Sequence 3:**

a. Depending on the key switch configuration the following:
b. Close Incomer 1 (400 V)
c. Close Incomer 2 (400 V) (Key switch dependent)
d. Close Incomer 3 (400 V)
e. Close Bus coupler 1 or 2 (Key switch dependent)
f. Proceed to energize plant.

PSE 11.3.10. Automatic stop control description

The master control station must sense the return of the 11 kV voltage. When it indicates the supply has returned the generator will run for a set period (5 seconds to 60 minutes) before the following sequence takes place:

- Sequence 1

a. Open Incomer 1 (400 V).
b. Open Incomer 2 (400 V).
c. Open Incomer 3 (400 V).
d. Open Bus coupler 1 if closed.
e. Open Bus coupler 2 if closed.
f. Open Genset 1 breaker.

- Sequence 2

a. Run down generator.

PSE 11.3.11. SCADA indication and alarm signals

The following signals must be made available to the SCADA system via Modbus running over Ethernet:

- Master station control switch in auto
- Master station control switch in manual
- Master station control switch in off position
- Master station emergency stop pressed.
- Generator 1 in service
- Generator 1 breaker status
- Total generator load (kW)
- Total generator apparent load (kVA)
- Total generator reactive load (kVAr)
- Generator load as % of available power
- Generator load a % of apparent load
- Generator 1 status (running/stopped)
- Generator 1 fault
- Generator 1 load (kW)
- Generator 1 apparent load (kVA)
- Generator 1 reactive load (kVAr)
- 11 kV Incomer breaker Status
- 11 kV Incomer breaker position (racked in)
- Breaker TRF 1 Status
- Breaker TRF 1 position
- Breaker TRF 2 Status
- Breaker TRF 2 position
- Breaker TRF 3 status

- Breaker TRF 3 position
- Bus coupler 1 status
- Bus coupler 1 position
- Bus coupler 2 status
- Bus coupler 2 position
- Generator load > 70%
- Generator load > 95%

PSE 11.3.12. Fuel storage

The day fuel tanks used for storage of fuel and would only be able to sustain operations of the Gensets for a few hours. A new 14000 litre bulk fuel tank is to be installed that would comply with the South African National Standards and Occupational Health and Safety Act (Act 85 of 1993). This bulk fuel tank will supply both Gensets with fuel.

A fuel control panel is to be supplied which will feed fuel to the required day tanks. The generator day tanks are to be installed with level switches for the automation of the fuel filling system. Solenoid valves must also be supplied between the main fuel line and the respective fuel tank to enable filling of the correct fuel tank. Isolation and bypass valves must also be included. A fuel cleaning system must also be included which will be used to remove water and particles from the fuel. The system will circulate the fuel in the main storage tank.

PSE 12. Supervisory control and data acquisition (SCADA)

The operations within the Highbury WTW are to be automated using a Supervisory Control and Data Acquisition (SCADA) system at both the LV and MV level. This will allow for remote monitoring and control of operations to be carried out by a competent person.

Provision is to be made to allow for manual operations to be carried out in the simplest manner in the unlikely event of the SCADA system failing.

The project covers the supply, delivery, installation and commissioning of the Plant Management and Automation System including, Data Historian, SCADA hardware and software, PLC's, configuration of all control software, hardware, and process instrumentation for Highbury Water Treatment Works.

The Control & Automation System to be supplied and installed under this contract, comprising of a SCADA control system and equipment, PLC devices, field instrumentation and cabling, will provide for the automated control of the Water Treatment Works areas such as the Clear Water Pump station, Filter Plant room, Rapid Gravity Sand filters, Backwash recycling Pump station, Supernatant Pump station, Sludge Dewatering plant, Medium voltage switchgear, Low Voltage Switchgear, Generator, Chlorination and Dosing equipment. The Control of the Highbury Water Treatment Works will be situated in the Admin Building Control Room.

The Plant Management System to be supplied and installed under this contract will provide for a fully integrated data acquisition, analysis and reporting system. This will comprise of a SQL Server Data Historian & Reporting software and hardware which will provide for real-time and historical data acquisition directly from multiple sources and therefore enable centralized reporting, trending and analysis of production data deriving from the plant.
.
A multiple user access license is to be made available for the data reporting system. The successful Tenderer will be required to configure an initial number of reports based on Tag definitions, etc. Cost of user training to be also included in order that Highbury technical staff may become autonomous in any further data reporting & analysis that may be required. This includes basic user training on the SQL Server database.

Windows based software for the SCADA stations and the latest Microsoft SQL Server based software for the data historian server is to be supplied. The software must help Highbury Water Treatment Works to comply the Blue Drop status certification when audited. The use of standard Microsoft Office tools for report and analysis purposes are to be used rather than customized applications.

Refer to the attached plant network layout configuration on drawing J31067B/ELE/163/A which gives a schematic view of the system topology that needs to be implemented. This drawing is for information only and the successful tender shall submit his own topology.

PSE 12.1. Communication interfaces

The following communications protocols must be provided:

- **Modbus over Ethernet**: All new equipment being installed at the Highbury and Thornhill water treatment works is being specified with Modbus communications over Ethernet.
- **Modbus RTU:** This will allow for legacy telemetry equipment to be incorporated in the PLC and SCADA system.
- **DNP3:** This will enable communications with the new protection relays to be installed on the new 11kV switchboard.
- For any telemetry equipment, the protocol shall be compatible with the existing equipment installed at Thornhill Water Treatment Works.
- 4-20 mA HART communication.
- Profibus

PSE 12.2. Computer Hardware

The following is the minimum requirements for the PC and associated hardware. The contractor must however check that this is suitable for the SCADA software offered.

- Processor: Intel i7 6 core hyperthreading processor
- Hard Disk Space: 1 TB SSD m.2 and 6 TB HDD with RAID 1 capability.
- Memory: 32 GB
- Monitor: 2 x 27-inch Samsung HDMI 1920 x 1080 minimum resolution, or equivalent.
- User interface: Keyboard and mouse
- Communications interface: 2 x Ethernet, 6 x USB3
- Operating system: Windows Server 2019

PSE 12.3. PLC and SCADA interface hardware

If the required PLC and SCADA signals cannot be read directly from a device the contractor may install suitable interface hardware. This hardware must be installed in a suitable junction box and located near the PLC and SCADA control. The interface hardware must be commercially available with good backup support. The junction box must have sufficient space for future expansion and must also include all protection, isolation, and power supplies. The hardware must be approved by the engineer prior to ordering.

PSE 12.4. PLC and SCADA Requirements

The PLC and SCADA software will be supplied with the development and user interface components. This will allow further expansion of the system by other support contractors. The PLC AND SCADA package must be well supported in South Africa with system integrators located in all major centres. Proprietary software packages that have been developed by the contractor or sub-contractor which is not supported by other parties will not be accepted.

All hardware equipment (i.e. power supplies, controllers, communication modules and networks) must have 100% redundancy.

PSE 12.4.1. Operator Login and Security

The PLC and SCADA must be able to be viewed without logging in. This will give staff on site the ability to see what is happening in the system without logging in. To invoke control actions, change settings or accept alarms will require the operator to login. The login will require a username and password.

PSE 12.4.2. Graphical Representation

The PLC and SCADA must display all the information in a graphical representation which is easy to understand and navigate. The system must give a high-level over-view of all the equipment and reservoirs in the Highbury WTW network. The operator must then be able to zoom into reservoirs or the water treatment works to gain more information.

PSE 12.4.3. Alarming and Event Management

All alarms in the system (low level, high level, pump trips) must be alarmed and stored in a SQL database. The alarm must be displayed in an alarm list and will need to be accepted by the operator before it is cleared. An operator with suitable rights will need to be logged into the PLC and SCADA system to enable the alarms to be accepted. An alarm management system must also be provided which should generate the following reports:

- Most occurring alarms from start to end date entered.
- Date and time of specified alarm from start to end date entered.

PSE 12.4.4. Scalability

The size of the PLC and SCADA system proposed is based on the estimated I/O for the completed system. The contractor will be responsible for considering any additional tag licenses required for SQL database access or calls to the Operating system that are not indicated in the list shown later in this document. As the system may grow further than anticipated the system must be scalable such that the licensed tag count can be increased without having to purchase a new PLC and SCADA software package and license.

PSE 12.4.5. Data Transfer

The PLC and SCADA system must have the ability to export historical data to spreadsheets and SQL databases.

PSE 12.4.6. Remote access and Web Access

Remote access to the PLC and SCADA is required. This can be via a remote client log in or preferably via a web enabled interface.

PSE 12.4.7. Mobile Phone Support

The PLC and SCADA package must have the ability to route specified alarms to cell phones via SMS messages. The contract presently makes no provision for any GSM modems for the mobile phone support.

PSE 12.4.8. Scripting

It is not envisaged that scripting will be required during the implementation of the PLC and SCADA. It is however a very powerful tool and could be required in future and is thus requested.

PSE 12.4.9. Data Logging

All analogue data must be logged to a SQL database (levels, flow, and pressure). All alarms must also be logged to a SQL database. Historic information must be easily accessible from the database and displayed on a graph. This information must also be easily exported to a CSV or similar file that a spreadsheet program can open. Dead bands must be used to limit the amount of data to be logged. The logging interval of analogue signals should be 30 seconds for fast moving signals (generator loads) and 5 minutes for slow moving signals (reservoir levels)

PSE 12.4.10. Licensing

Licensing via hardware key (HASP) is preferred as the license can easily be moved from one computer to another in the event of hardware failure. The hardware key should be USB based and should be connected to a USB port that is located internal to the computer to avoid the hardware key from being accidently removed.

PSE 12.5. Mimic Pages

This is a guide on the anticipated mimic screens and navigation between them. The contractor is responsible for ensuring the screens are easy to read and navigate.

The mimics shall be generated on the existing system.

There should be several tabs on the screen that will allow navigation between the various

a. Overall Plant layout
b. Communication system
c. PLC and SCADA layout
d. 11 kV switching station.
e. MCC and LV distribution network
f. Temporary raw water pump station
g. Raw rater reservoir and Inlet works.
h. Poly dosing system
i. Clarifloculator
j. Rapid gravity sand filters
k. Filter plant room and Clear water reservoirs
l. Clear water pump station and Isolation chamber
m. Backwash recycling.
n. Sludge holding tank and Sludge return pump station.
o. Chlorine dosing and Scrubber system
p. Rosedale Reservoir flow and level
q. Ngungululu Reservoir flow and level
r. Reports as required by Client.

The instrumentation, MCC data etc. should be available on all mimics associated with each section of plant.

PSE 13. Telemetry

The telemetry equipment must operate on an unlicensed frequency band and must not be subject to monthly or annual costs. The preference would be for a low frequency operating band as this is more capable of travelling longer distances or around hills and obstacles. GSM or similar technology will not be accepted due to the data costs.

The telemetry system must include the following:

- Instruments (level transmitters and switches)
- Transmitters
- Weatherproof enclosures
- Power supply and battery backup
- Antennas
- Main receivers

A provisional sum has been allowed for the power supply installation and instrumentation as this can only be determined following the site survey which will determine the radio transmitter location.

A provisional sum has been allowed for and the requirement of high sites which can only be determined following the site survey.

The telemetry equipment must interface with the PLC and SCADA over a suitable communications protocol. The telemetry equipment must be housed in a suitable control panel located near to the SCADA control PC.

PSE 14. PVC INSULATED CABLES

All low voltage cables to be supplied and installed as part of this Contract, shall be of the PVC/PVC/SWA/PVC type in accordance with NRS074 unless otherwise specified. All such cables shall be of the new material and shall bear the SANS mark.

All primary LV cables between the main distribution panel and the respective MCC's, or alternatively between the MCC and motors and equipment, shall be properly clamped to the full approval of the Engineer.

All cables shall be properly glanded off within the MCC and within each of the appropriate Kiosk / DB's / Terminal Boxes. Pratley glands will be provided with the associated rubber boots properly applied to prevent the ingress of water into the armouring.

All low voltage cables shall be installed at a minimum depth of 600mm below ground level or on cable racks. '

All cables and sleeves shall be installed in a neat and tidy fashion laid up in straight lengths next to one another. Twisting and curling of cables and zigzagging across the trench will not be accepted.

The following cables sizes are required:

- 1.5mm^2, 5C, Cu, PVC, SWA
- 1.5mm^2, 12C, Cu, PVC, SWA
- 1.5mm^2, 19C, Cu, PVC, SWA
- 4mm^2, 3C, Cu, PVC, SWA
- 10mm^2, 3C, Cu, PVC, SWA
- 2.5mm^2, 4C, Cu, PVC, SWA
- 6mm^2, 4C, Cu, PVC, SWA
- 10mm^2, 4C, Cu, PVC, SWA
- 16mm^2, 4C, Cu, PVC, SWA
- 25mm^2, 4C, Cu, PVC, SWA
- 35mm^2, 4C, Cu, PVC, SWA
- 50mm^2, 4C, Cu, PVC, SWA
- 70mm^2, 4C, Cu, PVC, SWA
- 95mm^2, 4C, Cu, PVC, SWA
- 120mm^2, 4C, Cu, PVC, SWA
- 185mm^2, 4C, Cu, PVC, SWA
- 240mm^2, 1C, Cu, XLPE, PVC, SWA

PSE 15. MEDIUM VOLTAGE CABLES

PSE 15.1. General

The general requirements for Medium Voltage Cables are covered by NRS 013:2007 as amended. Cables shall comply with the relevant SANS manufacturing standard and test voltages as prescribed by SANS10198-13 shall be applied during testing and commissioning.

Respective manufacturing standards:
SANS 97 (Paper insulated cables)
SANS 1339 (XLPE Cables)

The MV cables for this project shall comply with the requirements of

- SANS 1339:2010 for cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV.
- NRS 013:2007 Medium-Voltage Cables.
- The installation and laying of cable shall be in accordance with SANS 10198-2:2016.

In addition to the standards and specifications mentioned the Medium Voltage cables and the installation thereof shall also comply with the following Eskom standards:

Unique Identifier	Description
240-56030635	General information and requirements for medium voltage cable systems
240-56063792	Specification for medium voltage XLPE and Impregnated Paper Insulated Cables Standard

PSE 15.2. Excavation And Backfill

Determination of the thermal resistivity of soil to be used as bedding shall be in accordance with SANS 101985-5:2004.
The on-site method is preferred and shall be performed per batch of imported soil. Imported soil delivered to site shall be screened with sand to prevent the soil from washing away in raining conditions.

Width	:	450 mm
Length	:	Length of cable
Depth	:	1 000 mm
Road crossings depth:		1 500 mm

The bedding layer around the cable installation shall be imported loam soil with a thermal resistivity of 1.2 K.m/W, test certificates for the bedding shall be provided.

Claims for hard or soft rock must be classified by the Engineer or his representative before any backfilling is being done. Backfilling must be done with compaction of 150 mm layers.

Compactions certificates shall be provided every 80m proving compaction of the cable trench is the same or better than adjacent undisturbed soil (i.e. two compaction tests every 80m). The contractor shall care not to damage the cables during compaction testing.

PSE 15.3. Terminations

Raychem / approved alternative dry type terminations shall be used.

PSE 15.4. Cable Joints

Raytech heat shrink joints shall be used. No MV cable joints are required for this installation.

PSE 15.5. XLPE Cable Type

Type of cable	:	3 Core
System voltage	:	11 kV
Cable type	:	SANS 1339 FRPVC SWA Type A
Cross sectional area	:	150 mm^2
Installation condition	:	Buried in 1 000 mm deep trench.
Conductor material	:	Copper
Fault level	:	20 kA symmetrical and 27.2 kA earth fault
Colour sheath	:	Black PVC

Type of cable	:	3 Core
System voltage	:	11 kV
Cable type	:	SANS 1339 FRPVC SWA Type A
Cross sectional area	:	50 mm^2
Installation condition	:	Buried in 1 000 mm deep trench.
Conductor material	:	Copper
Fault level	:	6.4 kA symmetrical and 16.7 kA earth fault
Colour sheath	:	Black PVC

PSE 15.6. Schedule of Cables

The cables required in this contract are measured in the Schedule of Quantities and note must be taken of the fact that cables measured is only a preliminary quantity and that the final length of cables will be measured on site for final account purposes.

The schedule of cables is shown in The Schedule of Cables attached in Appendix A at the end of this document.

PSE 15.7. Termination boxes

All termination boxes and devices mounted at and on the motors shall comply with IP 65.

Boxes shall always be installed in such a position that the box lids can be easily removed and that full access to the terminals is possible.

PSE 15.8. Labels

All cable terminals and cable ends shall be clearly marked with stainless steel tags to enable the Contractor for this contract to do final "as built" drawings of the total installation complete with wiring diagrams showing all label numbers and cable designations.

The contract will not be regarded as complete until all "as built" drawings are completed and all cables are labelled to the satisfaction of the Engineer. The labels on all MCC panels shall contain the equipment names, kW size of motor and full load amps and shall be engraved on traffolite labels.

PSE 16. CONTROLS & INSTRUMENTATION

PSE 16.1. Lock stop buttons

Lock stop buttons shall be of the waterproof type mounted flush in an ABS enclosure and shall be fixed to the brackets at motors in such a way as not to damage the box as far as waterproofing is concerned. The button shall also be of the push-to-lock and turn-to-unlock type. Buttons and boxes shall comply with IP 65 requirements and the lockouts stop must be pad lockable.

The lock stop button box shall be mounted at the motor on a grade 304L stainless steel stand-up channel iron support which shall be bolted together with one of the motors hold down bolts. The cable shall be strapped to the support with stainless steel straps. Where outstations are supplied, the locks stop shall be installed in the outstation.

PSE 16.2. Outstations and Power Kiosks

The outstations and Power Kiosks will be manufactured from grade 304L stainless steel and powder coated Electric Orange as detailed in drawing J31067B/ELE/164/A. The protection of the kiosk and outstations shall conform to IP 65. The outstations shall be 1,2 or 3 way as detailed on the drawings.

a) Power Kiosk

- 1 x 40 A, 3 pole mcb - Mains.
- 1 x 15 A, 1 pole mcb’s for high mast lights.
- 1 x 20 A, 2 pole, 20 mA earth leakage for plugs.
- 1 x 20 A, 1 pole mcb’s for plugs.
- 1 x 30 A, 3 pole, 300 mA earth leakage for welding socket.
- 1 x Photocell with bypass circuit for outside lights.

PSE 17. SPARES

The following minimum spares shall be supplied to the Client for the project as a whole:

a) 1 x spare relay for each type used.
b) 40 x spare LED's (indication lamps).
c) 1 x spare coil for each contactor size used.
d) 50 x Spare control fuses for each size used.
e) Any special tools or equipment needed for adjustments, maintenance etc.
f) 1 x set of suitable electrical isolation safety gloves and face protector.
g) 3 x spare PLC I/O cards for each type used.
h) 2 x spare PLC Modules (CPU, Power supplies, Network switches, Communication cards etc.) for each type used.
i) 2 x Spare Fiber Optic Modules
j) 1x Spare HMI
k) i10 x spare Optocouplers.
l) 10 x Fused terminals.
m) 3 x spare electronic overload units and expansion cards
n) 3 x spare Energy management meters

The Contractor shall submit a comprehensive list with prices to be supplied at tender stage. The Contractor shall obtain the signature of the representative of the Client when delivering the manuals and spares.

PSE 18. MANUALS, SOFTWARE AND TOOLS

The Tenderer shall provide the following minimum manuals and software:

a) Seven sets of As Built drawings and Functional operation manuals for all equipment and systems which include but is not limited to the PLC, SCADA, Drives, Generator, Transformers, MV Switchgear, Telemetry, etc. Hard and Soft copies shall be submitted to the client.

b) All original software programs used in the plant configuration inclusive of Windows, SQL Server etc.

c) All loose manuals, brochures, etc. not included as standard with commercial computer software.

d) Programming Devices complete with all Hardware and OEM software required for programming of PLC, HMI, Instrumentation, Variable Speed Drives, Soft starters etc.

PSE 19. BUILDING INSTALLATIONS

PSE 19.1. Buildings

The Tenderer is to allow for the following notices, and electrical installation in the existing buildings.

PSE 19.2. Signs and Notices

All notices as required by the Occupational Health and Safety Act 85 of 1993 shall be supplied and positioned as required.

The following notices shall be proved as part of the building subcontract.

- *External doors*:

  Provide the following signs:

  "DANGER / GEVAAR / INGOZI" as well as "Unauthorised Entrance Prohibited / Ongemagtige Toegang Verbode".

- *Inside each room*:

  Provide and install on the inside of each door or on more convenient place, against a wall:

  "First Aid Treatment of Electrical Accidents / Noodhulpbehandeling by Elektriese Ongelukke" as well as "Procedure in case of fire / Prosedure in geval van brand".

PSE 19.3. Fire extinguishers

A 9 kg BCF fire extinguisher to be installed against the wall, next to the door.

PSE 19.4. General building electrical installation

PSE 19.4.1. General:

The complete electrical installation for lights and small power shall be provided as part of this contract.

The electrical installation shall be installed by a qualified and approved Electrical Contractor, in accordance with SANS 101042: 2020 as amended.

PSE 19.4.2. Power supply:

The distribution board for the building electrical installation will be supplied from the nearest electrical supply point as part of the electrical installation.

The supply will be a three phase 400 V, 4 wire, 50 Hz supply.

PSE 19.4.3. Distribution board:

Where the DB does not form part of the MCC as specified the following shall be provided:

Supply and install a surface mounted distribution board in the position shown on the relevant drawings.

PSE 19.4.4. Schedule of light-fittings:

Type A: 2 x 36W industrial corrosion resistant 304 stainless steel fluorescent luminaire with SANS approval.

Type B: 1 x 18W LED wall-mounted corrosion resistant bulkhead light fitting with die cast aluminium body and glass lens with SANS approval.

Type C: 1 x 143W LED Low bay corrosion resistant light fitting with die cast aluminium body and glass lens with SANS approval.

PSE 19.4.5. Electrical installation:

The contractor shall make provision for the supply, installation, and commissioning of the electrical installation of the building complete with distribution board, light-fittings, photocell, plug sockets, isolators, light-switches, conduit work etc. All conduit work shall be done with galvanised conduit surface mounted with proper spacer saddles fitted not more than 500 mm apart.

PSE 19.4.6. Earthing:

The whole of the installation shall be properly and effectively earthed such that the resistance to earth from any point in the installation does not exceed the values prescribed in the regulations as stipulated in clause 3 hereof and earthing shall generally be provided in accordance with SANS 10142 and SANS 10292.

The complete electrical installation must be properly earthed by means of separate earth conductors to the main earth bar of each distribution board and the earth bars of distribution boards shall also be mutually coupled with earth conductors.

Where any law, ordinance, by-law, rule, regulation, or instruction regarding earthing is enforced or is promulgated during the progress of this installation and is found to be at variance with the specification, the former shall in all cases take precedence.

The earthing of the whole electrical installation must be done to the satisfaction of the Engineer.

The Electrical Contractor must arrange with the local Supply Authority for a main earth connection onto the main earth point of the installation. All sub-distribution boards must be connected to the earth bar of the main board with bare copper stranded conductor or copper strap as specified in this specification.

All wiring trays, wiring channels, cable racks, control panels, etc must be connected to the main earth bar of the board which supplies these items with a stranded copper conductor or copper bar as specified.

Copper straps shall be used in vertical rising shafts, horizontal panels and ducts, ceiling voids, etc, where surface mounted armoured or unarmoured cables are in use.

Bare stranded copper conductors shall only be used in conduit together with PVC single core wires or together with armoured or unarmoured cables in pipes.

The armouring of cables may not be used as earth connections between distribution boards.

Tappings on copper strap or flat bar shall be brazed or silver soldered whilst stranded copper conductors shall be lugged onto solid copper bars for tap-off purposes. No soldered or brazed T-off tap joints will be acceptable on stranded copper earth conductors. Bolts, nuts, screws, etc, shall under no circumstances be used as means of connection for earthing points.

The main earth bar of the board shall be connected in two separate places to the nearest cold water supply pipe and to the Supply Authority's earth conductor or to the earth mat or earth spike as specified by the Engineer.

All earth leakage protection equipment suitable for a maximum working voltage of 660 V (rms) and a maximum line current of up to 100 amps (rms) shall conform to SABS 767 as amended to date. All earth leakage units for an operating range in excess of the above-mentioned must be approved by the Engineer before installation.

The earthing of all substations shall comply with the requirements of the Supply Authority and the regulations as mentioned.

The Electrical Contractor shall carry out all the necessary earth resistant tests on the installation after completion of the earthing of the installation and the results of these tests shall be submitted to the Engineer for approval.

Self-tapping screws shall not be allowed for the fixing of earth conductors in any part of the installation. All copper strap or stranded copper conductors which are employed for the earthing on the outside of the building shall be placed in an accessible position and shall be installed in galvanised conduit or galvanised water pipe to a height of 2 m above ground level from 300 mm under normal ground level for a mechanical protection of such conductors.

All earthing connections to water pipes and drainpipes and all other surface earthing connections shall be done before tile work or paintwork has been completed on the inside of the buildings.

The tank shall be fitted with a suitable filter, a gauge glass, and a low-level alarm, giving an audible and visible alarm.

PSE 20. HIGHMAST LIGHTS

PSE 20.1. General

It shall be noted that the Lighting Mast original equipment manufacturer shall be responsible for the detail steel pole and foundation designs. Designs shall be certified by a ECSA registered Professional Engineer.

All masts are to be designed to SABS 0225 Code of Practice

The high mast will be equal or similar to a mid-hinge mast 15 m high, or equivalent. The mast shall be equipped with 6 x 144-Watt Beka LED flood 64/144 OPT 5121 luminaires or equivalent and a Royce Thompson Photocell, or equivalent. The Photocell shall be set to switch on at 15 - 20 lux and off at 40 - 20 lux. All this relevant control gear shall be part of the mast.

The contractor must make an allowance in his pricing for the design of the foundations, excavations, steel reinforcement, and concrete as well as for the installation and commissioning of the mast by the high mast manufacturer.

PSE 20.2. Construction

- The mast shaft shall be mid hinged and 15 meters in length above ground level.
- The mast manufacturer must be an ISO9001 2000 certified mast supplier.
- Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.

MAST MANUFACTURERS WHO CLAIM TO BE IN THE PROCESS OF APPLYING FOR CERTIFICATION WILL NOT BE CONSIDERED.

PSE 20.3. Material

The material used in the fabrication of the mast shaft is, unless otherwise stated, Grade 300WA steel (Equivalent to BS4360).

PSE 20.4. Protective Finish

The mast shaft and all ancillary steelwork is hot dipped galvanized to ISO 1461.

PSE 20.5. Electrical Equipment

The following Electrical Equipment is to be included:

PSE 20.6. Electrical Cable

The electrical cable, which supplies power to the floodlight luminaires, will vary in size, depending on the electrical load to be carried.

The electrical cable of the flexible, unarmoured type, with 5 cores between 1.5mm2 and 4.0mm2 each, will be supplied.

PSE 20.7. Junction Box

A weather-proof junction box is fixed to the top of the pole and provides the termination point for the cable, as well as for the cables which supply power to the floodlight luminaires.

PSE 20.8. Photocell Control

If required, the mast can be fitted with a photocell (daylight switch) to switch the floodlights on and off.

PSE 20.9. Circuit breakers

The mast is fitted with 3 x 10 A Curve 2, 1 pole circuit breakers.

PSE 20.10. Foundation

The Mast is bolted to a Chimney and Pad type reinforced concrete foundation with cast in foundation bolts. The design and dimensions of the foundation will depend on factors such as wind velocity size of mast and soil conditions. Designs for foundations are to be signed off by a registered Engineer before construction is started.

PSE 21. TESTING AND COMMISSIONING

The registered installation electrician shall attend site upon request by the Engineer as reasonably required for Work inspection. Normally, inspection of Work in progress will take place on the same day as the general site meeting, or such other times as the Engineer may reasonably require. Handing-over inspections will be done at the completion of the Electrical Contractor’s testing, issuing of the Certificate of Compliance by the Electrical Contractor’s registered installation electrician, energizing the installation by the Supply Authority, authorizing of the installation and upon making a written request for the Engineer to carry out an initial handover inspection.

Where the installation is to be switched on and taken over in sections, the Certificate of Compliance shall be limited to that part of the Work. New Certificates of Compliance shall be completed for outstanding phases of the project as applicable, and the Supply Authority’s permission formally obtained to switch electricity to those areas.

The registered installation electrician shall, after requesting the Engineer to undertake an initial handover inspection, do a full interface Quality Assurance (QC) / Quality Control (QC) testing assessment and present results to Engineer (informing of pre-approved internal QC documents). Complete a proper inspection of his Work to ensure that everything is complete and in unity with the Documentation. Following this inspection, and rectification of any faults in parts of the installation that may be required, the registered installation electrician shall make a written request to the Engineer for a handover inspection.

Any faults still found in the installation shall be listed by the Engineer and handed to the registered installation electrician who shall attend to all faults within a realistic period as decided by the Engineer except that this period will in no circumstance exceed 14 days. Once all listed faults have been rectified, the registered installation electrician shall again request the Engineer in writing to carry out a final handover inspection.

Upon the successful completion of a handover inspection and the submission of a handover certificate by the Engineer, the accountability for the security of the installation, or part thereof, shall be deemed to be with the Client.

Under no circumstances will any inspection by the Engineer and/or, if appointed, the Electrical Clerk of Works or Resident Engineer, relieve the Electrical Contractor of his duties in terms of the Documentation.

On completion of the installation, or such part thereof as may be determined by the Engineer, the Contractor shall carry out installation testing and inspection in accordance with the OHS Acts (Act 85 of 1993) Electrical Installation Regulations; Part 8 of SANS 10142-1 :2020; SANS 10142-2 :2020 and/or any other relevant Standard.

The outcome of these tests, duly certified by the registered installation electrician, shall be submitted to the Engineer in the form of a typed test-result certificate. No testing for acceptance purposes will be carried out by the Engineer until this is received.

Upon receipt of the test certificate, the Engineer will arrange to carry out acceptance tests and to witness commissioning procedures, including but not restricted to polarity, earth leakage, load-balance, earth resistance, insulation resistance, earth loop impedance, prospective short circuit (PSC), 11kV Protection testing, 11kV VLF testing of cables and switchgear, Ductor (micro ohm), testing no load voltage, full load voltage, phase rotation, bonding and labelling checks. If any faults are found in the installation, a list of those immediately observed will be handed to the registered installation electrician by the Engineer. The Contractor shall forthwith correct such faults and issue a further test certificate endorsed “RE-TEST” with all reasonable dispatch whereupon the Engineer will carry out additional check-tests.

Any list of faults issued by the Engineer shall not be viewed as final but given only for the assistance of the registered installation electrician who will be bound to exercise all necessary diligence in their rectification and to check for any other faults and to rectify same.

The registered installation electrician shall supply all necessary testing instruments for carrying out tests, including, but not partial to: insulation resistance tester, earth resistance tester, PSC/earth loop-impedance tester, clip-on ammeter (e.g.: for load-balance testing), earth-leakage tester, injection tester, micro ohm tester etc. Where there is reason to doubt the accuracy of the instruments, the Contractor shall arrange for tests to check their accuracy.

Where cast-in conduit is installed, the registered installation electrician shall methodically check his layout, fastness etc, well before any concrete is poured. The Engineer shall be informed by the registered installation electrician in writing that he is ready for a check-inspection, giving the Engineer not less than 48 hours’ notice (usually by telefax). A qualified operative of the Electrical Contractor shall always stand by when concrete is being poured so that any conduits or boxes that may become loose, displaced etc can be refixed.

If it is necessary for the Engineer, his agents, or assigns, to spend extraordinary time in respect of checking, testing, inspection or any other matter due to the Electrical Contractor’s default or unsatisfactory attendance all costs of the Engineer in obtaining remedy shall be for the Electrical Contractor’s account. For example, if the Electrical Contractor failed to carry out his own prior testing in a sensible and diligent manner, or to check cast-in conduits properly before calling the Engineer to undertake a check-inspection, thus necessitating further visits and/or extra time incurred, costs of the Engineer will be charged to the Electrical Contractor. These costs will be deducted from the Electrical Contractor’s claims or shall be claimed by submission of an account to the Electrical Contractor. The Engineer’s claims for wasted time, including disbursements, shall be based on the applicable Engineering Council of South Africa, professional services fees and rates.

The Engineer requires, in any event, to witness the following tests and commissioning at the cost of the Contractor:

- MV Cables
- MV Switchgear
- Transformers
- Main Earth
- LV Cables for 1 000A and Over
- Standby Generator
- Pump Controls
- Lighting Control System/s
- 500 kW Pump Sets
- 200 kW Pump Sets
- Generator
- SCADA factory tests
- PLC factory tests

After commissioning, before practical completion, the Electrical Contractor shall arrange a thermal (infrared scan) survey of the following items as minimum:

- MV Switchgear
- Transformers, including Busbar Terminations
- Motor Control Centres
- All Distribution Boards

A complete colour printed report shall be submitted to the Engineer. In the event of any hotspots identified by the thermal survey, the Electrical Contractor shall, at own cost, remedy the fault/s and submit further thermal survey reports to prove that the fault/s have been remedied.

PSE 22. TRAINING

The Electrical Contractor shall provide training to the Employer/Employer's agent as specified elsewhere.

PSE 23. GUARANTEE AND FREE MAINTENANCE

The equipment will be installed long before the date of practical completion and the Tenderer shall supply proof from each equipment supplier that the effective date of the 12 months guarantee period will only commence on the start date of the Trial Operating Period and no other date.

The Electrical Contractor shall provide a 12-month guarantee (from above date) to replace or repair, free of charge, any part of the installation in which defects may develop as a result of manufacturing defects or poor workmanship.

PSE 24. OPERATING INSTRUCTIONS, PARTS LISTS, MAINTENANCE MANUALS AND AS-BUILT DRAWINGS

The Electrical Contractor shall supply, after approval by the Engineer, three bound sets of operating instructions, parts lists, maintenance manuals and as-built drawings including the following details and information:

- Contractor's and Supplier's details (name, address, email address, telephone, and facsimile numbers)
- Contractor's emergency (after hours) contact details
- A General Description of the Reticulation and Key Control Features
- MV Switchgear
- Transformer/s
- Busbar Trunking
- Schedule of Luminaries and Lamps indicating Manufacturer, Supplier, Brand Name and Type Number
- Cable Layouts, including Feeder and Control Cable Marking Numbers and Details
- Distribution Boards
- Power Factor Correction Equipment
- Meters and Meter Information (including multiplication factors and programming details as applicable)
- Uninterruptable Power Supply Operating Manual
- Standby Generator Operating, Spare Parts and Maintenance Manual
- Subcontractors/Suppliers Documents
- Test Certificates
- Certificates of Compliance
- Thermal Survey
- Guarantees and Warranties

The Contractor shall mark up one full set of the Engineer's drawings with relevant as-built changes and information and submit to the Engineer for his scrutiny 30 days before practical completion.

All documentation supplied is to be in the English Language of Medium.

The contract will not be accepted as complete until these have been supplied, complete and to the satisfaction of the Engineer.

PSE 25. RESIDENT INSTALLATION ELECTRICIAN

The Electrical Contractor shall provide a resident qualified electrical installation electrician who has passed a trade tested in this specific discipline. The installation electrician is to be appointed in a full-time capacity for the full duration of the construction phases of this project and shall be responsible for the electrical installation work, testing, commissioning and signing off of the electrical certificates of compliance etc.

The electrical Resident Installation Electrician is to have a minimum of seven years' experience in the construction, operation and maintenance of the electrical machinery installed for the scope of works as detailed in this tender document. No electrical installation work shall be permitted to take place on site unless the installation electrician is present on site.

The following certified documentation is to be forwarded with the tender documentation with regards to the above:

- Certified copy of the installation electrician's "wireman's license"
- Certified copy of the installation electrician's trade test certificate
- Certified copy of the installation electrician's curriculum vitae. Each page of the curriculum vitae is to be initialed by the installation electrician and with full signature on the final page confirming that the above is a true reflection of the installation electrician's qualifications and experience.
- Certified copy of the resident installation electrician being registered by the Electrical Contractor as a registered person with the Department of Labour
- In date certified copy of the Electrical Contractor being registered with the Department of Labour as an Electrical Contractor.

PSE 26. FIBRE OPTIC CABLE INSTALLATION

The Contractor for this contract shall supply, install and commission the fibre optic cables and cable as measured in the Schedule of Quantities.

The FO cable installation in this contract will be used as the communication highway between all the Distributed I/O and Controllers (PLC AND SCADA's) in this contract on a primary and secondary network.

The two-way data communication shall be via the fibre optic cable from the FO modules which shall form part of the PLC AND SCADA rack installation.

The data which will flow on the links between the PLC AND SCADA's will be in the form of high-speed digital analogue data and Engineering value data (converted in the PLC AND SCADA's from 4 – 20 mA signals to Engineering data). The FO links with remote ultrasonic flow / level instruments shall also form part of this contract. In these cases, the 4 – 20 mA analogue signal for levels or flows and the pulses emitted by the instrument, in the case of totalizing of flow, shall be transmitted back to the PLC AND SCADA as shown on the I/O schedules bound herein.

The lengths allowed in the Schedule of Quantities are not the final lengths. Final lengths must be measured on site for the runs of cable from various IO cabinets and finally to the PLC AND SCADA computer in the Administration building. The FO cable installation from remote measuring instruments also forms part of this contract.

Any low voltage power supplies for interface equipment shall be supplied and installed with such equipment.

Fibre optic cables shall be installed with the power cables in the cable trenches.

Fibre optic cables shall be Corrugated Steel Tape Cable with minimum 10 fibres, anti-rodent cable for direct buried installation equal or similar to existing, the cable shall be compatible with the equipment to be installed by the Tenderer.

The attenuation at 1310/1550nm shall be less than 0,35/0.21dB/km.

Ends of F/O cable shall be left long enough for making off in PLC AND SCADA cabinets.

The ends of the fibre optic cable, interface cards and the final connections of the equipment all forms part of this Contract.

End materials shall consist of:

a) Pigtails.
b) Termination boxes
c) Interface cards for two-way transmission of digital and analogue data to - and from the PLC AND SCADA.
d) Splicing and OTDR testing.

PSE 27. HOUSING FOR INSTRUMENTS AND MOUNTING OF INSTRUMENTATION

PSE 27.1. Construction Of Housings

Housings are required under this contract for the installation of converters and displays on site as close as possible to the sensor or transducer position. All the field instruments required under this contract shall have the housings specified hereunder. Quantities are measured in the Schedules of Quantities herein.

The housing required shall comply with the following requirements:

The housing shall be weatherproof and shall be manufactured from 2 mm 3CR12 steel or other stainless steel and shall be finished in a RAL 7032 Grey powder coating (IP66 rating).

The housings shall be:

- At least 650 mm high x 450 mm wide x 270 mm deep with glass door.
- At least 1150 mm high x 850 mm wide x 270 mm deep with glass door.

The door of the housings shall fit over a drip lip type flange on the front of the housings. The final dimensions shall however be suitable to house the largest converter/display unit of the particular field instrument.

A neoprene or other similar material shall be used on the inside of the door to press against the front edge of the lip to form a weatherproof seal when the door is closed.

The door shall be supported by 2 heavy duty brass or stainless-steel pedestal hinges and a heavy duty corrosion resistant padlock type handle shall be used on the door to pull the seal tight against the housing lip.

The door shall further be fitted with a 6 mm laminated glass window mounted in a front protrusion frame in the door with a holding frame to seal the glass absolutely weatherproof. Alternatively, the glass may be sealed with the compound used to seal automotive windshields. The glass aperture shall be at least 400 mm x 400 mm dimension.
The housing shall have a removable back plate for mounting of instruments or maintenance of instruments after installation.

The housing shall be mounted at a height of 1 000 mm from normal ground level on a hot dip galvanized angle iron steel stand. The stand shall consist of two upright 50 x 50 x 5 mm angle iron supports of 1 600 mm length i.e. to reach to the top of the housing when the housing top edge is flush with the upper ends of the uprights.

Three horizontal angle iron sections shall be welded between the uprights, one at the bottom, one at the bottom edge of the housing and one at the top edge of the housing, to form a solid frame for mounting of the housing. The overall width of the frame shall not be wider than the housing. In addition, the frame shall have two horizontal feet at the bottom of the frame for bolting to a concrete base. The feet shall be at least 600 mm long.

The frame shall be manufactured to have a smooth front plane for the mounting of the housing by means of 4 x 10 mm stainless steel bolts with washers, lock washers and nuts. The nuts shall be on the inside of the housing.

All welding, fixing holes and machine work shall be completed before the frame is galvanized.

The frame shall be mounted on site by casting the feet into a concrete block of dimensions 900 x 900 x 500 mm thick.

PSE 27.2. Mounting Of Instruments In Housings

Converter / transmitter equipment shall be mounted on the removable backplate in a position to enable the viewing of any display on the front of the converter through the glass in the door of the housing. The instruments with displays shall be mounted with the display not more than 75 mm behind the glass.

Incoming cables shall be terminated on a KLIPPON type terminal strip on the lower edge of the removable back plate.

All cables entering the housing shall only be at the bottom of the housing by means of the prescribed gland for that purpose. No open holes shall be left in the unit to keep the unit rodent or vermin proof. The incoming mains supply terminals shall not be directly adjacent to signal cable terminals.

The line and neutral mains wires shall be fused with clip open type HRC fuse holders on the terminal strip and the dead side of the fuses shall be strapped directly to 220 V AC 10 kA MOV surge arrestors mounted in such a position as not to cause damage to the converter or other equipment or wiring by screening the arrestors off with a sheet of TUFNOL or similar insulating material. Both line and neutral wires of the mains supply shall have surge arrestors.

The earth wire of the supply cable shall be strapped to an earth bar on the back plate as well as to a 10 mm dia brass stud which shall be installed through the housing side near the bottom of the housing for external earthing of the unit.

The supply wires of the instrument shall be connected to the respective terminals as well as the 230 V AC / 24 V DC power supplies which may be required for the particular converter or sensor or transducer of the instrument.

<u>NOTE that 24 V DC supply will not be available as power supplies on site. Instruments will all be supplied with single phase mains power, terminating in the housing, as specified further herein</u>.

All signal cables, coax cables, etc must terminate on the terminal strip as mentioned above and all signal wires shall be protected with 24 V surge arrestors. The supplier of the instrument must be consulted before surge arrestors are connected to transducer or sensor wires, as this can influence the operation of the instrument.

PSE 27.3. Mounting Of Transducer Or Sensor Head

The cable from the transducer or sensor head or pipe mounted meter section shall be protected against lightning induction or the weather as far as possible, by threading the cable through hot dip galvanized conduit. This conduit shall be installed from the bottom of the housing using locknuts and a bush and the conduit shall end as close as possible to the head.

In the case of Magflow meters, the conduit shall enter the manhole through the building work of the manhole. Earthing required to Magflow meters shall be by means of separate earth conductors connected directly to the earthing system installed by others.

In case of open channel flow meters or level sensing, the conduit shall be installed to below the bracket carrying the transducer head and shall terminate as close as possible to the head. The supplier's standard bracket shall be used for the mounting of the transducer in case of open channel mounting. The bracket shall, however, be manufactured from alloy metal or shall be hot dip galvanized.

If brackets are not available from suppliers of instruments, then 2 mm thick 309 stainless steel plate shall be used by forming a channel at least 50 mm deep and wide enough to mount the transducer under the channel by means of a stainless-steel bracket. The stainless-steel channel shall span the flow channel structure and shall be fixed at both ends with corrosion-resistant expanding bolts.

Transducers mounted over open sumps shall be mounted as prescribed by the supplier of the instrument, taking into account the dead zone, if any, of the head as well as the view angle of the head and any sloping sides or splays in the structure of the sump, which may influence the reading.

A stand-off bracket must be used in this case to mount the sensing head far enough from a vertical or sloped surface to obtain proper results and calibration.

PSE 28. AIRCONDITIONERS FOR BUILDINGS

PSE 28.1. Specific Technical Requirements for Split Type Units (Cassettes)

Split type units shall consist of a direct expansion indoor fan coil unit and a separate (remote) externally located air-cooled condensing unit.

The indoor fan coil unit shall be floor-mounted, wall mounted, under-ceiling mounted, ceiling cassette mounted, or above ceiling ducted type as called for.

Above ceiling units shall be properly insulated, particularly where exposed to high roof or lighting heat loads.

Controls shall be mounted on the unit in easily accessible location. In addition, a handheld remote control unit shall be supplied.

All conduit and draw boxes shall be installed flush in the walls or partitions if required.

Surface mounted wiring in trunking or the like will only be accepted if approved by the Engineer before the work is executed or specified as such.

No joints will be allowed in the control wiring.

Suction lines shall be insulated as specified. Suction and delivery lines may not be insulated grouped together as for a single line. Vapour barrier integrity will be critical to prevent dripping.

Gas piping (insulated as specified) and wiring shall be installed in galvanised steel trunking throughout for protection, painted as specified where exposed or visible.

Outdoor units shall be installed on raised plinths or where wall mounted on unistrut or approved galvanised steel brackets, neatly manufactured, and properly braced and fixed.

Refrigerant piping shall be sized and fitted with the necessary oil traps strictly in accordance with the manufacturer’s requirements.

The equipment offered shall be capable of operating to specified requirements with refrigerant piping of the maximum length and at the maximum difference in height between the indoor and outdoor units as specified.

The outdoor unit shall be enclosed with a protective cage to prevent theft and tampering. This cage shall be manufactured from 16 x 16 mm square tubing forming the outer frame and 12 mm diameter solid steel rod infill grid spaced 200 x 126 mm, all welded together with all burns and sharp edges removed and ground smooth.

The cage shall be held in position by way of locating brackets and secured with a rectangular type padlock (with two keys) in such manner that the cage can be easily removed once the padlock is removed. The keys shall be handed over to the Engineer upon commissioning of the system for onward transmission to the user Client.

The entire cage is to be hot dip galvanised after manufacture, treated with galvanised iron solvent cleaner, and spray painted with a Calcium Plumbate or other suitable undercoat and two coats of high gloss oil enamel in a colour to be advised, selected from the paint manufacturer’s standard range of colours.

PSE 28.2. Commissioning and Testing

PSE 28.2.1. Commissioning Technicians

The Tenderer shall allow in his tender price for the services of approved and expert commissioning Technicians, as may be appropriate for the individual specialised sections of his contract. Testing and commissioning shall be carried out by these Technicians.

Should undue problems be encountered at any time, the Contractor may be requested by the Engineer to obtain the services of a representative of the manufacturer of specified items of equipment, at no cost to the Client.

PSE 28.2.2. Notice of Testing and Commissioning

The Engineer shall receive not less than two weeks advance notice of any tests to be witnessed by him.

PSE 28.2.3. Failure of Works, Site or Commissioning Tests

Should the Engineer be notified to attend official tests as laid down, and should the equipment fail the test for any reason whatsoever, such that the Engineer is required to re-witness the test, the time, transport and disbursement by the Engineer in so doing will be for the Contractor's account, which amount may be deducted, at the option of the Client, from monies due to the Contractor.

PSE 28.2.4. Quality Testing of Equipment

The Client reserves the right to arrange for testing of any piece of equipment at will, to check on compliance with the relevant specifications. Should the particular piece of equipment pass the test, the cost of such testing will be borne by the Client. However, should it fail the test, the cost of the test, rectification of the shortcomings, retesting and repetition of the same test on the remaining like items will be for the Contractor's account.

PSE 28.2.5. Testing

The Contractor shall be responsible for carrying out all tests laid down in this specification.
Testing shall not begin until the system has been completed and is in full working order.

The plant shall be tested and operated to meet the performance figures and duties specified.

All safety features and interlocks will be tested.

The Contractor will be responsible for all costs incurred in the testing, including the supply, calibration and use of all instruments and tools, but not the supply of power on site.

All instruments and test equipment used shall be provided by the Contractor and shall be accurately calibrated and maintained in good working order. All test instruments used for tests to be witnessed by the Client's Representative shall be provided with calibration certificates, which must be available to the Client's Representative.

It is essential that the Contractor inspects and tests all equipment before requesting the Engineer to inspect or witness acceptance tests thereon.

All site acceptance tests must be carried out in the presence of the Client's Representative.

Should the Client wish to verify the calibration of any instruments, the Contractor shall make the necessary arrangements for the instrument to be re-calibrated by a recognised authority. Should their instrument prove to be correctly calibrated, the cost of the re-calibration test will be borne by the Client. Should the instrument prove to be in error, the cost of the tests will be borne by the Contractor.

Two copies of the complete test reports shall be submitted to the Client, prior to the first delivery of the project. All reports shall be neatly typed.

PSE 28.2.6. Commissioning

The Contractor shall carry out all tests and commissioning of the systems installed by him, in a co-ordinated and properly organised manner.

The testing procedures shall be sufficiently comprehensive to prove the correct functioning of every piece of equipment, and its suitability for the application.

After all systems and equipment have been tested and commissioned to the satisfaction of the Client, a detailed demonstration of all functions of the system shall be carried out in the presence of the Client's Representative, to allow him to become fully acquainted with the operation of the system.

The demonstration to the users shall include a repeat of the operational tests above.

The planning of this demonstration shall take place in collaboration with the Client.

A certificate of completion will not be issued until all tests have been satisfactorily completed, and the plant has operated successfully, to the complete satisfaction of the Client.

PSE 28.3. Performance Tolerances

All performance figures obtained during testing and commissioning must be within – 5 % and + 5 % of the specified performance figures specified. Should the plant fall to comply with these figures after it has been tested and operated for a period of seven days, then the Contractor shall have a further four weeks to meet the requirements of the specification, after which the Client shall have the right to reject the equipment and recover all monies paid to the Contractor for the rejected equipment.

PSE 28.4. Guarantee and Free Maintenance

The equipment shall be guaranteed against all failures attributable to defects in manufacture or installation workmanship, for a period of 12 months from contract take-over.

During this period a free maintenance service shall be carried out at three-month intervals, a total of four such services being required.

All parts, cleaning agents and lubricants etc that may be required during this period shall be supplied by the contractor free of charge.

PSE 28.5. Manuals

An original comprehensive user’s manual as printed by the manufacturer in English describing the operation, user’s setting of controls, and servicing (such as filter cleaning, lubrication, etc) shall be handed to the Engineer upon successful commissioning of the system, for onward transmission to the user client.

PSE 28.6. Miscellaneous Items

The Tenderer shall allow for all the necessary cabling, plugs, sockets, piping insulation and small items to complete the installation.

PSE 28.7. After-Sales Guarantee

The Tenderer shall allow for a one year on site change, guarantee for all equipment. The equipment shall be repaired within 24 hours after notification.

PSE 28.8. Equipment Insurance

The Tenderer must allow for full insurance in the event of theft, fire damage or any other cause from date of purchase up to installation and handover to the Client.

PSE 29. PLC INSTALLATION

i. PLC and SCADA compatible with Thornhill WTW PLC and SCAD at the following locations:

   - MCC 1 – Dosing Building
   - MCC 2 – Filter Plant Room
   - MCC 2A – Filter Building 1
   - MCC2B – Filter Building 2
   - MCC 3 – Chlorine Building
   - MCC 4 – Backwash Recycling Building
   - MCC 5 – Clear water Pump Station
   - MCC 6 – Sludge Dewatering
   - MCC 7 – Supernatant Pump Station

ii. All software programs for local and automatic control of equipment and for communication on a fibre optic network with the SCADA computer
iii. All connections between the PLC's and the marshalling cubicles in the PLC cabinets

iv. All fibre optic ends, converters, tails and the connections to complete the fibre optic communication network on the SCADA system.
v. System integration of the PLC software and data with the SCADA system on the network.
vi. System integration of existing PLC and SCADA network
vii. System integration of existing electrical equipment signals which may become necessary during the execution of this contract.

PSE 30. FACTORY (FAT) AND SITE (SAT) ACCEPTANCE TESTS

PSE 30.1. Factory Acceptance Tests (FAT) for MV Switchgear, Transformers, Generator, MCC, SCADA and PLC's

The FAT protocol is an inspection that includes both static and dynamic exhaustive testing of systems or major system components to support the qualification of equipment or a system. The tests must verify that all functionality detailed in the Control Philosophy and Technical Specifications is embodied and performs as specified. The FAT procedure shall be written by the Contractor and be witnessed by the client or client representative.

For the FAT the Contractor shall ensure that the MV Switchgear, Transformers, Generator, MCC's, Drives, SCADA and PLC equipment is fully functional and available at the FAT for testing.

PSE 30.2. Site Acceptance Tests (SAT) for for MV Switchgear, Transformers, Generator, MCC, SCADA and PLC's

The SAT is related to the FAT and also entails inspection and dynamic testing of systems or major system components to support the qualification of equipment. This is detailed in the Control Philosophy, written by the client and verifies that the installed functionality of the equipment meets or exceeds the operational requirements as specified in the Control Philosophy and Technical Specifications. The SAT is executed on completion of all commissioning tasks, but prior to the start of Performance tests.

C3.9 Variations and Additions to Standard SANS 1200 Specifications: General, Civil and Structural Works

NOTE : Numbering in the Project Specifications corresponds with the numbering of clauses in the Standard Specifications (SANS 1200).

Tenderers must make provision for all the relevant Project Specification requirements to be included when calculating the prices of the various items in the schedule of quantities.

In addition, the sum tendered shall cover all initial costs incurred in complying with the requirements of C1.2 Contract Specific Data

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NOTE

In certain clauses, the SANS 1200 standard specifications allow a choice to be specified in the project specifications between alternative materials and / or methods of construction and /or for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in this section. It may also contain additional specifications required for this particular Contract.

The number of each clause and each payment item in this part of the project specifications consists of the prefix PS followed by a number corresponding to the number of the relevant clause or payment item in the standard specifications.

The number of any new clause/s or payment item/s not in the original SANS 1200 specification but which is included here, follows-on from the last clause or item number used in the relevant section of the standard specifications.

PSA GENERAL (SANS 1200 A)

PSA 1 SCOPE

Replace the first paragraph of sub-clause 1.1 with the following :-

“This specification covers requirements, principles and responsibilities of a general nature which are normally applicable to all civil engineering contracts as well as the requirements for the Contractor’s establishment on Site”

PSA 2 INTERPRETATIONS

PSA 2.3 Definitions

Add the following definitions :-

“’General Conditions’ : The General Conditions of Contract specified for use with this Contract and the Special Conditions of Contract as applicable.

‘Specified’ : As specified in the Standardised Specifications, the Drawings or the Project Specifications.”.

The term “Engineer” shall be replaced by “Employer’s Agent”.

The Employer’s Agent shall be GIBB (Pty) Ltd.

The terms "ESCOM", "ESC" and "Electricity Supply Commission" shall mean "Eskom".

GCC: General Conditions of Contract (2015)

The terms “plant” and “construction equipment” shall be defined as contained in the GCC:2015. Hence, the term “plant” as contained in the SANS 1200 suite is replaced by “construction equipment”.

PSA 2.4b Abbreviations

Add to Sub-clause 2.4(b):
"MAMDD: Modified AASHTO maximum dry density".

PSA 2.8.1 Principle

In the fourth line of Sub-clause 2.8.1, after the word "specification", add: "or in the measurement and payment clause of the standard specification, particular specification or project specification".

Add the following to this clause:
Items which are designated as provisional quantities or provisional sums in the Schedule of Quantities are intended to provide for works, the need or extent of which shall be established by the Employer’s Agent during construction. Work scheduled as such shall only be undertaken on the written instruction of the Employer’s Agent and, where applicable, shall be paid for at the tendered rate or in the absence of rates shall be valued in accordance with Clause 6.4 of the General Conditions of Contract.

The Schedule of Quantities shall not be used for ordering purposes and no liability or responsibility shall be admitted by the Employer’s Agent in respect of materials ordered or procured by the Contractor on the basis of the Schedule of Quantities.

PSA 3 MATERIALS

PSA 3.1 Quality

Add to the Sub-Clause:

"No used or recycled material may be used in the Works unless expressly authorized by the Employer's Agent.

Materials specified as being to the approval of a Standards Bureau shall bear the official mark of the appropriate standard.

Samples of concrete aggregates and pipe bedding material are to be delivered to an approved laboratory.

Where a material to be used in this Contract is specified to comply with the requirements of an SANS Standard Specification, and such material is available with the official SANS mark, the material used shall bear the official mark.

The Contractor shall submit in good time, before any construction commences, to the Employer's Agent on site, samples of all materials intended to be incorporated into the works. The samples shall be accompanied by results of tests undertaken by an approved independent laboratory on the samples in question on behalf of the Contractor and at his cost, before consideration by the Employer's Agent

The Employer's Agent, during construction, will take independent samples from stockpiles of proposed construction materials on site and from the completed works. Approval will not be granted for samples delivered by the Contractor directly to the Employer's Agent's office. The Contractor shall be responsible for the cost of all failures on test samples and control testing.

All pipes, fittings and materials used in the Works, must bear the official standardisation mark of Standards South Africa where applicable. The mark on a pipe shall be visible from above after the pipe is laid.

Rubber articles, including pipe insertion or joint rings shall be stored in a suitable shed and kept away from sunlight, oil or grease.

Large items not normally stored in a building shall be neatly stacked or laid out on suitable cleared areas on the Site. Grass or vegetation shall not be allowed to grow long in the storage areas and the material shall be kept free of dust and mud and shall be protected from stormwater. Pipes shall be handled and stacked in accordance with the manufacturer's recommendations, special care being taken to avoid stacking to excessive heights and placing over hard objects. PVC pipes shall be protected from direct sunlight by suitable covers.

Every precaution shall be taken to keep cement dry and prevent access of moisture to it from the time it leaves the place of manufacture until it is required for use on the Site. Cement is to be used on a first in/first out basis. Bags of cement which show any degree of hydration and setting shall be removed from the site of the Works and replaced at the Contractor's own expense. Any cement older than six weeks is to be removed from site.

Materials shall be handled with proper care at all times. Under no circumstances may materials be dropped from vehicles. Large pipes or large plant shall be lifted or lowered only by means of suitable hoisting equipment.

Where propriety 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, the Contractor is to supply with their tender the name of the manufacturer and supporting documentation that show that the materials or articles comply with the relevant specifications. It is understood that the approval shall be at the sole discretion of the Employer and the Employer's Agent.

Irrespective of any approval granted by the Employer's Agent or the Employer, the Contractor shall be deemed responsible for quality of all materials used for construction and their specified performance."

Add new Sub-Clause:

"PSA 3.3 : Ordering of Materials

The quantities set out in the Schedule of Quantities have been carefully determined from calculations based on data available at the time and should therefore be considered to be only approximate quantities. The liability shall rest entirely and solely with the Contractor to determine before ordering, the required types and quantities of the various materials required for completion of the Works in accordance with the Specifications and the Drawings issued to the Contractor for construction purposes.

Any reliance placed by the Contractor on the estimated quantities stated in the Schedule of Quantities issued for tendering purposes, or measurements made by the Contractor from the drawing issued for tendering purposes, shall be entirely at the Contractor's risk, and the Employer accepts no liability whatever in respect of materials ordered by the Contractor on the basis of Tender Documents."

PSA 4 PLANT

PSA 4.2 Contractor's Office and Stores (Refer SANS 1921-1 Clause 4.14)

Add to the Sub-Clause:

"Neither housing nor shelters are available for the Contractor's employees, and the Contractor shall make his own arrangements to house his employees and transport them to site.

The Employer will place an area of ground at the disposal of the Contractor at the pipe yard site to enable him to erect his site offices, workshops and stores. The temporary facilities and ablution facilities shall comply with the requirements of the Local Authority.

On completion of the Works or as soon as the Contractor's facilities are no longer required the Contractor shall remove such facilities and clear away all surface indications of their presence. The site is to be rehabilitated as described elsewhere."

After the second paragraph add the following:

The suitable first aid services required in terms of Sub-clause 4.2 shall include, inter alia, a First Aid cabinet fully equipped and maintained with at least the minimum contents as listed in Regulation 3 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), to deal with accidents and ailments which are likely to occur during the construction period.

PSA 5 CONSTRUCTION

PSA 5.1.1 Setting out the Works

Add before the first sentence:

"The Contractor will be required to set out the various sections of the Works in the order that he proposes to undertake the work as per his program, at least two weeks prior to commencing work on these sections, to enable the Engineer to check the design proposals in the field and thereafter to make any minor changes which he may deem necessary. Any additional survey work or setting out required as a result of these changes shall be undertaken on a daywork basis."

Add the following to this clause:

"The Contractor shall be fully responsible for the setting out of the works, and where labour intensive work is specified, for the setting out of the daily construction tasks.

The Contractor, within two (2) weeks after the site has been handed over to him, is to ascertain the correctness of all pegs and bench marks. Any discrepancy shall immediately be reported in writing to the Employer's Agent. Any costs or subsequent costs arising from discrepancies which had not been reported to the Employer's Agent, within the aforementioned period, shall be the sole responsibility of the Contractor.

Tender drawings shall not be used for construction purposes."

PSA 5.1.2 Preservation and Replacement of Pegs Subject to Land Survey Act (Refer SANS 1921 - 1 Clause 4.15)

Add to the Sub-Clause:

"Before the commencement of construction work in the vicinity of boundaries, the Contractor, under the direction of the Employer's Agent, shall search for plot pegs where boundaries have not been established by the erection of walls or fences and the Contractor shall compile a list of such pegs that are apparently in their correct positions. At the completion of the contract, the Contractor shall expose the pegs that were listed at the commencement of the construction and the Employer's Agent will arrange for any such pegs that are missing to be replaced at the Contractor's expense.

All plot boundary pegs shall be marked with fencing droppers which shall be painted.

As the construction of the Works may necessitate the removal and re-location of certain survey beacons the Employer will make the necessary application to the Surveyor-General and, notwithstanding the provisions of Sub-Clause 5.1.2 will meet the costs of the re-survey by a Land Surveyor of these servitude beacons in their new position.

The Employer will accordingly indemnify the Contractor against all costs implied in Sub-Clause 5.1.2 in respect of those beacons which may have to be removed by the Contractor.

The Employer's Agent will arrange for any pegs that are missing to be replaced at the Contractor's expense.

All survey reference marks shall be clearly marked and protected by the erection of three fencing standards."

PSA 5.2 Watching, Barricading, Lighting and Traffic Crossings

Add the following to this clause:

"The Contractor shall employ competent watchmen to guard the Works both by day and night.

From the time any portion of the Works commences, until the Completion of the Works and the issue of the Certificate of Completion of the Works, the Contractor shall be responsible for protecting the property of the Employer and all persons having business on the Site from anything dangerous or likely to cause damage or injury. The Contractor shall take all practical precautions to avoid nuisance or inconvenience to the owners or occupiers of properties near to the Site and to the public generally whilst carrying out the Works and shall at all times keep the Site clean and in a safe and satisfactory condition.

Temporary traffic signs shall be erected when work is being done within and adjacent to roadways. The number and layout of the traffic signs shall comply with the Site Manual entitled "Safety at Roadworks in Urban Areas", as published by the Department of Transport

The Contractor shall control all access to the site, for authorised persons only, and shall ensure that the approved conditions of the Health and Safety Management Plan are adhered to."

PSA 5.4 Protection of Overhead and Underground Services

Add the following to this clause:

"Before construction of the Works, or any phase of the Works, the Contractor shall contact all relevant parties and authority officials to establish the existence of existing services on site. The Contractor shall be responsible for obtaining all necessary wayleaves. No claims shall be lodged by the Contractor for delays in obtaining such wayleaves or permits."

PSA 5.7 Safety

Add the following to this clause:

"Compliance with
1) OHS Act and Regulations and
2) Environmental Management Plan (EMP or EMPr)

Lump sums are provided in the Bill of Quantities to cover the contractor's cost for compliance with the requirements of the Construction Environmental Management Plan and the Occupational Health and Safety Act, 1993, the Construction Regulations, 2014 and the Health and Safety Specification respectively.

In addition, Sums are included under Time Related Items in the Preliminary and General Section of the Schedule of Quantities. The lump sums shall include full compensation for the provision of the necessary site official, the training, PPE, plans, audits, assessments, administration, etc. and all other costs required for compliance. Fines issued for non-compliance will be deducted from these Sums, but are not limited to the value of the Sums stated. "

Add the following clauses:

"PSA 5.10 Record Drawing Information

As the Works are progressing, the Contractor shall mark on a special set of drawings, all as-built details and submit them to the Employer's Agent's Representative for approval. No extra payment shall be made for preparation of these as-built plans.

All valves, chambers and the like shall be coordinated together with their invert and cover/ground levels on the as-built drawings.

The Certificate of Completion shall only be issued once all the as-built information has been received and verified by the Employer's Agent.

PSA 5.11 Clearance of Site on Completion

The Contractor shall obtain, from each property owner directly affected by the Works, a certificate to the effect that the property owner is satisfied with the standard of reinstatement of any fences, boundary walls or structures, compensation paid for loss or damage to stock, crops or property, material spoiled on their properties or any other condition affecting their properties as a result of the operations of the Contractor. The Contractor shall further obtain a Clearance Certificate from each authority whose services have been affected during the construction of the Works.

All such certificates must be lodged with the Employer's Agent before the Certificate of Completion will be issued.

PSA 5.12 Project Reporting
See C3.4.15.6

The following data is to be submitted monthly, at the site meeting, to the Employer's Agent :

- Updated program
- Construction equipment schedule
- Rainfall records

The tendered Fixed and Time Related Preliminary and General Charges in the Schedule of Quantities shall be deemed to include for all costs in this regard.

PSA 5.13 Daily Photography

For the purposes of recording daily progress over the whole Highbury WTW Site, the Contractor shall, from commencement of Works to final finishing, provide and maintain and operate all necessary drone aerial photography equipment to capture at noon every working day (weather conditions permitting), from selected pre-programmed fixed xyz coordinates and orientation above the site (one position pointing vertically downwards to record the overall site and four other positions to capture angled shots of the site from the North, South, East and West), high-resolution still photographs (min 12Mb) and make these available to the Employer and Engineer on a monthly basis.

PSA 6 TOLERANCES

PSA 6.2 Degree of Accuracy

Add the following to this clause:

“Degree of Accuracy II shall apply.”

PSA 7 TESTING

PSA 7.1 Testing Principles

Add the following to this clause:

“When giving notice, the Contractor shall provide the Employer’s Agent with the results of the check testing indicating that the work is to specification. The Employer’s Agent shall be given 48 hours’ notice of when testing or inspections are required.

The Employer’s Agent may from time to time carry out his own check tests on the work performed by the Contractor. Should such check tests show that the Contractor’s control testing be such that the quality of the Contractor’s work can be called into question, then the Employer’s Agent may order further check tests to be carried out on work already completed. All costs associated with such check tests shall be for the Contractor’s account, as also the costs of any other check test whose results to not comply with the specification.

Failure by the Contractor to notify the Employer’s Agent or to provide the required information or, where specified, to perform the required test, will be grounds to exempt the Employer from payment for the associated work and for all subsequent work which would be affected by the failure of the Work to be tested.

The Employer’s Agent will be under no obligation to the Contractor to perform the tests. If the Employer’s Agent elects not to perform a particular test after notification by the Contractor, the Contractor will be issued with a written instruction to proceed with the relevant works without the acceptance test being performed.

Nothing contained in this clause will relieve the Contractor of any responsibilities under the specification or in any way limit the tests, which the Employer’s Agent may call for or perform in terms of the specification.

Where the Employer’s Agent is called to witness certain control tests, such as the pressure testing of a pipeline, and the results of such tests do not comply with the specifications, then the Employer reserves the right to recover costs for the Employer’s Agent’s presence at the unsuccessful test from the Contractor.”

PSA 7.2 Approved Laboratories

Add the following to this clause:

“Acceptance testing shall be done by a laboratory selected by the Employer’s Agent. The Employer’s

Agent requires twenty-four hours' notice from the Contractor in order to perform the relevant acceptance test.

All acceptance testing by the Employer's Agent shall be paid for by the Contractor. The costs of such tests which meet the specification requirements will be reimbursed to the Contractor in the monthly payment certificate. This payment shall consist of a billed amount plus the tendered mark-up. A Provisional Sum has been provided in the Schedule of Quantities to allow for the cost of such testing.

The Contractor shall make due allowance for testing procedures in the construction program."

PSA 8 MEASUREMENT AND PAYMENT

PSA 8.2 Payment

PSA 8.2.1 Fixed-Charge and Value-Related Items

Add the following to this clause:

The fixed charge items will include all costs associated with dealing with compulsory sub-contracts.

PSA 8.2.2 Time-Related Items

Replace the contents of this sub-clause with the following:

Payment for time-related items will be effected as follows only after payment for the relevant fixed-charge item has been made : Subject to the provision of 8.2.3 and 8.2.4 payment will be made monthly in equal amounts, calculated by dividing the sum tendered for the item by the tendered contract period in months, multiplied by the months completed, provided always that the total of the monthly amounts so paid for the item is not out of proportion to the value of the progress of the works as a whole.

PSA 8.4 Scheduled Time-Related Items

Add the following to this clause:

The Contractor shall tender rates in the Schedule of Quantities to cover his time-related establishment costs. The amount tendered and paid shall be full compensation to the Contractor for:

i) The maintenance of his whole organization as established for this Contract.

ii) The maintenance of all insurances, indemnities and guarantees required in terms of the Conditions of Contract or Tender where applicable.

iii) Compliance with all general conditions and requirements which are not specifically measured elsewhere for payment in these Contract Documents.

Payment of the lump sum shall be made monthly in compliance with the method laid down in Sub-clause 8.2.2.

The Contractor will not be paid Time-Related Preliminary and General Charges for any Special Non-Working Days, which shall be deemed to have been allowed for in his rates.

PSA 8.4.2.2 Facilities for the Contractor

Add the following to this clause:

Facilities for the Contractor shall include all the costs of providing water for construction and water tightness testing of water retaining structures and pipelines.

Facilities for the Contractor shall include all the costs of providing facilities and materials for preventing covid-19 transmission as required by the prevailing regulations.

The costs for providing security against theft and vandalism will be included in the rates tendered for Contractor facilities. No separate payment will be made for the provision of security.

PSA 8.5 Sums Stated Provisionally by Employer's Agent

Replace the penultimate sentence of Sub-clause 8.5 to read:
"The percentage rate for (b) (2) above shall cover the Contractor's overheads, charges and profit on the work covered by the sums provisionally stated for (b)(1) above. Payment will be made on the basis of the sums actually paid for such work, exclusive of VAT."

PSA 8.5.1 Community Liaison Officer ……..… Unit : Prov Sum

A provisional sum is included to allow for the salary of a person working full time as the Community Liaison Officer (CLO). The Contractor shall ensure that the salary and other expenses due are paid timeously in accordance with the payment dates of his own staff.

A separate item for overheads, charges and profit on the above item is applicable.

PSA 8.6 Prime Cost Items

Replace the penultimate sentence of Sub-clause 8.6 to read:

"The percentage rate for (b) shall cover the Contractor's overheads, charges for taking delivery and profit on the supply of materials or goods covered by the sums stated in (a) above. Payment will be made on the basis of the sums actually paid for such materials or goods, exclusive of VAT."

PSA 8.7 Daywork

Add the following to this clause:

The rates submitted by the Tenderer in the relevant schedule of the Contract shall be applicable.

Provisional items for Daywork are scheduled as follows:

a) Labour at hourly rates for skilled, semi-skilled and unskilled labourers.
b) Purchase cost of Material with a percentage allowance on the net cost for delivery to Site and all Contractors charges.
c) The Contractor's own construction equipment as a Provisional Sum. Where not listed in the BoQ, rates shall be agreed with the Engineer before such work is put in hand.

Tendered unit rates or unit rates that are agreed in terms of Sub-clause 6.5.1.3 of the General Conditions of Contract for the Contractor's own construction equipment used for Daywork shall cover the full cost of the use of such construction equipment and shall, in addition, cover the cost of operators, consumable stores, fuel and maintenance.

The Contractor will be paid the actual net cost of construction equipment hired by him for Daywork and in addition will be paid a percentage allowance on the net cost of such hire, which allowance will cover the Contractor's own overhead costs and profit.

PSA 8.8 Temporary Works

Add the following to this clause:

PSA 8.8.1 Construct and Maintain Access Roads ……..… Unit : Sum

Any extension to existing access roads or construction of new access roads as may be required by the Contractor to access the site of the Works as well as regular maintenance thereof to ensure that the roads are kept in a serviceable condition, to the satisfaction of the Engineer, for the full duration of the contract shall be the responsibility of the Contractor.

Payment of the sum tendered will be made in monthly instalments over the full duration of the contract and shall cover any and all access roads that may be required as a result of the Contractor's method of working.

PSA 8.8.4 Existing Services

The tendered rate shall further cover the cost of backfilling the excavation with selected material compacted to 90% Mod. AASHTO density, keeping the excavation safe, and taking care that the services are not damaged in any way. The rate shall include for all negotiations with the authorities, notification to all affected parties and any other requirement to protect and complete the work.

Add the following clauses:

PSA 8.9 Survey Control and Setting out of Works ……..… Unit : Sum

Before commencement of work, the Contractor is to liaise with the Employer's Agent to establish the status of all survey pegs. If any pegs are missing, he shall immediately inform the Employer's Agent in writing.

On completion of the Contract the pegs that have been unavoidably disturbed will be replaced by the Employer. Pegs which have, in the opinion of the Employer's Agent, been disturbed due to the negligence of the Contractor will be replaced by a registered Land Surveyor at the Contractor's cost.

PSA 8.10 Compliance with OHS Act and Regulations
(Including the Construction Regulations 2014) … Unit : Sum

The tendered sum shall include full compensation to the Contractor for compliance with all the requirements of the OHS Act and Regulations (including the Construction Regulations 2014), Health and Safety Officer/s, medical examinations, accommodation, transport, communication implements, consultations, meetings and any other thing necessary for OH&S) and covid-19 regulations compliance for the full duration of the Contract.

This sum will be paid to the Contractor, in equal monthly amounts, subject to proper and accepted compliance.

PSA 8.11 Compliance with Environmental Requirements ……..… Unit : Sum

The tendered sum shall include full compensation to the Contractor for compliance with all the environmental requirements.

This sum will be paid to the Contractor, in equal monthly amounts, subject to proper and accepted compliance.

PSA 8.12 Alterations to Existing Services …. Unit : Sum

Temporary and permanent alterations made to existing services by the Contractor upon instruction of the Employer's Agent will be measured and paid under this item. Payment for works so ordered will be made on the basis of sums actually paid for materials, construction equipment and labour, exclusive of VAT.

PSA 8.13 Miscellaneous Items ……..… Unit : as scheduled

An item which refers to this clause will be measured in the unit scheduled.

The sum or rate for such item shall cover the cost of all materials, labour and construction equipment required to execute and complete the work, as specified, or described in the Schedule of Quantities or shown on the drawings.

psAB EMPLOYER'S AGENT'S OFFICE (SANS 1200 AB)

PSAB 3 MATERIALS

PSAB 3.1 Nameboards

Add the following:-

Employer's nameboards shall be erected within one month of the commencement of construction and shall be placed where ordered by the Employer's Agent. Any damage to these boards shall be repaired within 14 days of a written instruction received from the Employer's Agent. For details of the board refer to the Standard Drawings contained in this document.

All nameboards shall be removed 14 days prior to the date of the Final Approval Certificate.

PSAB 3.2 Office Building

Delete the first sentence and substitute the following:

The Contractor shall supply and furnish two (2 No) air-conditioned "Kwikjack" or similar (6 m x 3 m) offices and one air-conditioned "Kwikjack" or similar (9 m x 3.4 m) conference facility for conducting meetings.

Add to the Sub-clause:

In addition to the furnishings listed under sub-items (a) to (i), the following shall be provided and properly maintained:

(j) electrical installation to include at least two lights and two 15A plug points plus adequately sized air conditioning units (for heating and cooling) for each office or meeting space.
(k) one refrigerator of at least 100 litre capacity
(l) one kettle of at least 2 litre capacity
(m) one tea set comprising six cups and saucers, six teaspoons, one teapot, one sugar bowl and one milk jug
(n) covered parking for four vehicles.
(o) un-covered parking space for two vehicles.
(p) two "Barhold" or similar wall mounted racks each with 6 clamps suitable for hanging A0 sized drawings
(q) one large meeting table
(r) ten additional chairs

The Contractor shall supply one (1) lockable toilet for the exclusive use of the Employer's Agent's staff.

In addition, the offices for the Employers Agent shall be supplied with approved burglar proofing, the cost of which shall be taken as included in the relevant tendered rates.

PSAB 4 CONSTRUCTION EQUIPMENT

PSAB 4.1 Telephone

Delete the Sub-Clause and substitute the following:

The Contractor will be required to supply the Engineer's Site Staff with pre-paid air-time to the value of R500.00 each per month for their mobile phones as soon as the Contract commences.

Add the following new clauses:

The tendered Fixed and Time Related Preliminary and General Charges in the Schedule of Quantities shall be deemed to include for all costs in this regard.

Add the following new clauses:

PSAB 4.2 Covered Parking Bay

The Contractor shall also supply and maintain covered parking's for the exclusive use of the Employer and Employers Agent as stated in Clause 3.2 above. The parking shall be constructed with gum pole uprights with IBR or corrugated iron roofing supported on timber with 80% shade cloth cladding to the sides. The surface bed of the parking shall be free draining and constructed with a 100 mm layer of 19 mm stone.

PSAB 4.3 Uncovered Parking Bay

The Contractor will be required to supply the Engineer's Representative and Site Staff with the following:

i) Wi-Fi Internet Connection
ii) Access to a printer and photocopier and associated consumables
iii) Two vehicles.

Two vehicles shall be provided by the Contractor for the sole use of the Resident Engineer and Assistant Residential Engineer for the full duration of construction (up to issue of the Completion Certificate). The vehicles shall conform to the following:

- Not older than 5 years from date of 1st registration
- Not more than 80 000km on the odometer on hand-over
- 2 or 4 wheel drive bakkie or SUV
- Engine capacity of at least 1500cc
- Diesel engine
- Current roadworthy certificate (not less than 1 month old at time of handover)
- Fully comprehensive insurance with no excess payable
- Hired or Contractor-owned
- Garage card to be provided for refuelling.

The Contractor shall be responsible for all servicing, maintenance, repairs, payment of any policy excesses in the event of an insurance claim and washing it at least 2x per month. The Contractor shall also be responsible for providing a temporary alternative equivalent vehicle should the provided vehicle be not available for use for a period longer than 48h. Although the site staff members to whom the vehicles are allocated are not allowed to use it for personal travel outside Mthatha, said members may need to use the vehicles for attending to other work-related needs approved by the Engineer. The vehicles will revert to the Contractor upon issue of the Certificate of Completion or date as mutually agreed.

PSAB 5 CONSTRUCTION

PSAB 5.2 Engineer's Office (Refer SANS 1921-1 Clause 4.14)

Add to the Sub-Clause:

The toilet facilities provided for the sole use of the Engineer or his representative(s), the Employer's inspectors, CLO and PSC shall be maintained in a hygienic and sanitary condition and shall be removed on completion of the Works. The facilities provided shall conform to the local health authority's requirements as applicable and the Contractor shall pay all sanitary fees and charges.

PSAB 5.5 Survey Assistants

Delete the first sentence and substitute the following:

The Contractor shall make available to the Engineer two suitably educated labourers for use on and about the site on survey and other work directed by the Engineer at all reasonable times.

Add the following new clauses:

PSAB 5.6 Survey Equipment

Add new Sub-Clause:

The Contractor shall provide the following survey equipment on the Site from the commencement to the completion of the Works:

One automatic reading Engineer’s level plus tripod
One levelling staff (5 m long, 1 cm graduations)
One staff angle bubble
One metal change-point for levelling
One separate plumb-bob
One spirit level (one metre long)
One hammer (2 kg) with steel or wooden pegs as necessary
One 50 m steel or glass fibre tape
One 5,0 m (or longer) retractable steel tape.

The equipment may be shared by arrangement between the Contractor and the Engineer or his representative on Site. The Contractor shall keep the equipment continuously insured against any loss, damage, or breakage and he shall indemnify the Engineer and the Employer against any claims in this regard. Upon completion of the Works the survey equipment as listed above shall revert to the Contractor.

The Contractor shall maintain the equipment in good working order and keep it clean until the completion of the Works.

PSAB 5.7 Site Instruction Books

The Engineer shall supply a site instruction book for specific use on the Site. All instructions given by the Engineer’s Representative must be confirmed and countersigned by the Engineer. The instruction shall be countersigned by the Contractor before implementation.

The Contractor shall supply a triplicate book for site correspondence and inspection requests to the Engineer’s Representative. Reasonable notice shall be allowed prior to inspections. All inspections requests and approval/disapproval thereof shall be recorded by the Site staff in writing. All requests must be signed and dated by the Engineer’s Representative before implementation.

The Contractor in conjunction with the Engineer must ensure that a suitable site quality record system is put in place to record that each section, or work item, complies with the relative works specification.

PSAB 8 MEASUREMENT AND PAYMENT

PSAB 8.1 Scheduled Items

Delete the 1st sentence and substitute the following:

Items will be scheduled in terms of Sub-Clauses 8.3.2 and 8.4.2 of SANS1200 A.

PSAB 8.2.1 Fixed and Time-related Charges

Delete the 1st sentence and substitute the following:

The terms of Sub-Clause 8.2 of SANS 1200 A shall apply.

Add the following clauses:

PSAB 8.2.2 Furnished Office and Meeting Room

The Contractor shall supply, erect, maintain and service for the sole use of the Engineer's staff facilities as defined in PSAB 3.2 and PSAB5.2.

Payment will be made for the supply and erection of the above facilities under the provided fixed rate.

Payment will be made for the maintaining the above facilities in a suitable condition under the provided time related rate.

PSAB 8.2.3 Telephone

The Contractor shall provide air time as defined in Clause 4.1, as amended.

Payment will be made for supplying 3 x R500 monthly pre-paid airtime and data for the mobile telephone under the time related rate. The cost of making the airtime available shall be included in the tendered monthly rate rather than as a percentage mark-up (which would otherwise require invoices as proof of payment).

PSAB 8.2.4 Nameboards

The Contractor shall supply and erect nameboards in accordance with SANS 1200AB Clause 3.1.Payment will be made for the supply and erection of the nameboards under the provided fixed rate.

Payment will be made for maintaining the nameboards in a suitable condition under the relevant time related rate.

PSAB 8.2.5 Survey Assistants

Payment will be made for the employment of the survey assistants specified in Clause PSAB 5.5 under the provided fixed rate on verification of their availability by the Engineer. Should the survey assistants be removed from site during the course of the Contract then any payments made for the survey assistants will be reversed in the next interim payment certificate.

Payment will be made for the monthly cost of the survey assistants under the provided time related rate for as long as they are required to be available to assist the Engineer or his representatives.

PSAB 8.2.6 Survey Equipment

Payment will be made for the supply of the equipment specified in Clause PSAB 5.6 under the provided time-related rate on verification by the Engineer that the equipment specified is on site. No payment will be made if any of the items listed are not available to the Engineer.

The time-related rate is deemed to include maintaining the above equipment in a suitable condition.

PSAB 8.2.7 Covered Parking Bay

Payment will be made for the supply and installation of covered parking bay specified in Clause PSAB 4.2 under the provided fixed rate on verification by the Engineer that the parking bay specified is erected on site. Should the parking bays be removed from site during the course of the contract then any payments made for the supply of this equipment will be reversed in the next interim payment certificate.

Payment will be made for the maintaining of the above parking bays in a suitable condition under the provided time related rate.

PSAB 8.2.8 All other specified facilities for the Engineer

A fixed P&G lump-sum item will be measured for payment for all items specified in PSAB 4.3. This shall include up-front and fixed costs associated with the provision of the vehicles at the commencement of construction. Similarly a time-related P&G lump-sum item will be measured for payment for all time-related costs associated with providing the items in PSAB4.3 including the on-going provision of the vehicles over the tendered construction period. A further km-based rate is included to cover all distance travelled related costs. The vehicle logbooks shall be signed-off by the site staff members and Contractor on an agreed date every month immediately prior to submitting the monthly pay claim to the Engineer.

The cost of providing and maintaining all other facilities for the Engineer's Site Staff (such as cell phone airtime, access to WiFi and photocopying facilities) shall be included in the relevant fixed and time-related scheduled rates.

PSAB 8.2.9 Survey Equipment

Payment will be made for the supply of the equipment specified under the fixed P&G rate on verification by the Employer's Agent that the equipment specified is on site. Should any of this equipment be removed from site during the course of the contract then any payments made for the supply of this equipment will be reversed.

Payment will be made for maintaining the survey equipment in a suitable condition under the time-related P&G rate.

PSC SITE CLEARANCE (SANS 1200 C)

PSC 3 MATERIALS

PSC 3.1 Disposal of Material

Unless otherwise ordered by the Employer's Agent, the Contractor shall dispose of material resulting from clearing and demolition operations at a site to be determined by the Contractor. Such a site shall have the approval of the Employer's Agent, the Local Authority and the Environmental Control Officer.

Payment for the clearing, loading, transport, dumping fees and any other requirement or costs incurred shall be included in the rates submitted for site clearance.

PSC 5 CONSTRUCTION

PSC 5.3 Clearing

Add the following:

"Where any Portion of the Works traverses existing fences these shall be carefully uplifted, if required, and reinstated during the course of activities in that specific area. Where an uplifted fence interferes with the security of what it controls a temporary fence shall be installed and operated to the satisfaction of the Engineer or his Representative. Prior to removal or dismantling of any fence, the contractor will be required to photograph the fence for future reference."

PSC 8 MEASUREMENT AND PAYMENT

PSC 8.1 Basic Principles

Add the following :

"No separate payment will be made for topsoil removal or replacement along pipeline routes. The Contractor is to excavate trenches in such a manner that the top 150 mm of material is kept separate from other excavated material, for replacement on completion of backfill operations. All costs related to excavating this vegetation and topsoil, separate stockpiling, dust nuisance control and reinstatement of the topsoil upon completion of the backfilling operations, shall be deemed to be included in rates tendered for trench excavation and backfilling."

PSD EARTHWORKS (SANS 1200 D)

PSD 2 INTERPRETATIONS

PSD 2.3 Definitions

Amend the sentence headed "Restricted excavation" to read:

"Restricted excavation – All excavations for individual structures starting from the specified bulk excavation platform levels or, where no bulk excavation platform has been specified, from 150mm below natural ground level (ie excluding a nominal 150mm topsoil layer to be removed beforehand)."

Replace the definition "Borrow" with the following :-

"Borrow Material : Material, other than materials obtained from excavations required for the Works, obtained from sources such as borrow pits or the authorised widening of excavations. 'Borrow' shall have a corresponding meaning."

Replace the definition "Stockpile" with the following :-

"Stockpile (Verb) : The process of selecting and, as may be necessary, loading, transporting and off-loading material in a designated area for later use and a specific purpose."

Add the following definitions :-

"Fill : An embankment or terrace constructed from material obtained from excavations or borrow. In roads it includes the earthworks up to the underside of the Selected Sub-Grade level.

Fill (Material) : Material used for the construction of an embankment or terrace.

Roadbed : The natural in-situ material on which the fill, or in the absence of fill, any pavement layers, are to be constructed."

PSD 3 MATERIALS

PSD 3.1.2 Classes of excavation

Delete the contents of this clause and replace with the following:

"For this contract, the classes of excavation will be subdivided as follows:

(a) Soft excavation

All material which can still be efficiently excavated (in the opinion of the Engineer) by 30t excavator fitted with 'rock bucket' (excavator bucket typically fitted with not more than 3 tines designed to loosen layered weathered solid sedimentary residual material). This includes both soft soil material and weak mudstone / siltstone.

(b) Intermediate

All mudstone and siltstone material that the Engineer agrees can be more efficiently loosened for excavation by 30t excavator fitted with Heavy Duty hydraulic breaker. This includes excavating through previously placed and compacted broken stone layers (eg sludge loading platform and road crossings) and areas where the underlying rock has been previously blasted, but not excavated (eg scour/drainage pipeline for raw water reservoirs)

(c) Hard Excavation / Hard Rock

All unweathered sandstone material (in the opinion of the Engineer) which would normally be drilled and blasted if allowed:

1) Using Heavy Duty hydraulic breaker (albeit at a much slower rate of production than intermediate above);
2) Hard Rock excavation by drilling and pouring-in expanding grout: All material where Engineer agrees cannot reasonably be broken-out by 30t heavy duty hydraulic breaker alone due to access difficulties or extreme hardness.

Any unweathered boulders encountered shall be classified as 'Hard Rock: excavation by hydraulic breaker or expanding grout (as agreed with the Engineer)' where such boulders exceed 0,125m^3 (approx. 500 x 500 x 500mm) in volume. Boulders smaller than this size shall not be classified.

PSD 3.3 Selection

PSD 3.3.1 General

Replace 3.3.1 with the following:

The Contractor is required to select, strip 150mm deep and conserve all topsoil from all work areas not already stripped of topsoil; including:

- Temporary stockpile areas (except topsoil stockpile areas)
- Any other otherwise undisturbed area used by Contractor for his own purposes.

The Contractor shall, for bulk, restricted and trench excavation, actively select-out and keep separate all materials into one of the following groups:

- Soft fully-weathered soil
- Weak mudstone and siltstone (which is of little agricultural value, but still falls into the 'soft material' classification as defined in PSD 3.1.2 a)
- Intermediate material (as defined in PSD 3.1.2 b)
- Hard rock material (as defined in PSD 3.1.2 c).

Where the selected material is to be spoiled at the designated off-site spoil dump, the material shall be stockpiled separately at the spoil site in its respective group so that it can either be recovered later or selected by others. All material stockpiled on site for later use as backfilling or fill or landscaping shall also be stockpiled in their respective classification groups.

Add the following sub clause :-

PSD 5 CONSTRUCTION

PSD 5.1.1.1 Barricading and Lighting (Refer SANS 1921-1 Clause 4.18.2 and 4.18.3)

Delete the Sub-Clause and substitute:

Without limiting any obligation which the Contractor may have in terms of any Act, Ordinance or other legislation, the Contractor shall ensure that all excavations which are accessible to the public or which are adjacent to a public road or thoroughfare, or by which the safety of persons may be endangered are protected as set out in Clause 13 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 and that watchmen are employed to ensure that barricades, barriers and lights are effective at all times.

PSD 5.1.1.2 Safeguarding of excavations

Replace Clause 5.1.1.2 (b) with the following:

The Contractor must note that the excavations for most of the structures are deep. The Contractor is responsible for ensuring that all temporary excavation faces are stable and safe at all times and shall either:

- Provide a shoring system, designed by the Contractor and signed by a suitably qualified Professional Engineer, or

- Reduce the slope of excavations to the safe angle as determined by a suitably qualified Professional geotechnical engineer employed by the Contractor.

Where any part of the sides of the excavation for structures are steeper than 1 vertical : 2 horizontal and deeper than 1m below ground level, a 1m high perimeter barrier fence comprising at least 75mm diameter gum-poles or mild steel 'Y' fencing standard (at no more than 1,5m c/c) firmly anchored into the ground with at least 3 strands of high tensile fencing wire shall be erected no closer than 1m from the edge of the excavation (or further back if ground is unstable or disturbed). The barrier fence shall remain in place and be maintained until the relevant excavation is backfilled and/or profiled to shallower than 1:2 slope.

In addition, the Contractor shall provide stormwater diversion berms or ditches upstream of excavations for structures and, where reasonably possible, make all excavations free-draining. Where making excavations free-draining is not reasonably possible, the Contractor shall not allow water from any source to accumulate beyond 300mm deep anywhere in any excavations (excluding sludge and scour ponds once complete).

PSD 5.1.1.3 Blasting

Due to the proximity of structures, Mthatha Dam, and other Contractors, the use of drilling and blasting methods to excavate hard rock will not be allowed anywhere on site.

PSD 5.1.1.3d) Negligence

The Contractor shall be liable for all damages to services caused as a result of the Contractor's negligence.

PSD 5.1.3 Stormwater

Add the following to this Clause:

In that many of the excavations for structures cannot reasonably be made free-draining, it will be necessary to actively remove accumulated rain water from the excavations. The Contractor shall provide, operate and maintain sufficient pumping equipment, pipes and other equipment on site as may be necessary to keep all excavations largely free of standing water at all times.

The Contractor shall be responsible throughout the duration of the Contract, inclusive of the Defects Liability Period, for the provision of all soil erosion preventative measures necessary to protect the trenches, pipeline(s) and land utilised by the Contractor during the Contract from any adverse effects of soil erosion, settlement, scour, etc., resulting from the construction of the Works.

Cross embankments, generally extending across the full width of the working strip, consisting of low earth mounds shaped to rounded form and so oriented as to have a fall of 1% along their length, shall be constructed with compacted material having a minimum density of 90% modified AASHTO density and minimum dimensions and maximum spacing dependent on the slope of the ground along the length of the pipeline, as indicated in the following table:

Slope of Ground	Minimum Height	Minimum Base Width	Maximum Spacing
0% - 5%	No cross-embankments required		
5% - 10%	300 mm	1,2 m	40 m
10% - 15%	375 mm	1,5 m	30 m
Greater than 15%	450 mm	1,7 m	20 m

The height of the cross-embankments for a distance of 1 metre on either side of the trench centreline shall be raised 150 mm above the remainder of the cross-embankment to allow for settlement. In order to form a satisfactory drainage channel upstream of each cross-embankment (at a slope of 1%) the crown over the backfilled trench shall be removed for a distance of 0.5 m upstream of the cross-embankment.

Cross-embankments shall be constructed to the same minimum standards and dimensions indicated above wherever artificial slopes have been formed on the working strip or other areas used during construction and, with the approval of the Engineer, are permitted to be so left.

No additional payment will be made for the construction of cross-embankments which will be deemed to be included in the excavation rates.

PSD 5.1.4.1 Dust nuisance

Add the following to this Clause:

Given the very fine texture of the soil, in dry, windy weather, extremely dusty conditions can be expected on Site unless suitable mitigation measures are taken. The Contractor shall be responsible for actively implementing effective dust control measures such that dust levels do not hamper workers' health and productivity.

The Contractor shall plan his execution of the Works accordingly and shall use sufficient water (with or without approved additives) or other methods to keep the level of dust to a reasonable minimum. Water for this purpose may be abstracted from the nearby dam. This shall be done in consultation with the Engineer and to the Engineer's approval. The cost of all such mitigation measures shall be deemed to be included in the scheduled rates for excavation or Preliminary & General items.

PSD 5.1.6 Road Traffic Control

In the 4th line of Sub-Clause 5.1.6 amend "South African road traffic signs manual1)" to read:
"Southern African Development Community: Road Traffic Signs Manual1) and Chapter 13: [Road works Signing] of the South African Road Traffic Signs Manual1) ", and amend the footnote to read:

"1) Published by the Department of Transport, Pretoria."

Where traffic signals are required, they shall be provided and operated in accordance with the applicable requirements of the South African Road Traffic Signs Manual.

Where work is to be carried out while half of the roadway is closed to traffic, flagmen shall be provided and temporary road signs shall be erected, maintained and operated."

PSD 5.2.2.1 Excavation for General Earthworks and for Structures (Refer SANS 1921-1 Clause 4.10)

Regarding over-excavation and overbreak, add the following to sub-clause (e):

Where the Contractor excavates in material classified as 'soft' (in terms of PSD3.1.2) to dimensions in excess of those shown on the drawings or ordered by the Engineer or if the material in the bottom of an excavation is loosened before concrete has been cast, or if there is any over-excavation, or any loose or disturbed soil, it shall be removed and the over-excavation under structures shall be replaced, at the Contractor's expense, by imported G2 crusher run material from commercial sources compacted to 100% modAASHTO density or, alternatively, with 15MPa/20 mass concrete as ordered by the Engineer.

For restricted excavation in material classified as 'intermediate' or 'hard rock' (as defined in PSD3.1.2), an allowance for an average overbreak layer of 150mm below the required founding level (ie underside of blinding layer) for all structures will be automatically added to the quantity measured for payment for restricted excavation. Similarly, measurement for replacing overbreak with compacted G2 material (as per filling of over excavation mentioned above) will be automatically measured for payment. Over-break (and G2 filling) beyond the 150mm overbreak allowance shall be deemed to be over-excavation and therefore to the Contractor's account.

Add the following new Sub-Clauses:

(f) The Contractor shall inform the Engineer, in writing, at least 14 days before commencing any work which will result in a change in the topography of the site, whether such work is for the permanent works or for temporary works which the Contractor intends to execute for his own convenience. Thereupon, before commencing the work, the Contractor shall take cross-sections of the original ground profiles or another approved method to determine the ground profiles of the entire area to be worked. In addition all rock and/or foundation levels shall be recorded as the work proceeds.

The information so obtained shall be permanently recorded on a drawing or drawings which shall each be signed by both the Contractor and the Engineer. The Contractor shall then provide the Engineer with a reproducible copy of each drawing to serve as a permanent record both for the purpose of determining the quantities of excavation and earthworks carried out in the construction of the permanent works and the extent to which temporary works shall be removed or temporary excavations shall be refilled upon completion of the Works.

(g) Excavations to final level, ready to receive a blinding layer or concrete footing, shall be completed not less than 24 hours before such layer or footing is cast. The Contractor shall arrange for the inspection by the Engineer or his Representative of all surfaces immediately before backfilling of any kind or casting blinding.
(h) Where permanent concrete is to be placed against an excavated face, the excavation shall be trimmed to ensure that there is no projection greater than 20 mm protruding into the excavation profile.
(i) The Contractor shall not spoil, waste or stockpile excavated material without approval.

PSD 5.2 Methods and Procedures

PSD 5.2.2 Excavation

PSD 5.2.2.2 Borrow Pits

Add the following:

“A commercial source shall, for the purposes of this Specification, mean a source of material provided by the Contractor, not the Employer.

Where it is specified that material shall be obtained from commercial sources, the Contractor shall be responsible and include in his price for fill from commercial sources, for finding a source of suitable material, for making all arrangements for procuring the material with the owner of the source, for the payment of any royalties, charges or damages and for transporting the material to the site regardless of the distance involved.

No payment will be made for the removal of overburden or stockpiling at the commercial source and no extra over payment for excavating in intermediate, hard or boulder material shall apply.

Commercial sources shall not be used for any materials without the written approval of the Engineer.”

PSD 5.2.2.3 Disposal

Amend this Sub-Clause as follows:

A considerable volume of excavated material will need to be disposed of. A spoil site has been identified some 3km from the Site to the East.

As noted in PSD 3.3.1, spoil material shall be stockpiled separately at the spoil site in its respective group so that it can either be recovered later or loaded for other use by others.

PSD 5.2.5 Transport of Earthworks

PSD 5.2.5.1 Freehaul

Replace with the following:

All transportation of material within the boundary of the site and within less than 0,5 km from the site boundary shall be regarded as freehaul.

All material imported from commercial sources shall be classified as freehaul.

PSD 5.2.5.2 Overhaul

With the exception of material imported from commercial sources, all transportation of material beyond 0.5 km of the boundary of the site shall be classified as overhaul.

PSD 7 TESTING

PSD 7.2 Taking and testing of samples

Replace the contents of the sub-clause with the following:

The Contractor shall carry out sufficient process control checks on the compaction of all fill and backfill layers in the presence of the Engineer's Representative to be able to demonstrate that the specified compaction is being achieved. The frequency of testing shall be such that tests shall be carried out for every lift of backfill material starting from 300 mm. The costs of testing shall be deemed to be included in the rates for backfilling of the platform.

PSD 8 MEASUREMENT AND PAYMENT

PSD 8.1 BASIC PRINCIPALS

Add the following Sub-clauses:

PSD 8.1.4 Restricted excavation: Provision for working space and access ramps

The tendered rates for provision of working space (see Sub-Clause 8.3.5) shall be deemed to include excavation and subsequent backfilling of any access ramps required and all measures required to render the sides of the excavation stable and the supply, installation, maintenance and removal of safety barricades.

PSD 8.1.5 Recording of original ground profiles

The tendered rate for excavation shall cover the cost of recording the original ground profiles, rock and/or foundation levels, as applicable prior to commencement of any excavation, including stripping of topsoil. This is required to allow the Engineer to check the Contractor's survey and adjust his design levels if necessary.

PSD 8.1.6 Backfilling of over excavation

Backfilling over-excavation with compacted G2 material or mass concrete as specified in PSD 5.2.2.1(e) will not be measured for payment beyond unless the over-excavation is ordered by the Engineer to remove unsuitable material, in which case the additional excavation will be measured and paid as restricted excavation in 'soft' material and the G2 or mass concrete will be measured by volume, all to the additional dimensions ordered by the Engineer.

PSD 8.2.1 Computation of quantities

Add the following to Clause 8.2.1:

The volume of excavated material will be measured from the net outline of the structures and the average depth of excavation unless otherwise approved by the Engineer.

As noted in PSD 5.2.2.1, for restricted excavation in material classified as ‘intermediate’ or ‘hard rock’ (as defined in PSD3.1.2), an allowance for an average overbreak layer of 150mm below the required founding level (i.e. underside of blinding layer) for all structures will be automatically added to the quantity measured for payment for restricted excavation; as will the volume of G2 backfill.

PSD 8.3 SCHEDULED ITEMS

PSD 8.3.2 Bulk Excavation

Replace the contents of this clause with the following:

Separate scheduled items will be provided for each type of excavation material (in accordance with the selection criteria specified in PSD 3.3.1), together with its method of excavation and intended destination / use. The classification criteria specified in PSD 3.1.2 is intended to assist with making the distinction between ‘weak’ mudstone / siltstone from ‘intermediate’ mudstone / siltstone material and between ‘intermediate’ and ‘hard’ material (unweathered sandstone and dolerite). The distinction between ‘completely-weathered soft soil material’ and ‘weak mudstone’ is fairly obvious, but shall none-the-less be as agreed with the Engineer’s Representative. In all cases, the rates tendered shall make allowance for liaising and agreeing with the Engineer’s Representative as to which selection category material being excavated falls into, how it is to be excavated and where such material is to be placed.

Except for measurement of overhaul to the designated spoil site, there are no ‘extra-over’ excavation items.

The tendered rates for excavation shall cover all costs associated with excavating and spoiling or filling and any conditioning, gridding and compaction required to achieve the required compaction density. The tendered rates for overhaul shall cover all costs associated with selecting, loading and transporting the spoil material to the designated spoil dump and depositing the material in a way there is no mixing of the different selection types.

PSD 8.3.3 Restriced Excavation

Replace the contents of this clause with the following:

Separate scheduled items will be provided for each type of excavation material (in accordance with the selection criteria specified in PSD 3.3.1), together with its method of excavation and intended destination / use as per PSD 8.3.2 Bulk Excavation. Separate scheduled items will be provided for each type of structure.

PSD 8.3.5 Extra excavation to provide working space around structures

In addition to the provisions of clause 8.3.5, the tendered rates for ‘extra excavation in all materials for working space’ shall also include for:

1) Any lateral support (if necessary for stability) and any other measures required to render and maintain the excavation sides in a safe, stable state at all times as specified in clause 5.1.1.2 and PSD 5.1.1.2 b);
2) The cost of temporarily stockpiling working-space material (on or off-site), spoiling any unsuitable and excess material, processing to OMC and backfilling and compacting to 95% Mod AASHTO density in layers not exceeding 150mm.

3) Provision of access ramps into the excavation (or other means of providing safe access for personnel and plant to enter and exit the excavations).
4) Provision and maintenance of a 1m high barrier fence around all excavations deeper than 1,0m and where the sides of the excavation are steeper than 1 vertical : 2 horizontal.
5) Provision of stormwater diversion berms or ditches upstream of the excavation and maintaining a minimum of accumulated rain water in the excavations.

PSD 8.3.6 Overhaul

Replace the contents of this Clause with the following:

All movement of cut to fill material shall be regarded as freehaul. In addition, all movement of topsoil, and any other material within the boundary of the site and less than 0.5 km from the site boundary shall be regarded as freehaul.

Overhaul will only be paid where the transportation of material is beyond 0.5 km of the boundary of the site.

Overhaul shall not apply to imported material from commercial sources.

The overhaul distance shall be measured from the point of exit of the site perimeter to the agreed centre of the designated spoil area.

PSD 8.3.16 Retrieval of Spoil Material

Should spoiled material need to be retrieved from designated spoil site (only where instructed by the Engineer), this will be measured under the nearest equivalent scheduled item for excavation and also under 'extra-over for overhaul'.

psDB EARTHWORKS (PIPE TRENCHES) (SANS 1200DB)

PSDB 3 MATERIALS

PSDB 3.1 Classes of Excavation

Delete the contents of this clause and replace with the following:

"For this contract, the classes of excavation will be subdivided as follows:

(a) Labour Intensive Excavation

(i) Soft Excavation

Soft excavation shall be that excavation in material, which in the opinion of the Engineer, can be efficiently excavated and loaded by means of hand-held tools excluding pneumatic or hydraulic breaking tools. Soft excavation shall include all boulders with a volume of less than 0.125 m^3 and a maximum dimension of 500 mm, which can still be removed by hand methods.

(ii) Hard Excavation/Hard Rock

Hard excavation shall be excavation in material, which in the opinion of the Engineer, can only be removed efficiently with mechanical equipment such as jackhammers, drilling & blasting etc. Hard excavation shall also include boulders with a volume > 0.125 m^3 and the maximum dimension > 500 mm, which cannot be broken down and removed by hand methods.

(b) Machine Based Excavation

In cases where heavy excavation equipment is permitted, the classes of excavation will be subdivided as follows:

(c) Soft excavation

Soft excavation shall be excavation in all materials and boulders which in the opinion of the Engineer can be efficiently excavated and loaded by a 30t excavator fitted with 'rock bucket' (excavator bucket typically fitted with not more than 3 tines designed to loosen weak rock material).

(a) Hard Excavation / Hard Rock

Hard excavation shall be excavation in materials and boulders, which in the opinion of the Engineer, can only be removed efficiently with mechanical equipment larger than a 30t excavator, or with jackhammers, drilling & blasting, expanding grout etc.

PSDB 3.3 Selected Granular Material

For bedding material (padding) for steel, GRP and uPVC pipes see PSLB 3.3.

For HDPE and concrete stormwater pipes, suitable material shall be selected from local excavations or stockpiles.

PSDB 3.4 Selected Fill Material

For steel, GRP and PVC pipes, all material up to the underside of backfill shall be measured as selected granular.

PSDB 3.5(a) Backfill Material

In the third line delete "150 mm" and substitute "100 mm".

PSDB 3.5(b) Backfill Material

In the second line delete “PI not exceeding 12” and substitute “PI not exceeding 6”.

PSDB 3.5(c) Cement Stabilised Backfill

Add the following new Sub-Clause:
Where scheduled, or directed by the Engineer, backfill shall be stabilised with 8% cement by mass. The backfill material shall have a plasticity index not exceeding 10 and all material must pass through a sieve of aperture size not exceeding that specified in SANS 1200 LB, Sub-Clause 3.2, as amended.

The dry materials shall first be mixed in a concrete mixer thereafter sufficient water is to be added to produce the stiffest consistency available for placing and compacting with vibrators.

PSDB 3.7 Selection

Replace the words “if he so wishes” in the first line of the second paragraph with the words “at his own cost”.

PSDB 5 CONSTRUCTION

PSDB 5.4 Excavation

Add to the Subclause :

“Where a pipe is to be laid in a vertically-sided trench with temporary side support, it is necessary to ensure that the compacted bedding and backfill is hard up against the soil forming the trench side by withdrawing the temporary supports stage by stage as the backfill rises up the trench.

Where it is permitted for the pipe trench to cross surfaced roads (Generally paved road crossings will be effected by means of pipe or sleeve jacking), the Contractor shall neatly cut two parallel grooves into and through the "black top" before excavating between the grooves. The grooves are to be set back at least 200 mm from the edge of the excavation face to prevent raveling of the cut edge. The cost of this operation, where not scheduled separately, will be held to be covered in the general rates for excavation.

Add the following subclause:

PSDB 5.4.1 Determination of Method of Excavation:

Trenches for pipelines shall be excavated by either mechanical means or by hand, determined as follows:

Trial holes of minimum dimensions 1,0 x 1,0 m shall be excavated by hand along all pipeline routes at 50 m intervals ahead of the Contractor's program for trench excavation. The trial holes shall be to the depth required for the pipeline under consideration to a maximum depth of 1.5 m.

If material that cannot, in the opinion of the Engineer, be excavated by hand methods but can be machine excavated is encountered before the bottom of the trial hole, then excavation may be deemed to be carried out by mechanical means, the length of such excavation determined on the basis of other trial hole findings.

If hard rock material that can only be removed by blasting or using jackhammers is encountered before the bottom of the trial hole, then excavation may be deemed to be carried out by hand up to the level of the hard rock where after the excavation shall be completed by means of using blasting or jackhammers as appropriate. The length of such excavation determined on the basis of other trial hole findings.

If soft material only is encountered at such trial holes, then excavation may be deemed to be carried out by hand up to a maximum depth of 1,5m, the length of such excavation determined on the basis of other trial hole findings. Classification of excavated material shall be as per Clause PSDB 3.1.

PSDB 5.5 Trench Bottom

Add to the subclause :

Where pipes are laid in waterlogged conditions and/or where so instructed by the Engineer a 150mm thick layer of imported single sized stone (19mm size unless otherwise instructed by the Engineer) with a geofabric filter surround ("bidim" Grade A4 or similar approved) shall be constructed under the bedding layer specified for the pipes."

Add the following subclause:

PSDB 5.5.1 Jointing Holes

Jointing holes shall be cut of sufficient length and depth to allow for the proper making, welding or bolting of pipe joints and to ensure that joint collars or sleeves do not rest on the trench bottoms. After the pipework has been inspected, tested and approved by the Engineer, the jointing holes shall be refilled with selected soft material free from stone and then rammed to provide a continuous uniform support for the pipework. No specific payment will be made for forming and refilling holes, the cost of which is deemed to be included in the tendered rates."

PSDB 5.6 Backfilling

PSDB 5.6.1 General

Add the following:

"Notwithstanding the requirements of subclauses 5.6.1 and 5.6.6, no pipe joint or pipe filling shall be covered by either the bedding, blanket fill or the main fill prior to the successful completion of the visual inspection, and the pressure testing of the relevant section of the pipeline."

PSDB 5.6.4 Disposal of Intermediate and Hard Rock Material

Add the Following:

"The Contractor shall make his own arrangements for the disposal of excess intermediate and/or hard rock material. The disposal / spoil site shall meet with the approval of the Local Authority within whose area it falls, and the spoiling shall comply with the statutory and municipal regulations. The cost of all loading, hauling, dumping, spreading, compacting and any other costs or charges will be deemed to be included in the rates tendered for excavation."

PSDB 5.7 Compaction

PSDB 5.7.2 Areas subject to Traffic Loads

Add the following:

"All backfill to pipes under roads and in road reserves or future road reserves shall comply with the requirements of subclause 3.5(b) and shall be compacted in accordance with subclause 5.7.2."

PSDB 5.9 Re-Instatement of Surfaces

Add the following new subclauses:

"PSDB 5.9.7 Cultivated and Arable land

Where pipelines traverse cultivated and arable privately-owned or community land, the entire disturbed construction corridor (and any temporary construction access roads across such areas) shall be restored to their full cultivation potential; namely:

- The full original depths of the topsoil (‘A’ horizon) (applicable to full construction corridor) and subsoil (‘B’ horizon) (applicable where removed at site levelling and trench excavation stage) are replaced / reconstructed and lightly compacted to effectively match the natural undisturbed state of compaction. Where the ‘B’ horizon has not been excavated but has been subject to compaction by the construction activities, such compacted layers shall be scarified to the Employer’s Agent’s approval before replacing the topsoil over it.

“PSDB 5.9.7 Cultivated and Arable land

Where pipelines traverse cultivated and arable privately-owned or community land, the entire disturbed construction corridor (and any temporary construction access roads across such areas) shall be restored to their full cultivation potential; namely:

- The full original depths of the topsoil (‘A’ horizon) (applicable to full construction corridor) and subsoil (‘B’ horizon) (applicable where removed at site levelling and trench excavation stage) are replaced / reconstructed and lightly compacted to effectively match the natural undisturbed state of compaction. Where the ‘B’ horizon has not been excavated but has been subject to compaction by the construction activities, such compacted layers shall be scarified to the Employer’s Agent’s approval before replacing the topsoil over it.

PSDB 5.9.8 Cross Drainage Berms

Cross drainage berms are required along all steeply inclined pipeline routes at intervals to be determined by the Engineer, to minimize possible flood damage.”

PSDB 8 MEASUREMENT AND PAYMENT

PSDB 8.3 Scheduled Items

PSDB 8.3.1 Site Clearance and Topsoil Removal

No separate payment shall be made for topsoil removal or replacement upon completion along pipeline routes. See clause PSC 8.1.

PSDB 8.3.2 Excavation

Add the following sub-item to Sub-Clause 8.3.2 a):

“(d) Excavate to expose and remove existing pipeline:
1) Excavate to within 300mm of pipe crown…………………………… ……….Unit : m^3
2) Excavate by hand last 300mm of cover and expose and remove pipe…… …Unit : m
3) Prepare trench invert ready to receive new pipe…………………………. ….Unit : m
4) Excavate in all materials to deepen existing trench……………………………..Unit : m

Measurement for (d) 1) shall be by volume excavated. Rate to cover all items as per 8.3.2 (a), but shall also include all additional costs associated with taking care not to damage the pipe being excavated.

Measurement for (d) 2) shall be by length of pipe exposed and successfully removed. Pipes unnecessarily damaged in the recovery process (in the opinion of the Engineer) shall not be measured for payment. Rate to cover all costs associated with carefully removing the pipe, cleaning-off all soil and delivering the pipes to the Employer’s yard and stacking same in secure, sound manner; including supply of wooden support batterns. Damaged or otherwise unsound pipes are to be disposed of at an approved dump site.

Measurement for (d) 3) shall be by length of trench. Rate to cover cost of preparation of trench invert after removal of old pipe, ready to lay new pipe.

Measurement for (d) 4) shall be by length of trench excavation in all materials were necessary to deepen the trench to required depth after removal of old pipe (separate scheduled items in 1m depth increments measured from ground level). Rates to cover all items as per 8.3.2 (a); including cost of preparation of trench invert after removal of old pipe, ready to lay new pipe. Extra-over items for volumes of hard rock excavated shall be scheduled."

Add the following 'extra-over' sub-items to Sub-Clause 8.3.2.(b):

(3)	Hand excavation and backfill where ordered by the Engineer	…….. Unit : m³
(4)	Backfill stabilised with 8 % cement where directed by the Engineer	…….. Unit : m³
(5)	Working in confined area (area identified)	…….. Unit : Sum
(7)	Working next to (identified) structures	…….. Unit : Sum

The tendered rates for (4) above shall include full compensation for selecting, mixing, backfilling and compacting of the stabilised material to 90% of modified AASHTO density.

The rate tendered for Extra Over item (5) shall cover all additional costs associated with having to deal with local working-space factors hampering pipe trench excavation; including pipe laying, bedding and backfill.

The rate tendered for Extra Over item (7) shall cover all additional costs associated with having to deal with and providing temporary support to identified structures (such as street light poles) where trenching and pipe laying operations are endangering the stability of same.

PSDB 8.3.3.1 Deficiency in Backfill Materials

Payment for imported, graded stone laid under pipelines in accordance with PSDB 5.5 shall be paid for under either Sub-Clause 8.3.3.1(c) or as scheduled.

PSDB 8.3.3.4 Overhaul

No measurement for payment of overhaul will be made. All distances are Freehaul.
Add the following new item:

PSDB 8.3.4 a) Shoring

Add the following additional information to Sub-Clause 8.3.4 a):

The rate shall also include all dewatering (including operation and maintenance of pumps), piping, day work rates, for the entire duration the shoring is erect until the removal of the shoring. the contractor must take steps to ensure that the shoring or bracing is designed and constructed in such a manner rendering it strong enough to support the sides of the excavation in question. All bracing and shoring, to be inspected and recorded daily and after substantial rains. The trench opening shall be protected by a rigid barrier and have high visibility boundary indicators to prevent injuries/death from falling. All necessary and relevant steps shall be taken including submitting method statements to the engineer ensuring the safe and stable erection of the shoring/bracing. The method statements merely form part of the paperwork and the Contractor still takes full responsibility for any damage and loss of new and existing property (including the current materials, plant and equipment), injury, fatality, and any consequence that results in extra cost whatsoever.

PSDB 8.3.8 Cultivated and Arable land ………. Unit : Ha

Where extra measures are required to restore cultivated and arable land to its original cultivation potential (as described in PSDB 5.9.7), an extra-over item for the full width of the construction servitude will be measured for payment. The tendered rate shall cover all additional costs associated with taking extra care to remove, stockpile and maintain and conserve the topsoil (‘A’ horizon) and subsoil (‘B’ horizon) material and reinstate said layers to the Employer’s Agent’s satisfaction.

Failure to satisfactorily restore 100% of all such layers as specified in PSDB5.9.7 (including, in the opinion of the Employer’s Agent, unnecessary loss / mixing / contamination of the respective layers with other, unsuitable, material), will preclude the Contractor from achieving Practical Completion until such time as the Contractor has, at his own cost, made good the deficiency (including satisfactorily disposing of any contaminated material and importing approved similar topsoil and subsoil to replace unnecessarily lost material where necessary).

PSDB 8.3.9 Cross Drainage Berms **……..… Unit : Sum**

The tendered rate shall include all material, labour, and plant for the construction of cross drainage berms. A cross drainage berm shall be 300 mm high, 800 mm wide. The berms shall be constructed of selected excavated material compacted to 90 % MOD AASHTO or to the approval by the engineer, with no stones or rocks exceeding 100 mm diameter in the largest dimension. Cross drainage berms shall be placed at all steeply inclined pipeline sections at intervals to be determined by the Engineer.”

psDK GABIONS AND PITCHING (SANS 1200 DK)

PSDK 3 MATERIALS

PSDK 3.1.2 Gabion Cages

Add to the Sub-Clause:

The wire used for the fabrication of wire mesh cages and for lacing and bracing operations shall be zinc-coated mild steel wire with NO PVC coating. The lacing wire will be of the same or larger diameter of that used to manufacture the cage frames.

PSDK 3.1.2 Gabions

Replace Clause 3.1.2 with the following:

Gabion boxes shall consist of double twisted, hexagonal wire mesh of nominal 80 mm mesh, with 4.4 mm o/d frame wire and 2.7 mm o/d mesh wire. Complete with partitions at 1 m centres. All wire to be mild steel to SANS 1580 – 2010, zinc coated by hot-dip galvanizing to SANS 675 – 2009.

Mattresses shall consist of double twisted, hexagonal wire mesh of nominal 80 mm mesh, with 4.4 mm o/d frame and 2.7 mm o/d mesh wire. Complete with partitions at 1 m centres. All wire to be mild steel to SANS 1580 – 2010, zinc coated by hot dip galvanizing to SANS 675 – 2011.

PSDK 3.1.3 Geotextile

Add to the Sub-Clause:

Geotextile filter fabric:

Where the Engineer has authorised the use of geotextile filter fabric, this shall be measured by area as: width x nett length, where the width shall be the full or half-width supplied by the manufacturer which conforms closest to the specified of plus 2 x base width plus 200mm. The tendered rate shall include the cost of supply, placing and losses as a result of overlaps and over excavated trench widths.

Geotextile to conform to the following minimum specifications:

Material:	Nonwoven, needle punched, Continuous Filament, Polyester Geotextile (minimum)
Tensile Strength:	14 kN/m (minimum)
UV Stability:	70% strength retained after 1000 hours
Permeability @ 50mm head:	3.6 m/s$\times10^{-3}$

The material shall be placed as directed and shall not be exposed to direct sunlight for prolonged periods.

PSDK 3.2 Pitching

PSDK 3.2.1 Stone

Amend the Sub-Clause as follows:

In Table 2, Column 2, for extra heavy, replace 300 with 500.

PSDK 3.2.3 Wire netting

Add to the Sub-Clause:

Wire netting for gabion and mattress cages shall be hexagonal steel wire mesh strengthened by selvedges of heavier wire and by mesh diaphragms that divide the cases into 1 m compartments.

Nominal 80 mm mesh shall be used for gabion cages with 2.7 (Refer to PSDK 3.1.2) mm diameter galvanised steel wires.

Nominal 80 mm mesh shall be used for mattress cages with 2.7 (refer to PSDK 3.1.2) mm diameter galvanised steel wires.

Selvedge wire shall be galvanised and the diameter shall be a minimum of 4mm.

PSDK 5 CONSTRUCTION

Add new Sub-Clause:

PSDK 5.1.3 Diaphragms

Each diaphragm shall be connected in the same manner to the sides and top panels in addition to the bottom panel.

PSDK 5.2.3 Assembly

Add to the Sub-Clause:

All gabion and mattress cages shall be connected to adjacent gabion and/or mattress cages by lacing the adjacent selvedges together with 2.0 mm dia. galvanised steel wire. The lacing shall be in accordance with Sub-Clause 5.1.2.

PSDK 5.2.4 Rockfilling

Add to the Sub-Clause:

Particular care shall be taken in the filling gabions and mattresses so as to ensure that the voids in the rockfill are reduced to the minimum that can be reasonably achieved. In order to minimise the voids in the rockfilling, the filling shall proceed in layers not exceeding 300 mm deep and each layer shall be rodded and barred so as to compact the rockfill before filling of the next layer commences. Where appropriate, hand packing of selected rock particles shall be carried out.

PSDK 5.2.4.2 Mattresses used in revetments and aprons

Add to the Sub-clause:

Where gabions and mattresses are placed in exposed positions the rock particles forming the exposed faces shall be specially selected so as to present a fair and even surface.

PSDK 5.3.4 Wired Pitching

Add to the Sub-Clause:

The areas in which wired or grouted wire pitching are to be used will be indicated on site by the Engineer.

psDM EARTHWORKS (ROADS, SUBGRADE) (SANS 1200 DM – 1981)

PSDM 3 MATERIALS

PSDM 3.1 Classification for excavations purposes

Delete the clause and replace with the following:

The classification of material for excavation shall be as specified in Project Specification Clause PSD 3.1.2.

PSDM 3.2.3 Selected Layer
Add the following:

The Contractor shall obtain selected subgrade material from selected excavation material on site.

PSDM 5 CONSTRUCTION

PSDM 5.2.3.3a) Preparation and compaction of road bed

Substitute the first paragraph with the following:

The roadbed shall be scarified to a depth of 150 mm, watered, shaped and compacted to 93 % of AASHTO density (100 % for sand), except where otherwise ordered by the Engineer.

PSDM 7 TESTING

PSDM 7.3.2 Routine inspection testing

Replace the contents of this sub-clause with the following:

No density shall be less than the specified minimum density for the relevant layer.

The cost of additional testing ordered by the Engineer, and of which the results do not comply with the specified minimum requirement for the material, shall be borne by the Contractor and will be subtracted from the monthly payment certificates.

PSDM 8 MEASUREMENT AND PAYMENT

PSDM 8.3.4 Cut to fill, borrow to fill

Add the following to the contents of this sub-clause:

If scheduled otherwise, classification and payment for excavation in soft, intermediate and hard material shall be as per PSD8 items.

PSG CONCRETE (STRUCTURAL) (SANS 1200 G)

PSG 2 INTERPRETATIONS

PSG 2.4.2 Strength concrete

Add the following to Clause 2.4.2:

With the exception of mixes weaker than 15 MPa, all concrete for the Works shall be considered to be strength concrete, with reference to the table below:

ELEMENT	28 DAY STRENGTH (MPa)	EXPOSURE CONDITION	COVER (mm)
BLINDING, MASS CONCRETE, SCREED	15	SEVERE	N/A
INTERNAL SURFACE BEDS	30	MODERATE	40
FISHWAY BENCHING MASS CONCRETE	25	SEVERE	N/A
RC FOUNDATIONS	35	SEVERE	50
(INTERNAL) RC COLUMNS	35	MODERATE	40
(INTERNAL) RC SLABS	35	MODERATE	40
(INTERNAL) RC BEAMS	35	MODERATE	40
WALLS	35	SEVERE	50
(EXPOSED) RC COLUMNS	35	SEVERE	50
(EXPOSED) RC SLABS	35	SEVERE	50
(EXPOSED) RC BEAMS	35	SEVERE	50

To ensure uniformity of colour of the formed surfaces of all concrete which will be visible on the exterior of the structures, the cements shall be supplied by a single cement factory. Tenderers are to make allowance for this in concrete rates.

PSG 3 MATERIALS

PSG 3.2 Cement

Add the following to Clause 3.2:

CEM1 42.5 as specified in SANS EN 197-1 common cements, a 75% CEM1 42.5 and 25% PFA blend or 50% slagment and 50% CEM1 shall be used as specified in the relevant sections of SANS 1491 and SANS EN 197-1. Any variations to these are subject to the Engineer’s approval.

For non-structural concrete CEMI 32.5 is acceptable.

PSG 3.2.3 Storage

Add the following to Clause 3.2.3:

Cement shall be used in the order in which it is received (first in, first out basis)

Cement kept in storage for longer than 6 weeks shall be removed from site and not used in the Works.

Any cement that shows signs of hydration, such as the formation of lumps, may not be used and is to be immediately removed from site.

"Cement and PFA shall be stored in a closed structure or container and shall not be kept in storage for longer than two months without the Engineer's permission."

PSG 3.3 WATER

Replace the contents of Clause 3.3 with the following:

Only potable quality water from an approved source may be used for mixing concrete. Water from a river or stream may only be used for curing.

PSG 3.4 AGGREGATES

PSG 3.4.1 Applicable Specification

Add the following to Clause 3.4.1:

The maximum aggregate size shall be 26mm. The nominal stone size specified in the concrete grade shall mean stone conforming to SANS 1083 for the nearest equivalent size.

Any aggregate may be used provided the free sodium alkali content in the concrete mix does not cause an alkali-aggregate reaction.

Coarse aggregate may be obtained from the nearest available commercial sources, and shall be subject to the Engineer’s approval.

Flakiness index of coarse aggregates when tested in accordance with SANS 5847 shall
not exceed 35.

Soundness to be tested in accordance with ASTMC33 and C88 (SANS 5839) coarse aggregates shall not show a loss in mass of more than 18% and fine aggregates not more than 15% after 5 cycles using magnesium sulphate.

Shrinkage shall be determined in accordance with SANS 5836. The upper limits of shrinkage shall be:
Fine aggregate : 150% of the shrinkage of the reference aggregate
Coarse aggregate : 150% of the shrinkage of the reference aggregate
The reference aggregate shall be defined by the *Engineer*.
The volume of water required to mould the sample in accordance with SANS 5836 shall be reported with the above results.

Fine aggregate may be obtained from local sources subject to testing of its suitability by an approved laboratory and approval by the Engineer.

Aggregates shall be tested periodically for reactivity, and shrinkage, the costs of which shall be deemed included in the rate tendered for concrete. A trial design mix will have is to be prepared and the results submitted to the Engineer for approval before construction begins.

At least one month before commencement of concrete work the Contractor shall supply at his own cost representative samples to the Engineer of the aggregates he intends using, together with certificates from an approved laboratory indicating that the aggregates comply with the specifications. Approximately 50 kg of each sample of aggregate shall be supplied.

After approval, these samples shall be taken as standard for the agreed aggregates to be used in the Works. If at any time during the course of the Contract the Engineer considers that there has been any deviation from the approved standard the Contractor shall submit further tested samples of material to the Engineer for approval.

Aggregates for grouting

Notwithstanding the requirements of Sub-clause 3.4.1, the grading of the fine aggregate (sand) and coarse aggregate (stone or pea gravel) to be used for grouting shall conform to the grading given in Tables 1 and 2 respectively, below.

TABLE 1 - SAND	
Test sieve nominal aperture size, mm	% Passing (by mass)
9,5	100
4,75	95 - 100
1,18	45 - 65
0,3	5 - 15
0,15	0 - 5

TABLE 2 - STONE OR PEA GRAVEL	
Test sieve nominal aperture size, mm	% Passing (by mass)
9,5	100
4,74	95 - 100
2,36	0 - 5

Dolomitic Aggregate

Coarse and fine dolomitic aggregate may be used. When tested in accordance with the method specified in Appendix C of SANS 677, not more than 25% by mass of the dolomitic aggregate shall be insoluble in hydrochloric acid.

PSG 3.5 ADMIXTURES

Add the following Clause PSG 3.5.3:

PSG 3.5.3 Concrete using reactive aggregates

The Contractor shall provide the Engineer with sufficient data to enable him to assess the degree of alkali-aggregate reactivity of the aggregates to be used for the concrete.

Where reactive aggregates and other quarzitic aggregates are used for concrete, the Contractor shall, in order to ensure that the concrete is not subject to alkali-aggregate reaction, design his mixes and/or use cement with a sufficiently low alkali content such that the total equivalent sodium oxide content of the concrete is less than 1.8kg/m3.

(NOTE: The equivalent sodium oxide content (alkali content) is measured as (Na2O + 0.658 K2O). For cement it is expressed as a percentage by mass, for concrete is it expressed in kg/m3).

In the case of other aggregates that are less reactive, the Engineer will determine the type and degree of precautionary measures to be adopted.

For each delivery of cement or precast concrete units the Contractor shall provide acceptable written evidence that the requirements of this clause are being met.

PSG 3.5.4 Pulverized Fly Ash (PFA)

PSG 3.5.4.1 General

Concrete containing a percentage of Pulverized fly ash (PFA) shall be termed ‘FA concrete’. The particular brand of PFA the Contractor intends to use shall conform to the requirement of SANS 50450.

All concrete used in water-retaining structures shall be ‘FA concrete’ unless otherwise shown on the drawings or ordered by the Engineer.

FA concrete shall conform to the requirements of SANS 1200 G for concrete and the additional requirements specified below.

PSG 3.5.4.2 Source and quality

Fly Ash shall be procured from an approved source and shall be of a consistent quality conforming to SANS 1491-2. In particular it shall be tested for and shall conform to the following:

- The loss on ignition shall not exceed 5% (Category A)
- The percentage by mass retained on 45 micron screen shall not exceed 12% (Category S)

PSG 3.5.4.3 Cementitious material

The cementitious material used for FA concrete shall consist of a mixture of between 70% and 80% by mass of ordinary Portland cement and of between 30% and 20% by mass of PFA.

PSG 3.5.5 Waterproofing Admixture

All strength concrete batched for water retaining structures shall contain 5 kg/m^3 “Xpex Admix C-500NF” or similar approved.

PSG 3.6 REINFORCEMENT

Mild steel shall be in accordance with SANS 920 – Type A 250 MPa yield and high yield stress steel according to SANS 920 – Type C, Class 2, Grade 1, 450 MPa yield.

Add the following Clauses:

PSG 3.9 Granolithic screed

Granolithic screed shall consist of:

Cement	1 part by mass
Sand	1,25 parts by mass
Coarse aggregate	2 parts by mass

The coarse aggregate shall consist of granite or other approved chips which shall pass a 10 mm sieve and be retained on a 5 mm sieve.

The water/cement ratio of the mix shall be at least 0,5.

PSG 3.10 Bond breaker

The bond breaker where specified under floor slabs shall be 250 micrometre polythene sheet complying with SANS 952, Type D.

PSG 3.11 MATERIALS FOR MOVEMENT JOINTS

PSG 3.11.1 General

The various jointing materials, the manufacturers of the materials and the methods of application shall be as approved by the Engineer. Materials shall be stored and protected to avoid damage, degradation, distortion or contamination.

The joint materials shall be resistant to ultraviolet light and to biological degradation.

PSG 3.11.2 Waterstops

Waterstops shall be of approved manufacture and of the pattern and the material and widths scheduled and specified and shown on the drawings. They shall comply with the tolerances specified in clause 6.1 of SANS 1200GThe waterstops shall conform to the Specifications as set out in CKS 388 for Rubber Waterstops and shall have the appropriate physical properties as set out below:

Form	Black Rubber

Hydrostatic Head	Up to 50m
Tensile strength	>20.7 MPa
Elongation at break	500%
Hardness BS degrees (IRHD)	62 to 72°

All intersections between waterstops shall be pre-fabricated in the factory in accordance with the manufacturer's instructions and to approval of the Engineer. Only straight lengths of waterstop may be field-welded using the appropriate jigs and tools.

Where required, waterstops shall have eyelets so that they may be tied securely to the adjacent reinforcement. Waterstops shall be centre bulb unless specified otherwise elsewhere.

PSG 3.11.3 Joint Formers

Closed cell expanded polyethylene joint formers shall have the following typical properties:

Property	Unit	Value	Value Test Method
Density	kg/m^3	110	DIN 53420
Compression Stress at compression strains of 10% 25% 50%	kPa kPa kPa	175 210 340	DIN 53577 DIN 53577 DIN 53577
Compression set after 24 hours recovery	%	14	
Tensile Strength	kPa	680	DIN 53571
Elongation at Break	%	49	DIN 53571
Max. water absorption after 24 hours by volume	%	0,1	ASTM C-177

Joint formers shall be pre-cut to suit the application as per drawings with a tear-out strip for forming the specified recess for the sealant. The joint formers shall be developed for use in applications with a head of water of at least 10m. If so required the filler shall be glued into position with approved epoxy glue.

Joint formers will be used for expansion joints in the walls and roof and as indicated on the drawings.

Joint formers will also be used where the perimeter walls are cast up to the beams and shall have a thickness of 12 mm. Where this is the case, the joint formers will be cut out to a depth of 12 mm to allow a cavity for the application of an approved 12 mm x 12 mm UV resistant polyurethane sealant.

PSG 3.11.4 Bond Breakers, Primers and Sealants

The bond breaker (if specified) shall be self-adhesive PVC tape (or equal, approved material) with a width the same as the joint recess into which it is to be applied.

The primer, if required for the sealant, shall be fully compatible with the sealing compound that is to be used.

The elastomeric sealant shall be a one-component polyurethane liquid polymer base complying with the requirements of SANS 110. The polymer shall be pouring grade for horizontal or near horizontal joints and gun grade for vertical/overhead joints and joints steeper than 1 in 10 to the horizontal. Sealants shall have a movement tolerance of 25 %. Sealants shall have been tested to ensure that they are non-toxic and do not impart any odour or taste to, or otherwise taint, the water.

These sealants shall be suitable for indoor as well as outdoor applications and shall be UV resistant.

The sealant shall be suitable for use at movements and connection joints in floors as well as for joints in contact with potable water.

Sealant samples shall be timeously submitted for testing upon the request of the Engineer.

Selected contraction and expansion joints will be waterproofed by an approved high performance tape/bandage placed over the joint as indicated on the drawings. This tape shall have a minimum thickness of 2 mm and dimensions as indicated on the drawings.

The tape shall be bonded to the concrete and covered with an approved epoxy-paste adhesive which is not sensitive to moisture.

This tape shall have the following typical properties:

- Suited for use in Potable water
- High water pressure resistance
- High Durability and chemical resistance
- UV- and weather resistant
- Root-Resistant
- Plasticizer free

PSG 3.12 WATERPROOFING SLURRY

An approved cementitious in-depth waterproofer shall be used on planned construction joints as indicated on the drawings. Surfaces shall be prepared and the product shall be applied as per the approved manufacturer's instructions.

The waterproofing slurry shall be suitable for use on concrete substrates and should be suitable for use in potable water structures.

The slurry shall have the following typical properties:

Appearance	Grey Powder
Workability at 20 °C	Approximately 30min
Setting time at 20 °C	1-2 hours

PSG 3.13 TORCH-ON WATERPROOFING

Waterproofing for the parapets of the roofs of both the utilities building and guard house shall be with a torch-on waterproofing system. Waterproofing shall be done according to the approved manufacturer's specifications.

PSG 3.14 POLYURETHANE COATING ON FLOORS AND WALLS

Epoxy flooring and walls shall be provided for the High Lift Pump Station Building. This flooring shall have be a heavy duty self-smoothing polyurethane screed such as Sikafloor -21N PurCem or similar approved. Covering for walls and bund walls shall be a similar approved product suitable for the application. The product shall be applied to a minimum thickness of 5 mm on designated concrete surfaces including bund walls, drainage channels, plinths and on the brick walls up to a height of at least 1500 mm as per Drawings. This screed shall have excellent resistance to chemicals and be able to resist a wide range of organic and inorganic acids, alkalis, amines, salts and solvents. The screed shall be odourless, shall have a high mechanical resistance and shall be easily maintained. The epoxy shall be colour coded for different areas of the utilities building as per the Drawings. The coating shall be jointless and shall have a bond strength in excess of the tensile strength of the concrete

PSG 4 PLANT

PSG 4.3 MIXING PLANT

PSG 4.3.1 General requirement for mixing plant

Add the following to Clause 4.3.1:

Stand-by mixers of adequate capacity and with an independent power unit shall be maintained on site for immediate use in the event of breakdown of the regular mixers failure of the power supply.

PSG 4.4 VIBRATORS

Add the following to Clause 4.4:

Stand-by vibrators of adequate capacity and with an independent power unit shall be maintained on site for immediate use in the event of breakdown of the regular vibrator failure of the power supply.

Vibrators for in-situ concrete shall be of the internal or immersion type.

PSG 4.5 FORMWORK

PSG 4.5.1 Design

Add the following to Clause 4.5.1:

Detailed drawings of the formwork shall be issued by the Contractor for its fabrication. All such design and drawings shall be available for inspection by the Engineer if so required.

The Contractor shall arrange for a Professional Engineer to design and sign the drawings for the formwork (including all supports) to be used for suspended slabs and roofs.

No formwork which is in the opinion of the Engineer major formwork shall be erected without the Engineer's prior written approval of the design and moving or handling arrangements. The Contractor's proposed design and drawings shall be submitted to the Engineer in ample time to permit examination without delay to the works, and in any event not less than three clear days before the date when the Contractor proposes to commence fabrication of the formwork. The Engineer's approval for use shall not be deemed to relieve the Contractor of his responsibility for the adequacy of the formwork.

Where smooth or special formwork is required, only new or as-new steel shuttering shall be used. Where steel is definitely impractical, an alternative may be used but only as approved by the Engineer.

PSG 4.5.3 Ties

Add the following to Clause 4.5.3:

After removal of ties, all ferrules are to be drilled out of the concrete to provide an oversized reamed hole free of all remnants of the ferrule and blown out to remove all dust and other loose material.

The surface of the hole is to be primed by well wetting with a cement/SBR latex slurry and the hole filled by caulking with a cementitious mortar consisting of 1 part cement to 2 parts concrete sand by volume, well mixed with sufficient clean water to obtain the required consistency. This grout is to be well tamped into the hole to completely fill same and provide a dense, void-free plug. The surface is to be trowelled to finish flush with the surrounding area.

The use of sleeves for formwork ties through the walls of water retaining structures will not be permitted. Ties, when cast in, shall have some form of positive anchorage to prevent any rotation when loosening formwork and some form of water bar to restrict seepage along the tie.

For Watertight concrete structures the shutters shall be fastened using an approved imbedded fastening system. Open ferrules will not be permitted.

Add the following Clause:

PSG 4.6 Water-bath

A temperature-controlled water-bath with a capacity to cure two hundred cubes shall be provided on site. The water-bath shall be located under cover.

PSG 5 CONSTRUCTION

PSG 5.1 REINFORCING

PSG 5.1.2 Fixing

Add the following to Clause 5.1.2:

Fixing of reinforcing bars by welding and heating of bars will not be permitted.

Any bars which are severely rusted or with a cross-section which is, in the Engineer's opinion, reduced by rusting or other cause, shall be rejected and immediately removed from site,

Where clips, stools and other supports are not shown on the drawings and are structurally not required, the Contractor shall provide those supports he deems necessary to ensure the correct positioning of the reinforcement, to the satisfaction of the Engineer. The cost of such steel, labour, and other fixing materials shall be inclusive in the rate for the scheduled reinforcement and no additional payment shall be made.

Fixing blocks for the attachment of fixtures may be embedded in concrete provided that the strength or any other desirable feature (such as appearance of the member) is not, in the opinion of the Engineer, impaired thereby.

Supports shall be of approved precast concrete blocks properly shaped to maintain position or proprietary supports of an approved type. Concrete blocks shall be adequately cured as specified. Wooden supports shall not be used nor shall bars be placed in succeeding layers of fresh concrete nor shall bars be adjusted during the placing of concrete. Tie-wire shall point away from the nearest formwork face.

PSG 5.2 FORMWORK

PSG 5.2.1 Classification of Finishes

Add the following to Clause 5.2.1:

Formwork panels or forms shall be free from surface markings. The form surface shall be so lined that it is free from nail, screw, rivet, weld or other marks. Special care shall be taken to avoid form oil, curing water or other stains on exposed surfaces. The forms shall not be re-used unless in perfect condition and capable, in the opinion of the Engineer, of producing exactly the same surface pattern texture and finish as the previous cast.

Rough formwork Degree of Accuracy III may be used on the outside faces where the concrete is more than 300 mm below the final ground level.

Smooth formwork Degree of Accuracy I will be used elsewhere unless specified otherwise.

All honeycombing shall be repaired by cutting back to sound concrete and patching with a suitable repair procedure to the approval of the Engineer.

PSG 5.2.2 Preparation of Formwork

Add the following to Clause 5.2.2:

All exposed external angles in concrete work shall have 20 mm x 20 mm chamfers unless otherwise specified or ordered, but the top edge of a slab that is to receive an applied finish shall not be chamfered.

Formwork shall be completely grout-tight under vibration.

PSG 5.2.5 Removal of Formwork

Add the following to Clause 5.2.5.2:

Where test cubes to determine stripping times are not made, the minimum periods, which shall elapse between the time of the placing of the concrete and the time of removal of the forms shall, unless otherwise agreed with the Engineer, be in accordance with the table hereunder, where each day covers a full 24 hour period. The following table 2 supersedes table 2 in SANS 1200 G.

Table 2: Removal of Formwork (Minimum stripping time in days (24 h))

	CEM I		**CEM II/A & CEM II/ B (MAX 29% EXTENDER)**		**CEMII/B (30-35% EXTENDER)**	
TYPE OF STRUCTURAL MEMBER OR FORMWORK	**Normal weather (Above 15° C)***	**Cold weather (Below 5° C)***	**Normal weather (Above 15° C)***	**Cold weather (Below 5° C)***	**Normal weather (Above 15° C)***	**Cold weather (Below 5° C)***
Beam sides, wall or unloaded columns	1	2	2	4	2	6
Slabs, with props left underneath	4	7	5	8	6	10
Beam soffits, props left in place	7	12	8	14	10	17
Removal of slab props	10	17	10	17	12	21
Removal of beam props	14	21	14	21	18	28

*Average daily temperature of the atmosphere adjacent to the concrete as measured by a maximum and minimum thermometer. When the average daily temperature is between 5°C and 15°C the minimum stripping times shall be interpolated from the table.

The table assumes that the member concerned is not subjected to any heavy construction loads and that the total force to be supported is not more than half the design load. Where heavier loads are to be carried, no stripping of soffits shall be permitted until the concrete has attained its full strength. Any days during which the average temperature was below 2°C shall be completely disregarded.

In the case of walls and columns the stripping times shall be determined by means of cube test results in the first instance, so as to ensure that no damage is caused to the structures by removing formwork.

Add the following to Clause 5.2.5.5:

Special attention is to be paid to the repair and sealing of shutter-ties in all water retaining concrete to ensure watertightness.

PSG 5.3 HOLES, CHASES, AND FIXING BLOCKS

Add the following Clauses:

Fixing blocks for the attachment of fixtures may be embedded in concrete provided that the strength or any other desirable feature (such as appearance) is not, in the opinion of the Engineer, impaired thereby.

PSG 5.4 PIPES AND CONDUITS

Add the following Clauses 5.4.1 to 5.4.3:

PSG 5.4.1 Fixing for equipment and pipe specials

The Contractor will be responsible for the forming of pockets and grouting in of pipe items and/or holding down bolts for equipment supplied under the contract.

Upon completion of the positioning and alignment of equipment, the Contractor shall, grout up pipe items, pockets and base plates (subject to below) necessary for the permanent installation of the equipment.

Only after the Engineer is satisfied with the alignment and the level of each item of plant shall the Contractor grout up the base plates/pipe specials with an approved non-shrink grout.

PSG 5.4.2 Pipes and conduits embedded in concrete

Except with the written approval of the Engineer, no pipes other than those shown on the drawings shall be embedded in concrete and the approval of the Engineer for the position of all services to be embedded shall be obtained before concreting commences.
The clear space between pipes of any kind embedded in reinforcement concrete and the clear space between such pipes and reinforcement shall not at any point be less than:

a) 40 mm, or
b) 5 mm plus the maximum size of coarse aggregate, whichever is the greater.

PSG 5.4.3 Casting/grouting in of pipes and specials

Where pipes are to be cast into concrete, the Contractor shall provide a box-out in the wall and grout the unit in at a later stage. When constructing such a box-outs, reinforcement shall not be cut, but shall run through the opening. Reinforcement shall be cut and/or bent out at a later stage to suit the item being cast in. After installation of the item the remaining reinforcement shall be bent back in position.

Where box-outs for pipes/specials have been provided in the walls, the Contractor shall be responsible for the grouting in of such pipes/specials regardless of whether or not these have been supplied by himself.

An approved non-shrink grout shall be used for the grouting in of pipes and specials after they have been positioned. The details and method statement is to be submitted to the Engineer for approval prior to the commencement of any grouting. The approval by the Engineer shall not relieve the Contractor from his obligation to provide a watertight joint between the concrete and grout used.

PSG 5.5 CONCRETE

PSG 5.5.1 Quality

Add the following to Clause 5.5.1:

Where 35 MPa concrete is specified for severe exposure, the minimum and maximum cementitious contents of 325 kg/m^3 and 450 kg/m^3 respectively shall be used. For concrete containing extenders the maximum cementitious content shall be 450 kg/m^3. The water to cement ratio for this class of concrete shall not exceed 0.50.

All concrete mix designs shall be approved by the Engineer in advance.

The mix design and casting procedure shall be approved by the Engineer prior to casting. All excavations and foundations must be checked and approved by the Engineer or delegated Geotechnical Engineer prior to casting.

All Water Retaining structures, manholes and valve and other chambers shall be constructed using watertight concrete. The Contractor shall abide by all conditions set out in sub-clause 5.5.11 of SANS 1200 G, and pay particular attention to this aspect of the works.

Cubes shall be taken on all pours in accordance with SANS 1200 G. Payment shall be included in the rate tendered for the supply of concrete. No payment shall be made for concrete pours on which no cube tests have been performed. A single cube test comprises the mean crushing strength of 3 cubes taken from the same batch of concrete and cubes must be taken at the frequency specified SANS 1200 G

The concrete shall be tested for water sorptivity, oxygen permeability, chloride conductivity, depth of cover and shrinkage; the details of the tests are given in the specification.

PSG 5.5.1.4 Chloride Content

Add the following to Clause 5.5.1.4:

Efflorescence will not be acceptable on any exposed concrete surface

PSG 5.5.1.5 Durability

Add the following to Clauses 5.5.1.5:

The water/cement ratio, as specified in Table 5 in SANS 1200 G, but shall not exceed 0.5 for severe exposure conditions.

The exposure conditions for the various structural elements are as indicated on the general notes drawing.

PSG 5.5.1.6 Prescribed Mix Concrete

Add the following to Clause 5.5.1.6:

Notwithstanding the requirements of Sub-clause 5.5.1.6, samples of aggregates will not be made available by the Engineer. The Contractor shall supply aggregates from commercial sources located by him, complying with the requirements of Sub-clause 3.4.1, as amended, for the production of prescribed mix concrete.

"No-fines" concrete:

A nominal aggregate size of 19 mm shall be used in the manufacture of "no-fines" concrete.

No-fines concrete shall be laid where specified and shall consist of coarse aggregate, cement and water only. No-fines concrete shall have a 28-day characteristic strength of 15MPa unless specified otherwise elsewhere. No fine aggregate shall be used. Sandwiching or layering of pours will not be permitted. The Contractor shall cast to the profile depth in one pour.

The mixing of the cement and water paste shall have the consistency of paint capable of coating each coarse aggregate particle uniformly and sufficiently to form a small fillet at all the contact points of each stone in the aggregate.

Between 24 and 48 hours after the no-fines layer has been laid it shall be covered with 1:4 cement: sand mortar layer with a nominal thickness of 2 mm. The mix shall be comparatively dry to ensure that it does not penetrate and block the cavities in the no-fines concrete. The surface shall be steel floated to form a plane surface.

The mortar skim shall be cured in the same manner as concrete for a period of not less than 2 days.

Payment shall be per cubic metre of no-fines concrete placed. The rate shall include compaction and skimming to the approval of the Engineer.

PSG 5.5.1.7 Strength Concrete

Add the following to Clause 5.5.1.7:

The concrete mix design for strength concrete must be prepared in an approved laboratory and the results of actual test mixes must be submitted for approval together with 7-day and 28-day strength test results at least 14 days prior to casting of the concrete. Special attention is drawn to the fact that the concrete mix must provide a very dense and impervious concrete.

The Contractor shall submit details of the proposed concrete aggregates and design mix to the Engineer for approval, after which he shall be required to make a trial mix and obtain cube test results to validate the proposed mix. Only after receipt of satisfactory cube test results, the Contractor shall be permitted to use the mix in the construction of water retaining structures. The cost of designing and proving the proposed concrete mix shall be deemed to be included in the tendered rates.

There shall be three grades of strength concrete used on the works designated Grades 35/19, 30/19 and 25/19, and composed of cementitious material, sand and stone as previously specified .

a) Grade 35/19 Concrete for Water Retaining Structures

For Grade 35/19 concrete Ordinary Portland Cement (OPC) and Pulverised Fly Ash (PFA) shall be blended together such that the combined cementitious material comprises 70% OPC and 30% PFA by mass.

The minimum content of combined cementitious material shall be not less than 360 kg and not more than 450 kg per cubic metre of concrete and the minimum cement/water ratio shall be 2,0.

The characteristic cube strength at 28 days shall be not less than 35 MPa.

The concrete mixes for the abovementioned grades of strength concrete are to be designed by an approved laboratory. At least six weeks before placing any concrete on the works the Contractor shall supply and deliver to the laboratory, at his own cost, samples of the aggregates he proposed to use in the concrete mixes. The Contractor shall include in his tender for all the fees and charges levied by the laboratory and all other costs incurred in designing and adjusting the strength concrete mixes.

The Engineer may call for revised mix designs at any stage during the Contract.

Where blinding layers are specified, the concrete shall be grade 15 MPa/19 placed and finished off to the final level.

In order to facilitate or increase the workability of concrete in the fresh/plastic state, to ensure watertightness without increasing the water/cement ratio, the Engineer may approve the use of an additive.

Design slumps shall conform to table 3 of subclause 5.5.1.2.

PSG 5.5.2 Batching

Add the following to Clause 5.5.2:

Batching of all strength concrete shall be by mass. Prescribed concrete may be batched by volume. Batching shall not be done by wheelbarrow.

All concrete shall be mechanically mixed.

Stand-by mixers of adequate capacity and with an independent power unit shall be maintained on site for immediate use in the event of breakdown of the regular mixers failure of the power supply.

PSG 5.5.3.2 Ready-Mixed Concrete

Replace the contents of Clause 5.5.3.2 with the following:

Concrete produced at a central facility, other than at the site of the Works, shall not be accepted for use in the Works except with the prior and express approval of the Engineer. When such approval has been given the Engineer will then decide whether or not to accept the test results obtained by the facility concerned.

The use of concrete from a ready-mixed concrete facility shall be permitted subject to the following provisos:

- The facility shall be accredited as being compliant with the requirements of the ISO 9001-2000 standard.
- The concrete batching plant shall be inspected by the Engineer for compliance with SANS specifications and his approval must be obtained in writing before commencement of the concrete works.
- Before any ready-mixed concrete is used on the works, the Contractor shall furnish the Engineer with a copy of his letter to the supplier in which was specified:
  i) the type of cement(s);
  ii) the nominal maximum sizes of aggregates;
  iii) the cement / water ratios;
  iv) the required compressive strengths;
  v) the required slump at the time and place of delivery; and
  vi) the type of additive - documentary evidence proving the suitability of the additive for use in the concrete, particularly in the grade 35/19 water retaining concrete, shall be given to the Engineer for his prior approval.

The following shall be specified in the Contractor's contract/order with the ready-mixed concrete supplier and a copy of the relevant documentation shall be given to the Engineer's Representative:

- A maximum delivery period of 90 minutes from the time water is added to the concrete mix to the actual completion of the discharge of concrete on site shall be permitted. The discharge period (including placing the concrete) shall not exceed 30 minutes. (90 mins is the max.)
- The concrete slump of every truckload shall be measured on delivery to site as soon as discharge commences and it shall comply with Clause SANS 1200 G 5.5.1.2 prior to any concrete from that truck being placed. No additional water may be added to the mix after it has left the batching plant without the written approval of the Engineer's Representative.
- A detailed computer printout of the constituents of the concrete mix from the batching plant is to be handed over to and retained by the Engineer's Representative on site on arrival (i.e. truck registration, mix proportions and the time water was added to the mix). The masses of the concrete constituents of each truck shall be checked against that of those submitted with the trial mix, subject to the batching accuracy as specified in SANS 0100-2: 1992. The arrival time of each truck on site and the time that the concrete discharge is completed shall also be recorded by the Engineer's Representative. Dedicated truck drivers shall be used, where possible, for the delivery of the concrete to site.
- When required the Contractor shall satisfy the Engineer that acceptable alternative means of supplying concrete have been arranged and can be brought into operation in the event of disruption in the supply of concrete. In this regard, the Engineer may require that the alternative means of supply shall commence if the disruption in the supply of ready-mixed concrete has lasted for a period of 1½ hours.
- The use of ready-mixed concrete will in no way relieve the Contractor of any of his obligations for providing concrete that complies with the specifications."

PSG 5.5.5 Placing

Add the following to Clause 5.5.5:

PSG 5.5.5.1 No cast shall be started when rain is falling or, when in the Engineer's opinion, heavy or continuous rain is probable. Should rain occur after the commencement of casting, the Contractor shall provide all measures necessary to ensure satisfactory completion and protection of that section of the works being cast. No cast shall be started when weather conditions are such that sand or salt spray is blown onto steel, formwork or concrete.

Add the following Clause PSG 5.5.5.10:

PSG 5.5.5.10 Casting of Concrete in Excavation

Structural concrete shall not be cast directly against the side of any excavation without the use of formwork unless prior approval has been obtained in writing from the Engineer.

Concrete used in pipe trenches for encasement and for the thrust / anchor blocks may be cast directly against the side of the excavation.

After vibration, the concrete shall be spaded in corners, in angles and against forms to release air bubbles which may have been trapped in these positions.

PSG 5.5.6 Compaction

Add the following to Clause 5.5.6:

All concrete shall be vibrated with approved internal vibrators of minimum 65 mm diameter and ample power to maintain a speed of at least 7000 rpm when immersed. Electrically driven vibrators shall be used when practicable. Smaller diameter vibrators may be used subject to the approval of the Engineer where areas of rebar congestion restrict the use of large diameter vibrators.

Vibrators shall be inserted only at a sufficient distance from the sloping face of an advancing layer to prevent undue slumping or flow of the face.

PSG 5.5.7 Construction Joints

Add the following to Clause 5.5.7:

PSG 5.5.7.1 General

The edge of joints, exposed to view in the finished structure, shall be so formed as to provide a straight edge true to line and level.

All joints, other than expansion, contraction and other movement joints shall be treated as follows:

As soon as practical the construction joint surface shall be prepared to receive fresh concrete. This preparation, as specified in Sub-clauses 5.5.7.3(a) to (d), shall be such as to remove all laitance or inert and strengthless material which may have formed by high pressure water jets or sand blasting and the specified chipping or sand blasting shall be such as to produce a roughened surface all over. The timing of this operation is important in order to obtain the required finish. Each joint shall be inspected by the Engineer before it is rendered inaccessible by the erection of further shuttering.

Construction joints shall be covered with a waterproofing slurry as indicated on the drawings.

When concreting is interrupted concrete surfaces shall be protected from the sun as specified in Sub-clause 5.5.8(d) or by means of hessian kept damp until concreting is resumed.

About ½ hour before placing concrete or mortar, construction joints shall be saturated with water and immediately prior to placing concrete or mortar on any part of the joint, all surplus water shall be removed by compressed air jets or other approved method.
Unless construction joints between designated joints shown on the drawings are authorized by the Engineer in writing, concrete in the floor and wall shall be cast continuously between the designated joints shown on the drawings.

All costs connected with the forming of construction joints shall be deemed to be included in the relevant concrete rates.

Particular attention should be paid to construction joints where works has been standing for a considerable period of time. In addition to the above requirements the joints shall be cleaned of any other deleterious material (e.g. fungal growths, mould, plant growth etc.) which may affect the performance of the joint.

Well before construction, the Contractor shall submit a construction plan for each structure to the Engineer for approval which shows his planned construction joint positions.

Add the following Clauses PSG 5.5.7.4 – 5.5.7.12:

PSG 5.5.7.4 Formed Joints (Generally Vertical or Near Vertical)

Formed joints will be considered to be designated joints as defined in Sub-clause 2.4.3. (The forming of a straight edge to a construction joint as specified in PSG 5.5.7.1, as amended, does not constitute a formed joint).

Each joint shall be formed as shown on the drawings, complete with rebates, formwork, waterstops, sealants, approved joint filler, dowel bars and their PVC tubes, etc. as indicated.

PSG 5.5.7.5 Non-Designated Joints

Any non-designated joints shall be identical to designated joints, as shown on the drawings, which would be used in similar positions and shall perform the same function.

PSG 5.5.7.6 Joints between Footings or Floors and Walls or Columns

Construction joints between foundations, footings or floors and walls, columns or piers connected to them, shall not be made flush with the supporting surface, but shall be made at a distance above the footing or floor shown as on the drawings or approved by the Engineer. The "kicker" shall be cast as an integral part of the foundation, footing or floor.

PSG 5.5.7.7 Construction Joints

- Construction Joints In Walls Or Footings

Construction joints may only be placed where shown on the drawings or to the approval of the Engineer.

The entire contact surface along the joint in the concrete already cast shall be chipped or water jetted to expose the coarse aggregate to 5 mm beyond the surrounding matrix. Care shall be taken to ensure that the concrete structure is not damaged and that all loose material is removed. The surface must be thoroughly cleaned and wetted before casting against the joint.

- All construction joints in the reservoir walls and footing shall be cast with water stops. Water stops shall be rubber, as per detail drawings.

Payment shall be per linear meter. The rate shall include the cost of all material and labour for the construction of the joint as indicated on the drawings, including formwork, testing and making good. Rates shall also include the cost of the supply and placing of any waterstops, dowels or other insets.

PSG 5.5.7.8 Application of Primers and Adhesives

The concrete to which the primer or adhesive is to be applied shall be dry and shall be cleaned of all dust, grit, grease, surface laitance and foreign matter by compressed air and/or water, solvents, or other suitable approved means. The Contractor shall provide on Site an approved moisture meter to measure the degree of dryness of the joint. This meter shall be made available to the Engineer for testing. The joint shall be approved for the application of the primer and adhesive if the moisture content of the concrete is less than or equal to 5%. It may be necessary to dry the concrete surfaces locally to reduce the moisture content to 5% or less.

All application and drying times shall be included in the Tender Programme.

PSG 5.5.7.9 Contraction and Expansion Joints

Expansion and contraction joints shall be constructed as detailed on drawings using rubber water stops. These joints shall be formed true to line in smooth formwork. Water stops extruded from recycled material shall not be permitted. Prior to bandaging, concrete surfaces shall be prepared by means of high pressure water jetting, scabbling, sandblasting, etc. upon approval by the Engineer.

A waterproofing bandage shall be used for joints as indicated on the drawings and as described in section PSG 3.11.4. The bandage shall be applied and installed as per the instructions of the approved manufacturer.

All surfaces shall be thoroughly cleaned of all accretions of concrete or other foreign matter by scraping or other approved means.

Particular care shall be taken to compact the concrete around waterstops, edges, etc. using adequate approved tools and experienced, reliable workmen.

Rebates for seals shall be formed to required dimensions and lines, or cut true to line and size after floating the surface and before the final set of the cement has taken place. All rebates, etc., shall be adequately protected against damage until the completion of the work; accidental damage which in the opinion of the Engineer will impair the performance or appearance of the joint shall be made good by reconstructing the work as directed by the Engineer. Rebates for seals shall be grit blasted or wire brushed on all faces to remove surface laitance and thoroughly cleaned with soft brushes and/or compressed air jets, and, if necessary, dried by blow-lamp or other approved means before priming.

Payment shall be per linear meter. The rate shall include the costs for all materials and labour for the construction of each joint as shown on the drawings including the cost of formwork, testing and making good and shall include the cost of supplying and placing any waterstops, dowels or other insets.

PSG 5.5.7.10 Installation of Waterstops in Joints

Where waterstops are required, they shall be installed in the longest practicable lengths , and securely held to shape, lines, etc. in proper formwork.

Waterstops shall be held in the formwork so as to prevent air pockets forming underneath them. Special precautions shall be taken, to the approval of the Engineer, to ensure that all flexible waterstops are in perfect contact with well compacted void-free concrete.

PSG 5.5.7.11 Installation of Joint Filler in Expansion Joints

Filler in the joints shall be neatly butted so as to exclude mortar from the joint. Edges of filler strip against waterstops, concrete, formwork, projections, etc., shall also be closely fitted to exclude mortar, so that there is no resistance (other than the compression of the filler) to the expansion movement for which the joint is designed.

Joint filler shall be fixed to the first cast of concrete with an approved adhesive and as directed by the Engineer.

PSG 5.5.7.12 Application of Joint Seals

Rebates shall be cleaned as required by PSG 5.5.7.6 Application of primers and adhesives and shall be inspected and approved by the Engineer's Representative before filling.

Joint sealants and primers shall be applied strictly in accordance with the approved manufacturer's instructions. Flow and non-slumping grades shall be used for horizontal and vertical joints respectively unless indicated otherwise. Immediately after the compound is applied the joint shall be protected against damage until completion of the Contract.

Batch numbers of sealants shall be recorded. Only skilled workmen, experienced in this type of work shall be employed to apply the sealant.

Immediately after the compound is cold the joint shall be protected against damage until completion of the contract.

PSG 5.5.8 Curing and Protection

Add the following to Clause 5.5.8:

Notwithstanding the provisions of a) to g) above, curing shall be achieved using an approved curing compound (applied in accordance with the manufacturer's specifications) in addition to water curing and well-secured plastic sheeting (where possible). The curing compound used shall be to the approval of the Engineer. Wax based curing compounds will not be permitted. Water curing alone shall not be permitted. Where the Contractor fails to make adequate provision for ensuring proper curing for a minimum continuous period of 7 days, the Engineer may condemn the affected pour whereupon the affected area shall be broken-out and replaced at the Contractor's cost. Where the Engineer does not require the affected concrete to be broken out and replaced, the Engineer shall deduct 10% of the measured concrete volume for not fully meeting the specification.

The curing compound shall be applied immediately as formwork is progressively stripped or, in the case of unformed surfaces, when the concrete has taken its initial set. It shall preferably be applied by spraying and the rate of application shall be strictly in accordance with the manufacturer's recommendations. A method of monitoring the area to which curing compound has been applied and the application rate shall be as approved by the Engineer and rigidly applied by the Contractor.

Minimum stripping times for formwork shall be strictly observed (Table 2 of subclause 5.2.5.2 shall apply).

PSG 5.5.8.1 Horizontal Surfaces

Horizontal surfaces shall be wet cured only. The Contractor shall provide a method statement describing his proposed method of curing. This method statement is to be approved by the Engineer prior to construction.

PSG 5.5.8.2 Curing for Normal Concrete Surfaces

In order to achieve durable, impermeable concrete, all exposed surfaces (including joint surfaces) of strength concrete shall be properly and carefully cured. Curing shall take place from the time that the concrete has taken its initial set. (the length of time when formwork is in place may be deducted from the curing period).

The use of membrane curing compounds will be allowed on vertical faces or steeply inclined faces (i.e. steeper than 15° to the horizontal) of cast in situ members of the structures. Approval will be subject to the Contractor producing sufficient, satisfactory cube crushing strength test results where the crushing strength of cubes which have been cured with the proposed curing membrane and left exposed to the elements are compared with those of an equal number of water cured cubes. The crushing strength of cubes cured with the proposed membrane shall be at least 85% of the crushing strength of the water cured cubes.

Before any membrane curing compound is used, each batch shall be tested on a trial surface to ensure that it forms a satisfactory membrane, and any compound which is unsatisfactory in the opinion of the Engineer, shall be rejected. Curing membranes will be disallowed if permanent discolouration of the concrete takes place. Surfaces where curing membranes are used shall be treated in such a manner that the final concrete texture and colour blends in with the rest of the concrete work. Furthermore, the Engineer shall, at his discretion, require the Contractor immediately to adopt an effective alternative means of curing any area of the structure to which a membrane has been applied which, in the opinion of the Engineer, is unsatisfactory. The curing compound used shall be to the approval of the Engineer. Wax based curing compounds will not be permitted.

The curing compound shall be applied immediately as formwork is progressively stripped or, in the case of unformed surfaces, when the concrete has taken its initial set. It shall preferably be applied by spraying and the rate of application shall be strictly in accordance with the manufacturer's recommendations. A method of monitoring the area to which curing compound has been applied and the application rate shall be as approved by the Engineer and rigidly applied by the Contractor.

Surfaces of joint rebates, where elastomeric sealant is to be applied, shall be protected from contamination by curing compound by the use of masking tape.

Curing times shall be included in the Tender Programme.

The Contractor shall immediately adopt an effective alternative means of curing any area of the structure where, in the opinion of the Engineer, curing is unsatisfactory.

Particular attention should be taken to proper curing of the vertical surfaces of the reservoir retaining walls in order to limit drying shrinkage cracking. A suitable curing regime shall be submitted to the Engineer for approval prior to the commencement of any concrete works.

PSG 5.5.9 Adverse Weather Condition

Replace the contents of Sub-clause 5.5.9.2 with the following:

No placing of concrete shall take place if the ambient temperature exceeds 32ºC, or is likely to rise to above 32ºC during the casting period or within eight hours after casting is completed.

If concrete is to be cast during times of high ambient temperature or hot drying winds, the Contractor shall be responsible for taking the necessary steps to keep the placement temperature as low as possible. Such steps include the spraying of the coarse aggregate with water, the painting of silos with a reflecting aluminium paint, the insulation of tanks and pipelines, and the protection of concrete ingredients against the direct rays of the sun. The area of the pour shall be shaded before and during concreting and the concrete shall be shaded from the time of mixing until eight hours after placing.

Windbreaks shall be erected if necessary.

PSG 5.5.10 Concrete Surfaces

Replace the contents of Clause 5.5.10 with the following:

PSG 5.5.10.1 Screeded Finish

After placing and compacting the concrete on a top (unformed) surface shall be struck off with a template to the designated grades and tamped with a tamping board to compact the surface thoroughly and to bring mortar to the surface, leaving the surface slightly ridged but generally at the required elevation. No mortar shall be added, and noticeable surface irregularities caused by the displacement of coarse aggregate shall be made good by re-screeding after the interfering aggregate has been removed or tamped.

PSG 5.5.10.2 Wood-Floated Finish

Where wood-floating is ordered or scheduled, the surface shall first be given a finish as specified in Sub-clause PSG 5.5.10.1, as amended, Screeded finish and, after the concrete has hardened sufficiently, it shall be wood-floated, either by hand or machine, only sufficiently to produce a uniform surface free from screeding marks.

PSG 5.5.10.3 Steel-Floated Finish

Where steel-floating is specified or scheduled, the surface shall be treated as specified in Sub-clause PSG 5.10.1, as amended, Screeded finish except that, when the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be steel-trowelled under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

Add the following Clauses PSG 5.5.10.4 – 5.5.10.6:

PSG 5.5.10.4 Brushed Finish

Where brushed finish is specified or scheduled, the surface shall be treated as specified in Sub-clause

PSG 5.10.1, as amended, Screeded finish except that, when the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be finished/brushed by dragging a broom across the surface of the concrete in order to obtain a non-slip surface.

PSG 5.5.10.5 Power-Floated Finish

Where a power-floated finish is specified, the surface shall be trowelled smoothly with a well-balanced power trowel. Care shall be taken to ensure the surface is trowelled when it is at the optimum trowelling consistency.

PSG 5.5.10.6 Rough Finish

In certain special cases where a rough finish is desired or specified on the drawings, the surface shall be screed-tamped to an approximately even dense surface, and shortly after final set of cement the surface shall be wire broomed and washed down to remove any laitance, leaving a clean rough surface with coarse aggregate partially exposed, but not disturbed.

PSG 5.5.10.6 Granolithic Screeds

PSG 5.5.10.6.1 General

Before placing any granolithic screeds the base concrete shall be chipped to expose the aggregate over 100% of the area to be screeded and soaked with water for at least 24 hours.

The base concrete shall be thoroughly cleaned by scrubbing and all standing water removed after soaking. A 1:2 cement/sand grout shall then be brushed into the prepared surface followed by the granolithic screed before the grout sets. The granolithic screed shall be of the driest feasible consistency with a slump not exceeding 50 mm and shall be formed true to profile and shape as required and shown on drawings. Before placing granolithic screed against an adjacent band of granolithic screed the edge of the latter shall be prepared by chipping back to firm material, wire brushing and brushing with grout as for the base concrete.

Granolithic screed shall be compacted to remove all air and shall be screeded and finished with a steel trowel to Degree of Accuracy 1.

The trowelling shall be carried out in the following stages:

a) First - as soon as the granolithic screed has been compacted and screeded.
b) Second - after 2 hours to close the surface and remove laitance.
c) Third - after a further 4 hours.

The time intervals are estimated as appropriate to normal temperature conditions and shall be varied by the Contractor to ensure a smooth dense finish.

Granolithic screed shall be cured as specified in Sub-clause 5.5.8(b), as amended, but shall additionally be protected from direct sunlight and drying winds as it is being placed.

PSG 5.5.14 Defects

Add the following to Clause 5.5.14:

All defects shall be repaired as soon as possible after the formwork has been removed and the Engineer has inspected the concrete. A statement of the method to be used for each repair shall be submitted to the Engineer for his approval before any work is carried out. The Engineer may prohibit the further placing of concrete in the particular area concerned until he is satisfied that the repair has been satisfactorily executed.

Honeycombed or otherwise defective concrete shall be cut out, together with part of the sound concrete, as directed by the Engineer; anchor reinforcement drilled into holes into sound concrete shall be provided if and as ordered by the Engineer. The cavities shall then be filled in flush with the concrete of the same mix but in general a smaller maximum aggregate size to be specified by the Engineer, placed against special formwork; the joint being treated as a construction joint. For minor honeycombing and defects, the Engineer may order a shallower cut-out, the edges of which shall be square to the face, or preferably undercut to a depth of at least 25 mm. Such cut-outs shall be filled with mortar of composition and colour similar to the concrete mortar, and applied by a tradesman or suitably skilled personnel.

Exposed corners, etc., which are patched shall be bonded to sound concrete by approved epoxy resin or similar bonding agents applied in accordance with the manufacturer’s instructions. An approved experienced specialist sub-contractor shall be employed for critical work, such as the above, if directed by the Engineer.

Special care shall be taken to ensure that any repair exactly matches the formed surface in colour and texture.

No patching or filling of surface defects other than air holes shall be permitted. If the exposed surface has defects which are in the opinion of the Engineer detrimental to the desired architectural effect, that cast of concrete shall be removed and reconstructed at the Contractor’s cost; any adjacent casts damaged in this process shall also be reconstructed.

Add the following Clauses PSG 5.5.16 – 5.5.18:

PSG 5.5.16 Casting Pipes and Specials in Concrete

Where the pipe or specials is to be cast into a valve or other chamber or manhole, the Contractor may elect to provide a box-out in the wall and cast the unit in at a later stage. When constructing such box-outs reinforcement shall not be cut but shall run through the opening. Reinforcement shall be cut and/or bent out at a later stage to suit the item being cast in. After installation of the item the remaining reinforcement shall be bent back in position.

Before commencing the positioning in holes of any pipes/specials the Contractor shall:

a) remove all formwork and boxing remaining in the holes;
b) make any alternations required to the position and shape of the holes and cut reinforcement to suit the item, as directed by the Engineer; and
c) thoroughly scabble and water jet the sides of the holes so as to obtain a satisfactory bond surface for the new concrete and treat the surface as specified in Sub-clause 5.5.7.3, as amended.

Immediately prior to the placing of mortar and concrete around the pipes, the surface of the existing concrete shall be saturated with water. All surplus water shall be removed and the surface covered with a layer, approximately 12 mm thick, of mortar made of the same mix as the concrete in which the pipes/specials are to be placed.

The concrete ingredients shall be mixed and placed as dry as possible to obtain a dense, waterproof concrete. The concrete shall be carefully worked around the puddle flange, if any, and the pipe barrel or body of the special, and shall be vibrated in layers so as to obviate a falling away from pipe/special surfaces of the concrete already placed. The whole shall, when set, form a dense, homogeneous, and waterproof mass.

PSG 5.5.17 Precast Paving Slabs

The area to be paved shall be compacted to 93% of MAMDD, trimmed and then treated with an approved weed killer, with care being taken to avoid contaminating surrounding areas. The paving slabs shall be laid on a sand bed approximately 25 mm thick, which shall be graded to the required levels and slopes as approved by the Engineer. The joints between the slabs shall be 2 mm to 6 mm wide and shall be grouted with cement mortar. Gaps in the pattern of slabs shall be filled with grade 15 MPa/19 mm concrete and given a wood floated finish.

PSG 5.5.18 Items to be cast in or grouted into concrete

PSG 5.5.18.1 Fixings for equipment supplied under separate contract

a) The Contractor will be responsible for the forming of pockets to the details shown on the drawings to accommodate holding down bolts for equipment supplied under a separate contract. Holding down bolts will be supplied by and positioned by others.

b) After casting of the concrete all shuttering shall be removed and the sides of the bolt holes and surface on which the machine base is to be placed shall be scabbled to remove all defective concrete, laitance, dirt, oil, grease and loose material.

c) Upon completion of the positioning and alignment of equipment and when instructed by the Engineer the Contractor shall in collaboration with the mechanical contractor, grout up pockets and baseplates by filling pockets and voids under the baseplates with an approved non-shrink grout.

PSG 5.5.18.2 Fixings for items supplied under this Contract

Holding down bolts or other fixings required for the installation of items supplied under this Contract shall be provided by the Contractor. These fixings shall be cast in or grouted into pockets or installed by other means as approved by the Engineer.

Where anchor bolts are used which are installed into holes drilled into concrete or masonry these shall be of a type approved by the Engineer. All such bolts used shall be manufactured from stainless steel or a metal with a resistance to corrosion equal to that of grade 304 stainless steel. Precautions to be taken when stainless steel fixings are used on galvanised steel members.

Anchor bolts shall have mean ultimate tensile resistance and mean ultimate shear resistance at least equal to those specified below:

Specified Anchor Size	Mean Ultimate Tensile Resistance (kN)	Mean Ultimate Shear Resistance (kN)
M10	36.8	18.90
M12	53.3	28.4
M16	72.4	53.6
M20	149.2	92.4

PSG 5.5.18.3 Supervision

The Contractor shall be responsible for ensuring that the erection of the concrete work is carried out under the supervision of a person with adequate knowledge of the mixing, transporting, placing and curing of concrete.

PSG 5.5.18.4 Programme and Plant

Prior to carrying out any concrete work, the Contractor shall obtain the approval of the Engineer in respect of:

a) Structural programme,

b) Concrete plant details,

c) Materials to be used in concrete,

d) Details of concrete

e) Construction joints

PSG 5.7 POLYURETHANE COATING ON FLOORS AND WALLS

Polyurethane coating on floors and walls of the High Lift Pump Station building shall be installed as per the Manufacturer’s specifications and by a skilled supplier or Contractor as approved by the Engineer.

Designated walls shall be covered with the coating

PSG 7 TESTS

PSG 7.1.1 Facilities

Add the following to Clause 7.1.1:

Water-Bath

A temperature-controlled water-bath with a sufficient capacity to cure the amount of cubes required shall be provided on site. The water-bath shall be located under cover.

PSG 7.1.2 Frequency of Sampling

Add the following to Clause 7.1.2:

One sample shall consist of three concrete test cubes.

For each sample taken the position in the structure shall be recorded where the batch represented by that sample is placed as also the date sampled.

Sampling of concrete of a particular grade shall be as specified in Sub-clause 7.1.2 with the following frequency of sampling referred to in Sub-clause 7.1.2.2 being amended to read as follows:

"A minimum of 4 samples per day of each grade of concrete placed or 6 samples for pours in excess of 10 m3 shall be taken."

PSG 7.2 Testing

Add the following Clauses PSG 7.2.5

PSG 7.2.5 Testing Watertight Concrete

All potable water retaining structures shall be disinfected before testing only if specified on the drawings.

The procedure for disinfecting the structures shall be as follows:

The entire inside surface of the structure including columns and roof shall be thoroughly hosed down with water and brushed until properly cleaned off all dirt and other foreign matter.

The floor of the structure shall then be flooded to a depth of 300 mm with purified water, with calcium hypochlorite solution being added gradually to mix thoroughly as the water enters. The water shall be dosed with calcium hypochlorite at a rate of 150 grams per cubic metre of water entering the structure. The entire inside surface shall again be scrubbed using this water. The workers engaged in this operation shall wear clean rubber boots. On completion the water is to be run to waste once the free chlorine is reduced to an acceptable level, and the floor of the structure shall be swept clean.
The chlorinated water shall be stored until the free chlorine level has dropped to an acceptable level. Excess dirt swept from the floor into the sump may be discharged subject to written approval being obtained from the Local Authority.

PSG 7.2.6 Water-tightness testing of the structure

For testing for water-tighness, the structure shall be cleaned and initially filled to the normal maximum level with the water at a uniform rate of not greater than 2 m in 24 hours.

When first filled, the water level should be maintained by the addition of further water for a stabilising period while absorption and autogenous healing take place. After a stabilization period of 21 days, refill (top up) and record the water level at 24 hour intervals for a test period of 7 days. During this 7 day test period the total permissible drop in level, after allowing for evaporation and rainfall, should not exceed 1 mm per 1m water depth.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of the liquid-retaining walls shall be assessed by the Engineer against the requirements of the specification. Any necessary remedial treatment of the concrete, cracks, or joints shall be carried out from the liquid face where practicable. If a lining is used for this purpose, it shall be sufficiently flexible and not be in any way detrimental to the water quality.

In the event of any leakage or dampness being evident at any stage of the filling or testing or in the event of the Engineer considering the final degree of water-tightness to be unsatisfactory, the Contractor when ordered by the Engineer shall discontinue such filling or testing and shall, at his own expense, immediately take approved steps to rectify the leakage and to make the work thoroughly sound to the complete satisfaction of the Engineer. All such rectification work shall be continued assiduously until a satisfactory test is obtained, which shall prove to the Engineer that water-tightness has been obtained.

The Works will not be certified complete until the structure has been proved by testing to be watertight to the satisfaction of the Engineer.

Testing of the roof of water retaining structures

The roof shall be tested on completion by using a hose or sprinkler system to obtain a sheet flow over the whole area of the roof for a period of not less than 6 hours.

The roof shall be considered satisfactory if no leaks or damp patches appear on the soffit.

PSG 7.2.7 Durability Testing:

Concrete shall comply with the durability parameters defined below:

a) Water Sorptivity:

Sorptivity is sensitive to surface effects and may be used to assess the effectiveness of initial curing.

b) Oxygen Permeability:

Permeability is sensitive to changes in the coarse pore fraction and is thus a means of assessing the degree of compaction of concrete. It may be used to quantify the microstructure of the concrete and is sensitive to macro-defects such as voids and cracks. Permeability shall be tested in a manner approved by the Engineer.

c) Chloride Conductivity:

Chloride conductivity provides a method of characterisation of concrete in the marine environment and may be used to assess the chloride resistance of concrete.

Unlike oxygen permeability and water sorptivity, chloride conductivity is not really a measure of construction quality, but it shall be used for materials selection and design of mixes in aggressive chloride conditions. It will therefore only be used as a check on mix designs during the initial stages of construction.

d) Concrete Cover:

Concrete cover is a dimensional indicator of cover concrete depth. Cover concrete is the outer concrete layer which protects the internal reinforcing steel, and its depth varies according to the requirements of the different environmental exposure classes.

Test for cover shall be conducted using an approved calibrated electromagnetic cover meter.

This test shall be conducted when instructed by the Engineer to confirm that the specified depth of concrete cover has been achieved. The cover meter tests shall cover at least 1 m2 for every 10 m2 exposed. The average cover of the 1 m2 subjected to the test shall be used to determine the payment, unless the Contractor chooses to carry out additional tests as detailed under clause PSG 7.3.8. The cover meter must be calibrated for each project by drilling and measuring actual cover in at least 3 locations to validate the readings.

Minimum cover to reinforcing for the utility building and guard house shall be as indicated on the drawings.

e) General:

Durability predictions will be based on the following tests that shall be arranged by the contractor. The durability testing shall be carried out by a laboratory approved by the Engineer.

f) Shrinkage

The dry shrinkage tests shall be conducted in accordance with SANS 1085. The drying shrinkage shall not exceed 0.04%.

PSG 7.3 Acceptance Criteria for Strength Concrete

Add the following Clauses PSG 7.3.6 – 7.3.10:

PSG 7.3.6 Durability Index Tests

Testing for durability shall be carried out using test panels which are constructed with the same concrete mix, formwork type, and compaction and curing methods as the actual concrete drums. The test panel shall be 150 mm thick, and of at least 0.5 m sides. Samples for testing shall be obtained from the face of the test panel that mimics the cast face of a drum, after a period of 28 days curing. The test panels required for durability testing shall be constructed:

a) At the start of production
b) Initially for the first 50m3 batch of concrete.
c) Thereafter 2 sets for every discreet element namely floors, sloped floors and walls.

The durability tests are to be carried out by an accredited laboratory approved by the supplier in terms his Quality Management System and shall be:

a) Oxygen permeability index test (OPI)
b) Water sorptivity index test (including porosity)
c) Chloride conductivity index test

The test procedures for these tests are obtained from the University of Cape Town Durability Index Test Manual.

Two sets of four cores each (70 mm dia) are required from a test panel: four cores for the oxygen permeability and water sorptivity tests; four cores for the chloride conductivity test.

The required target values for the tests are summarized in the table below. (These are the average values for the four core specimens used for the testing on each occasion). These values are required to be met simultaneously for both sets of cores, i.e. the cores must pass the requirements for both OPI and chloride conductivity.

PSG 7.3.6.1 Durability Test Parameters

DURABILITY INDEX TEST	TARGET VALUE
Oxygen permeability index	≥ 10 (log scale)
Chloride conductivity index	≤ 0.6 m.sec/cm
Water Sorptivity	≤ 8 mm / hr0.5

In the case that the results do not comply with the above values in the above table, another set of cores shall be drilled from the test panel. Where the second set of cores fails to comply with target values, a drum from that batch of concrete shall be sampled by way of drilling four cores for each of the oxygen permeability test and the chloride conductivity test. If these sets of cores fail either of the target values for OPI or chloride conductivity, all drums from that batch of concrete shall be discarded. The contractor shall keep records of all tests results relating to the samples tested.

The contractor shall ensure that site testing is carried out by a trained person. The contractor shall ensure that all off-site laboratory testing is performed in an approved laboratory approved in terms of their Quality Management System.

PSG 7.3.7 Criteria for the Compliance with the Requirements

No extra payment shall be made for cube strength testing. The cost of cube strength testing shall be included in the rates tendered for concrete.

Water used for testing shall be free of charge except for failed tests when water will be charged at standard municipal rates.

In the event that the actual achieved average cube strengths of an element are less than 85% of the target mean strength, the Engineer may instruct the taking of cores for additional strength testing. The cost of taking the cores and repairing the holes in the structures shall be for the Contractor’s account.

The Engineer will conduct routine tests for the durability parameters on cores taken from the completed elements during the construction, the costs for which shall be to the Employer’s account unless the parameters are not met.

The test results shall be accepted or rejected based on the criteria as set out in PSG 7.3.6.1 based on the following categories:

a) Full Acceptance:
Concrete shall be accepted unconditionally and full payment shall be made.

b) Conditional Acceptance:
Concrete may be accepted at the Engineer’s discretion with a warning that construction methods be examined to improve the durability criteria. A reduced payment shall be applied to all the relevant pay items under SANS 1200 G for the non-conforming element or concrete pour. Alternatively, the Contractor may elect to carry out remedial work to improve the durability of the concrete to the criterion of “Full Acceptance” to the satisfaction of the Engineer, and receive full payment. All proposed remedial measures shall be subject to the approval of the Engineer. The cost of all such remedial work shall be for the Contractor’s account.

c) Rejection:
The concrete shall be removed and replaced with fresh concrete at the expense of the Contractor, as directed by the Engineer.

Should the test result(s) indicate conditional acceptance or rejection of the item tested, the Contractor shall have the option of carrying out additional tests on that item, at his own expense, to confirm or disapprove the original test result(s). Not more than two such additional tests shall be carried out.

PSG 7.3.8 Procedure in the Event of Non-Compliance with the Requirements

Structural concrete elements or concrete pours shall be represented by test cubes and extracted cores, which shall be tested for strengths and the appropriate durability parameters.

If the durability parameters have been proved acceptable, the costs for such testing shall be borne by the Employer. However, where non-compliance to the specified parameters has been identified, the assessed element shall be rejected and at the Engineer’s sole discretion any of the following measures may be considered at the Contractor’s expense:

a) Coating with an approved product specifically designed to improve the non-conforming parameter depending on the severity of the test results.
b) Acceptance at reduced payment.
c) Demolition and rebuilding.

PSG 7.3.9 Tests Ordered By the Engineer

One concrete cube strength test shall comprise the results of tests carried out on three standard test cubes made from concrete sampled from one batch of concrete in accordance with these specifications.

Percentage payment for concrete cover shall be based on the average result of the total number of cover meter tests performed on a particular concrete element.

The overall percentage payment applied to a concrete member shall be based on the average of the percentage payments applicable to each durability parameter, together with the percentage payment based on the strength requirements described in the project specifications.

The reduced payments shall apply to the relevant payment items scheduled in the Schedule of Quantities.

PSG 7.3.10 Grouting

The Contractor shall, where so ordered, carry out a site test for each grouting procedure. The tests shall be carried out on a dummy bedplate similar in configuration to that which is to be grouted, but not exceeding 1 m2 in area unless otherwise ordered. When the dummy bedplate is dismantled, the underside shall show a minimum grout contact area of 80% with reasonably even distribution of the grout over the surface grouted except that, in the case of expanding grout, the minimum grout contact area shall be 95%. The test shall show evidence of good workmanship and materials and the results shall be to the satisfaction of the Engineer.

The Contractor shall, when so ordered, make standard test cubes from various grout mixtures and also subject them to compression tests to determine whether the specified strength has been achieved. Test procedures shall comply with the relevant requirements of Sub-clauses 7.2.1 to 7.2.3.

PSG 7.3.11 Durability Parameters Acceptance Ranges

When tested in accordance with the test procedures described below for each potential durability parameter, the concrete shall meet the limits given in the tables below:

PSG 7.3.11.1 Water Sorptivity and Oxygen Permeability

Table PSG 7.3.11.1 Water Sorptivity and Oxygen Permeability		
Acceptance Category	Test No. / Description / Unit	
	Water Sorptivity (mm/h)	Oxygen Permeability (log scale)
Concrete made, cured and tested in laboratory	6	> 10.0
Full acceptance of in-situ cast concrete	< 8	> 9.15
Conditional acceptance of in-situ cast concrete (with remedial measures)	8 - 15	8.75 – 9.15
Rejection	> 15	< 8.75

PSG 7.3.11.2 Chloride Conductivity

Table PSG 7.3.611.2 Chloride Conductivity (severe to very severe conditions)				
Concrete	100% PC	10% CSF	30% FA	50% GGBS

Curing Period	28d	90d	28d	90d	28d	90d	28d	90d
Full wet cured	1.25	1.00	0.50	0.45	1.50	0.40	1.25	1.00
Moist cured (3 – 7d)	1.75	1.60	0.60	0.55	2.25	1.25	2.25	2.00

PSG 7.3.11.3 Concrete Cover

Table PSG 7.3.11.3 Concrete Cover			
Test Description	Specified Cover (mm)	Acceptance Range	
		Minimum	Maximum
Concrete cover to reinforcement	20 – 30	As specified	As specified + 5 mm
	30 - 80	As specified	As specified + 10 mm

PSG 7.3.12 Determination Of Reduced Payment

Payments for all durability concrete shall be based on the test results. The durability parameters are calculated according to Tables PSG 7.3.12.1, PSG 7.3.12.2 and PSG 7.3.12.3 below.

Table PSG 7.3.12.1 Water Sorptivity

TEST	Coastal (≤ 5 km from coast and up to 15 km up river valleys/estuaries)		Inland (> 1 km from coast)	
Water sorptivity (mm/h)	TEST RESULT	% PAYMENT	TEST RESULT	% PAYMENT
	< 8	100%	< 8	100%
	8 < 12	90%	≥ 8 < 12	90%
	12 < 15	85%	≥ 12 < 15	85%
	≥ 15	0%	≥ 15	0%

Table PSG 7.3.12.2 Oxygen Permeability

TEST	Coastal (≤ 5 km from coast and up to 15 km up river valleys/estuaries)		Inland (> 1 km from coast)	
Oxygen Permeability Index (log scale)	TEST RESULT	% PAYMENT	TEST RESULT	% PAYMENT
	> 9.15	100%	> 9.5	100%
	> 9.0 ≤ 9.15	90%	>9.25 ≤ 9.5	90%
	> 8.75 ≤ 9.0	85%	>9.0≤ 9.25	85%
	≤ 8.75	0%	≤ 9.0	0%

Table PSG 7.3.12.3 Concrete Cover

TEST	Coastal (≤ 5 km from coast and up to 15 km up river valleys/estuaries)		Inland (> 1 km from coast)	
	TEST RESULT	% PAYMENT	TEST RESULT	% PAYMENT
30 mm specified	≥ 30 ≤ 40	100 %	≥ 30 ≤ 40	100 %
	≥ 25 < 30	40 %	≥ 20 < 30	40 %
	< 25 or > 40	0 %	< 20or> 40	0 %

40 mm specified	≥ 40 ≤ 50	100 %	≥ 40 ≤ 50	100 %
	≥ 35 < 40	40 %	≥ 30 < 40	40 %
	< 35 or > 50	0 %	<30or>50	0 %
50 mm specified	≥ 50 ≤ 60	100 %	≥ 50 ≤ 60	100 %
	≥ 45 < 50	40 %	≥ 40 < 50	40 %
	< 45 or > 60	0 %	< 40or> 60	0 %
60 mm specified	≥ 60 ≤ 70	100 %	≥ 60 ≤ 70	100 %
	≥ 55 < 60	40 %	≥ 50 < 60	40 %
	< 55 or > 70	0 %	< 50or> 70	0 %
65 mm specified	≥ 65 ≤ 75	100 %	≥ 65 ≤ 75	100 %
	≥ 60 < 65	40 %	≥ 55 < 65	40 %
	< 60 or > 75	0 %	< 55or > 75	0 %
TEST	Coastal (≤ 5 km from coast and up to 15 km up river valleys/estuaries)		Inland (> 1 km from coast)	
75 mm specified	≥ 75 ≤ 85	100 %	≥ 75 ≤ 85	100 %
	≥ 70 < 75	40 %	≥ 65 < 75	40 %
	< 70 or > 85	0 %	<65 or> 85	0 %
80 mm specified	≥ 80 ≤ 90	100 %	≥ 80 ≤ 90	100 %
	≥ 75 < 80	40 %	≥ 70 < 80	40 %
	< 75 or > 90	0 %	<70 > 90	0 %

Percentage payment for concrete cover shall be based on the average result of the total number of cover meter tests performed on a particular concrete element.

The overall percentage payment applied to a concrete member shall be based on the average of the percentage payments applicable to each durability parameter, together with the percentage payment based on the strength requirements described in the project specifications.

The reduced payments shall apply to the relevant payment items scheduled in the Schedule of Quantities.

PSG 8 MEASUREMENT AND PAYMENT

PSG 8.1.1 Formwork

Add the following Payment Item PSG 8.1.1.7 – 8.1.1.9:

PSG 8.1.1.7 Edges of blinding layer

No separate payment will be made for formwork to the edge of the blinding layer. The rates tendered for concrete to the blinding layer shall cover the cost of such formwork.

PSG 8.1.1.8 Chamfers and fillets

No additional payment will be made for chamfers and fillets up to 40 mm wide. Larger fillets and chamfers will be measured by length in accordance with Sub-clause 8.2.5.

PSG 8.1.1.9 Kickers

Formwork for kickers will be measured as plane (or circular) vertical (not as narrow widths) and no separate payment items will scheduled for kickers.

PSG 8.1.2 Reinforcement

Add the following to Payment Item 8.1.2.2 and 8.1.2.3:

Notwithstanding the method of measuring and paying for reinforcement specified in Sub-clauses 8.1.2.2 and 8.1.2.3, reinforcement will be measured and paid for as scheduled.

PSG 8.1.3 Concrete

Add the following to Payment Item 8.1.3.3:

The rates for concrete shall also cover:

a) the use of dolomitic aggregate where prescribed,
b) the cost of the preparation of design mixes by an approved laboratory and submission for approval by the Engineer,
c) screeded finish of unformed surface as specified in PSG 5.5.10.1, as amended, Screeded finish, and
d) Inclusion of admixtures where specified.

PSG 8.2 SCHEDULED FORMWORK ITEMS

Add the following to Payment Item 8.2:

Rates for formwork shall include any additional items required for the fastening of formwork such as embedded fastening systems.

PSG 8.2.8 Edges of blinding layer

No separate payment will be made for formwork to the edge of the blinding layer. The rates tendered for concrete to the blinding layer shall cover the cost of such formwork.

PSG 8.4 SCHEDULED CONCRETE ITEMS

PSG 8.4.4 Unformed surface finishes **Unit: m2**

Add the following to Payment Item 8.4.4:

The rates for unformed surface finishes shall cover the cost of providing the respective surface finish as specified in PSG 5.5.10, as amended, Concrete Surfaces.

- Screeded Finish Unit: m²

Add the following Payment Item PSG 8.4.7 :

PSG 8.4.7 Cast in of Pipes through Walls and Floors of Structures **Unit: No**

Unless scheduled separately, casting in of pipes through walls and floors of structures shall be deemed to be included in the rates for pipes and structures. For scheduled items, different items will be stated for ranges of diameters of pipes to be cast through walls and floors of structures, and thickness of the walls and floors (or type of structure) as applicable.

The tendered rate shall include full compensation for cutting and splicing reinforcing where required, for opening and closing of formwork where required, securing of pipes against uplift and for all additional costs required to install pipes in the exact positions as shown on the drawings. At box-outs for pipes below ground level and for water retaining structures the rate shall include chipping and wire brushing the concrete surfaces to expose the coarse aggregate and coating the surfaces with an approved wet to dry epoxy to specification before casting in of the pipe.

PSG 8.5 JOINTS

Add the following to Payment Item 8.5:

Only designated joints as shown on the drawings will be measured for payment according to the length of each type of joint constructed. The rate shall cover the cost of all materials, labour and plant required to construct each type of joint specified on the drawings, including the cost of all shuttering, treatment of the joint as specified in Sub-clause 5.5.7.3, as amended, the provision of chamfers as specified where concrete is exposed, as well as testing and repairing where necessary. The rate shall also include any waterbars, dowels or other inserts as indicated on the drawings.

Non-designated joints will not be measured for payment.

Add the following Payment Item PSG 8.5.1 to this payment clause:

PSG 8.5.1 Formed joints Unit: m

Formed joints will be measured by the length of the joint.

The rates shall cover the cost of all operations and materials specified in Sub-clause 5.5.7, as amended, and Sub-clause PSG 5.5.7.2, as amended, Formed joints (generally vertical or near vertical), and detailed on the drawings such as joint filler, dowel bars and tubes, joint sealant, bitumen coats, etc., including waterstops or water bars as detailed. The rates shall also include the treatment of the surfaces before applying sealants, fillers, slurries or any other coatings.

Formed joints shall be classified in the bill as on the drawings.

Construction joints which shall be covered with a waterproofing slurry as indicated on the drawings, shall include the rates of the waterproofing slurry and the application thereof.

PSG 8.7 Grouting ....Unit: m^3

Add the following to this payment clause:

Grouting of base plates and equipment bases will be measured by the volume of grout used.

The rate shall cover the cost of the supply and floating in of grout under the plates to ensure solid and complete filling of the gap.

PSG 8.8 HD Bolts and miscellaneous Metal Work ....Unit: No.

Add the following to this payment clause:

Fixing of holding down bolts will be measured by number. The rate shall cover the cost of all things necessary to ensure that the bolts are effectively and rigidly held in position during casting, complete with sleeved pockets, all as detailed on the drawings.

Add the following Payment Items PSG 8.9 – 8.16

PSG 8.9 GRANOLITHIC SCREEDS Unit: m2

Special floor finish will be measured by area. The rate shall cover the cost of the supply and application of the specified material, complete as specified by the manufacturer and to the approval of the Engineer. Repairs to unsatisfactory work will not be paid for.

Measurement of granolithic screeds will be by the surface area covered.

The unit rate or lump sum shall cover the cost of all materials, labour and equipment required to provide the screed as specified in Sub-clause PSG 5.5.10.6, as amended, Granolithic screeds. The rate shall include the steel float finish.

PSG 8.10 NO-FINES CONCRETE Unit: m3

No-fines concrete will be measured by volume. The volume measured shall be based on the neat dimensions as shown on the drawings. The Contractor shall make provision in his rates for additional volume which may be required as a result of any overbreak during excavation.

The rate shall cover the cost of supplying materials, constructing and placing in position the no-fines concrete, and shall include for the steel floated 2 mm mortar skim.

PSG 8.11 ITEMS CAST IN CONCRETE Unit: No.

Items cast in concrete will be measured by number separately for each type of item.

Notwithstanding Sub-clause 8.2.6, the rate shall cover the cost of fixing in position and casting in the item as construction proceeds, irrespective of whether the Contractor chooses to fix the item in the formwork and cast it in directly or to box out a hole and grout the item in subsequently. At box-outs for pipes below ground level and for water retaining structures the rate shall include chipping and wire brushing the concrete surfaces to expose the coarse aggregate and coating the surfaces with an approved wet to dry epoxy to specification before casting in of the pipe.

The item will be measured and paid separately.

PSG 8.12 DURABILITY TESTS Unit: Sum

The durability test will be paid by a lump sum separately for the reservoir structure.

The sum shall cover the cost of all labour, equipment and materials to carry out the tests, as specified in PSG 7.2.7, to rectify faults and to achieve a test result to the satisfaction of the Engineer. Durability tests will include tests for Sorptivity, Oxygen Permeability, Chloride conductivity, Concrete Cover and Shrinkage as specified in PSG 7.2.7.

PSG 8.13 Precast paving slabs...Unit: m^2

Precast paving slabs will be measured by the area paved.

The rate shall cover the cost of compacting the area, application of weed-killer, supplying, laying and bedding the slabs, grouting the joints and filling any gaps, all as specified.

PSG 8.14 FA concrete...Unit: m^3

Measurement and payment for FA concrete shall be as specified in Sub-clause 8.1.3 as amended.

The tendered rate shall cover all costs in connection with the supply, storage, handling on site and mixing in of PFA.

PSG 8.15 WATERTIGHTNESS TEST Unit: Sum

The watertightness test will be paid by a lump sum separately for each structure.

The sum shall cover the cost of all labour, equipment and materials to carry out the tests, as specified in PSG 7.2.6 to rectify faults and to achieve a test result to the satisfaction of the Engineer.
The sum shall include for all water required over and above that required for one filling of the relevant structure based on the assumption that water will be available in time as part of this Contract.

The sum shall include for all water required over and above that required for one filling of the water retaining structure based on the assumption that water will be available.

A provisional item is provided for an extra payment to the above to allow for the water not being available in time and the Contractor has to make his own other arrangements for providing water for testing. Such an arrangement shall only come into effect on the Engineer's instruction.

PSG 8.16 POLYURETHANE COATING ON FLOORS Unit: m²

Polyurethane coatings shall be measured per square meter. Rates for polyurethane coatings shall include supply, delivery and installation as well as all materials and colour pigments used as per drawings and specifications. The rates shall cover all components required for the application of the 5 mm screed as per the Supplier's specifications.

PSG 8.17 Black Plastic Bond Breaker...Unit: m²

A 250 micron black plastic continuous layer is to be laid over the no-fines concrete under the reservoir floor. The side and end laps shall not be less than 100mm. Just before casting the sheeting shall be perforated in a grid pattern at 1 m centres.

Payment shall be by the square meter laid. Care shall be taken not to rip or tear the sheeting. All repairs shall be at the Contractor's expense.

PSG 8.18 BITUMEN EMULSION Unit: m²

Bitumen Emulsion will be used as a bond breaker between surfaces and joints. The rate for the emulsion shall be per square meter and shall include the rate for the cleaning of surfaces, materials and labour required for application.

PSG 8.21 TORCH-ON WATERPROOFING Unit: m²

Rates for torch-on waterproofing required at the roofs of the guard house and utilities building will be per square meter. Rates shall include the cost of all material, plant and labour required for this installation.

PSH STRUCTURAL STEELWORK (SANS 1200H)

PSH 3 MATERIALS

PSH 3.1 Structural Steel

Add to the Sub-Clause:

Except where scheduled to the contrary or shown on the drawings, the grade of steel to be used in the manufacture of the following shall be that grade normally supplied by reputable manufacturers approved by the Engineer:

All structural steelwork which shall include ladders, safety cages and platforms, shall be manufactured in conformity with SANS 1431 to the following grades:

- Hot-rolled Sections: S355JR
- Hot-formed Hollow Sections: S355JR

Except where shown to the contrary on the drawings or in the schedule of quantities.
All steelwork not specified as Stainless Steel to be sand blasted to SA 2.5 and hot-dip galvanised to SANS 763.

All stainless steel shall be grade 304L, except where shown to the contrary on the drawings or in the schedule of quantities.

Grade 3Cr12 steel shall be used where scheduled or shown on the drawings and shall be fully pickled and passivated prior to installation.

PSH 3.3 Steels Used For Cold-Formed Sections

Add the following to Clause 3.3:

Cold formed sections are to be provided in accordance with BS 2994: 1967.

PSH 3.5 Welding Consumables

Add the following to Clause 3.5:

All welds to be designed to transmit full member strengths and to be 6 mm fillet welded unless specified.

PSH 3.6 Bolts, Nuts And Washers

All bolted connections to be designed in accordance with SANS 0162-1:2005.

PSH 5 CONSTRUCTION

Add the following to Clause 5:

All structural steel works to be carried out in accordance with SANS 2001 – CS1:2005 unless specified otherwise elsewhere.

PSH 5.1.2 Contractor to Provide Shop Details

Add to the Sub-Clause:
The Contractor shall prepare his own shop details based on the dimensions and details given on the drawings and will be required to submit his shop details to the Engineer at least 3 weeks prior to fabrication. Written consent must be obtained from the Engineer, prior to commencing fabrication. The Contractor is still responsible for ensuring that the shop details are dimensionally correct.

PSH 5.2 Fabrication

Add the following to Clause 5.2:

Fabrication of steelwork shall be sequenced so as to limit welding distortion and the possibility of locked-in stresses.

PSH 5.2.6 Handrails

Add to the Sub-Clause:

Handrailing shall be of tubular construction in GMS or Grade 304L stainless steel of an approved proprietary make as scheduled.

Hand and knee rails shall be not less than 32 mm O.D. (wall thickness not less than 1,6 mm) and the height of the handrails (centre) shall be 1 000 mm above walk-way level, with knee rails located approximately midway between.

Stanchions shall be not less than 44 mm O.D. (wall thickness not less than 1,6mm) and shall have ball type or spun and flared connectors to suit horizontal or angled handrailing as required. The base plates shall not be less than 8mm thick.

In general all bends in the hand and knee railing shall be 140 mm radius. Handrails shall be either side or top mounted and shall be fastened with stainless steel nuts, bolts and washers.

Spacing between stanchions shall be determined by site conditions but in no case shall it exceed 1 800 mm c/c. At bends, stanchions shall be provided on either side at a distance of 300 mm from mid-bend.

Finished handrailing shall be true to line and level and connections shall be securely fixed by means of 2 No. stainless steel pins, finished flush on each side of the joints (to the approval of the Engineer).

All ends shall have closures joining the hand and knee railing.

The rate quoted per metre is to include for the supply and installation of the handrail, knee rail, portion of a stanchion, footing, Chemical type holding down bolts and nuts (expanding anchors will not be acceptable) and is to be inclusive of all cutting, mitring, welding, grinding and waste.

PSH 5.2.7 Ladders

Add to the Sub-Clause:
Stairs and ladders are to be provided in accordance with the details shown on the drawings.

PSH 5.2.8 Open Grid Floors

Add to the Sub-Clause:
Open grid steel flooring is to be cut and framed to the required panel shapes and sizes all in accordance with the details shown on the drawings.

PSH 5.2.10 Protective Treatment

Add to the Sub-Clause:
All mild steel shall be hot-dip galvanised except where shown to the contrary on the drawings or in the schedule of quantities. Hot-dip galvanising shall conform to SANS 121;2000 for heavy duty coatings or equivalent. Screwed and socketed tubing shall be galvanised in compliance with BS 1387. Galvanised malleable cast iron fittings shall comply with SANS 509.

PSH 5.2.11 Pipe Clamps and Brackets and/or Supports (New Sub-Clause)

Clamps and brackets around pipes and supports under pipes and valves are to be constructed to the details shown on the drawings and are to be provided with all necessary bolts for fixing to concrete.

Where pipes and valves are supported inside concrete chambers on fabricated steel pipe supports, a layer of 6 mm thick GP rubber sheet (Shore hardness 65) shall be attached to the top surface of the steel support by contact adhesive prior to receiving the pipe or valve to be supported. The rubber is to extend 20mm beyond the edges of the plate.

PSH 5.3.4 Welding

Add the following to Clause 5.3.4:

Details of the weld procedures, consumables to be used in the welding process as well as shop drawings shall be submitted to the Engineer for approval at least 14 days prior to fabrication.

All welding is to be carried out by suitably qualified coded welders. No welding is to take place without the approval of the Engineer.

PSH 5.3.6 Grouting

Add to the Sub-Clause:
The Contractor will be fully responsible for all grouting work under this Contract.

PSH 6 TOLERANCES

PSH 6.1.3 Accuracy of Erection

Add to the Sub-Clause:
The accuracy of erection shall be the degree of accuracy II as tabulated but amended as follows:
In items d)1) and d)2) of the table the Degree of Accuracy given as "± 5" shall be read as "± 3".

PSH 7 TESTING

PSH 7.1 Test Certificates

Delete the part sentence "in terms of the project specification" from the wording of the Sub-Clause and add the words "when so requested by the former" at the end of the sentence.

PSH 8 MEASUREMENT AND PAYMENT

PSH 8.3 Scheduled Items

Add the following introduction to the subsequent Sub-Clauses:

The tendered rates shall cover the cost of preparing shop details (where applicable), the supply of all materials, fabrication, process control, loading, transporting to Site, off-loading, erection (unless separately included), setting into concrete or brickwork and grouting in. They shall also include for the supply of all nuts, bolts, holding down bolts, washers, rivets, cutting to waste, all temporary bracing, templates and shuttering necessary for installing, transporting and erecting.

Where the scheduled items for steelwork include corrosion protection, then the price stated shall also include for such protection as specified in SANS 1200 HC as amended by PSHC. Similarly the materials and corrosion protection for nuts, bolts, washers etc shall match the steelwork ordered.

Where the requirements of the above introduction conflict with the requirements of Sub-Clauses 8.3.1 to 8.3.6 inclusive the requirements of the introduction shall take precedence. Holding down bolts (i.e. bolts secured in concrete, brickwork etc shall be of the Chemical type (expanding anchors will not be acceptable).
m outer edge to outer edge at a maximum tension which shall not exceed the maximum working tension and other working properties of the shade netting during periods of maximum contraction."

PSHC CORROSION PROTECTION OF STRUCTURAL STEELWORK (SANS 1200HC)

PSHC 5 CONSTRUCTION

Add the following Clause:

PSHC 5.1 Structural steel

All structural steel members shall be hot dip galvanized unless otherwise indicated on the drawings and BoQ.

PSHC 5.3 Dressing and Repairs During Fabrication

Add to the Sub-Clause:

Edges shall be ground to a smooth radius of at least 2 mm unless otherwise indicated

PSHC 5.4.1 Preparation for Coating-General

Add to the Sub-Clause:
The work of surface preparation prior to painting shall be carried out at the manufacturer's works.
The work of surface preparation prior to galvanising shall be carried out at the galvaniser's works.

PSHC 5.4.3.1 Abrasive Blast Cleaning

Add to (a) General:

The standard of blast cleaning required in terms of Swedish Standard SIS-05-59-00 is Sa 2 1/2.

The surface profile after blasting shall be in accordance with the paint manufacturer's requirements for the particular paint system being used.

Add to (b) Dry Abrasive Blast Cleaning

The blast cleaning media shall not be recycled.

PSHC 5.4.3.2 Cleaning by Hand or with Power Tools

Add to the Sub-Clause:
Cleaning by hand or power tools, where permitted or ordered by the Engineer, shall be to standard St 3 of SIS-05-59-00.

PSHC 5.7 Coating system for New Steelwork

Add to the Sub-Clause:

All structural steel members shall be hot dip galvanized

The coating system to be applied under this Contract shall be carried out strictly in accordance with the manufacturers instructions which written instructions shall be obtained by the Contractor and a copy handed to the Engineer's Representative prior to commencing painting operations.

The paint system to be used shall be selected by the Contractor from the following alternative systems:

PSHC 5.7.1 Painting System No. 1

For structural steelwork coastal regions - exterior work

AECI Dulux	**DFT (µm)**	**Plascon**	**DFT (µm)**
Zinc galv 6[(2)]	75	Zinc rich primer M1 233	70
Zinc galv 1	touch up	Chemcote High Build	70

		CHC 101 – light grey	
Chlorinated Rubber – Kemrist	90 165	Chemcote enamel CHC 3000 series	30 170

PSHC 5.7.2 Painting System No.2
For structural steelwork coastal regions - interior work

AECI Dulux	**DFT (µm)**	**Plascon**	**DFT (µm)**
Zinc galv 6(2)	60	Degrease with Aquasolv GR	-
Zinc galv 1	touch up	Zinc phosphate Primer UC 182	55
Chlorinated Rubber - Kemrist	60 120	Alkyd undercoat UC 189	35
		Enamel	30 120

PSHC 5.7.3 Painting System No.3
For overcoating galvanised work

AECI Dulux	**DFT (µm)**	**Plascon**	**DFT (µm)**
Prepare surface Galvkleen	-	Prepare surface cleaner GIC	-
Corrocote 2(2)	10	Galvogrip metal primer	30
Chlorinated Rubber – Kemrist	70 80	Universal undercoat UCI	30
		Supergloss Enamel Code G	25 85

PSHC 5.8 Application of Painting Coatings

Add to the Sub-Clause:
No application of paint shall be carried out before the paint manufacturer has approved the firm of applicators and the plant to be used, except where instructed to the contrary by the Engineer.

Where applicable, the range of temperature, outside the range of +5º to 35ºC, within which paint may be applied, shall be that range which the Contractor shall obtain in writing from the manufacturer of the paint.

The embedded lengths of irremovable fasteners which penetrate deeper than 75mm from the concrete face may be left as base metal. The remaining portion shall comply with the paint system specified for the adjacent steelwork.

Surfaces which will become inaccessible for coating after fabrication or erection shall be given the full paint treatment specified plus one further top coat prior to the surfaces becoming inaccessible.

PSHC 5.9 Application of Metal Coatings

Add to the Sub-Clause:
The grade of HDG (hot dipped galvanising) required shall be carried out in accordance with SANS 121:2000, and shall be that for heavy duty coatings. This shall be applicable to all metalwork where HDG is called for either on the drawings or in the Schedule of Quantities.

PSHC 7 TESTING

PSHC 7.1d) Testing by the Contractor

Tests are not required to be carried out after the application of each intermediate coat.

PSHC 7.3.8 Dry Film Thickness

The frequency of DFT test readings required is to be in accordance with SANS Method 141.

PSL MEDIUM PRESSURE PIPELINES (SANS 1200 L)

PSL 1 SCOPE

Replace Clause 1.1 with the following:

This specification covers the supply and installation of pipelines, specials and fittings for rising mains, gravity mains, pipework for pumping installations and reservoirs as well as reticulation.

PSL 2 INTERPRETATIONS

PSL 2.4 Abbreviations

Add the following:

“HDPE	:	High Density Polyethylene
mPVC	:	Modified Polyvinyl Chloride
oPVC	:	Orientated Polyvinyl Chloride
DI	:	Ductile Iron
GRP	:	Glass Reinforced Polyester
CML	:	Cement Mortar Lining
FBMDPE	:	Fusion Bonded Medium Density Polyethylene”

PSL 3 MATERIALS

PSL 3.1 General

The materials and construction of all pipes, fittings, valves and specials shall comply with the appropriate SANS, BS or other appropriate specification, whether stated or not, and shall be approved by the Engineer. Only full-length pipes bearing the relevant standard’s mark will be acceptable. Cut pipes shall only be used at pipe junctions to position valves and specials as shown on the drawings, and at connections to structures. When laying the pipes the markings shall be visible from above.

The Contractor shall be responsible for the structural and hydraulic design of all fabricated steel pipe specials (puddle pipes in hydraulic test point anchor blocks, offtake chambers, isolating valve chambers, meter chambers, non-return valve chambers etc) where these are not standard off-the-shelf items designed and guaranteed by the manufacturer for the purpose intended (see also PSL7 for quality control requirements for specials).

Add the following subclauses:

PSL 3.1.1 Materials Control

PSL 3.1.1.1 Checking Material Lists and Drawings

In the case of materials to be supplied by the Employer as “free issue”, not more than 4 weeks after the contract has been awarded the Contractor shall complete his check of the available materials in the stock yards against the drawings and advise the Engineer of any shortages or omitted items.

The materials stored in the stock yard/s for “free issue” by the Employer to the Contractor shall be fully inspected by the Contractor to confirm compliance with the specification and once satisfied, the Contractor shall sign acceptance of the material where after, any damage or other problems with the materials so accepted by the Contractor shall be the responsibility of the Contractor.

If any variations in the contract are authorised, the Contractor shall ensure that any additional items to be supplied by the Contractor (or the Employer where applicable) are ordered in good time so as not to cause delay to the works.

The Contractor shall check the delivery timing of all items and ensure that it is in line with the Contract program. Any critical items that could be delivered late are to be brought to the attention of the Engineer.

The delivery status of materials is to be checked and followed up upon by the Contractor throughout the contract.

PSL 3.1.1.2 Materials Control – General

The Contractor is held responsible for the inspection and control on site of all the materials and equipment for the duration of the Contract. Once material and equipment has been accepted, any subsequent damage shall be made good to the satisfaction of the Engineer at the expense of the Contractor. Damage to internal linings and external coatings that are necessary and incidental to good welding practices and the manufacturing of pipe specials are excluded.

Any item damaged beyond repair shall, at the discretion of the Engineer, either be replaced at the Contractor's expense or the value reimbursed in full to the Employer as appropriate.

PSL 3.1.1.3 Acceptance of Pipes, Fittings and Materials

Before acceptance of any pipes, fittings or other items of equipment the Contractor is to carry out a thorough inspection to ensure that the materials have been delivered undamaged and are as ordered.

Pipes shall be checked for:

1. Identification
2. Certification
3. Soundness and Internal lining
4. Ends bevelled correctly
5. Circumference according to specification and within tolerance

Inspection of pipe fittings, valves and other equipment shall include, but is not limited to:

1. Identification
2. Certification
3. Material schedule and rating
4. Lining, where specified
5. Coating where specified
6. Circumference according to specification and tolerance
7. Damage to items – example flange faces

Defective items shall not be accepted, but marked, quarantined and immediately reported to the Engineer.

If accepted, the Contractor shall take the required steps to ensure that all delivery documentation together with signed acceptance notes is filed in the Construction Dossier.

PSL 3.1.1.4 Material Storage

The Contractor shall store all items so that no damage occurs whilst awaiting installation. Where practical, items are to be stored in lockable containers for protection from the weather and pilferage.

All piping, pipe fittings and equipment stored outside or awaiting installation are to be protected from the weather, stormwater and soil wash and stored on pre-prepared surfaces. Pipes taken over from the Employer shall receive the required attention in order to ensure safe storage in yards, protected from fires, vandalism and incidental damage that can reasonably be prevented.

PSL 3.1.1.5 Handling Pipe, Fittings and Equipment

Strict supervision shall be maintained at all times when handling pipes and equipment. Particular attention is to be given to correctly rated lifting gear, slings and lifting beams. All lifting gear is to be inspected regularly for signs of wear and tear in terms of the relevant Safety Legislation and Clauses. Equipment is to be lifted at the recommended points specified by the manufacturer. Pipe is to be lifted with a lifting beam and slings, which shall be fitted at quarter points around the pipe. Due care shall be taken when fitting and placing slings to ensure that ancillary items do not get crushed during lifting. Pipe coating is to be protected by padding or otherwise from scuffing damage during lifting.

The equipment utilized for lifting pipes is subject to approval by the Engineer, which approval shall in no way absolve the Contractor of any responsibility in this regard, and all equipment judged unsuitable according to this specification or found to be unsuitable in practice shall be removed from site and replaced at the Contractor's expense. It is prohibited to handle pipes using chains or any other device involving metal contact with the pipe coating.

The Contractor shall ensure that all lifting equipment complies with the relevant safety regulations at all times.

Wet sponge tests shall be done to detect holidays on coatings and linings (where appropriate) of the pipes.

The Contractor shall, at his own expense, test each and every surface area, internal lining (where appropriate) as well as external coating during construction as per this specification. Testing for holidays shall be done after inclusion of materials, manufactured specials and equipment, as well as pipes, into the permanent works. Any defects found shall be repaired and the costs for remedial work shall be deemed to be included in the tendered rates for the construction of the pipeline. These tests and results shall be recorded on the Quality Control Plan as approved by the Engineer.

PSL 3.4 Steel Pipes, Fittings and Specials

PSL 3.4.1 General

Add to the subclause:

"All steel pipes and fittings under this contract shall be to the dimensions and details shown on the drawings or schedule of quantities. All pipes, fittings and specials shall have their relevant item numbers painted onto the exterior surface prior to despatch from the factory.

Steel pipes may be supplied by the Employer shall be checked for acceptance by the Contractor in accordance with SANS 719 and including the integrity of the coatings and linings."

Further, it is a contractual requirement that all Steel pipe and fabricated steel specials shall be fabricated in accordance with an approved quality control plan (QCP). Manufacture shall not commence until such time as the QCP has been approved by the Employer's Agent. The Contractor shall, in consultation with the Engineer, prepare and submit for approval a draft QCP within 14 days of award of the contract.

The Engineer shall approve the QCP, subject to amendments if necessary, and advise the Contractor accordingly within 14 days of receipt of the draft QCP. The QCP shall address inter alia the following tests/inspection:

TYPICAL QUALITY CONTROL TESTS OR INSPECTIONS	
PARAMETER	**COMMENT**
Material certification	To comply with the relevant standards
NDE testing	To comply with the relevant standards
Verification of tolerances	eg "Go, No-Go" gauges
Surface preparation	eg cleanliness and blast profile
Coating / lining performance criteria	To comply with the relevant standards
Material identification	To comply with the relevant standards
Personnel certification (including welders and	To comply with the relevant standards

TYPICAL QUALITY CONTROL TESTS OR INSPECTIONS	
PARAMETER	**COMMENT**
NDE)	
Weld preparation	To comply with the relevant standards
Compliance with dimensional tolerances	To comply with the relevant standards
Hydrostatic testing	To comply with the relevant standards
Coating/lining thickness tolerances	To comply with the relevant standards

An independent Inspectorate employed by the Engineer shall verify that the QMP is being adhered to and sign-off acceptance of each and every special delivered to site. No specials shall be incorporated into the Works until signed-off. A Method Statement for any remedial works required to achieve compliance shall be agreed with the Engineer and the costs of all such work be to the Contractor's account.

PSL 3.4.2 Pipes of NB up to 150mm

In the second and third lines delete '*medium class, shall be screwed and shall comply with the applicable requirements of SANS 62*' and substitute with 'heavy duty class to SANS 62 Part 1 unless otherwise specified, shall have plain ends, and be hot dipped galvanized to SANS 121.

PSL 3.4.3 Pipes of NB over 150mm

Delete the contents of this sub clause and substitute:

PSL 3.4.3.1 Grade of Pipe

All pipes supplied shall comply with SANS 719/71, as amended by this project specification.

SANS 719 Grade B steel shall be used for pipes unless otherwise specified in the drawings or in the schedule of quantities

PSL 3.4.3.2 Welds

Pipes shall be manufactured from steel strips or plates continuously welded along the seams and the height of the inner weld reinforcement shall not exceed 1mm. In the case of pipes used with couplings, the external weld reinforcement shall be ground flush with the outer wall of the pipe over a suitable distance of the pipe. Pipes must have a continuous helical seam but for smaller than 300mm diameter, longitudinal and circumferential seams would be acceptable.

PSL 3.4.3.3 Hydraulic Testing at the Factory

Each pipe shall be hydraulically tested in accordance with SANS 719, clause 7.3 to 3500kpa."

PSL 3.4.4 Fittings and Specials

Add the following:

"All bends, fittings and specials shall be manufactured from straight pipe specified elsewhere unless otherwise stated in the Bills of Quantities

The lengths of the pipes shall be as dimensioned on the drawings but shall be verified on site prior to fabrication.

All steel pipes & fittings larger than DN 150 to be FBE or solvent free epoxy coated and lined to minimum thickness of 400 micron unless otherwise specified.

All steel bends, fittings and specials shall be fabricated to the dimensions and details shown on the drawings and/or described in the Bills of Quantities.

Where drawings containing pipework and fittings do not have dimensions and have not been individually itemized on the drawings or bill of quantities, the pipework design, supply, delivery, handle install, test and commission is the Contractors responsibility. This shall be scheduled in the bill of quantities, as well as described in the Project Specifications and/ or indicated indicatively in the drawings.

The sides of taper pieces shall diverge at an angle of not more than 11° to each other.

All steel pipes & fittings larger than DN150 to have either a minimum 4.5mm wall thickness to SANS 719 Grade B or to have a diameter to thickness ratio of 125, whichever is greater.

Individual bends, fittings and specials DN150 and smaller shall be hot-dip galvanised to heavy duty grade in accordance with SANS 121 after fabrication. Where a hot dipped galvanised fitting is to be welded to a coated and lined pipe, the galvanising is to be abraded off prior to welding. The external coating at the welded joint is to be primed and coated with an approved anti corrosion system as specified elsewhere.

Bends, fittings and specials shall be manufactured and tested in accordance with the specification for straight pipe and additionally with Section 8 of BS EN 10311: 2005 and BS 10224: 2002. The nominal dimensions of each bend, fitting and special required are itemised in the Bills of Quantities and/or on the drawings and 'exact length' tolerances shall be adhered to – subject to verification on site prior to fabrication. All plain ends on bends, fittings and specials shall have the plain ends prepared for butt welding except those plain ends that are to be jointed with adaptor joints or bell ends.

Bends shall generally be of the formed type except where otherwise stated or shown on the drawings.

The bend, fitting, and special fabricator shall supply written confirmation that all hand welding was carried out by coded welders.

The Contractor will be responsible for the design and provision of strengthening webs, crotch plates, gussets etc as may be necessary to prevent excessive deflection or deformation of fittings and specials when subjected to hydraulic pressure tests, and the tendered rates for the work will be deemed to include for the design and provision of this reinforcing wherever necessary. All calculations are to be submitted to the Employers Agent prior to fabrication. All crotch plates, wrappers, collars and gussets to be provided by the Contractor under this Contract are to be manufactured from SANS 719 Grade B steel, or of the same grade as the main pipe.

Bends shall be fabricated in accordance with the Table below.

Deflection of Angle	
Up to and including 3 °	One pipe end scarfed on site
Exceeding 3 ° and up to and including 9 °	Mitre cut (two pipe ends scarfed on site)
Exceeding 9 º but less than 15 º	2 segment bend
15 º and larger but less than 45 º	3 segment bend
45 º and larger but less than 60 º	4 segment bend
60 º and larger but less than 75 º	5 segment bend
75 º and larger but less than 90 º	6 segment bend

Long radius bends shall have a centre to face radius of at least 2.5 times the pipe diameter.

Bends greater than 90º shall be fabricated from combinations of items from the table above.

Shop drawings of bends, fittings and specials shall be submitted to the Engineer for approval prior to manufacture.

All flanged bends, fittings and specials shall be hydraulically tested at the fabricator's premises to the same pressure that they will be subjected to during the hydraulic testing of the completed pipeline. No visible signs of leakage will be permitted.

All welding shall conform to SANS 0167-1984 and SANS 044 specifications.

All welded fittings and flanges shall be documented as per specifications and welders must be qualified to WQR. All welds are to be 100% visually inspected inside and out. Examination and testing of welds shall be performed in accordance with section PSL 3.4.8.

Cutting and welding of flanged bends, fittings and specials will not be permitted on site. Any adjustments required due to on site conditions will have to be made at the fabricator's premises and all coating and lining repairs and tests completed prior to being returned to site."

Add the following new subclauses:

PSL 3.4.5 Stainless Steel Pipework

Pipework fittings and specials shall comply with the dimensional requirements specified for mild steel pipe work, fittings and specials. The wall thickness shall be not less than 4,0 mm for pipes of diameter up to 150 mm and not less and 5,0 mm for pipes exceeding 150 mm in diameter, or as called for on the pipe schedules.

Stainless Steel pipework, fittings and specials shall be Grade 304L and shall not be supplied coated unless otherwise specified.

Plain ends of pipes and fittings shall be covered and protected against damage whilst being transported and stored.

PSL 3.4.6 Puddle Collars and Anchoring Flanges

Puddle collars and anchoring flanges used as pipe anchorages shall be of the same dimensions as corresponding flanges but those cast into concrete walls are to be undrilled. The collar/flange shall be capable of transmitting a longitudinal force 33% greater than the internal hydraulic pressure to be applied when testing, multiplied by the area of the bore and, under that condition, the stress in the material shall not exceed its yield stress.

Where puddle collars are shown on the drawings as being 20 mm thick, those collars are not required to transmit thrust, their purpose being to assist with the waterproofing of the concrete chambers by increasing the path that ground water might have to take to enter the chambers.

Where polyethylene pipes are cast into concrete structures, they shall be specially prepared and adapted by positioning a custom-made tight-fitting natural rubber sealing sleeve around the circumference of the pipe and in the case of structured-wall pipe creating shear keys through removing small segments of the outer wall. The rubber seal shall be 10 mm thick and 200 mm wide or 80% of the width of the wall and shall be 60 to 65 shore hardness, with a vulcanised joint. It shall need to be stretched over the pipe circumference to ensure a tight fit.

PSL 3.4.7 Closure Pipes

Closure pipes, which are to be cut on site to the exact lengths, shall have the diametrical tolerances specified for the pipe ends applied over the full length of the pipe. Closure pipes shall be supplied in standard lengths.

PSL 3.4.8 Welding Tests at fitting Fabrication Shop(s)

PSL 3.4.8.1 Qualification Tests for Welding Procedures

Only appropriately coded welders may be used.

The qualification tests for welding procedures shall be carried out generally in accordance with the requirements of the American Petroleum Institute API 1104. The detailed procedure to be adopted during manufacture shall be established and the quality of the welds so produced shall be determined by carrying out one transverse tensile weld test and two guided cold bend tests on suitable coupon plates.

The tests are to be carried out before fabrication of fittings is commenced.

The coupon plates shall be prepared either from plates of the same material as the pipe and welded in a similar manner to that to be used during production, or by cutting suitable specimens from a pipe selected at random by the Engineer from the first production. The coupon plate for the tensile weld test and those for the guided cold bend tests shall be prepared in accordance with the requirements of SANS 719.

The qualification tests shall be considered satisfactory if:

a) The weld has a joint efficiency greater than 95% of the minimum specified tensile strength of the parent metal and,
b) The bend test specimens are capable of being bent around a former with a diameter equal to six times the nominal thickness of the plate to an angle of 180 degrees without developing a crack, except at the arises of the specimen, of length or width greater than 3 mm.

Failure to pass the above qualification tests shall result in the rejection of any pipes welded with the procedure used and the preparation of a new qualification of procedure test.

Any changes in the electrode case type used or change of flux used shall require a qualification test before approval of the procedure is granted.

PSL 3.4.8.2 Radiographic Examination of Shop Welds

The Contractor shall include in his prices for the supply of fittings and specials, the cost of carrying out, under the supervision of the inspector appointed by the Employer, examination of shop welds on the following basis:

a) One hundred percent radiographic examination of all welds deposited manually or semi-automatically in fittings and specials which cannot be hydraulically tested prior to the fittings and specials being installed in the pipeline.

b) Ten percent radiographic examination of all welds deposited manually or semi-automatically in specials and fittings that are to be tested hydraulically prior to the fittings and specials being installed in the pipeline.

The Engineer shall in all cases determine which welds are to be radiographed on the quantity basis specified above. All radiographs and records thereof made by the Contractor shall be made available to the Engineer to enable him to determine whether the welds are acceptable or not and no coating, lining or wrapping of pipes shall be permitted until the welds have been accepted by the Engineer. To avoid unnecessary delays, at the option of the manufacturer, radiographs may be approved by the manufacturer's inspectors subject to them being subsequently approved by the Engineer.

When a section of the weld is shown by radiography to be unacceptable, and if the limits of the deficient weld are not defined by the radiograph, additional radiography shall be carried out at the Contractor's expense until the limits of the deficiency are determined.

Repairs shall be made to defective welds at the Contractor's expense. All repair welds shall be identified with a stamp marking, indicating which welder conducted the repair. Repaired welds shall be radiographed at the Contractor's expense but after any repair welder has had ten consecutive repairs approved, the extent of the radiography of the repairs conducted by the welder may be decreased by agreement between the Engineer and the Contractor.

PSL 3.7 Other Types of Pipes

PSL 3.7.2 Polyethylene Pipes

Delete this Subclause and replace with the following:

PSL 3.7.2: Polyethylene (PE) Pipes and Fittings

All pipe and fittings are to be PE-100, compliant to SANS ISO 4427 Part 1 unless otherwise specified. Pipe must be supplied from a SANS and ISO 9001 approved manufacturer and member in good standing with SAPPMA (South African Plastic Pipe Manufacturers Association), and will meet the following:

Pipe Characteristics	*Applicable Standard*
Outer Diameter	ISO 11922-1 (Grade B)
Min Wall Thickness at any point	ISO 11922-1 (Grade U) – ISO 4065
Ovality	ISO 11922-1 (Grade N)

All HDPE Pipes shall be indelibly marked at 1 metre intervals in accordance with the applicable SANS / ISO standard:

- TRADE NAME Manufacturer/Supplier Name
- SPECIFICATION SANS ISO 4427
- PIPE OD e.g. 630
- PIPE OD TOLERANCE Grade B
- WALL THICKNESS e.g. 51.4
- NOMINAL PRESSURE e.g. PN 12.5
- MATERIAL DESIGNATION PE 100
- BATCH No. Manufacturer/Supplier Trace ability
- PROJECT NAME XXXXXXX

PSL 3.7.2.1 Unreinforced PE pipes

Unreinforced PE pipes and fittings shall comply with the relevant requirements of SANS/ISO 4427.

PSL 3.7.2.2 Steel-mesh-reinforced Polyethylene (PE) pipes

Steel-mesh-reinforced PE pipes shall comply with the requirements of SANS 370.

PSL 3.7.2.3 Materials Control – General

The Contractor is held responsible for the inspection and control on site of all the materials and equipment for the duration of the Contract. Once material and equipment has been accepted, any subsequent damage shall be made good to the satisfaction of the Engineer at the expense of the Contractor.

Any item damaged beyond repair shall, at the discretion of the Engineer, be replaced at the Contractor's expense.

PSL 3.7.2.4 Acceptance of Pipes on Delivery to Site.

The Contractor is to ensure that the manufacturer makes available a full-time field technician to supervise the offloading, stacking and protection of the pipes to ensure that all the manufacturer's specifications and requirements regarding stacking and storage are met.

Before acceptance of any pipes, the Contractor is to carry out a thorough inspection to confirm together with the field technician that the materials have been delivered undamaged and are as ordered.

Defective items shall not be accepted, but marked, q
ed and immediately reported to the Engineer.

Add the following sub-clauses:

PSL 3.7.3 mPVC Pipes

mPVC pipes shall not be permitted unless otherwise shown or agreed with the Engineer

PSL 3.7.4 oPVC Pipes

oPVC pipes shall not be permitted unless otherwise shown or agreed with the Engineer

PSL 3.7.5 Ductile Iron Pipes

Ductile Iron pipes, fittings and accessories shall be fitted with spigot and socket rubber ring joints and shall comply with the relevant requirements of BS, EN 545: 2010 and ISO 2531- 2009.

The following documents form a part of this Specification to the extent specified herein. In any case of conflict, the requirements of this Specification shall prevail. The latest issues shall apply.

BS EN545: 2010	:	Ductile Iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods.
ISO 2351 – 2009	:	Ductile Iron pipes and fittings, fittings, accessories and their joints for water pipelines – Requirements and test methods.
ISO 4179	:	Ductile Iron pipes for pressure and non-pressure pipelines – Centrifugal cement mortar lining – general requirements.
ISO 8179-1/2	:	Ductile iron pipes – External zinc coating with finishing layer.
ISO 8180	:	Ductile iron pipes – Polyethylene sleeving.
ISO 4633	:	Rubber seals-Joining rings for water supply, drainage and sewerage pipelines- Specification for materials
EN15189	:	Ductile Iron pipes – External polyurethane coating
BS EN 14901:2006	:	Epoxy coating for Ductile Iron pipes and fittings

PSL 3.7.5.1 Ductile Iron Fittings and Accessories

All bends, fittings, couplings and other accessories for ductile iron (DI) pipe shall be fabricated from ductile iron (DI) and shall comply with the test pressures as specified.

Corrosion protection coatings (external) and linings (internal) for fitting and accessories shall be as specified for pipes save that, where appropriate, hand application of linings and coatings may be used.

Repair work shall be carried out as for pipes.

PSL 3.7.5.2 Corrosion Protection of Ductile Iron (DI) Pipes

Unless otherwise stated, ductile iron pipes shall be cleaned and then externally zinc sprayed with a finishing layer (coating) to ISO 8179-1.

Pipe ends shall be coated as follows:

1. External surface of spigot: Zinc spray coating with finishing layer
2. Flanges and sockets (face and internal surface): Bituminous paint or synthetic resin paint to supplement the zinc spray coating. All paints shall be approved for use on potable water applications by an approved body (USA Environmental Protection Agency (EPA) or similar).

<u>External Zinc Coating and Finishing Layer</u>

The external coating of centrifugally spun ductile iron pipes shall comprise a layer of metallic zinc, covered by a finishing layer of bituminous or synthetic resin paint compatible with zinc. Both layers (zinc and finishing layer) shall be works-applied using suitable spray equipment.

The metallic zinc coating shall cover the external surface of the pipe and provide a dense and continuous uniform layer. It shall be free of bare patches, areas of lack of adhesion or other defects and shall be visually uniform. The mean mass of zinc shall not be less than 200 g/m^2. Zinc purity shall be at least 99.99%.

The finishing layer (bituminous or synthetic resin paint) shall be physically and visually uniform over the entire metallic zinc layer and shall be free from defects such as bare patches, areas of lack of adhesion, air bubbles, pinholes, runs and sags. The mean thickness of the finishing layer shall not be less than 70 µm and the local absolute minimum thickness shall be 50 µm.

<u>Shop and Field Repairs</u>

Damage to coatings where the area of total removal of zinc has a width exceeding 5 mm or other areas designated by the Engineer shall be repaired in the following manner:

Where applicable, remove the finishing layer by mechanical or other means, to 50mm beyond the zinc area to be repaired, to achieve a sound, clean zinc substrate surround.

Repair the damaged area by means of metallic zinc spray or by means of a zinc rich paint containing at least 90% zinc by mass as appropriate. The mean mass of the cured applied zinc paint dry film shall not be less than 200 g/m^2. The zinc paint repair shall terminate 10 to 15 mm from the finishing layer of the repair site. The zinc repair site shall appear visually uniform and shall be free of defect.

Once the zinc repair has cured completely, the entire area shall be painted with bituminous or synthetic resin paint, overlapping at least 20mm onto the sound undisturbed finishing layer and allowed to cure. The finishing layer shall be defect free and appear to be visually uniform and shall be allowed to cure completely before being handled or buried.

<u>Polyethylene Sleeving</u>

Where specified for Ductile Iron pipes as an additional external corrosion protection barrier to the zinc coating and finishing layer, polyethylene sleeving shall comply with ISO 8180 – 1995. The nominal thickness of the sleeving shall not be less than 200 µm and the density shall be between 910 and 930 kg/m^3.

<u>Internal Cement Mortar Lining</u>

The cement mortar lining of ductile iron pipes shall constitute a dense, homogeneous layer covering the entire internal surface of the pipe barrel. It shall be works applied by centrifugal spinning process or by centrifugal spray head or a combination of these methods. Troweling to achieve a smooth internal bore shall be permitted.

The cement mortar mix shall comprise cement (or high alumina cement) to ENV 197-1, suitably graded sand (with no organic impurities, fine clay particles or other deleterious matter that may adversely affect the mortar quality) and potable water. Chloride-free admixtures shall be permitted with the approval of the Engineer. The ratio of sand to cement shall not exceed 3.5 by mass. The water / cement ratio shall be determined for the particular lining process and this ratio shall be maintained to achieve the relevant specifications.

The freshly applied lining shall be cured by approved means to provide sufficient hydration of the cement and, after curing, the cement mortar shall have a minimum 28-day compressive strength of 50 MPa.

The surface of the cement mortar lining shall be uniform and smooth and shall have a nominal lining thickness and minimum lining thickness as indicated below. Trowel marks may be evident but there shall be no recesses, intrusions or local defects which reduce the thickness to below the minimum thickness specified below. Upon installation, the pipes shall have a minimum Hazen Williams smoothness coefficient of 120 (C >= 120).

Fine crazing or hairline cracking associated with cured cement-rich mortars will be acceptable provided that there is no evidence of mortar disbondment from the substrate. The maximum permissible shrinkage crack width and radial displacement is given below.

CEMENT MORTAR LINING THICKNESS AND PERMISSIBLE CRACK WIDTH			
Diameter Nominal (DN)	***Lining Thickness***		***Maximum crack width and radial displacement***
	Nominal [1]	***Tolerance [2]***	
40 to 300	*4.0*	*-1.5*	*0.4*
350 to 600	*5.0*	*-2.0*	*0.5*
700 to 1200	*6.0*	*-2.5*	*0.6*
1400 to 2000	*9.0*	*-3.0*	*0.8*

NOTE:
1. *Pipe ends may have a chamfer not exceeding 20 mm in length*
2. *Negative tolerance specified only*

<u>Shop and Field Repairs</u>

Where cement mortar lining repair is deemed to be necessary, it shall be repaired in the following manner:

Defective mortar shall be carefully removed to ensure that adjacent sound mortar is fully bonded to the ductile iron pipe substrate.

The adjacent sound mortar shall not be feathered but shall be cut-back at approximately an 80° angle to achieve a “dove-tail” joint.

All mortar shall be removed from the repair area to achieve a clean ductile iron pipe substrate and the repair area shall be washed with copious quantities of potable water.

The repair shall be effected using either a rich cement mortar or a compatible polymer mortar (EPIDERMIX 338 or similar approved) which shall be worked in by hand; care being taken to avoid the inclusion of air bubbles. Latex additives, designated (by EPA or similar body) as being suitable for use on potable water installations may be used.

Large Repair Areas.

The repair shall be smoothly and neatly trowelled to match the adjacent pipe profile.

PSL 3.7.6 Glass Reinforced Polyester Pipes (GRP)

Glass Reinforced Polyester pipes and fittings shall conform to ASTM D3262 and ASTM 3754 and AWWA C 950.

The applicable SANS specification for these pipes is:

SANS 1748 – 2004 Part 1 Glass - Fibre – Reinforced Thermosetting Plastics (GRP) pipes Part 1 Pipes for Water Supply, Sewerage or Drainage.

The manufacturer shall have an ISO 9001: 2008 Quality Management System.

Installation

Installation shall be in accordance with SANS 1200 LB and LD for Flexible Pipes. Pipes shall be either plain ended with Double Bell couplings or Bell and Spigot. A typical pipe will be described as PN 16 DN 700 SN 5000 GRP pipe

ESR - Glass shall be used for sewer applications and E- Glass shall be used for water applications."

PSL 3.8 Jointing Materials

PSL 3.8.2 Flexible Couplings

Delete the subclause and replace with the following:

"Where ordered, steel flexible couplings are to be of the "Viking Johnson"/"Klamflex"/"Aqualok" or similar approved type without central registers, each comprising one centre collar, two special flanges, two rubber rings and hot dipped galvanised mild steel bolts.

Steel couplings shall be assembled strictly in accordance with the manufacturer's instructions and all bolts shall be torqued to the value recommended by the manufacturer. On completion of hydraulic pressure testing of the installation, the entire joint shall be protected as described in Clause PSL 3.9.3.8.

The tendered prices for laying and jointing are to include for the supply of all necessary materials, plant and labour to complete the joint and necessary corrosion protection as specified.

Flexible couplings shall conform generally to BS 10311: 2005 for slip-on type couplings and shall be of approved manufacture. They shall be capable of being tightened and released without damaging or improperly distorting the rubber seating rings and shall be designed to prevent the rubber rings being blown out under pressure or sucked in under vacuum.

Each coupling is to be capable of withstanding the test pressure applicable to the pipes with which they are to be used without exceeding a stress in the steel of 67% of the yield point.

Mild steel couplings shall be protected by an approved epoxy coating system such as an approved solvent-free epoxy (SFE) system such as "Nordbak 1" or similar approved system and applied within 4 hours of abrasive blast cleaning the metal surfaces of the coupling in accordance with ISO 8501-1 Grade Sa 2½. Nuts, bolts and washers shall be hot dipped galvanised. The plain end of the pipe shall be properly prepared, and in the case of steel pipes before corrosion protection, so as to accept the flexible coupling.

Adaptor couplings and anchoring adaptor joints shall comply with the above specification for flexible couplings and be of a similar design, but one end shall be flanged to enable connection of plain ended pipes to flanged joints. The adaptor joints are to be complete with bolts and nuts for connecting the flanged joint to the anchoring flange situated generally 300 mm to 400 mm from the plain end of pipe. All bolts, nuts and washers are to be hot dipped galvanised. In order to anchor the plain ended pipe to the flanged joint all of the bolts for the flanged joint are to pass though the anchoring flange and are to be fitted with nuts and washers at the flanged joint and on either side of the anchoring flange."

Dismantling joint shall comply with the above specification for flexible couplings and be of a similar design, but both ends shall be flanged to enable connection of two flanged joints. The adaptor joints are to be complete with bolts and nuts for connecting to each flange. All bolts, nuts and washers are to be hot dipped galvanized.

PSL 3.8.3 Flanges and Accessories

Add the following:

"All flanges, gaskets, bolts, nuts washers and other appurtenances required for the execution of the work under this Contract shall be supplied and installed by the Contractor under this Contract and shall comply with the following:

1. **The sizes and drillings shall comply with SANS 1123** as shown on the drawings or as scheduled in the Bills of Quantities.
2. **Flanges shall be sized and drilled to Table 16 as a minimum unless otherwise specified in the drawings or in the schedule of quantities. Flanges** shall be sized and drilled to match the pressure rating of the adjacent fitting or pipe for pipes and fittings rated > 16 bar.
3. Flanges cut from steel plate shall be machined flat on the front face, but with a raised face.
4. All PE flange connections to PE or other materials shall be of the HP type unless otherwise stated.
5. For PE flanges, the spigots shall be of sufficient length to enable both HE butt welding and HW welding.
6. Backing flanges for PE shall be manufactured from galvanised or powder coated steel
7. The use of standard stub ends for PE pipes shall not be permitted.
8. The body of PE flanges shall be manufactured in the injection moulding process or alternatively, in the case of larger dimensions, from a piece of homogeneous semi-finished material. Semi-finished materials manufactured from wound rods or the subsequent application of other forms of reinforcing shall not be permitted.
9. Proof that flanges and accessories are manufactured in accordance with DIN EN ISO 9001 shall be provided.
10. No machining need be carried out on the back face (except where insulating flanges are to be installed) provided that face is sufficiently flat to ensure square bedding of the bolt heads and nuts and provided that all weld reinforcement is removed.
11. Temporary end covers shall be provided by the Contractor for protection of flanges, and prepared plain ends of pipes and fittings to prevent damage to internal lining during transportation and during handling on site.
12. All piping and flanged surfaces shall be cleaned before connections are made.
13. The (raised) faces of flanges that are in to be in contact with gaskets shall be masked and shall not be painted or coated. The mating flange shall then receive one coat of an approved rust inhibitor. Care shall be exercised to ensure that after the application of all coatings there are no runs or drips on the mating surfaces of the flanges and that the flange profiling is clearly visible over the entire face. Excessive coating build up in flange bolt holes that could snag bolts will not be permitted.
14. Flanged joints shall be connected with the specified bolts, nuts and double washers (one under the bolt head the other under the nut) all of which are to be supplied by the Contractor.
15. All bolts, tie-bolts, nuts and washers shall be galvanised to SANS 121: 2011 and shall comply with the relevant requirements of SANS 135: 2011 and SANS 136: 2008 where applicable.
16. The length of each bolt shall be such that after the bolt has been tightened, the end of the bolt shall project beyond the outer face of the nut, but not by more than two threads. Tie-bolts on restrained/anchoring couplings shall be fitted with “backing nuts” and washers.
17. Each flanged joint is to be fitted with an approved and suitably rated gasket and sealed watertight such that there will be no visible sign of leakage under the specified factory and field test pressures and under the in-service working conditions (pressures).

18. All bolts are to be tightened in a predetermined pattern with opposing bolts being tightened sequentially. When all bolts are tight, each bolt is to be torqued to the required/recommended torque in a predetermined pattern with opposing bolts being tightened sequentially.

All bolt threads shall be liberally coated with “Copper slip” or similar approved compound prior to assembly.

All GMS nuts, bolts, washers, threaded bars and all other GMS or uncoated metal surfaces, both in buried and exposed situations, shall, after successful pressure- testing and after thorough brushing / chipping to remove concrete splatter etc, de-greasing and detergent cleaning and clean water rinsing, shall be corrosion protected as described in PSL 3.9.3.18 and PSL 3.9.3.19."

PSL 3.8.4 Loose Flanges

Add the following:

“Flange jointing material, when installed in the complete pipeline, shall be capable of withstanding transient pressures of up to the specified field test pressure. Under this condition no damage shall be caused or leakage shall occur through the joint. Bolts and nuts shall be galvanised to SANS 121: 2011 and shall comply with the relevant requirements of SANS 135: 2011 and SANS 136: 2008 where applicable. Upon completion, bolt heads, washers and nuts shall be wrapped with the “Denso Mastic Blanket System” comprising of a priming solution, mastic blanket, petrolatum tape and lay-flat sheeting as described in PSL 3.9.3.8. “

PSL 3.9 Corrosion Protection

PSL 3.9.2 Steel Pipes

Delete Sub-Clauses 3.9.2.1 and 3.9.2.2 and replace with:

“Steel pipes, fittings, flanges and specials shall have their surfaces thoroughly cleaned by Grit blasting to a finish complying with the requirements of SIS 05 59 00 for a Sa 2½ finish. Grit for blast cleaning shall be in accordance with SANS 064.

Surfaces shall, within 4 hours after cleaning, be primed with the specified primer or if no primer is specified, with the first coat of the specified system.

All materials used shall be of the highest quality and in accordance with the manufacturer's requirements. Particular care shall be taken to ensure compatibility of all materials used with others forming part of the corrosion protected system. Manufacturer's application and overcoating times and specific instructions relating to curing periods and humidity limitations shall be strictly adhered to.

Corrosion protection systems shall not be applied over any surface containing traces of grit, grease, oil, loose rust, millscale or any contaminants or corrosion products. All surfaces shall be absolutely dry.

Welds and adjacent parent metal shall be ground smooth and all weld spatter removed. Sharp edges shall be avoided and where they are evident the removal shall be effected by grinding to a radius of not less than 3 mm.

The Contractor shall arrange for the Engineer or his representative to be present during surface preparation and coating application to ensure compliance with the specification.

Add the following new subclauses:

PSL 3.9.2.1 Holiday Testing

All Holiday Testing shall be carried out with an instrument approved by the Engineer. The sparking detection test shall conform to the standards as set out in SANS 1217:2001. The Contractor shall familiarise himself with the dielectric strength (breakdown strength) of all the coatings and linings he works with for the different pipe sizes. The Contractor shall also have an in depth knowledge of the Holiday Testing equipment he works with, in order to calculate the Corona discharge effect for the typical brush being utilised, with reference to the specific ambient conditions for any specific test.

All Holiday Testing shall be executed at a voltage which is set at 50% of the value of the dielectric strength of the lining or coating being tested. The Contractor shall carefully analyse the loss in test voltage as a result of the Corona Effect, specific to the ambient conditions surrounding the test. The test voltage of the Holiday Testing equipment shall be adjusted such that the voltage drop as a result of the Corona Effect will be taken into account when the actual 50% threshold of the dielectric strength is calculated.

The Holiday Test equipment shall be calibrated by an approved supplier and checked every 30 minutes or every time a test at a different location is started. Each piece of equipment shall have a unique identification number with calibration certificates and detail of equipment utilized shall be submitted to the Engineer for approval. Method statements for the process of holiday testing shall be submitted to the Engineer for approval.

The correct equipment for the type of application will be utilized. For example, where pin holes have been repaired and re testing for effectiveness of repair work being done, the Contractor shall utilize the correct equipment to effect same and this shall include the use of a pencil brush which concentrates the efforts of holiday testing at the repair. Where spark tests are performed on Tape Wrap systems, the minimum brush width shall be 300 mm. The brushes utilized shall be brass bristle cone brushes. The typical brush speed shall be 200 to 300 mm/sec when doing spark tests.

The Contractor shall, at his expense, test each and every surface area, that is internal lining (where applicable) as well as external coating, during construction as per this specification. Testing for holidays shall be done after inclusion of materials, manufactured specials and equipment, as well as pipes, into the permanent works. Any defects found shall be repaired and the costs for remedial work shall be deemed to be included in the tendered rates for the construction of the pipeline. These tests and results shall be recorded on the quality control plan as approved by the Engineer.

PSL 3.9.2.1.1 Inspection, Detection and Repair of Holidays

Complete sets of transistorised portable holiday detection equipment with adjustable output voltage with interchangeable 200 mm brush and full circle electrodes, adaptable for use on damp or dry surfaces of coatings of pipes, buried valve bodies, fittings and couplings of any diameter in the range DN 200 to DN 1200 are to be provided, tested, maintained and recharged when necessary by the Contractor, for use by the Engineer's Representative in inspecting coatings, wrappings and external protection of pipes, valves, fittings and couplings at the site of the Works and/or the point of delivery in accordance with the following:

When laying of pipes or fittings or covering of pipes, buried valve bodies, fittings or couplings with padding or concrete is proceeding in more than one 250 metre long section of the working strip on any day, the Contractor shall provide a sufficient number of complete sets of holiday detection equipment in addition to the holiday detection equipment required by his own staff to permit the person appointed by the Engineer to carry out holiday inspections simultaneously at each such section of the working strip.

The Contractor shall include in his tendered rates an allowance to cover the provision by him of all the necessary equipment for the Engineer’s Representative as set out above as well as any and all extra labour and equipment necessary for all special handling of pipes, valves and fittings which is required in order to facilitate the following standard holiday detection operations which will be carried out by the Engineer or his Representative.

During laying operations the full circle electrode of the holiday detector will be passed over all the external surface of each pipe, except such area as may be covered by a belt sling or other approved handling tackle not exceeding 600 millimeters in total width used for supporting the pipe in the course of the laying operation immediately prior to lowering the pipe into its trench. Only if a holiday is detected in the course of the inspection described above, will the entire external surface of the pipe have to be inspected by passing the full circle electrode of the holiday detector over the full length of the pipe. At the laying site the holiday detection equipment will also be used to check the external coating of fittings before laying and to check completion of external coatings over welded joints or couplings after hydraulic pressure testing of the pipeline.

The Contractor shall so carry out his laying work as to provide reasonable time and access to the Engineer for the purpose of the inspections described above. The tendered rates for pipework shall be deemed to include for all holiday detection described in this Specification.

All work ordered by the Engineer in writing to be carried out by the Contractor in assisting in any holiday detection inspection which the Engineer may carry out in addition to the standard operations described above and proving of repairs mentioned below shall be carried out by the Contractor at agreed rates.

All holidays, voids, pinholes or other flaws in the coatings or wrapping or completed external covering to welds, couplings or buried valve bodies are to be made good by the Contractor at his expense. Holiday testing and repairs to free issue pipes prior to acceptance by the contractor are dealt with separately under Clause PSL 3.9 and items are included in the Bill of Quantities for the repair of such defects.

Protective coating or wrapping to pipes and fittings or completed external covering to joints and buried valve bodies which are inadequately bonded, damaged by abrasion, below the minimum thickness, do not comply with the materials specifications and are in any other manner defective must be removed and replaced at the expense of the Contractor. All pinholes and other defects located by means of the holiday detector shall be repaired to the satisfaction of the Engineer and proved sound by the holiday detector.

The coating of each pipe shall be inspected and holiday detected by the Contractor, immediately prior to being laid and these inspections will be witnessed and signed off by the Engineer or an appointed third party inspection authority. Two thirds of the circumference of each pipe and fitting will be inspected outside the trench, after the pipe/fitting has been transported to the construction site where it is to be laid. This inspection is to be carried out shortly before each pipe is hoisted for laying in the trench. The balance of the circumference of each pipe/fitting will be inspected once the pipe/fitting has been laid in the trench. This will require the pipe/fitting to be rotated to facilitate inspections.

All remedial work that is required shall be affected immediately upon detection of any holidays. The cost of holiday testing and effecting remedial work to the coating of the pipe at the installation location, as a result of construction or transportation or storage damage, shall be deemed to be included in the tendered rates for the laying of the pipe/fitting.

Each and every external coating make good at welded joints, shall be holiday tested around the full circumference and be subject to approval in terms of the relevant Quality Control Procedure. All costs associated with holiday detection and any costs of effecting remedial work, shall be deemed to be included in the tendered rates i.e. no special or “extra over” payments will be made for external repairs or make goods at joints.

All pipe specials being corrosion protected with an external epoxy coating, shall be holiday tested before being incorporated into the works as well as holiday tested after inclusion into the works. All the costs of holiday detection and any costs for effecting remedial work shall be deemed to be included in the rates for the laying of the pipe/fitting.

The corrosion protection systems on all fittings and manufactured specials shall be holiday tested once included into the permanent works. All the costs of holiday detection and any costs of effecting remedial work shall be deemed to be included in the tendered rates for the laying of the pipeline.

The appropriate wet sponge tests shall be conducted on the internal surfaces of all epoxy linings, and particularly on reinstated areas and make good at joints, and on manufactured specials and repairs to linings. This will be carried out from time to time and again before final cleaning of sections of the pipeline that are completed. All the costs associated with wet sponge holiday detection and any costs for effecting remedial work shall be deemed to be included in the rates for the laying of the pipeline.

PSL 3.9.2.1.2 Holiday Testing of Pipe at Pipe Yards (Free Issue Pipe Only)

In the case of free issue pipe, the external pipe coatings will be checked at the point of delivery, as supplied by the pipe manufacturer. All defects will be indicated on the Independent Third Party Test Reports. Some of the defect repairs will have been carried out under the pipe supply contract. The Contractor shall be required to repair the remaining defects at the cost of the Employer. Items will be provided for this purpose in the Bill of Quantities.

It shall be the Contractor's responsibility to detect defects in free issue pipes, including their ends, coatings and linings before taking receipt. The Contractor shall execute holiday detection tests on all the pipe coatings in the pipe yard before uplifting and transportation commences and this will be subject to witnessing and sign off by the Engineer or an appointed third party inspection authority. This will determine the baseline to be used when handling and transportation damage, if any, is assessed.

PSL 3.9.2.1.3 Holiday Testing of Pipe at Work Fronts

The coating and lining, if appropriate, of each pipe shall be inspected and holiday detected by the Contractor immediately prior to being laid and these inspections shall be subject to witnessing and sign off by the Engineer or an appointed third party inspection authority. Two thirds of the circumference will be inspected outside the trench, after the pipe has been transported to the construction site where the pipe will be laid, and the balance of the circumference will be inspected once the pipe has been laid into the trench and rotated 180º. All testing shall be marked on the pipe from start of test point to completion of test point. All remedial work shall be effected immediately upon detection of any holidays. The cost of holiday testing and effecting remedial work to the coating of the pipe at the installation location as a result of construction or transportation damage by the Contractor shall be deemed to be included in the tendered rates for the laying of the pipe.

PSL 3.9.2.1.4 Holiday Testing on Tape Wrap Systems

Each and every external coating repair at welded joints, that are repaired with a tape wrap system, shall be holiday tested and subject to approval in terms of the relevant Quality Control Plan. All costs for the holiday detection shall be deemed to be included in the tendered rates for the laying of the pipe.

PSL 3.9.2.2 Hot Dip Galvanising

Where ordered or specified, galvanised steel pipework shall comply with SANS 121 and be entirely coated with zinc after fabrication by complete immersion in a zinc bath. The finished surface shall be clean and uniform and any excess being removed. The zinc deposit shall exceed 0.700 kg / m^2

PSL 3.9.2.3 Repairs to Epoxy Coatings

In addition to the contents of this clause, the contents of PSL 3.9.3.4 shall also be applicable.

PSL 3.9.3 Protection against Electrolytic Corrosion

Change the heading of this subclause to:

PSL 3.9.3 Protection against Electrolytic Corrosion and general repair and making good procedures for linings and coatings."

In the fifth line delete 'terms of the project specification' and substitute with 'the PSL specification or unless specified elsewhere.'

Add the following new subclauses:

PSL 3.9.3.1 Preparation of Steel Surfaces for Repairs and/or Reinstatement of Internal Lining and/or External Coating

The following method is applicable to the preparation of exposed steel surfaces prior to the carrying out of any repair procedure to internal linings and/or to external coatings. This specification is applicable to all steel surfaces that have been stripped of its corrosion protection layer, internally or externally, as a result of the manufacturing of specials, construction activities or pipe laying, welding and/or damages caused by handling or latent defects in application.

Degreasing:

All bare metal surfaces shall be degreased in order to remove grease and oil from the pipe surface as a first step in the preparation process i.e. before grit blasting and/or power brushing starts. Degreasing shall be carried out using an approved water based solvent degreaser such as that complying with SANS 1216 or, for use in enclosed systems, with SANS 1365. The surface shall then be cleaned with potable water and left to dry completely before the next step is taken.

Grit Blasting – Internal Lining Repair:

Grit blasting of bare metal surfaces shall take place after degreasing of the area. Abrasive material used for blast cleaning shall be free from oil or grease, as shall be the compressed air used in air blast cleaning.

The finished grit blasted surface shall be to Sa 2½ of ISO 8501-1 with a 75 micron angular profile. Hackles shall be removed with coarse abrasive paper.

Transition areas from internal lining to bare metal which has been grit blasted, shall be smooth without rough edges or flaking appearances.
All grit blasting within the pipe line that is under construction, shall be performed by way of a "vacuum blast" process in order to limit the generation of dust. Grit blasting shall, under all circumstances, be carried out using equipment suitable for the size of the work to be undertaken.

Damp hessian sacking or other suitable material is to be temporarily fixed around the pipe on both sides of the work areas to prevent damage to the adjoining pipe coating/lining.

All residual dust and debris shall be removed.

Before work commences, the Contractor shall provide the Engineer with a method statement for approval for each type/location of grit blasting.

Power Brush – External Coating Repair:

Power brushing of bare metal surfaces shall take place after degreasing of the area as specified. The area that has been power brushed shall be free from rust, laitance, dust, oil or other deleterious matter before the application of primer. Any areas in the region where power brushing took place shall be free from signs of disbonding of lining and/or coating. The surface finish, once power brushing has been completed, shall conform to minimum St 2 standard.

PSL 3.9.3.2 Preparation Mixing and Application of Epoxy Compounds

When mixing two part epoxies the base and activator shall be mixed in accordance with the manufacturer's instructions. Mixing in the original container will only be permitted by means of methods that ensure full integration of different parts of the compound into a homogeneous compound with the characteristics as intended by the manufacturer. The different parts of the compound shall not be diluted. Mixing shall only be allowed with full batches and reduction of volumes from mixing packs by means of weight or volume measurement, which will result in smaller portions to be mixed, will not be allowed. In the application of the epoxy the following shall be strictly in compliance with the manufacturer's instructions:

- Method of application (Type of brush or roller.)
- Over coating time.
- Temperature range for application.
- Method of mixing base and activator.
- Number of coats to achieve the specified thickness.
- Safety aspects e.g. Eye and hand protection, ventilation, fire precautions, etc.

- Note that roller and brush applicators shall be replaced once the product application expiry time has been reached on any specific applicator tool.

Uncured epoxy must be regarded as being toxic and shall be handled in accordance with the manufacturer's instructions. Adequate lighting and ventilation shall be provided whilst working within the pipeline.

Only solvent free epoxy repair kits shall be utilized to repair the internal linings of the pipeline. This specification refers to "two part epoxy" as an epoxy repair kit which consists of a base and an activator approved by the Engineer and could be products similar to "Denso ST100", "Sigma SF 523", "Nordbak", etc.

For the repair of cement mortar linings, "Epidermix 338" or similar approved shall be used.

The Contractor's tendered rates for the laying of the pipe shall be deemed to include for all the repairs and make-goods that have to be effected in order to deliver a serviceable and acceptable pipe line. (This excludes such repairs as instructed by the Engineer as a result of manufacturing defects, if any).

Two-part epoxy may only be applied on steel surfaces prepared as specified in PSL 3.9.3.1.

PSL 3.9.3.3 Making Good of Cement Mortar Lining at Welded Joints

All cement mortar lined pipes shall have their cement mortar lining stopping a minimum of 25 mm from each plain end and from each end and it shall be 'chamfered' by 15 degrees to provide a positive dove-tail joint for the epoxy repair plug after field welding to another pipe.

When cement mortar lined straight steel pipes are cut, the cement mortar lining is to be cut back between 25 mm and 50 mm from the cut end of the pipe and "chamfered" by approximately 15 degrees to provide a positive dove-tail joint for the epoxy mortar repair plug after butt welding.

The surfaces are to be prepared as specified in PSL 3.9.3.1.

In the case of plain ended pipes, after welding, a band of "Epidermix 338" or similar approved epoxy, shall be applied internally on the uncoated steel adjacent to the cement mortar lining to a width to suit the cement mortar lining "cut back" and to a thickness to suit the mortar lining thickness of the pipe.

In the case of collared or bell ended pipes, the repair shall be made using a mortar mix and the plain end of the adjoining pipe shall be pushed into the bellmouth (or into the external sleeve when there is no bellmouth) in such a way that the mortar band is compressed and makes contact with the transverse face of the cement mortar lining of both pipes as follows:

Immediately before joining the pipes, a slurry of Ordinary Portland Cement (OPC – CEM I 32.5) mixed with a suitable SBR Latex for use with OPC (Nitrobond SBR from Fosroc or similar) and clean water in the proportions 1:1 shall be applied to the shoulders of the cement mortar linings in the sleeve and spigot ends of the pipes to be joined. Thereafter a sufficient suitable mix of dry plaster sand and OPC (CEM I 32.5) in a proportion of 1:1 by mass and sufficient liquid (Nitrobond SBR mixed 1:1 by volume with water) to produce the correct consistency for plastering shall be troweled against the shoulder of the cement mortar lining in the sleeve end.

As the pipes are pushed together, the cement mortar lining in the spigot end shall be pressed against the mortar in the sleeve end to make a continuous lining. The excess material that is squeezed into the bore of the pipes is to be removed by drawing a suitable plug that is 5 mm smaller than the bore of the cement mortar lining across the joint. The plug that is used shall be such as to render an even and smooth finish to the mortar at the joint. The timing of when the plug is pulled through is critical and shall be carefully controlled.

PSL 3.9.3.4 Repair and Making Good of Solvent Free Epoxy Linings

In addition to the contents of clause 3.9.2.3 of SANS 1200L, the following shall be applicable:

ll making good of internal solvent free epoxy linings at damaged areas and at welded and flanged joints that is required to ensure continuous internal corrosion protection to steel surfaces shall be carried out strictly in accordance with the solvent free epoxy manufacturer's specifications. The surfaces are to be prepared as specified in PSL 3.9.3.1.

The epoxy material shall be sufficiently thixotropic that 500 micrometers dry film thickness can be achieved in one application without sagging. The material shall be applied to the clean, dry, abraded area so as to fully cover it and extend to no less than 50 mm of the edge of the abraded area. A "halo" of abraded area shall be visible around the repair material.

After curing, the repaired section and at least 250 mm of the surrounding area, shall be tested for electrical insulation defects as specified elsewhere. There shall be no electrical insulation defects.
The Contractor shall ensure that repairs and particularly the making good of linings at welded joints, is carried out progressively as the pipe is being laid and shall not be permitted to lag behind for more than three pipe lengths at each working front.

PSL 3.9.3.5 Repair of Cement Mortar Lining

Free issue pipes with linings damaged prior to acceptance by the Contractor shall be marked and recorded by both the Contractor and the Engineer's Representative and then repaired by the Contractor. The payment rate for repair shall be made at the scheduled rate. Once the Contractor has completed any repairs (if necessary) and accepted the pipes from the Employer, any subsequent damage to the lining in the pipes shall be repaired by the Contractor at his expense.

Any repairs necessary on pipe supplied by the Contractor shall be carried out at the Contractor's expense.

All repair procedures shall be subject to the prior approval of the Engineer. Generally, a crack is to be ground out using a mechanical grinder down to the steel wall to form a "dove-tail" groove with a minimum width of 8 mm. Care must be taken not to grind any of the steel pipe wall. The groove shall be rendered free of laitance, dust, oil, grease, fractured aggregate and other deleterious matter. The steel pipe wall internal surface shall be rendered free of rust and other deleterious matter by wire brushing (apply white spirit if necessary). The groove shall be filled with "Epidermix 338" (or equivalent approved), mixed and applied in accordance with the procedure set out in PSL 3.9.3.3.

PSL 3.9.3.6 Repair of FBMDPE Coating (Large Areas)

A large area repair is defined as an area larger than 650 mm^2.

Free issue pipes with external coatings damaged prior to acceptance by the Contractor shall be marked and recorded by both the Contractor and the Engineer's Representative and then repaired by the Contractor. The payment rate for repair shall be made at the scheduled rate. Once the Contractor has completed any repairs (if necessary) and accepted pipes from the Employer, any subsequent damage to the coating in the pipes shall be repaired by the Contractor at his expense.

Any repairs necessary on pipe supplied by the Contractor shall be carried out at the Contractor's expense.

All damaged and blistered FBMDPE coating caused by welding or other mechanical means shall be removed back to sound coating by mechanical grinding or other approved means.

The exposed steel surface shall be power wire brushed to remove dirt, scale, rust and other foreign matter to a surface profile equivalent to a Class St 2 finish. Weld spatter shall be removed by chipping or grinding to a smooth surface flush with the surrounding steel. Welds shall have a smooth contour free from sharp edges, protrusions and undercut. Sharp edges and protrusions shall be removed by grinding to a smooth radius of curvature of not less than 3 mm.

Degreasing of the exposed steel surface shall be done in terms of Clause PSL 3.9.3.1.

The surrounding sound FBMDPE surface shall be feathered from steel surface to maximum thickness and then abraded to a distance of 100 mm beyond the defective area. The abrasion shall be carried out with clean emery paper of 80 to 100 mesh so as to produce a suitably rough surface profile without causing the removal of excessive amounts of protective material. Virgin Sintakote powder is to be melted into the defect to ensure proper mechanical bonding with the steel surface and chemical bonding with the existing Sintakote. The melting of the virgin material shall be such that melting is not effected with an open flame. The melted powder shall be shaped with a hot spatula to form a smooth surface over the repair area.

Under no circumstances will patching of damaged areas by means of pieces of tape wrap, be allowed.

PSL 3.9.3.7 Repair of FBMDPE Coating (Small Areas)

A small area repair is defined as an area less than 650 mm^2.

A small area repair is effected by means of the application of a hot spatula to repair the defect, provided that there is a residual layer of polyethylene adhering strongly to the steel surface. Alternatively, virgin Sintakote powder material may be melted with heated spatula over the damaged area, to fill the mechanical damages in the coating and fuse with the surrounding coating material, all as per the manufacturer's recommendations.

At each pinhole detected by the Holiday test, the surrounding area shall be abraded to 25mm beyond the defective area. The abrasion shall be carried out with clean emery paper of 80 to 100 mesh so as to provide a suitably rough surface profile without causing the removal of excessive amounts of coating material. A hot spatula shall be utilized to work Sintakote into the pinhole defects. It is noted that any cluster of pinholes within a radius of 25mm shall be regarded as one defect.

PSL 3.9.3.8 Repair of Three Layer Polyethylene Coatings

Free issue pipes with linings damaged prior to acceptance by the Contractor shall be marked and recorded by both the Contractor and the Engineer's Representative and then repaired by the Contractor. The payment rate for repair shall be made at the scheduled rate. Once the Contractor has completed any repairs (if necessary) and accepted pipes from the Employer, any subsequent damage to the coating in the pipes shall be repaired by the Contractor at his expense. All making good of the exterior coatings at damaged areas that is required to ensure continuous corrosion protection to steel surfaces shall be carried out strictly in accordance with an approved method statement that is to be prepared by the Contractor.

Any repairs necessary on pipe supplied by the Contractor shall be carried out at the Contractor's expense.

The basic requirements are the careful cut back of the outer sleeve and removal of the residual adhesive layer. The exposed surfaces are to be prepared as specified in PSL3.9.3.1 and this is to be followed by the application of an approved epoxy material followed by the application of a shrink sleeve covering the whole of the affected area with an overlap of no less than 50 mm.

The epoxy material shall be sufficiently thixotropic that 500 micrometres dry film thickness can be achieved in one application without sagging.

After curing, the repaired section and at least 250 mm of the surrounding area, shall be tested for electrical insulation defects as specified elsewhere. There shall be no electrical insulation defects.

PSL 3.9.3.9 External Coating Repair on Continuity Bonds

Electrical continuity bonding shall be carried out by a cathodic protection sub-contractor.

After successful testing of each weld in the presence of the Engineer's Representative the pipe coating shall be repaired in accordance with PSL 3.9.3.4.

The cable ends shall be covered with "Denso" mastic prior to tape wrapping.

PSL 3.9.3.10 External Corrosion Protection of Welded Joints and Coating Repairs

All factory coated steel pipes will be supplied with the external coating cut back 100 mm from each pipe end. Where pipes are to be cut, either on site, or for the purpose of fabricating bends, fittings and specials, or in the event of the pipe coating being damaged, the pipe coating shall be cut back 100 mm from the intended cut area before the pipe is cut. Damp hessian sacking or other suitable material is to be temporarily fixed around the pipe to prevent damage to the pipe coating during welding operations. Once welding is complete, and all weld splatter and burnt coating has been removed, the welded pipe joints shall be wrapped in the following manner.

The following specification is based on "Denso" products and systems. Alternative products and procedures may be proposed by the Contractor and, if approved by the Engineer, they may be used. Irrespective of which products are approved by the Engineer and used by the Contractor, all procedures shall be carried out strictly in accordance with the Contractor's method statements which must conform to the manufacturer's recommendations.

A fundamental outcome is a sound and continuous coating that is free from wrinkles and that does not have any entrapped air pockets or any air bubbles.

Surface Preparation:

The bare metal shall be cleaned and wire brushed to minimum St 2 standard and, degreased with white spirit. The adjacent pipe coating shall be cleaned to a minimum of 300 mm either side of the joint and the edges "feathered" to achieve a tapered transition over a distance of 100 mm. The sound, parent coating surface shall be roughened with sandpaper over an area 250 mm either side of the joint.

Priming:

The entire pipe and coating surface over a length of 250 mm on either side of the joint shall be primed using "Denso Primer D" (or equivalent approved). Care shall be taken to obtain a thin even film with no runs or sags. The primer shall be allowed to cure until "tack dry" before the application of the tape commences. Priming may only be carried out on those areas that are to be wrapped that same day. If primed areas are to be left overnight, those areas shall be re-primed before wrapping.

Profiling Tape:

A 1,5 mm thick x 50 mm wide "Denso profiling Mastic with a petrolatum Sealing Tape" (or equivalent approved) shall be applied to the full circumference of the weld bead in accordance with the manufacturer's specifications. Care shall be taken to ensure a smooth profile and to avoid air bubbles being trapped beneath the tape. (Note: The profiling tape may be omitted at the discretion of the Engineer. Tenderers shall nonetheless allow for the profiling tape in their tendered rates).

Tape Wrapping:

The joint shall then be wrapped (minimum 55 % overlap) with a petrolatum system including mastic profiling puddy, butyl rubber/bitumen tape and PVC backing film "Denso Ultraflex 1250 Polyethylene/Bitumen" tape, or similar approved, starting at the roughened section (250 mm from the welded joint) in accordance with the manufacturer's requirements to create a 500 mm wide wrapping, centred over the welded joint. A 100% overlap is required on the first and last revolutions of the tape wrapping operation. It is important that tension in the tape be released when the wrapping of the last half circumference of the pipe. The Contractor shall ensure that the wrapping overlaps or covers a minimum of 150 mm of the pipe coating. A secondary or outer tape wrap layer is then to be applied over the first layer with a 10% tape overlap.

An alternative tape wrapping system that may be used is the "Densotherm 35 Hot Applied Bitumen Tape" system. The procedures are similar to those for the "Denso" system described above except that the underside of the tape shall be heated as it is applied and the overlaps and seams of the tape are to be sealed by means of a heated tool.

PSL 3.9.3.11 External Corrosion Protection of Shop-Fabricated Pipe Bends and Fittings

The external coating of shop fabricated bends and fittings shall be carried out as follows:

- Where a substantial part of the external coating on the parent pipe is intact, the coating repairs/make good shall be carried out in accordance with PSL 3.9.3.5 or
- Where black (uncoated pipe has been used), the coating shall be carried out with an approved solvent-free epoxy (SFE) system such as "Nordbak 1" or similar approved system or
- Where only a relatively small proportion of the external coating on the parent pipe remains, all of the remaining coating shall be removed and the entire bend/fitting shall be coated with an approved solvent-free epoxy (SFE) system such as "Nordbak 1" or similar approved system.

All crotch plates and wrappers/collars shall be coated with an approved solvent-free epoxy (SFE) system such as "Nordbak 1" or similar approved system.

After application of the SFE coatings to the crotch plates and collars/wrappers, approved mastic (refer PSL 3.9.3.8) shall be placed in all crevices that may become moisture traps.

No additional payment will be made for any of this work as the costs are deemed to be included in the scheduled rates for bends and fittings.

PSL 3.9.3.12 External Corrosion Protection of Site-Fabricated Pipe Bends and Fittings

The coating repairs/make good shall be carried out in accordance with PSL 3.9.3.10.

PSL 3.9.3.2 Payment for Inspection and Testing

Repairs by the Contractor will be subject to inspection by the Engineer and the Employer's Third Party inspection agent. Should additional expenditure be incurred by the Employer's inspector, due to any failure of the prescribed tests, then such additional expenditure shall be reimbursed to the Employer by the Contractor and shall be deductible from the Payment Certificates.

PSL 3.9.5 Joints, Bolts, Nuts and Washers

Replace clause with

"All joints, bolts, nuts and washers shall be hot-dip galvanised in accordance with SANS 121 unless stated otherwise. Electroplating shall not be permitted.

Where nuts and bolts are required for jointing, couplings, etc., there shall be 2 sets of washers per nut and bolt unless otherwise specified.

Where additional corrosion protection is specified the relevant clauses of PSL 3.9.6 shall also apply."

PSL 3.9.6 Corrosive Soil

Change the heading of this subclause to:

PSL 3.9.6 Additional Corrosion Protection

Replace clause with the following:

"Unless scheduled or ordered separately, steel or cast iron pipes, fittings, valves and joints shall be treated as follows:

PSL 3.9.6.1 Wrapping of Permanently Exposed and Cast-in Pipes and Fittings

All coated and/or galvanised steel pipes which are to be **permanently exposed (above and below ground) and cast in concrete** shall, in addition to the specified corrosion protection at flange/adaptor/anchoring joints, be protected with the "Denso rubber Bitumen/Acrylic Pipeline Tape (Steelcoat 500)" system or similar approved UV resistant coating. The pipe surface shall be prepared and the coating applied in strict accordance with the manufacturer's instructions. In the case of cast-in pipes, the wrapping shall extend for at least 150mm on either side of the soil/concrete/air interface.

Surface Preparation:

(i) Remove all Grit and/or dust before priming at the average spread rate as specified by the manufacturer.

(ii) The adjacent coating shall be cleaned to a minimum of 300 mm beyond the section to be wrapped.

(iii) Grease and oil shall be removed with a non-volatile solvent. The surface shall then be cleaned with potable water and allowed to dry completely.

Priming:

(i) "Denso Primer D" shall be applied to the prepared surfaces extending 300 mm on either side of the area to be wrapped at a nominal coverage rate of 8 m² per litre. Care shall be taken to obtain an even film with no runs or sags. Only those areas that are to be wrapped the same day shall be primed to avoid any recontamination to the pipe. If primed areas are to be left overnight, these areas shall be re-primed before wrapping. Any surface oxidation, or other foreign agents shall be removed by reprocessing through the necessary cleaning steps.

(ii) The flow of primer shall be regulated so that the pipe surface is entirely covered. Solvents shall be allowed to flash off for a minimum of 30 minutes before application of tape or mastic. Uncoated, flooded, or areas primed over improperly cleaned pipe, shall be cleaned to the satisfaction of the Engineer and re-coated.

Tape Wrapping:

The joint shall be spirally wrapped (minimum 55% overlap) with "Denso rubber Bitumen/Acrylic Tape (Steelcoat 500)" (or approved equivalent) in accordance with the manufacturer's requirements, to at least 150mm regardless of diameter, beyond the concrete/soil or concrete/air interface and at least 1 000mm beyond the soil/air interface in the case of pipes extending above ground. A 100% overlap is required on the first and last revolutions of the tape wrapping operation. Care shall be taken to ensure a smooth profile and to avoid air bubbles being trapped beneath the tape. The tape shall not be stretched and it is important that tension in the tape be released when the wrapping of the last half circumference of the pipe.

In the case of pipes cast into concrete, the profiling tape shall stop 20mm short of any puddle flange.

PSL 3.9.6.2 External Corrosion Protection for Pipes, Joints, Fittings and Fasteners in Chambers

(a) Pipes and Fittings

For steel pipes and fittings in chambers with the same coating as mentioned in PSL 3.4.3 and 3.4.4, shall be protected by an additional UV resistant paint top coat of Re-coatable Polyurethane (Carbothane 134za) minimum dry film thickness of 40 micron unless specified elsewhere.

(b) Flanges and Flexible Adaptor / Anchoring Joints

All flanges and flexible joints and adaptor/anchoring joints and their associated bolts, nuts and washers, **shall**, notwithstanding that the flexible and adaptor/anchoring joints will be epoxy coated as specified elsewhere, **be protected as described below**.

(Note: This specification is based on a "Denso" system. Alternative products may be used, subject to approval by the Engineer).

Surface Preparation:

The entire surface area of the flange/adaptor/anchoring joint, and its bolts, nuts and washers, up to no less than 250 mm either side of the joint, shall be cleaned of all dirt and other deleterious matter. The cleaned area, up to 200 mm either side of the flange/adaptor/anchoring joint, shall then be wire brushed.

Priming:

The cleaned flange/adaptor/anchoring joint, bolts, nuts, washers and the adjoining 200 mm length either side shall be primed with "Denso Priming Solution", or if moisture is present, with "Denso S105 Paste".

Application of Mastic Blankets:

Narrow strips cut from "Denso Mastic Blanket" shall be applied to the flange/ adaptor/anchoring joint to achieve a smooth profile with a 50 mm splayed fillet being formed at the joint/pipe interface. Care shall be taken, particularly at bolts, to avoid the formation of air pockets. Complete "Denso Mastic Blankets" shall then be applied (mastic side down) to the flange/adaptor/anchoring joint until the flange/adaptor/anchoring joint is completely enveloped.

The blanket shall be overlapped at least 50 mm and shall extend at least 150 mm along the pipe barrel on each side of the flange/adaptor/anchoring joint. The ends of the blanket shall be bound to the barrel of the pipe on each end with 100 mm wide "Denso Tape". The "Denso Tape" overlaps shall be 50 mm and shall extend 100 mm onto the blanket and 150 mm onto the pipe barrel.

Application of Protective Sheeting:

The entire flange/adaptor/anchoring joint shall then be wrapped with 350 micron polyethylene sheeting which shall end 400 mm beyond the joint. The protective sheeting shall be secured to the pipe barrel and along the seam with 48 mm wide "Denso Adhesive Tape"

The "denso" petrolatum system shall be used, including mastic profiling puddy, petrolatum tape and Ultraflex PSA 180 tape

(c) Nuts, Bolts and Washers (Fasteners)

In buried situations and/or in chambers below ground level, upon completion, bolt heads, washers and nuts shall be wrapped with the "denso" petrolatum system including mastic profiling puddy, petrolatum tape and Ultraflex PSA 180 tape as described in PSL 3.9.3.10."

PSL 3.9.6.3 External Corrosion Protection for Pipes, Joints, Fittings and Fasteners below-ground (buried) exposed

(a) Buried Pipes (short runs)

This involves the external corrosion protection for buried short pipe lengths for GMS pipes, epoxy coated steel pipes and uncoated steel pipes that have not been mentioned above.

The pipes mentioned above shall be protected with a "denso" petrolatum system including mastic profiling puddy, petrolatum tape and Ultraflex PSA 180 tape or similar approved coating. The pipe surface shall be prepared, and the coating applied in strict accordance with the manufacturer's instructions.

Surface Preparation:

(i) Remove all Grit and/or dust before priming at the average spread rate as specified by the manufacturer.

(ii) The adjacent coating shall be cleaned to a minimum of 300 mm beyond the section to be wrapped.

(iii) Grease and oil shall be removed with a non-volatile solvent. The surface shall then be cleaned with potable water and allowed to dry completely.

Priming:

(i) “Denso Primer D” shall be applied to the prepared surfaces extending 300 mm on either side of the area to be wrapped at a nominal coverage rate of 8 m² per litre. Care shall be taken to obtain an even film with no runs or sags. Only those areas that are to be wrapped the same day shall be primed to avoid any recontamination to the pipe. If primed areas are to be left overnight, these areas shall be re-primed before wrapping. Any surface oxidation, or other foreign agents shall be removed by reprocessing through the necessary cleaning steps.

(ii) The flow of primer shall be regulated so that the pipe surface is entirely covered. Solvents shall be allowed to flash off for a minimum of 30 minutes before application of tape or mastic. Uncoated, flooded, or areas primed over improperly cleaned pipe, shall be cleaned to the satisfaction of the Engineer and re-coated.

Tape Wrapping:

The pipe shall be spirally wrapped (minimum 55% overlap) with by "denso" petrolatum system including mastic profiling puddy, petrolatum tape and Ultraflex PSA 180 tape (or approved equivalent) in accordance with the manufacturer’s requirements. A 100% overlap is required on the first and last revolutions of the tape wrapping operation. Care shall be taken to ensure a smooth profile and to avoid air bubbles being trapped beneath the tape. The tape shall not be stretched and it is important that tension in the tape be released when the wrapping of the last half circumference of the pipe.

(b) Fittings, Valves, Flanges and Flexible Adaptor / Anchoring Joints

Every **buried** cast iron/steel coupling, joint, flange, valve, or small unsheated portions of pipe near the joint (flange) where scheduled, shall be protected by the following "Denso" or equal approved anti-corrosion system:

After the pipework has been satisfactorily tested (and bonded at the couplings for electrical continuity if applicable) the exposed portion of the coupling, joint or flange and the unsheathed portions of the pipes at the joint and the bodies of all buried valves are to be covered with an approved a "denso" petrolatum system including mastic profiling puddy, petrolatum tape and Ultraflex PSA 180 tape applied strictly in accordance with the manufacturer's instructions.

The external sheathing system, which shall be to the approval of the Engineer, shall be carried out as follows:

All loose dirt, rust, mill scale and flaking paint shall be removed by wire brushing all exposed metal surfaces. An approved priming solution shall be applied by brush with care being taken to ensure all exposed metal surfaces are coated.

"Denso", "Corromastic" or equal approved mastic profiling puddy is to be packed around the joint and/or valve body to form an even contour for the application of “denso” petrolatum tape and Ultraflex PSA 180 tape. A fillet is to be formed between the flange and the pipe barrel/valve body and, in the case of flexible couplings, mastic profiling puddy is to be packed around the bolts to a height of 3 mm above the bolts. Care must be taken to ensure that no air is entrapped.

A layer of petrolatum impregnated tape is to be spirally applied with a minimum overlap of 50 mm. All air pockets are to be removed.

An overwrap of adhesive PVC (Ultraflex PSA 180) tape is to be spirally applied with a minimum of 25 mm overlap and with at least two laps over the untreated sheathing on either side of the joint.

The whole sheathed area of the joint and pipe is to be subjected to holiday detection and, if proved sound and approved by the Engineer, may be covered with "padding" sand."

(c) Nuts, Bolts and Washers (Fasteners)

In buried situations and/or in chambers below ground level, upon completion, bolt heads, washers and nuts shall be wrapped with the "denso" petrolatum system including mastic profiling puddy, petrolatum tape and Ultraflex PSA 180 tape as described in PSL 3.9.3.10."

PSL 3.9.6.4 External Corrosion Protection for Pipes, Joints, Fittings and Fasteners above-ground exposed

(a) Pipes and Fittings

For above ground steel pipes and fittings not cast in concrete, larger than DN150 and the same coating as mentioned in PSL 3.4.3 and 3.4.4, shall be protected by an additional UV resistant paint top coat of Re-coatable Polyurethane (Carbothane 134za) minimum dry film thickness of 40 micron unless specified elsewhere.

For above ground steel pipes and fittings not cast in concrete, smaller than and including DN150 with the same coating as mentioned in PSL 3.4.2, no additional corrosion protection wrap/paint is applied.

(b) Valves, Flanges and Flexible Adaptor / Anchoring Joints

For all Flexible and Flanged Joints in above ground application with the same coating as mentioned in PSL 3.4.3 and PSL 3.4.4 shall be protected by an additional UV resistant paint top coat of Re-coatable Polyurethane (Carbothane 134za) minimum dry film thickness of 40 micron unless specified elsewhere.

(c) Nuts, Bolts and Washers (Fasteners)

All bolts, washers, threaded bars etc mentioned in PSL 3.8.3 is to be corrosion protected completely and generously by an approved heavy-duty, self-heathing, surface tolerant, hand painted, flexible polymer-modified wax corrosion-inhibitor such as 'Chesterton 740 or similar approved heavy duty rust guard' minimum dry film thickness of 36 micron

PSL 3.9.6.5 External Corrosion Protection for Pipes, Joints, Fittings and Fasteners above ground in buildings / pumpstations

(a) Pipes and Fittings

For steel pipes and fittings in buildings and pump stations (non-immersed conditions), larger than DN150 and the same coating as mentioned in PSL 3.4.3 and 3.4.4, shall be protected by an additional UV resistant paint top coat of Re-coatable Polyurethane (Carbothane 134za) minimum dry film thickness of 40 micron unless specified elsewhere.

For steel pipes and fittings in buildings and pump stations (non-immersed conditions), smaller than and including DN150 and the same coating as mentioned in PSL 3.4.2 there shall be no need for additional corrosion protection. However, if majority of the pipework in the specific location (pump station / building) is Epoxy coated then over coat with UV resistant paint top coat of Re-coatable Polyurethane (Carbothane 134za) minimum dry film thickness of 40 micron (colour to suit valves and couplings).

(b) Fittings, Valves, Flanges and Flexible Adaptor / Anchoring Joints

For all Flexible and Flanged Joints in above ground application with the same coating as mentioned in PSL 3.4.3 and PSL 3.4.4 shall be protected by an additional UV resistant paint top coat of Re-coatable Polyurethane (Carbothane 134za) minimum dry film thickness of 40 micron unless specified elsewhere.

(c) Nuts, Bolts and Washers (Fasteners)

All bolts, washers, threaded bars etc. mentioned in PSL 3.8.3 is to be corrosion protected completely and generously by an approved heavy-duty, self-heathing, surface tolerant, hand painted, flexible polymer-modified wax corrosion-inhibitor such as 'Chesterton 740 or similar approved heavy duty rust guard' minimum dry film thickness of 36 micron

Add the following new sub-clause:

PSL 3.10 Valves

Change the heading of this clause to the following and add:

PSL 3.10 Valves and Other Mechanical/Electronic Accessories

PSL 3.10.1 Isolation Valves (General)

The Contractor is referred to the Umgeni Water Particular Specification for Valves. Where conflict exists, the requirements in this specification shall take precedence.

Unless otherwise stated, all isolation and scour valves shall be of the Waterworks Pattern Sluice Valve type.

The following general requirements shall be met:

a) The valve class shall be at least equal to that of the pipework in which it is to be installed. All valves shall be rated for a working pressure of at least 1,6 MPa (Class 16), unless otherwise specified in the drawings and schedule of quantities.

b) The valves shall be supplied with non-rising type spindle. Spindles shall be threaded such that two turns of the hand wheel shall effect a movement of 25 mm on the valve gate. This allows for easy identification of the valve diameter.

c) The valves shall be fitted with a cast iron cap attached to the spindle by means of a Stout brass screw with hexagonal head or with a handwheel as indicated on the drawings or specified in the Schedule of Quantities. The handwheel shall indicate the direction of closing.

d) The valves shall be ***CLOCKWISE CLOSING.***

e) The design of the valve guides shall be such that all valves supplied can be mounted in any position.

f) The stuffing box may either be of the conventional type with gland packing with a gland secured with 2 No. bolts and nuts. The nuts shall be of the Tee pattern and the gland stuffing box shall be capable of holding four rings of a standard size of gland packing. The gland stuffing box shall be capable of being repacked under working pressure, preferably with the gate in the open position. The gland shall fit neatly and snugly into the stuffing box. The base of the gland and the stuffing box shall be chamfered to force the packing against the spindle.

   Alternatively the sealing of the spindle in the body may be by means of O-rings which are retained in position by means of machined Grooves in the valve body and which seal against the spindle. If this type of valve is offered, tenderers should indicate with their tender the cost of a service head for each size of valve offered. Such service head shall be supplied complete with seals, gate, spindle and cap.

g) The valves shall be double flanged and drilled in accordance with SANS 1123 appropriate to the Class of valve required/specified.

h) Each valve shall be supplied with 2 No. full face gaskets and the requisite number of bolts, nuts and washers to suit the valves. Sufficient bolts, nuts and washers shall be supplied for both faces of the valves. The cost of these items shall be included in rates tendered.

i) The valves shall be drop tight at the specified working pressure applied to one side of the gate and the other side subject to open end conditions.

j) In addition to the above conditions (i) when called for in Schedule of Quantities, valves for installation on fire hydrants shall be drop tight when subjected to working pressures within in range 345 kPa to 1380 kPa under unbalanced open end conditions, and chattering of the gate in its guides during operation of the valves shall be reduced to a minimum to prevent damage to the valve seats.

Every valve shall be internally and externally fusion bonded epoxy powder coated to a minimum 250 micron DFT, as standard.

PSL 3.10.1.1 Resilient Seal Valves

a) General

Valves shall be double flanged and be resilient seated and unless otherwise specified, the valves shall be of the non-rising spindle type.

The valves shall be capable of withstanding the nominal pressure and specified test pressure and shall have the capability to seal drip tight bi-directionally. The valves shall generally be manufactured in accordance to SANS 664.

b) Gate Design

The gate shall be fully rubber encapsulated inside and outside therefore to ensure drip tight sealing and avoid corrosion. The gate shall further have a drain hole, preventing stagnant water or impurities from collecting.

Rubber utilised in the coating of the wedge shall be inert and shall not impart odour, taste and colour and shall be suitable for drinking water applications. The gate nut shall not be fixed to the wedge, thereby reducing opening torques.

c) Gate and Body Design

The gate shall have optimally placed guides of wear resistant plastic so as reduce the torques as well as reduce wear between the rubber and the coating on the body. The bore of the body shall be straight through design in order to allow cleaning with a badger.

d) Valve Bonnet

The valve shall utilise 3 independent bonnet seals which shall include a set of stem steels embedded in non-corrosive material, a back seal to prevent leakage when changing seals, and wiper ring to protect against debris entering the valve.

Two friction washes (sizes 50mm – 200mm) and thrust ball bearings (250mm – 600mm) shall be in incorporated to ensure smooth spindle operation as well as to reduce opening and closing torques.

A full circle thrust collar shall be utilised to ensure low torque operation. O-ring stem seals shall be replaceable under pressure for sizes 50mm – 200mm.

e) Spindle

Spindles shall be made of stainless steel. The stem threads shall be rolled to maintain steel structure and increase strength and, to ensure smooth thread edges and consequently a low operating torque.

f) Body and Bonnet Assembly

The rubber bonnet gasket shall fit in a recess in the valve bonnet preventing blow out of the seal under surge conditions. The bonnet bolts shall pass through the gasket and sunk into the bonnet and sealed for corrosion protection.

An edge protecting ring shall permanently be fitted around the body and bonnet joint in order to protect the coating during transportation and installation.

PSL 3.10.1.2 Wedge Gate Valves

Wedge Gate Valves shall be of the Waterworks Pattern Sluice Valve type and be manufactured to a standard of not less than that specified in SANS 664.

The following special requirements shall be met:

a) The lugs on the gate and the spindle are to conform to 3.2.3 of SANS 664 and are to be machined to a good fit and finish.

b) Valve trim shall be either Type B (Gun metal trim) or Type C (Stainless Steel trim) as specified in SANS 664 Clause 3.5.5. Tenderers must indicate in their tender what type of trim is offered.

c) Seat rings shall comply with Clause 3.5.6 of SANS 664 and shall be pinned into position.

d) The stuffing box may either be of the conventional type with gland packing with a gland secured with 2 No. bolts and nuts. The nuts shall be of the Tee pattern and the gland stuffing box shall be capable of holding four rings of a standard size of gland packing. The gland stuffing box shall be capable of being repacked under working pressure, preferably with the gate in the open position. The gland shall fit neatly and snugly into the stuffing box. The base of the gland and the stuffing box shall be chamfered to force the packing against the spindle.

e) Valves which incorporate a thrust plate of the horseshoe type will NOT be considered.

f) Every sluice valve shall be provided with substantial guides cast on each side of the gate, preferably extending to the top of the nut box and operating along corresponding guides cast in the sides of the valve body. (Brass trim only).

g) When called for in the Schedule of Quantities, valves shall, in place of the guides described in (f) above, be fitted with machined bronze guide shoes on either side of the gate operating in accurately matching machined bronze guide channels fixed on the sides of the valve body. The bronze guides shall be of phosphor bronze to B.S. 1400 PB 2-0.

The gate valves shall be supplied with the gland packing installed and shall be either "Maxmech Style M57, Chesterton 1724" or similar approved.

3.10.1 4 Butterfly Valves

The valves shall be manufactured in accordance with BS 5155 (cast iron and carbon steel butterfly valves for general purposes), as far as is applicable.

The Contractor is referred to the Umgeni Water Particular Specification for Double Flanged Butterfly Valves for sizes from 400NB where working pressure does not exceed 40BAR (4000kPa) and the Umgeni Water Particular Specification for Valves.

Where conflict exists, the requirements in this specification shall take precedence. Thereafter the Umgeni Water Particular Specification for Double Flanged butterfly valves shall take precedence over the Umgeni Water Particular Specification for Valves

The following criteria for construction shall be met:-

a) Body

Where wafer-lug type butterfly valves are specified, these shall be of the wafer-lug type, with drilled/tapped bolt holes, to allow the valve to be used at maximum working pressures of respectively 20 and 16 bars in terminal positions. This is to allow downstream pipework to be disassembled with the upstream pipework under pressure.

Valves designed for to allow the valve to be used at maximum working pressures of 16 bars at terminal positions unless otherwise specified in the drawings or schedule of quantities.

Bodies shall be one piece casting Ductile Iron, UTS 400 MPa, YP 250 MPa, (elongational 12%) grade EN GJS-400-15 to BS EN 1563 or equivalent for sizes up to 1500mm. Sizes above shall be of cast steel grade 480 to BS 1504-161. Bodies shall never be in contact with the fluid conveyed and shall be fully protected internally by the resilient seat.

b) Disc

Shall be cast or stamped, spherically machined and positively splined or keyed internally to the driving shaft. (Use of plinths or bolts is totally prohibited).

Selection of the disc material shall be made taking into account the aggressivity of the fluid. (Cupro-aluminium or stainless steel 316 or equivalent).

c) Shaft

Butterfly valve technology shall be such that the shaft will never be wetted. (Dry shaft) Stainless Steel, AISI 420 of high mechanical characteristics shall be used.

It shall be positively splined or keyed to the disc. The upper and lower shaft and tie-bolt, when assembled to the disc, shall give in effect a one-piece shaft/disc assembly. At least three bearing assemblies, consisting of steel outer shell, with sintered bronze inner lining, coated with Teflon, facing shall be used.

The upper shaft shall be carried in two bearings, the lower in one.

d) Liner

The resilient, synthetic rubber seat shall be easily replaceable (bonded liners are prohibited) and shall entirely cover the inside of the body overlapping over the sides to form the seal between the body and matching pipework.

Where necessary, it shall be keyed to the body with annular grooves in the bore of the valve. The design shall be such as to allow the disc to seal drop-tight to the liner so that there is no ingress of fluid to the shaft area.

e) General

Valves with “0” Ring Shaft Backup Seals shall not be considered. The Manufacturer shall be able to offer alternative grades to cope with various fluids.

Quarter-turn handles shall be supplied for valves up to and including 150mm nominal diameter. The handle shall be lockable in all intermediate positions and be adaptable to the valves.

For valves larger than 150mm a gear shall be used. The gear operator shall be designed with a worm and nut system. The gear operator shall be irreversible in any position. The gear shall have a handwheel and an indicator protected by plexiglass, showing the position of the disc. If specified, limit switches shall be fitted, mounted in a waterproof and dustproof housing.

The direction of opening of the butterfly blade shall be such that the bottom of the blade moves in a downstream direction.

All handwheels shall be fitted with a suitably sized shear-pin that shall fail before damage can be done to the drive gearing of the valve.

Where specified, U-section wafer-type valves, as described in BS 5155, shall be acceptable, provided that:

the valve is suitable for individual bolting of each flange and the dimension between the inside faces of the flanges is not less than 3D, where D is the diameter of the flange bolts as specified in BS 4504: Part 1, or SANS 1123

PSL 3.10.2 Air Release Valves

The Contractor is referred to the Umgeni Water Technical Specification for Air Release and Vacuum Break Valve. Where conflict exists, the requirements in this specification shall take precedence.

a) Function

The required valves shall provide any of the functions, or combination of functions, described below as specified in the schedule of quantities:

- Pipeline filling
- Uninterrupted high volume air discharge through the large orifice.
- Pipeline draining or Column Separation
- Uninterrupted high volume air intake through the large orifice.
- Pipeline full and operating
- Discharge of disentrained pressurized air through the small orifice.
- Rapid Filling / Column Separation

The valve must incorporate an integral surge alleviation mechanism which will automatically dampen surge pressures due to rapid air discharge or the subsequent rejoining of separated water columns.

b) Construction and design

The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats housed in a tubular stainless steel or corrosion protected body with stainless steel ends secured by means of stainless steel tie rods.

Large orifice sealing shall be effected by the flat face of the control float seating against a nitrile/EPDM rubber ‘O’ Ring housed in a dovetail Groove circumferentially surrounding the large orifice. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice on a natural/EPDM rubber seal affixed to the control float.

The intake/discharge orifice area shall be equal to the nominal size of the valve i.e. a 150mm (6”) valve shall have a 150mm (6”) intake/discharge orifice. The air valve class shall be at least equal to that of the pipework in which is to be installed, with a minimum working pressure of at least 1,6 MPa (Class 16).

Surge Alleviation Mechanisms

The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns. The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure. Relief mechanisms that act subsequent to valve closure cannot react in the low millisecond time span required and are therefore unacceptable.

Relief mechanisms shall activate at a maximum differential pressure of 5kPa between the inside and outside of the valve.

Where specified, the air valve shall be fitted with a stainless steel spring or similar device to immediately active the air release function to the surge alleviation mechanism.

c) Performance Requirements

The valve design shall be proven and performance criteria shall have been confirmed by a recognized independent authority.

The selected air valve range shall have factory test results which verify the claimed air intake and air release performance characteristics.

Air valve ranges without verified factory performance tests will not be accepted.

PSL 3.10.3 Float Control Valves

Float Control Valves shall be hydraulically controlled dual diaphragm end line type control valves with either a direct or remote pilot to facilitate automatic control of levels in tanks and reservoirs with an inherent slow closing characteristic to automatically reduce induced pressure when closing.

Float valves shall have a concentric cast iron body and bonnet, which shall be coated and lined with fusion bonded epoxy powder coated to 250 microns.

The spacer piece and plug assembly shall be manufactured from solid HDPE and the diaphragms shall be manufactured from proprietary elastomer as specified by the manufacturer. The internal filter mechanism shall be manufactured from LG2 brass and 304 stainless steel. The control orifice, trim and fasteners shall all be manufactured from Grade 304 stainless steel.

Valve construction shall be such that deformation, leaking or damage of any kind does not occur when the valve is subjected to testing pressures of 1.5 x the designed working pressure.

The valve shall be supplied with a direct or remote (as specified), magnetic two level latch type pilot with a fixed deadband. The pilot shall be constructed of brass with stainless steel trim and shall be fitted with an “Eclipse shallow pot” type magnet. The pilot float arm shall be constructed from stainless steel and the ball from polypropylene.

The pilot shall be able to remain “closed” or “open” when the water surface is turbulent and shall only change state at either end of the deadband.

Where a filter is specified to prevent debris from entering the valve, it shall be a cone filter manufactured from powder coated mild steel.

Float valves shall be supplied with stud connections suitable for alignment to flanges conforming to PN16 ratings of BS EN 1092 standards, or as otherwise specified in the drawings or specifications.

Float valves shall be suitable for operating under a static pressure of 16 bar and shall be able to operate at a residual pressure of at least 0.1 bar.

PSL 3.10.4 Meters

PSL 3.10.4.1 Woltmann Type

Water meters used in this application in nominal bore sizes from 40mm to 150mm must comply with the South African Bureau of Standards Specification No. 1529-1:1994 and Section 18 of the Trade Metrology Act No. 77 of 1973 and Regulation 80 of Part II of the Trade Metrology Regulations.

All Water Meters, sizes 40 mm to 100 mm, must be tested and sealed by an authorised officer in a SANAS (S.A.B.S. 0259) accredited laboratory, situated within the borders of the Republic of South Africa.

The Water Meter must be of the Woltmann WP helical vane inferential velocity type with the following capabilities:-

METER SIZE (mm)	**40**	**50**	**80**	**100**	**150**	**200**	**250**	**300**
Max. Flowrate **qs** ± 2% (m^3/h)	90	90	200	250	600	1000	1600	2000
Permanent Flowrate qp ± 2% (m^3/h)	50	50	120	180	450	700	1000	1500
Transitional Flowrate qt ± 2% (m^3/h)	1.0	10	2.0	2.0	4.0	6.0	11.0	15.0
Minimum Flowrate q min ± 5% (m^3/h)	.35	0.35	0.5	0.6	2.0	4.0	6.0	12.0
Starting Flow (m^3/h)	0.15	0.16	0.22	0.25	0.90	1.2	1.8	1.8
Maximum Working Pressure (Kpa)	1600	1600	1600	1600	1600	1600	1600	1600
Body Length (mm)	311	200	200	250	300	350	450	500

In addition, the meters offered must comply with the following:-

- Epoxy coated cast iron body.
- Counter to be encased in a Copper can with mineral glass lens sealed to IP 68 standards to prevent condensation from forming under the lens, thus providing clear reading in any environment.
- Scratch resistant mineral glass counter window able to withstand the impact of a 25mm steel ball dropped onto the centre from a height of one metre.
- Counter unit must be equipped to generate pulse outputs, as per the following:

<u>Meter sizes 40 mm to 100 mm</u>	One pulse per 10 litres One pulse per 1 000 litres
<u>Meter sizes 150 mm & 200 mm</u>	One pulse per 100 litres One pulse per 10 000 litres

Meter must have the following features to facilitate convenience of on-site replacement :

(a) Fully shrouded, pre-calibrated replaceable mechanism.
(b) Helical vane fitted in a shrouded cartridge designed to direct the entire volume of water through the measuring element ensuring body impact is negligible on the accuracy.

- Must be suitable for Vertical, Horizontal or Inclined Installation.
- Meters must be capable of measuring reverse flows within the same Class B accuracy envelope as per the Specification (No. 1529-1, 1994) for forward flow, i.e.± 5% q min & 2% qp to qs.
- Meter must be provided with a pressure tapping (1/4 BSP), into which a pressure gauge or pressure transducer can be fitted to measure the downstream pressure of the meter.
- Suitable for water temperatures up to 50°C and maximum working pressure of 1 600 kPa, unless otherwise specified in the drawings and schedule of quantities.
- All internal plastic components to be constructed of virgin materials.

- The meter must perform within the legal accuracy specification, with a length of pipe, the same diameter as the meter, three diameters long, free from fittings and valves, fitted at the inlet to the meter body and one diameter long fitted to the outlet of the meter body.

- Each Meter must be backed with a two year warranty against faulty workmanship and/or materials.

Spare parts for all Water Meters offered must be available in South Africa and still be available for a period of ten years after the purchase of the water meter.

3.10.4.2 Electromagnetic Type

The magnetic flow meters shall be flanged to SANS 1123 for process connection sizes and pressures specified in the BOQ. Installation shall form part of the mechanical portion of the Works. The primary element casing shall be of 3CR12/mild steel, appropriately coated, painted and treated for corrosion protection. The tube material shall be at least of 304 stainless construction with a polyurethane lining. The electrodes shall be constructed of 316 stainless steel. The sensor shall have an environmental protection rating of IP68 with factory potted terminal housing and shall be equipped with integral cables long enough to reach the transmitter. No cable joins will be permitted. The transmitter shall have microprocessor-based electronics with local flow rate and total indication in an IP65 enclosure. The transmitter enclosure must be installed above any flood level.

The transmitter shall conform to the following:

Power supply	:	230V AC power supply 50Hz
Outputs	:	4 x OCT digital programmable outputs Isolated (Fwd Pulse, Rev Pulse, Empty pipe, low battery) 1 x passive 4-20mA
Range	:	0.1-10m/s
Accuracy	:	Error better than 1% of full scale > 0.5m/s
Repeatability	:	0.2% of span

The transmitter shall have Profibus, Hart Ethernet configurable connections.

3.10.4.3 Ultrasonic Type

No strap-mounted or clamp-on type ultrasonic flow meters shall be accepted.

The ultrasonic flow meters shall be the in-line type and shall be flanged to SANS 1123 for process connection sizes and pressures specified in the BOQ. Installation shall form part of the mechanical portion of the Works.

The primary element casing shall be of mild steel, appropriately coated, painted and treated for corrosion protection. The tube material shall mild steel construction with a polyurethane lining. Where a stainless steel casing and tube is specified, the grade shall be EN 1.4404 (AISI 316L). The wetted transducers and transducer holders shall be constructed of stainless steel EN 1.4404 (AISI 316L).

The sensor shall have an environmental protection rating of IP68 with factory potted terminal housing and shall be equipped with integral cables long enough to reach the transmitter. No cable joins will be permitted.

The transmitter shall have microprocessor-based electronics with local flow rate and total indication in an IP65 enclosure. The enclosure shall be of die-cast aluminum or stainless steel (EN 1.4404) construction. The transmitter enclosure must be installed above any flood level.

All externally mounted flowmeters and components shall be of stainless steel construction unless otherwise specified. All internally mounted flowmeters and applicable components shall be of mild steel construction unless otherwise specified.

The transmitter shall conform to the following:

Power supply	:	230V AC power supply 50Hz
Outputs	:	4 x OCT digital programmable outputs Isolated (Fwd Pulse, Rev Pulse, Empty pipe, low battery) 1 x passive 4-20mA
Range	:	0.1-10m/s
Accuracy	:	Error better than 1% of full scale > 0.5m/s
Repeatability	:	0.2% of span

The transmitter shall have Profibus, Hart Ethernet configurable connections.

3.10.4.4 GSM Data loggers

GSM data loggers shall be 3.6V lithium battery powered and in an IP65 wall mount enclosure with extended battery pack for the line pressure transducer. The data logger should have 2 x digital inputs and 5 x Analogue inputs. Logged data should be transferred to the Mycity server at 24hr intervals. The data should be accessed via the Mycity password protected website. Data should display graphically in graph and table format for user selectable periods. The data must downloadable in Excel format.

The flow transmitter and data logger for the flow meters shall be installed remotely and above any flood level in a wall mounted IP65 enclosure.

PSL 3.10.5 Strainers

All strainers shall be “Y” type configuration and shall conform to the following:

- Cast iron body and lid and shall be fusion bonded epoxy coated both inside and outside.
- Face to face dimension of all flanged strainers shall be according to EN 558-1 GR 1. Strainers shall be supplied with stud connections suitable for alignment to flanges conforming to PN16 ratings of BS EN 1092 standards, unless otherwise specified in the drawings and schedule of quantities..
- Strainers shall be suitable for operating under a static pressure of 16 bar, unless otherwise specified in the drawings and schedule of quantities.
- The screen shall be a fine-meshed double screen manufactured from stainless steel able to restrain parts bigger than 0.5mm for sizes DN 40mm – DN 150mm, and able to restrain parts bigger than 0.6mm for sizes DN 200mm – DN 300mm.
- All fastening bolts and nuts to be stainless steel.

PSL 3.10.6 Reflux Valves

The Contractor is referred to the Umgeni Water Particular Specification for Valves. Where conflict exists, the requirements in this specification shall take precedence.

a) General

Reflux valves shall be double-flanged, for horizontal and vertical mounting, of robust construction and suitable for the operating head and close drop tight, unless otherwise permitted in the Project Specification.

Bodies shall be one piece casting Ductile Iron, UTS 400 MPa, YP 250 MPa, (elongational 12%) grade EN GJS-400-15 to BS EN 1563 or equivalent for sizes up to 1500mm. Sizes above shall be of cast steel grade 480 to BS 1504-161.

The body, cover and door shall be of the Ductile Iron grade EN GJS-400-15 to BS EN 1563 or equivalent approved/ The door shall be fitted with a zinc-free phosphor-bronze face, closing on a corresponding bronze face, in the body.

The valves must be of the "non-slam" type, for horizontal or vertical installation. Unless otherwise specified, all reflux valves shall be fitted with an external counterweight arm to ensure non-slam closure.

External spring assisted closure will also be permitted. Valves with a stainless steel perforated cone, or resilient conical diaphragm, are also acceptable.

Wafer-type reflux valves shall have ductile iron bodies with domed 316 stainless steel gates. Seats shall be machined with a dove-tail groove to accommodate an O-ring to ensure drip-tight sealing.

Valves shall be installed between suitable retaining flanges, which shall be independent of any other piece of equipment.

Valves shall be guaranteed to be leak tight in their particular application.

Valves shall be coated (externall) and lined (internally) in accordance with the Umgeni Water Particular Specification for Valves.

b) Nozzle-type Reflux valves

Nozzle-type or "Silent" check valves shall be double flanged. The "globe" style of construction shall be used.

The design shall be such that the disc does not rely on back flow for closure. Closure shall be performed by a stainless steel spring that pushes the disc against the stainless steel seat.
The valve shall be fully open under normal operating conditions.

Discs shall close with a positive action and no possibility of slamming shut during any stage of the closing or opening operation. The spring assisted low inertia internal components must ensure rapid closing and minimise secondary slam even at high flow deceleration rates. The disc shall at all times stay perpendicular to flow.

The valve disc shall be of ductile iron grade EN-GJS-400-15 construction. Valve rings shall be of EN 1.4404 construction.

The bearings shall be of bronze construction or superior.

All internal components shall be of stainless steel construction, including the shaft, stopper, spring, bolts, nut, and setscrew.

External fasteners (flanged connections) shall be mild steel (hot dip galvanized).

PSL 3.10.7 Flow Limiting Valves

The Contractor is referred to the Umgeni Water Particular Specification for Valves. Where conflict exists, the requirements in this specification shall take precedence.

The limiter valve shall consist of a wafer pattern with rubber control ring orifice inserts, which effects a consistent flow control within ± 10% of the rated flow for a differential pressure across the valve over a range as specified. The valve must sit between two flanges.

The valve body shall be of stainless steel grade 316 construction. The control rings shall be made of flexible nitrite elastomer rubber and shall be able to move on a tapered seat in the body as the flow increases and be replaceable. The valve shall be complete with control rings for the specified flow.

The valve design shall be proven and performance criteria shall have been confirmed by a recognized independent authority.

The valve class shall be at least equal to that of the pipework in which it is to be installed. All valves shall be rated for a working pressure of at least 1,6 MPa (Class 16), unless otherwise specified in the drawings and schedule of quantities.

PSL 3.10.8 Knife Gate Valves

The design of the knife gate valve shall be of a type suitable for the operation environment and fluid medium described elsewhere in the document.

Preference shall be given to double flanged units.

Valves and their method of actuation shall be designed to operate under the full pressure rating of the valve.

Valves shall have cast iron bodies unless otherwise specified. The knife gate shall be of stainless steel (AISI 316) construction. The handwheels shall be of cast iron, or of stainless steel (where specified).

The valves shall have chamfered blade edges and resilient body seals. Blade faces shall be surface ground or otherwise provided with two flat, parallel surfaces.

The blade seal shall be protected by a non-metallic scraper or similar device.

It shall be possible to adjust the blade seal while the valve is in line under pressure.

All fasteners on the body of the valve shall be of EN Grade 1.4401 (316), or better (this does not necessarily apply to flange bolts).

Valves shall be droptight. Blade seals shall not leak.

The valve shall be capable of operating reliably at any point in the specified range.

The valve shall be provided with manual handwheel operation or shall be provided with electric actuation with manual override, as specified elsewhere. The operation shall be smooth and handwheels shall not require a peripheral force greater than 250N (i.e. the sum of the forces on both sides shall not be greater than 250N).

Corrosion protection shall be to the Client Particular Specification for Valves, or superior.

PSL 3.11 Manholes and Surface Boxes

Add the following sub-clause:

PSL 3.11.7 Pipeline Markers

Where so instructed by the Engineer or as shown on the drawings, the Contractor shall erect pipeline markers. These markers will be precast concrete units manufactured out of 25 Mpa concrete to the dimensions shown on the drawings and shall comply with SANS 1200 GA Concrete (Small Works)."

Add the following new sub-clause:

PSL 3.12 Padlocks for Manholes, Air Valve Chambers, Reservoirs etc.

All padlocks for use in locking manholes, air valves chambers, valve chambers, reservoirs etc shall be "lock-a-like" 70 mm Discus Lock with all working mechanisms treated with copper slip. The cost of padlocks will be deemed to be included in the Contractor's rates for the manhole cover and/or locking bar."

PSL 4 PLANT

PSL 4.1 Handling and Rigging

Add the following:

"The plant and rigging equipment used for the handling of pipes shall be such that no pipe shall be overstressed during any operation.

In the transportation, loading and unloading of pipes, the Contractor shall at all times operate and maintain an adequate fleet of vehicles to ensure that pipes or their protective linings and coatings are not damaged. In particular, the use of excavation equipment for handling of pipes will not be permitted.

Pipes shall be moved with the use of padded slings of width sufficient to prevent damage to the coating. Chain slings, hooks, wire ropes, rope slings without canvas covers, composition belt slings with protruding rivets an any other equipment liable to damage the coating shall not be used. Slings shall be suitably rated for the loads to be handled and in good condition. The use of deteriorating and frayed slings is prohibited.

All pipes are to be lifted and handled with the aid of a "spreader" lifting beam. Special care shall be taken to ensure that no damages occur to pipes or coatings as a result of pipes sliding on or hitting adjacent pipes. The dragging or skidding of pipes and specials in contact with the ground shall not be permitted.

Whenever pipes are stacked, or otherwise stockpiled, or are transported, use shall be made of suitable resilient material as dunnage which shall not disintegrate of deteriorate when exposed to the elements for prolonged periods or under loads from adjacent pipes (See PSL 4.1.1 below). Pipes shall be stacked with a minimum clearance of 50 mm between adjacent pipe walls and a minimum of 75 mm clear of the ground.

The ends of the pipes should be kept covered by suitable end pieces to prevent damage through the intrusion of foreign matter. Level, cleared ground, free of vegetation should be chosen for the stacking site.

Fire breaks are essential, and pipes must be protected from damage by vandals or animals"

Add the following sub-clauses:

"PSL 4.1.1 Stacking and Storage of HDPE Pipes

All pipes shall be delivered in 9m or 12 m lengths.

Pipes of different PN designations shall not be transported or stacked together. Stacks shall be kept separate and carefully marked.

PE pipes must be evenly supported in order to prevent distortion. All bearing surfaces must be free from contact with sharp objects. Any projecting sections such as stub flanges must be supported to prevent damage.

The pipes shall be stacked in uniform stacks, as described below:

The area for stacking of pipes shall provide a suitably regular surface onto which to place the pipes.

Care should be taken to ensure that, prior to commencement of stacking, the area is free of rocks and other debris that may cause damage to the pipes.

Pipes shall be stored on timber planks (dunnage) of minimum dimension 75mm x 75mm placed directly on the prepared surface at a maximum 1.5m centers. The planks shall be of sufficient length that, once the pipe or multiples of pipes are chocked, the plank extends to at least 100mm beyond the outside edge of the outside chock. Every pipe shall be chocked, regardless of whether it is constrained by pipes on either side and pipes shall be chocked such that a gap of at least 50mm is maintained between pipes. All chocks are to be secured (screwed/nailed) to the spacer plank to ensure that they cannot be moved/removed.

Pipes shall not be stored more than 3 (three) high and all the requirements for stacking and chocking between layers of pipes shall be as set out above.

Add the following sub-clause:

PSL 4.1.2 Stacking of Ductile Iron Pipes

The pipes shall be stacked in uniform stacks, sockets at the same end, as described below:

Bottom Layer: The bottom layer shall be laid on 2 timbers, arranged in parallel; one timber being 1m from the socket end and the other 1m from the spigot end. The pipes shall be laid parallel with one another. The sockets touch and shall not be in contact with the ground.

The pipes at the two ends shall be secured at the socket and spigot with large wooden wedges nailed to the timbers. The intermediate pipes shall be secured at the spigot end only, using smaller wedges.

Upper Layers: Each tier consists of parallel pipes laid in line vertically. Each tier is separated by timbers slightly thicker than the difference in diameter (socket – barrel).

Fittings and accessories shall be packed in robust timber crates and secured in position to prevent chaffing in transit.

The contractor shall supply all necessary timber dunnage/crating necessary to stack the pipes in accordance with the above specification. Timber dunnage shall be sufficiently robust to prevent crushing or breaking and shall be of sufficient size to prevent contact with the ground.

Add the following sub-clause:

PSL 4.4 Packing

Goods should be suitably packed in such manner as will ensure safe and efficient transport by road or rail, and the Contractor shall include in his prices for whatever packing may be necessary in this respect. Small items particularly liable to damage or loss in transit should be crated. All crates and packing material shall, after use, become the property of the Employer, unless distinctly specified otherwise, or if returnable, shall be so at the Contractor's expense.

PSL 5 CONSTRUCTION

PSL 5.1 Laying

PSL 5.1.1 General

Add to the Sub-Clause:

"The Contractor will be responsible for clearing the areas required for pipe storage that shall include the removal of rock, stones and all combustible material. He/she shall also be responsible for maintaining the area in a clean and tidy condition for the duration of the Contract.

The Contractor is to allow for any and all costs in regard to the storing of pipes in his tendered rates for supply and delivery in the case of pipes supplied by the Contractor or the rates for collect from storage and transport to site in the case of free issue pipes should he require secondary storage of the free issue pipes.

Upon delivery of the pipes, fittings, specials and valves, these will be inspected jointly by the Engineer's Representative and the Contractor. Any items found to be damaged shall be returned to the factory for repair or replacement, in which case the costs of additional transport, repair or replacement shall be borne by the Contractor if the pipes were supplied by the Contractor and not by the Employer.

The Contractor will be held fully responsible for the care and safety of all pipes and fittings, etc, on site, and shall bear the cost of all renewals, which may be necessary to make good losses, damages or breakages. Furthermore, he shall be fully responsible for handling and re-loading material at the storage areas and for transporting and offloading of all such materials to the Site of the Works.

Before commencing pipelaying, the Contractor shall properly distribute pipes, fittings and specials, along the trenches. Valves and couplings shall not be distributed until they are actually required for laying in their designed position."

Add the following new subclause:

PSL 5.1.2 Damage

Add the following:

"The Contractor shall be responsible for protecting pipes fittings and valves from grass fires at all times and shall keep grass cut short in the vicinity of all pipework items.

Should trenches be inundated by water, there is a risk of movement of the pipes by flotation. The Contractor shall ensure that trenches are not flooded by stormwater and that pipes laid in the trench are backfilled as soon as possible after laying, except at joints made with couplings or flanges which must be kept visible until the pipeline has been satisfactorily tested.

Steel pipes with welded joints may, after all specified testing and corrosion protection has been satisfactorily completed and with prior approval from the Engineer, be backfilled at the same time as backfilling the pipeline.

Should movement of the pipes occur, the Contractor shall remove the pipes from the trench and thoroughly clean and relay the pipes. This work shall be carried out at the Contractor's expense."

PSL 5.1.3 Keeping Pipelines Clean

Add the following:

The Contractor shall take all of the steps necessary to prevent flooding of the Works and hence ensure that all work is carried out in the dry, and that the ingress of dirt and or dirty water into the pipes is pro-actively prevented. The ends of all laid pipes must be closed at all times when work is not being carried out.

Add the following sub-clauses:

"PSL 5.1.3.1 Cleaning Pipe Internals

The Contractor shall ensure that all pipe work installed is free from any internal contaminants. All traces of dirty water, slag, splatter, swarf, cuttings, coupons, welding rod ends, grinding dust, dirt and other debris are to be removed from the inside of the pipe as it is installed.

The relevant safety procedures are to be followed when entering pipes.

The Contractor shall ensure that all dust, grit and powder that accumulates in the pipe as a result of grit blasting for the repair of internal linings, be removed from the pipe in an acceptable manner before the internal lining repairs are carried out.

Once the lining repair has been completed, cleaned off and inspected, that specific section of the pipe shall be blocked off to prevent any further access by workers.

The Contractor shall take note that flushing of the completed pipeline may not be allowed after construction has been completed and therefore clean house keeping practices will be required under all circumstances during construction. The tendered rates for pipe laying shall include for the clean house keeping practices required.

Each section of the pipeline is to be internally inspected and passed by the Engineer once construction has been completed. If the pipework is not satisfactory, the Contractor shall re-clean the pipe at his own expense until the pipe is passed by the Engineer. The Engineer reserves the right to utilize cameras or any other means to inspect inaccessible areas.

PSL 5.1.3.2 Cleaning of Valves and Fittings

All flanges, valves, fittings and equipment may only be installed in pipe work after they have been thoroughly cleaned. Flange faces shall be checked for damage before being incorporated into the permanent works and any damage shall be reported to the Engineer."

PSL 5.1.4 Depths and Cover

Add the following:

“Water mains shall be so laid in road verges that the minimum cover from the finished surface level to the top of the pipe barrel is 800 mm. Under carriageways, water mains shall be laid horizontally and so that the minimum cover is 1 000 mm, the change to the cover under the carriageway from the verge being affected as specified in Subclause 5.1.4.2 of SANS 1200 L. Bulk supply mains shall be laid so that the minimum cover, in all situations, is 1 000mm.”

Add the following new subclauses:

PSL 5.1.5 Working Inside Pipes and Protection of Internal Lining

All possible care shall be exercised during construction in order to avoid damage being inflicted to the pipe lining as a result of the installation and welding activities, and the following procedures shall always be adopted:

- Placing of rubber protection mats in the pipeline to ensure that no damage occurs as a result of foot traffic, falling tools and equipment, weld splatter and or grinding spray.
- On steep slopes, the mat is to be restrained from sliding down the pipe.
- Labourers working inside the pipe are to wear soft soled shoes.
- Wet sacking or rubber matting shall be placed on the pipe invert in the areas where welding or flame cutting operations are in progress to minimise the extent of damage to the lining from weld splatter or molten metal from flame cutting. This requirement shall be strictly enforced.
- Tools shall be placed on rubber foam or resilient rubber matting to protect the pipe lining against mechanical damage. Care must also be taken on steep slopes to restrain equipment and hand tools from sliding down the pipe during construction.
- Particular care is to be taken inside the pipe when tie-ins into the pipe are done for the purpose of fitting air valves, scour valves, by passes and other tie-ins.

Once internal work in a specific pipe sections has been completed and the pipe has been successfully cleaned, holiday detected and approved as being constructed to the satisfaction of the Engineer, the Contractor shall block off that section of pipe to prevent any further man entry into same.
The rates tendered in the Bills of Quantities shall include for all the measures required under this clause.

Detection of holidays in the internal epoxy lining will only commence once all internal activities in the pipe line have been completed. That is welding of joints, preparation of joints for epoxy reinstatement, as well as epoxy reinstatement in terms of the requirements of this specification. This excludes repair of epoxy lining as a result of damage incurred before the pipe is transported to the construction site as these defects will be repaired in the pipe yard.

Once all work is complete in a particular length of pipe, the Contractor shall arrange for the pipe to be thoroughly swept of all dust and debris. The pipe lining and joint repair will then be tested with a "wet sponge" detector set at 90 Volts in order to detect any electrical insulation defects."

The Contractor shall take note that flushing of the completed pipeline may not be allowed after construction has been completed and therefore clean house keeping practices will be required under all circumstances during construction. The tendered rates for pipe laying shall include for the clean house keeping practices required.

Each section of the pipeline is to be internally inspected and passed by the Engineer once construction has been completed. If the pipework is not satisfactory, the Contractor shall re clean the pipe at his own expense until the pipe is passed clean. The Engineer reserves the right to call for the use of cameras or any other means to inspect inaccessible areas; all at the Contractor’s expense.

PSL 5.1.6 Equipment for Inspecting Internal Surfaces of Pipes

The Contractor shall make the following equipment available for use by the Engineer for the inspection of the internal surfaces of pipes DN 700 and larger:

- One pair of boots having leather uppers and rubber soles
- One one-piece overall with at least one breast pocket
- One adjustable safety harness
- Two screw drivers, 5 cm and 10 cm long
- One small peen hammer
- A two-cell torch with a 10W light bulb with two sets of rechargeable batteries and a battery charger and spare bulbs
- A sufficient length of 16 mm diameter rope to suit the conditions on site.
- One trolley suitable for inspecting pipes of the appropriate diameter(s).

The equipment shall be kept in good condition and operating order throughout the duration of the Contract. No separate payment will be made for this equipment and the costs therefore will be deemed to be included in the tendered rates.

PSL 5.1.7 Pipe Support

Temporary pipe supports may be used to assist setting up and assembly. However, it is preferred that permanent pipe supports are installed as soon as possible to minimize double handling and/or omission during construction.

Permanent pipe supports shall be constructed as indicated on the drawings or as directed on site.

Before testing, all permanent supports shall be complete and all temporary supports removed, unless otherwise agreed by the Engineer.

PSL 5.1.8 End Caps

The Contractor shall, at the end of each day’s work, fit end caps to the open ends of the pipeline under construction. The end caps shall be manufactured in such a manner that it can be fitted to seal off the pipeline to the extent that it is totally dust and water proof. The end cap shall be able to withstand a pressure of 5 m head of water externally when fitted.

End caps shall be maintained during non-working periods.

The tendered rates for the laying of pipe shall be deemed to include for the supply, fitment, and maintenance of the end caps.”

PSL 5.2 Jointing Methods

PSL 5.2.2 Flanges (Steel Pipelines)

In the heading delete "(Steel Pipelines)"

Add the following:

"Before being brought together, the ends of the pipes, fittings, couplings and flanges are to be inspected and cleaned to ensure that all parts forming the joint are undamaged and clean.

When jointing flanges, the faces shall be cleaned thoroughly and an approved full faced jointing material (compressed fibre cement or other approved gaskets on flanged joints), cut properly to size, is to be inserted immediately before bringing the two flanges together. Before closing the joints, the flanges must be parallel to each other, with all bolts inserted in the bolt holes. After the fittings have thus been aligned and well supported, the joint shall be bolted up to a uniform tightness using torque wrenches to achieve the required compression force on the gasket.

Only full-face gaskets are to be used, the jointing material shall be flush with, or protrude beyond, the outer circumference of the flange (this is not applicable to raised face flanges). On completion of the joint, the flanges and bolts shall be protected as described in Clause PSL 3.9.3.8."

PSL 5.2.3 Welding (Steel Pipelines of Diameter 600 mm or Greater)

Delete the title and replace with "Welding (Steel Pipelines and Specials)".

Delete the 1st sentence and replace with:

Field and shop welding of steel pipes, bends and fittings shall be carried out in accordance with the relevant requirements of the latest version of API 1104. Prior to commencement of welding, the Contractor shall produce a qualified welding procedure in accordance with the latest version of API1104, for the intended sizes, processes, positions, and consumables to be used on the project.

Welding shall be carried out by welders who are competent in terms of the procedure approval test given in API 1104. Prior to commencement of welding, the current qualification of each welder must be produced in accordance with the welding procedure. Should constant repairs be required on welds carried out by one particular welder, the Engineer may require that the welder be re-tested or removed from the project."

Add the following Subclauses:

PSL 5.2.3.1 Radiographic Examination of Welds

The Contractor shall include in his tendered rates for supply (if appropriate), handle, lay and bed of all pipes, bends, fittings and other specials for the cost of carrying out, under the supervision of an inspector appointed by the Engineer or Employer, examination of shop and field welds on the following basis:

a) Field Welds:

   All welds will be tested and adjudicated in accordance with API 1104. Radiographic testing is to be carried out on 100% of the welds.

   Repairs of welds will be permitted in accordance with approved repair procedures. Repairs shall be re-examined using the relevant non-destructive testing method. All costs associated with the repair of defective welds will be borne by the Contractor.

b) Fabrication of Bends, Fittings and Specials

   i) ONE HUNDRED percent radiographic examination of all weld deposited manually or semi-automatically in bends, fittings and specials which cannot be hydraulically tested because they have a plain end.

   ii) FIFTY percent radiographic examination of all welds deposited manually or semi automatically in all flanged bends, fittings, and specials which are to be tested hydraulically.

c) On-Site Fabrication of Bends, Fittings and Specials

ONE HUNDRED PERCENT radiographic examination of all weld deposited manually or semi-automatically in bends, fittings and specials.

The Engineer will, in all cases, determine which welds are to be radiographed on the quantity basis specified above. All radiographs and records thereof shall be made available to the Engineer to enable him to determine whether the welds are acceptable or not and no lining or wrapping of pipes, bends or fittings shall be permitted until the welds have been accepted by the Engineer. To avoid any unnecessary delays, at the option of the fabricator, radiographs may be approved by the manufacturer's inspectors subject to them being subsequently submitted to, and approved by the Engineer.

When a section of the weld is shown by radiography to be unacceptable and, if the limits of the deficient weld are not defined by the radiograph, additional radiography shall be carried out at the Contractor's expense until the limits of the deficiency are determined.

In the event of any welded joint proving unsatisfactory when the pipeline is subjected to radiographic tests, the Contractor shall be held responsible for all costs involved in repairing the joint or cutting it out and welding a new section of pipe, as may be ordered by the Engineer, and thereafter restoring the lining and wrapping, if these have become damaged, all to the satisfaction of the Engineer.

All repair welds shall be identified with a stamp marking, indicating which welder conducted the repair. Repaired welds shall be tested at the Contractor's expense.

After jointing and testing, the protective lining and wrappings are to be rendered continuous with the same materials as applied to the body of the pipe. Holiday detection tests shall be carried out in the field to ensure continuity of lining and wrapping

The tendered prices for supplying (when appropriate), transporting, laying, jointing and testing of pipes are to include for all the work described above and for the supply of all necessary materials, including welding, all necessary plant and labour.

d) Production Testing of Welds (Not applicable to pipes supplied by the Employer)

The Contractor shall also include in his prices for the supply of pipes the cost of carrying out at the factory, non-destructive tests of shop production welds (additional to the qualification tests for welding procedure) on the following basis:-

One pipe from each one hundred pipes produced shall be selected at random and specimens for two guided cold bend tests and one transverse tensile test shall be cut therefrom and tested in accordance with SANS 719:1971, Section 7.

In the case of the guided cold bend tests, where welding is carried from one side only, bend - specimens shall be tested with the rest of the bend in tension; where welded from both sides the specimens shall be tested with the inner and outer welds in tension alternately.

Tensile tests shall be carried out as for the qualification tests.

The pipes from which successfully tested specimens have been taken shall be trimmed to the maximum possible length and shall be accepted by the Employer for payment purposes as full standard pipe lengths.

In the event of the welds of any pipe failing to reach the standard of acceptance, such pipe shall be rejected. Two further plate coupons shall be prepared from different pipes, selected at random by the Engineer, for each specimen that has failed to reach the required standard. In the event of such additional tests proving to be satisfactory repairs to the pipe originally failing any test will be permitted by the Engineer and such repairs and subsequent re-test shall be at the Contractor's expense. In the event of the additional tests also failing to reach the required standard the Engineer shall have the right to reject the entire batch of pipes from which the coupon plates were cut.

PSL 5.2.3.2 Welding Procedure

Welding shall, unless otherwise prescribed in the approved welding procedure, commence at the top of the joint and proceed downwards. In addition to the root weld, at least two further passes shall be made, none of which is to exceed 3 mm in depth but this is subject to the approved welding procedure.

PSL 5.2.3.3 Aligning

The alignment of abutting ends shall be such that the offset does not exceed 1,5 mm. Line-up clamps ("dogs") shall not be used for the "fit-ups". The use of "bridges and wedges" or any other method that may reduce the pipe wall thickness when removed or in any way introduce unnecessary stresses into the pipe is forbidden.

PSL 5.2.3.4 Weather Conditions

Welding shall not be performed under conditions that could affect the quality of the welded joint (e.g. high moisture or windy conditions). Windshields may be used where practical.

PSL 5.2.3.5 Clearance

The minimum clearance around the pipe during welding shall be 500 mm or such other minimum distance that may be required to facilitate compliance with the approved welding procedure. When welding in the trench, adequately sized "fox holes" shall be excavated/formed so as to provide adequate access for the welders. The cost of which is to be included in the submitted rates for excavation of trenches

PSL 5.2.3.6 Visual Inspection

ONE HUNDRED percent of each joint will be examined and the following criteria shall be met:

All welds shall be substantially uniform in appearance with the inner and outer weld beads not exceeding 1 mm and 3 mm in height respectively unless otherwise required in terms of the approved welding procedure.

Undercut will not be permitted under any circumstances.

The weld, heat affected zone, and surrounding parent metal shall be free from cracks, porosity and trapped slag.

All weld splatter must be removed prior to corrosion protection application.

PSL 5.2.3.6 Non-Destructive Testing After Construction

The Employer's Cathodic Protection Professional Services Provider will carry out coating integrity surveys along the full length of the pipeline as prescribed in the Employer's Cathodic Protection Specification.

Any defect(s) found in the pipeline coating, as a result of the PCM or DCVG testing shall be located and repaired by the Contractor at his expense.

In the case of PCM testing, all coating defects identified with an area greater than 0,5 square centimetre per 12 metre length of pipeline shall be located and repaired.

In the case of DCVG surveys, all coating defects identified with a value greater than 3% IR (or such other value as may be determined and agreed following analyses of the results of the first section which undergoes DCVG testing) shall be located and repaired. The agreement between the Contractor and the Engineer on this baseline, will be set as the criteria for the coating repair requirements by the Contractor on the whole pipeline.

Depending on the extent of the defects identified during PCM or DCVG testing, the Engineer may call for a further survey after the initial defects have been repaired by the Contractor, the cost of which testing shall then be borne by the Contractor.

PSL 5.2.3.7 Quality Control

Records of which welds were carried out by each individual welder as well as non-destructive testing results shall be submitted to the Engineer monthly. Should there be repetitive or serious defects, this information shall be forwarded to the Engineer immediately."

Add the following new subclauses:

"PSL 5.2.5 Polyethylene (PE) Pipes and Fittings

PSL 5.2.5.1 Unreinforced PE pipes

Unless otherwise specified, any of the following may be used to joint pipes together:

a) Mechanical joint compression fittings that comply with the requirements of SANS 14236
b) Suitable push-fit fittings recommended by the pipe manufacturer
c) Heated-tool socket weld or electrofusion fittings that comply with the requirements of SANS 4427-3
d) Butt fusion as per SANS 10268
e) Ductile iron fittings that comply with the requirements of SANS 52824;
f) Mechanical jointing systems that comply with the requirements of SANS 4427-3. Note that the use of standard stub ends for PE pipes shall not be permitted. (PSL 3.8.3)

PSL 5.2.5.3 PE Pipe Welding Requirements

PSL 5.2.5.3.1 Applicable Standards

All pipes, fittings, welding processes and equipment are to comply with the relevant standards:

- SANS 10270 - Welding of Thermoplastics – Approval of welding Procedures and Welds
- SANS 10268-1 – Welding of Thermoplastics – Part 1: Heated Tool welding
- SANS 10268-2 – Welding of Thermoplastics – Part 2: Electrofusion welding
- SANS 10268-10 – Welding of Thermoplastics – Part 10: Weld defects
- SANS 10269 – Welding of Thermoplastics – Testing and approval of welders
- SANS 1671-1 – Welding of Thermoplastics – Machines and equipment – Part 1: Heated Tool Welding
- SANS 1671-2 – Welding of Thermoplastics – Machines and equipment – Part 2: Electrofusion Welding
- SANS 6269 – Welding of Thermoplastics – Test Methods for Welded Joints

PSL 5.2.5.3.2 General Welding Requirements

Welding must take place in a dry and protect site. Suitable measures must be taken to protect the welding operation from adverse ambient conditions (rain, high humidity, wind). Ambient temperature must be recorded for each weld. . The welding machine and the supports of the pipes must be erected so that they cannot move in any direction during welding.

The contractor must apply for approval of welding procedures and welds in accordance with SANS 10270. The Welding Procedure Specification Qualification Report must be signed by the inspector with one copy handed to the Engineer. The Qualification file as described in Clause 9 of SANS 10270 must be handed to the client prior to commencement of any production / construction site welding activities.

Welding is to be carried out only by welders certified by the National approved training body (Thermoplastics Joining Committee – National Panel of Examiners). The operator's current and valid welding certificate must be presented to the Engineer before any welding commences.

PSL 5.2.5.3.3 Butt Fusion Welding

Butt Fusion Welding may only be used to join pipes of the same SDR (Standard Dimension Ratio).

Only automated, approved, and calibrated welding machinery will be permitted. A calibration certificate must be presented to the Engineer before any welding commences. Every welding machine shall be marked in accordance with Clause 4.7 of SANS 1671-1, with the following items:

a) The manufacturer's name
b) Type of welding machine
c) Manufacture date
d) Serial number of machine
e) Safety information for the operation of the machinery

The welding machinery shall allow for control and adjustment of the various welding parameters in accordance with Clause 4.5 of SANS 1671-1.

Instructions for the safe and correct operation, maintenance, servicing and calbration of the welding machinery must be supplied and shall include, as a minimum, the items a) to e) in Clause 4.8. of SANS 1671-1.

Process reports for each weld with the information listed in items a) to m) of Clause 4.5.4.1 of SANS 1671-1 must be complied and handed to the Engineer prior to commencement of any welding activities.

Heated tools shall comply with Clause 5.4 and the specific requirments of Clause 6 in SANS 1671-1. Surface coatings for heated tools are permitted to allow for easy cleaning with the exception of PTFE spray and galvanic coatings containing copper and cuprous material. The requirements of Clause 5.4.3 in SANS 1671-1 shall be adhered to should PTFE be used as a surface coating. The heating plate shall be cleaned with an appropriate non-oil based cleaning solvent using the method described in Clause 5.1 of SANS 10268-1.

Pipe joint ends shall be prepared using the method described in Clause 5.2 of SANS 10268-1. This includes proper alignment of the joint (maximum offset limited to 10% of pipe wall thickness), machine facing to ensure a smooth joint end and cleaning with an appropriate solvent such as isopropyl alcohol. All measures shall be taken to prevent contamination of the joint surface by grease, dirt and dust.

The Butt Welding jointing process shall comply with Clause 5.4 of SANS 10268-1. Should the pipe manufacturer's specification and instruction differ from Clause 5.4, the maufacturer's instructions shall apply.

PSL 5.2.5.3.4 Electrofusion Welding

Electrofusion welding may be used to join pipes of different SDR. Only automated, approved, and calibrated welding machinery is permitted. A calibration certificate shall be presented to the Engineer before any welding activities commence.

Only bar coded fittings and Electrofusion Control Units shall be used. The computerised printouts of the weld parameters and information for each weld shall be compiled and handed to the Engineer upon his/her request. Every welding machine shall be marked in accordance with Clause 8 of SANS 1671-2, with the following items:

a) Manufacturers name
b) Serial number of machine
c) Type of machine
d) Input and outlet volatages
e) Frequency
f) Insulation protection class (to SANS 60529) and
g) Duty cycle

Instructions for the safe and correct operation, maintenance, servicing and calibration of the welding machinery must be supplied and shall include, as a minimum, the items a) to e) in Clause 9 of SANS 1671-2.

Joint surfaces must be prepared in accordance with Clause 6.1 of SANS 10268-2. The pipe must be cut square and all oxidation shall be removed using a purpose made reaming/scraping tool, suitable for the outside diameter of the pipe to be reamed, immediately before welding. The external surfaces of the pipes to be joined and the inside surface of the electrofusion coupling shall be wiped clean with a suitable solvent such as isopropyl alcohol as described in Clause 6.1.4.2 of SANS 10268-2.

The manufacturer's instructions for the electrofusion welding process must be strictly adhered to and only approved, certified and calibrated machinery may be used. Welding is to be carried out only by welders certified under the Thermoplastics Welding Institute of South Africa (TWISA) or the Plastics Federation of South Africa.

The Electrofusion welding jointing process must comply with Clause 6.3 of SANS 10268-2. Should the pipe manufacturer's specification and instruction differ from Clause 6.3, the manufacturer's instructions shall apply. All completed welds will be visually inspected and will be recorded on an appropriate weld defects check sheet in accordance with SANS 10268-10. Weld assessment Class III will be applicable

PSL 5.2.5.3.5 Fittings

(a) Tees and Bends

Injection moulded fittings shall be used wherever possible. Where factory fabricated fittings are to be used for tees and bends their pressure class shall be de-rated in accordance with the appropriate standard. Injection moulded fittings are deemed to be fully rated and need not be de-rated as in the case of fabricated fittings.

(b) Saddles

Only electrofusion type saddles are permitted. Electrofusion saddles shall comply with ISO 4427 – 3 and ISO 4427 – 5.

(c) Compression Fittings

Compression fittings may be used to join pipes with diameter size smaller than DN 100. Compression fittings shall comply with SANS 533 and shall conform to ISO 4427.

(d) Mechanical **Couplings**

Mechanical couplings must be of the tension resisting type to counter the shortening of the pipe and resultant induced longitudinal stresses when pressurised due to Poisson effect and thermal contraction. External restraints must be provided for anchorage of the pipes to be joined, and specialist suppliers of pipes and fittings should be consulted for suitable jointing solutions.

The use of flexible couplings ("V.J couplings") is expressly prohibited under all conditions and circumstances.

(e) Flanged Connections

Flanged connections comprised of butt welded HDPE stub flanges and steel backing rings which are bolted to other flanges. The body of the PE fitting must be manufactured in the injection moulding Process or from a piece of homogeneous Semi-finished material. **Semi-Finished Materials Manufactured From Wound Rods Or The Subsequent Application Of Other Forms Of Reinforcing Are Not Permitted.** Bolts are to be numbered and tightened in a cross pattern sequence. Bolt torque must be as per the guidelines of the supplier of the stubs. Bolts are to be re-torqued 24to 48 hours after initial tightening in accordance with the manufacturer's specification to counteract reduced tension in the tie bolts resulting from visco-elastic relaxation of the HDPE material under stress thus maintaining sealing pressures and ensuring leak free joints. Gaskets are not required provided that the mating faces of the HDPE stub flanges have not been damaged.

PSL 5.2.5.4 Steel-mesh-reinforced Polyethylene (PE) pipes

Steel-mesh-reinforced PE pipes shall be joined by means of either electrofusion couplings or flanged fittings that comply with the requirements of SANS 371.

PSL 5.2.6 Cut pipes

Cut pipes may be used where required as closure lengths. The cut ends shall be dressed square and to a smooth even finish which shall not be inferior to that of the ends of uncut pipes. The finished dimensions of ends cut on site must be within the tolerances applicable to the ends of the particular types of pipes to be laid. The cost of cutting and trimming pipes shall be included in the rates tendered for laying and jointing pipes."

PSL 5.3 Setting Valves, Specials and Fittings

Add the following to the Subclause:

"Valves are to be set correctly in the positions indicated and supported on concrete stools, except where not so required by the Engineer. Valve spindle guide brackets and stays where provided shall be secured into position against concrete work and set and carefully adjusted in order to give true vertical alignment of the spindle."

PSL 5.10 Disinfection of Potable Water Pipelines

Delete the clause and replace with:

"The entire pipeline disinfection will be monitored by the Engineer's Representative and/or the Employer's personnel. The disinfection criteria are stringent and the Contractor shall keep the pipeline clean throughout the Contract.

The Contractor will be required to submit a detailed method statement for approval by the Engineer. A minimum requirement will be that the method statement deals with the method of dosing and how the dosing rate will be controlled to ensure a uniform distribution throughout the pipeline being disinfected, the chemicals to be used, the anticipated range of dosing rates and equipment to be used, and the name and qualification the Contractor's person supervising the disinfection.

Once a successful hydraulic test of the entire pipeline has been achieved and the connections have been completed, the pipeline shall be drained. The pipeline shall then be re-charged in accordance with PSL 7.3.4 – "Initial Filling of the Pipeline". Whilst being charged, a sodium hypochlorite solution shall be dosed at a temporary connection(s) made at an air valve(s), which will be confirmed by the Engineer in order to achieve a theoretical total chlorine concentration of 25 ppm (mg/l).

Once the entire pipeline has been filled in this manner, it shall be left for a 24-hour period. Thereafter, total chlorine concentrations shall be measured at each scour point. A concentration of 20ppm total chlorine will be considered acceptable. Should this concentration not be achieved at all scours, the Contractor shall take all steps considered necessary by the Engineer to achieve satisfactory disinfection, at his/her own cost.

Once satisfactory disinfection has been achieved, the pipeline shall be drained via the scour valves (or by other means approved by the Engineer) and sufficient sodium thiosulphate (typically 1 part of total chlorine) shall be dosed into the scour-wet wells to fully neutralise the chlorine before discharging to watercourse.

The pipeline shall then be re-charged in accordance with the stated procedure and, after 24 hours, samples shall be taken and sent to an approved laboratory for analysis (at no cost to the Employer). Should the following limits not be achieved, the Contractor shall carry out at his/her own cost, all steps deemed necessary by the Engineer to achieve satisfactory disinfection.

Water Quality Limits:

PARAMETER	COUNT
e. coli	0
Coliforms	0
Faecal Streptococci	0

The cost of the provision of water and all chemicals for disinfection shall be deemed to be included in the tendered rates"

Add the following new subclause:

"PSL 5.11 Pipeline Markers

Markers are to be erected 300 mm off the edge of the pipe trench to the left of the trench and at right angles to the trench centre line at all horizontal changes of direction and on both sides of all road and river crossings, at valve chambers and at intermediate intervals of 50m unless agreed with the Engineer.

At bends the marker will be erected at the P.I. point of these 300 mm offset lines."

PSL 5.12 Cement Stabilising Bedding and Selected Fill around Pipes

Where shown on the drawings or directed by the Engineer, the bedding and selected material around the pipe shall be stabilized with 8% by mass of OPC. This is applicable to water course crossings, under trafficked areas and on steep slopes.

In all cases, the cement shall be added to the bedding / selected fill material outside the trench and in such a manner so as to achieve full dispersion of the cement in the material and achieve Optimum Moisture Content when placed and compacted around the pipe. Excess water content is to be avoided so as not to create a 'concrete encasement' of the pipe.

PSL 6 TOLERANCES

PSL 6.2 Control Points

Add the following:

"On completion of the contract, the Contractor shall provide the Engineer with a list of as built coordinates (Accurate to 0.1 m) for all air valves, scour valves, isolation valves and standpipes. The cost of providing this information shall be deemed to be included in the rates tendered for the individual items."

PSL 7 TESTING

PSL 7.2.1 Dye-Penetrant Test

all fillet welds shall be subject to dye penetrant testing the cost of which shall be deemed to be included in the tendered rates for pipelaying.

PSL 7.2.2 Radiographic Examination

butt-welded joints and bell-end joints shall be radiographically tested in accordance with PSL 5.2.3.

PSL 7.3 Standard Hydraulic Pipe Test

Option 1: All measures required for obtaining, purchasing, tankering, pumping and/or piping the water for testing and disinfection of the pipeline shall be deemed to be included in the tendered rates for laying of the pipeline.

Option 2: Were possible, water used for one filling of the pipeline for hydraulic testing will be provided by the Employer free of charge. Additional water used due to unsuccessful hydraulic tests will be charged at the Employer's bulk rate per kilolitre that is charged to the employer by DWS. Filling of the pipeline for hydraulic testing shall be carried out slowly to enable air to escape and under the direction of the Engineer.

Where the Employer is unable to supply water for testing, an item to collect and convey water from a specified source shall be scheduled for payment.

PSL 7.3.1 Test Pressure and Time of Test

Add the following to the subclause:

"The sections in which the pipeline may be tested will be at the discretion of the Contractor, except that the pipeline shall be tested in sections not exceeding a maximum allowable length of 2 000 m unless otherwise agreed by the Engineer. The Contractor shall make due allowance in the construction program and in the tendered rates for the entire testing operation including for the provision of temporary end stops (flanges or bullnoses) and any other costs incurred associated with testing the pipeline.

The pipe shall not be tested until the associated structural concrete for anchorage has cured for 28 days or until such concrete has attained the specified design strength. In the case of cement mortar lined pipes, once filled, the pipe shall be left for 24 hours to permit maximum saturation of cement mortar linings.

The section to be tested shall be pressurised to the specified pressure and left for 24 hours, during which period, the pressure drop (if any) and the quantity of water required to be pumped in to restore the test pressure shall be measured and recorded. In addition, all flexible and flanged joints shall be visually inspected and there shall be no sign of leakage.

The permissible leakage for welded and flanged steel pipelines is zero (0) litres.

At all times when there is water in the pipeline, and particularly during filling, testing and draining of the pipeline, all air valves shall be in operation and their individual isolating valves shall be open."

PSL 7.3.1.2 Delete the contents of this subclause and replace with the following:

"Subject to the provisions of 7.3.1.3 and 7.3.1.4, the test pressure for field testing shall be 1.25 times the designated working pressure at any point on the longitudinal section of the pipeline up to a maximum of 1.0 MPa, above which it shall be the designated working pressure plus 0.5 MPa.

For the purposes of this calculation, the designated working pressure shall be taken as the pressure rating of the pipe."

PSL 7.3.1.4 Delete the contents of this subclause and replace with the following:

The field test pressure shall not exceed the appropriate of the values in the following table.

Type of pipe	Applicable materials standard	Maximum field pressure at any point of the pipeline
Steel	SANS 62-1, SANS 62-2, SANS 719	50% of the hydraulic test pressure
Ductile iron	SANS 50545	Allowable site test pressure (PEA)
Reinforced concrete	SANS 676	75% of hydraulic test pressure
Prestressed concrete	SANS 975	75% of hydraulic test pressure
Fibre cement	SANS 1223	75% of hydraulic test pressure
GRP	SANS 1748-1	1.5 times the rated pressure class
Polyethylene (PE)	SANS 4427	1.5 times the rated pressure of the pipe
Steel-mesh-reinforced PE	SANS 370	1.5 times the rated pressure of the pipe
Polypropylene	SANS 15874-2 and SANS 15874-3	1.5 times the rated pressure of the pipe
uPVC	SANS 966-1	1.5 times the rated pressure of the pipe
mPVC	SANS 966-2 or SANS 1283	1.5 times the rated pressure of the pipe
oPVC	SANS 16422	1.5 times the rated pressure of the pipe

Add the following new subclauses:

PSL 7.3.4 Initial Filling of Pipeline

The entire process for filling the pipeline at any time during testing or disinfection shall be carried out under the supervision of the Engineer and will also be monitored by the Engineer and/or the Employer's personnel. Under no circumstances will the Contractor be allowed to carry out filling of the pipeline without the supervision of the Engineer, neither shall he/she permit any other persons to carry out such filling without the written permission of the Engineer.

Any damage to the pipeline caused by non-compliance with this Sub-Cause shall be rectified at the Contractor's expense.

PSL 7.3.5 Connections after Testing

The connections of the new pipework to the existing pipework shall only be carried out after the pipeline testing has been completed and accepted by the Engineer. For this reason, testing must be carried out against a blank flange or bullnose end cap at these locations.

PSL 7.3.6 Remedial Measures

In the event that a pipe section fails a test, the Contractor shall carry out all remedial measures necessary to obtain a successful test of each individual section and the entire pipeline, at his/her own expense. Such remedial measures shall in no way compromise the original pipeline specifications.

PSL 7.3.7 Draining of the Pipeline

The pipeline may have to be drained to carry out remedial measures and it must be drained before the disinfection process commences. The pipeline shall be drained via the scour valves in a manner that does not cause erosion of the streambeds or negatively impact on the environment in any way. All such drainage of the pipeline shall be carried out under the supervision of the Engineer's

Representative.

Add the following subclauses:

PSL 7.5 Testing of Valves

All valves shall be pressure tested according to SANS 664 or other applicable code at the appropriate test pressure. Test certificates shall be issued to the Engineer upon delivery to site.

No separate payment shall be made for testing of valves and hydrants and the scheduled rates for the supply and installation of valves shall include for all costs in respect of testing.

PSL 7.6 Commissioning

The pipeline will be considered to have been commissioned and practically complete once all the associated structures are sufficiently complete to carry out their structural and hydraulic function and the hydraulic test and disinfection of the entire pipeline has been successfully completed."

PSL 7.7 Water Tightness Test for Chambers

Add new Sub-clause:

On completion of each concrete chamber, and prior to completion of the backfilling around the chamber, a water tightness test shall be undertaken by the Contractor. This shall be carried out by excavating a trench approximately 0,5 m deep around the periphery of the chamber and continuously (for at least 4 hours) maintaining it full of water. Should there be any noticeable leaks into the chamber, the Contractor shall carry out at his/her own expense whatever measures are necessary to waterproof the chamber to the Engineer's satisfaction.

PSL 7.8 Testing of PE pipes and materials

PSL 7.8.1 Raw Material Acceptance Tests:

The material used for the production of the pipes and fittings shall be a high density polyethylene PE 100 complying to SANS ISO 4427 Part 1. To ascertain the quality of this product the following tests shall be performed, prior to manufacture of the pipes or fittings.

- Density
- Melt Flow Index
- Carbon Black Content
- Thermal Stability

Copies of all test schedules and manufacturer's quality control records shall be available for examination by the Employer and/or the Engineer.

The following documents are required:

- Certificate of Registration – SANS ISO 9001:2008 or National Equivalent
- Permit Certification – SANS 4427 for PE 100
- the Quality Control Plan (QCP shall include Raw Material and Product Test Certificates)
- SANS or National Equivalent Quality Systems Audit Reports – Last 2 Audits

PSL 7.8.2 Testing of Pipes:

Testing as contained in the SANS 4427:1996/ ISO 4427:1996 specification Part 1 and

2 will be used as guidelines. Tests shall also be conducted ad-hoc by a registered and authorised testing authority.

PSL 7.8.3 Destructive Testing of Welds

The testing of welds shall comply with the requirements of SANS 6269 Edition 1.1.

The standard destructive tests described are as follows:

- Tensile test;
- Tensile-creep test; (not required unless specified normally for chemical high end applications only)
- Bend test; and
- Peel test for electrofusion joints only.

PSL 7.8.4 Non-Destructive Testing of Welds

The testing of welds by non-destructive testing will be conducted by the Engineer's Representative on site and before any production weld is made by the contractor on site. The following procedure shall be followed:

- The Contractor shall not undertake any welding without the presence of Engineer's Representative;
- The testing machinery shall be checked and approved by the Engineer's Representative before testing commences;

PSL 7.8.5 Field Pressure Testing Procedure for HDPE pipes

The method described below describes the procedure to be followed for field pressure testing of HDPE pipe:

- Fill the pipe with water
- Bleed off any trapped air
- Over a period no longer than 10 minutes, increase the pressure at a constant rate to the specified field test pressure (the Field Test Pressure Horizon is shown on the small scale long section drawing)
- Maintain the test pressure by continuous pumping for 10 minutes, then stop pumping
- Close the shut-off valve to the pipe and monitor the pressure for a period of 60 minutes. Inspect the pipe visually for leaks during this time.
- If the pressure has dropped more than 30% at the end of the 60 minute period, the pipe shall not have passed the pressure test. Continue to look for leaks and repair as necessary.
- If the pressure has dropped less than 30% at the end of the 60 minute period, rapidly decrease the pressure in the pipe by 2,0 bar (200 kPa) by releasing water from the pipe.
- Monitor the pressure for 60 minutes. If the pressure remains constant or increases during this time the pipe is deemed to have passed the pressure test.

If the pipeline does not pass the pressure test:

- Remove the test pressure
- Permit the test section to 'relax' for not less than 8 hours

- Repeat the above procedure.

PSL 8 MEASUREMENT AND PAYMENT

PSL 8.2 Scheduled Items

PSL 8.2.1 Supply, Lay and Bed Pipes Complete with Coupling……………….............Unit : m

Rename this subclause PSL 8.2.1 a) and add the following:

“A maximum payment of 80 % of the tendered rates will be made for a completed section of pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 20% of the tendered rates will be made upon successful completion of the pressure testing and disinfection for the relevant section of pipeline.

The rates tendered for the laying and bedding of pipes, bends, fittings, and valves, shall be deemed to include the costs associated with the field pressure testing and disinfection of the pipeline.

Pipelines will be measured by length over all lengths as laid. No deduction will be made for specials and valves. Separate items will be scheduled for each diameter and each type and class of pipe laid.”

Add the following subclause:

PSL 8.2.1 b) Collect from Designated Pipe Yard/s, Transport, Lay and Bed Pipes Complete with Coupling…………………………………………..………………………..…… Unit : m

Pipelines will be measured by length over all lengths as laid. No deduction will be made for specials and valves. Separate items will be scheduled for each diameter and each type and class of pipe laid.

The rates shall cover the cost of the collection of the pipes from pipe yard, transportation to the site of the works, offloading and placing/stringing to suit the contractor’s laying methods, handling, inspecting, bedding, laying, jointing, cutting, testing and, when relevant, disinfecting the pipes and the joints.

A maximum payment of 80 % of the tendered rates will be made for a completed section of pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 20% of the tendered rates will be made upon successful completion of the pressure testing and disinfection for the relevant section of pipeline.”

PSL 8.2.2 Extra-over 8.2.1 a) and 8.2.1 b) for the Supplying, Laying and Bedding of Specials Complete with Couplings.

Add the following:

“A maximum payment of 80 % of the tendered rates will be made for a special once installed in the pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 20% of the tendered rates will be made upon successful completion of the pressure testing and disinfection for the relevant special.

The rates for the supply and installing of valves and specials shall cover the cost of any cutting, trimming, and jointing of pipes required for the installation of valves, bends and fittings in the positions shown on the drawings. Unless specific provision is made in the Bills of Quantities, no separate payment will be made for forming of any additional joints and/or for the supply of additional jointing materials which may be required for the connection of cut pipes.

The rates tendered for the laying and bedding of pipes, bends, fittings, and valves, shall be deemed to include the costs associated with the field pressure testing and disinfection”.

PSL 8.2.3 Extra-over 8.2.1 a) and 8.2.1 b) for the Supply, Fixing and Bedding of Valves

Add the following:

“A maximum payment of 80 % of the tendered rates will be made for a valve once installed in the pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 20% of the tendered rates will be made upon successful completion of the pressure testing and disinfection for the relevant special.

The rates for the supply and installing of valves and specials shall cover the cost of any cutting, trimming, and jointing of pipes required for the installation of valves, bends and fittings in the positions shown on the drawings. Unless specific provision is made in the Bills of Quantities, no separate payment will be made for forming of any additional joints and/or for the supply of additional jointing materials which may be required for the connection of cut pipes.

The rates tendered for the laying and bedding of pipes, bends, fittings, and valves, shall be deemed to include the costs associated with the field pressure testing and disinfection”.

PSL 8.2.15 Special Wrapping in Corrosive Soil

Change the heading of this subclause as follows:

PSL 8.2.15 Additional corrosion protection of Pipes, Specials, Joints, Valves and Fittings

a) **Additional Corrosion Protection of Flanges and Flexible Adaptor/Anchoring Joints ...Unit: No.**

Separate items will be scheduled for flanges, flexible joints and adaptor/anchoring joints of each diameter and type. The unit of measurement shall be the number (No) of paired flanges/joints protected as specified in the specifications. The rate will include for all materials, manufacturing, delivery, painting, wrapping and erection of each unit.

b) **Additional Corrosion Protection of Buried Valves, and specials ……….……….Unit: No or m**

Separate items will be scheduled for valves, flexible and flanged joints and pipes of each diameter and type. The unit of measurement shall be the number (No) of buried paired couplings, joints, flanges or valves as specified or the length of pipe as specified. The rate will include for all materials, manufacturing, delivery, painting and erection of each unit.

In the case of valves, the rate shall include for protection of the whole of the valve body, all flanges integral to the valve, the connecting flanges to the valve i.e. including the two flanges of the pipework connected to either side of the valve, and the packing of mastic (without tape or sheathing) over the gland adjusting bolts and nuts."

c) **Additional Corrosion protection of Cast-in Pipes and Fittings….………………..Unit: No or m²**

If separate items are scheduled, for each diameter of cast in pipe and fittings to be wrapped, the unit of measurement shall be No. of completed wrappings inclusive of the encasement length. The rate will include for all materials, manufacturing, delivery, painting and erection of each unit.

d) **Additional Corrosion protection of Permanently Exposed Pipes and Fittings….Unit: m or m²**

If separate items are scheduled for each diameter of exposed pipe (above and below ground) to be protected, the unit of measurement shall be in meters for the length of exposure. If not the unit of measurement will be square metres of completed wrapping and/or painting as specified.

Add the following new payment items:

PSL 8.2.16 : Pipeline Markers………………………………………….…………..…… Unit : No

The unit of measurement will be the number of markers erected and accepted by the Engineer and the rate will include for all materials, manufacturing, delivery, painting and erection of each unit.

PSL 8.2.17 : Valve Markers………………………………………..………………………. Unit : No.

The unit of measurement will be the number of markers erected and accepted by the Engineer and the rate will include for all materials, manufacturing, delivery, painting and erection of each unit.”

PSL 8.2.18 Cutting into and Connecting to Existing Pipeline ………………………….Unit : Sum

Cutting into and connecting to existing pipeline

The rate for cutting into and connecting to existing pipelines shall cover the cost of liaison with the Employer’s Operators, isolating and draining the existing pipeline, cleaning and preparing the pipe for cutting, cutting, preparing the pipe ends for jointing, welding / jointing and connecting the new pipework, making good internal linings and external coatings, re-commissioning the pipeline, and including all temporary supports, bedding and backfilling.

PSL 8.2.19 Cement Stabilising Bedding and Selected Fill around Pipes………………….Unit : m³

An item, extra-over laying and bedding pipes, will be measured for payment for cement stabilising the bedding and selected fill around the pipes where directed by the Engineer. Separate items will be scheduled for stabilising on steep slopes and for stabilizing at watercourse crossings.

The tendered rates shall cover all additional costs associated with supplying the cement at the percentage specified and mixing it in and achieving Optimum Moisture Content for compaction around the pipe.

“PSL 8.2.20 Mitre Cut Joints.. Unit: No.

Mitre cuts (two piece bends) up to 15^{o} in steel pipelines may be carried out in the field only if ordered/permitted by the Engineer.

The rate shall cover the cost of cutting, forming, and bevelling the ends of the pipes at the joint, all welding, testing and forming joint holes in all materials and for making good the internal linings and external coatings on the welded joints.

PSL 8.2.21 Cutting Pipes

a) **Extra over for forming scarf joint……………………………………….…………………Unit: No.**
b) **Extra over for cutting pipe as closure……………………………….……………………Unit: No.**

Payment will only be made where shown on the drawings or where instructed by the Engineer's Representative. No payment will however be made for cutting pipes to suit the installation of bends, fittings, and valves that are shown on the drawings.

The rates shall cover the cost of cutting, forming and bevelling the ends of the pipes at the joint, all welding, testing and forming joint holes in all materials and for making good the internal linings and external coatings on the welded joints.

PSL 8.2.22 Repair of FBMDPE Coatings Defects

a) **Repair defect smaller than 650mm^2 (Small Areas)………………………….…………….Unit: No**

Repair defects in FBMDPE coatings of size smaller than 651 mm^2 according to PSL 3.9.3.1 & PSL 3.9.3.12

b) **Repair defect larger than 650mm^2 (Large Areas)…………………….……………….. Unit: No**

Repair defects in FBMDPE coatings of size between 651 mm^2 and 1000 mm^2 according to PSL 3.9.3.1 & PSL 3.9.3.11

c) Repair defect larger than 1000mm^2 (Very Large Areas)…………………..…………….. Unit: m²

Repair defects in FBMDPE coatings of size between 651 mm^2 and 1000 mm^2 according to PSL 3.9.3.1 & PSL 3.9.3.11

PSL 8.2.23 Repair of 3 Layer PE Coatings Defects…………………………………….. Unit: m^2

Repair defects in 3 Layer Polyethylene coatings according to PSL 3.9.3.1 & PSL 3.9.3.13

PSL 8.2.24 Repair of Cement Mortar Lining Defects…………………………………… Unit: m^2

Repair defects in CML lining according to PSL 3.9.3.1 & PSL 3.9.3.10

PSL 8.2.25 Repair of Damage due to Thermic Welding……………………………….. Unit: No

Repair defects in pipe coating and lining arising from thermic welding for continuity bonding according to PSL 3.9.3.14

PSLB BEDDING (PIPES) (SANS 1200 LB)

PSLB 2.3 DEFINITIONS

Main fill:
Delete "150 mm" in second line and substitute "300 mm".

PSLB 3 MATERIALS

PSLB 3.1 Selected Granular Material

(For bedding material for steel pipes see PSLB 3.3 below)

In the second line delete "19 mm" and substitute "10 mm".

Add to the Sub-Clause:

The maximum compactibility factor shall be 0,4.

PSLB 3.2 Selected Fill Material

Not required. All material up to the underside of backfill shall be measured as selected granular. (for bedding material for steel, GRP and PVC pipes see PSLB 3.3)

PSLB 3.3 Bedding

All pipes except concrete stormwater pipes laid under this Contract will be considered as being flexible pipes. Bedding (selected granular and selected fill material) for steel, GRP, PVC, large-bore HDPE (>DN200) and concrete stormwater pipes along roads shall be (for the Mthatha area) G7 granular decomposed dolerite (known locally as “Sugar Dolerite” or “Sibunga”), carefully selected, with maximum particle size of 5 mm and which shall not cake nor form lumps when drying. Samples of bedding material shall be submitted by the Contractor to the Engineer for approval well in advance of construction. Only after the Contractor has received written approval from the Engineer, may he/she proceed with placing the approval material as selected granular material.

No sharp-edged stones shall be allowed to come into contact with the pipes or fittings. Joint holes (pockets) shall be provided in the trench bottom and bedding, at each pipe joint to facilitate welding, and no extra payment will be made for forming or filling the joint holes (pockets) with padding sand.

All bedding used for the cradle beneath and surrounding the coated steel pipes shall comply with the following requirements:

GRADING ANALYSIS RANGE	
SIEVE SIZE (mm)	**PERCENTAGE PASSING**
6,7	98 to 100
4,76	85 to 100
2,36	55 to 95
1,18	30 to 75
0,60	20 to 50
0,425	16 to 38
0,30	13 to 27
0,15	5 to 18
0,075	0 to 12

The material shall be free of organic matter and shall have a compatibility factor of not more than 0.4.

The material should be classified as silty to fine sand having a stiffness ratio of not less than 5,0 MPa. Furthermore, the origin of the materials should, preferably, be river transported since it is preferable that the larger grains (3,0 to 4,8 mm in size) be rounded and not sharp and angular.

Depending on the actual material supplied by the Contractor, the moisture content may be critical to enable satisfactory placing and compaction and the Contractor will be deemed to have allowed in his tendered rate for any and all adjustments required to the moisture content of the bedding material at all times.

Items have been provided in the Bill of Quantities for the provision of approved bedding material from approved Commercial or other approved off-site sources.

No extra payment will be made for forming or filling joint holes (pockets).

Bedding for small-bore HDPE pipes (water reticulation) and concrete stormwater pipes traversing open ground areas (ie *not* along roads or under platforms) shall be material selected from local excavations or stockpiles.

PSLB 3.4 Selection

PSLB 3.4.1 Suitable Material Available from Trench Excavation

Delete the Sub-Clause and substitute the following:

The excavation of a pipe trench shall comply with the requirements of Sub-Clause 5.4 of SANS 1200 DB and the provisions of Sub-Clause 3.7 of SANS 1200 DB (in terms of which, for the purposes of providing bedding materials, the Contractor is not required to use selective methods of excavating) shall apply. Nevertheless the Contractor shall take every reasonable precaution to avoid burying or contaminating material that is suitable and is required for bedding or covering the pipeline. If, in the opinion of the Engineer, bedding material can be produced from the excavated material, the Contractor shall, if so ordered by the Engineer, screen or otherwise treat (as scheduled) the excavated material in order to produce material suitable for bedding (see also Sub-Clause PSLB 8.1.2).

PSLB 5 CONSTRUCTION

PLSB 5.1 GENERAL

PSLB 5.1.4 Compacting

Delete the second line and substitute: top of the pipeline) shall be 93% mod AASHTO.

Add to Sub-Clause 5.1.4:
Steps will have to be taken by the Contractor to ensure that flexible pipes do not deform excessively in cross-section during and after construction and backfilling operations. The maximum deflection which will be acceptable at any stage during or after construction is 2% of the pipe diameter horizontally or vertically. The Contractor will be required to provide the necessary apparatus and to monitor deflection during construction.

Pipe deformations will only be maintained within the specified tolerances by correct backfilling practice. No heavy compaction equipment will be permitted for compaction of any pipe bedding, only pneumatic or hand rammers being acceptable. To this end, and to achieve the 93% compaction specified it is required that the bedding material be brought up evenly on either side of the pipe. The use of complete saturation of the material as a method of achieving the specified compaction may, subject to the Engineer's approval, be used. However, in this regard, Tenderers are advised that the presence of excessive quantities of water in the pipe trench could lead to flotation of the pipe.

Prior to the commencement of pipe laying the Contractor will be required to submit, to the Engineer, for his approval, his proposed methods of placing, and compacting methods which he proposes to implement in order to ensure compliance with the specification.

PSLB 5.1.5 Testing

Flexible and flanged joints shall be left exposed with a minimum of 300 mm clearance around the bottom of the pipe during hydraulic pressure testing of the pipe to facilitate inspection.

PSLB 5.2.5 Stone Bedding

In areas where waterlogged conditions exist or where ordered by the Engineer, special drains consisting of a 150 mm thickness (See PSDB 5.5) of single sized stone with a geofabric filter surround ("Bidim" Grade A4 or similar approved) extending the full width of the trench shall be provided below the bedding to the pipes. The excavation for these drains will be measured in cubic metres at the contract rate applying to unsuitable excavation below the bottom of the trench. The stone filling will be paid for per cubic metre and the geofabric filter will be paid for per square metre. All measurements in this connection will be to a width equal to the base widths and depths ordered.

PSLB 5.3 Placing and Compacting Flexible Pipes

PSLB 5.3 (a) Bedding Cradle

Delete the sub-clause and substitute the following:

The pipes shall be bedded on a minimum 100 thick layer of compacted granular bedding material on which a 50 mm thick layer of uncompacted granular bedding material has been placed and spread. Loose granular bedding material lying next to the pipe shall be placed into the haunch area and compacted with suitable hand tools (covered with rubber to prevent damage to the pipe coating), and additional selected granular material shall be added and compacted in 150 mm thick layers up to the mid point of the pipe diameter in the vertical plane. The remainder of the bedding i.e. the selected fill blanket, shall be placed in layers up the sides of the pipe, each layer being compacted until a level of 300 mm above the crown of the pipe is reached.

All bell (fox) holes shall be filled with bedding material.

PSLB 5.3 (b) Selected Fill Blanket

Delete "200 mm" from title.

PSLB 6 TOLERANCES

PSLB 6.1 Moisture Content and Density

Add to the Sub-Clause:

The permissible deviations applicable are to be those for Degree of Accuracy II class of work.

PSLB 8 MEASUREMENT AND PAYMENT

PSLB 8.1.3 Volume of Bedding Materials

Add the following:

The volume of bedding materials will be computed from dimensions shown on the drawings. The volume occupied by the pipe (measured to the outer diameter) shall be excluded from the bedding volume and will not be measured. No additional payment will be made for bedding material placed in bell (fox) holes

PSLB 8.2.3 Concrete Bedding Cradle

Add the following paragraph to the Sub-Clause:

All concrete bedding to pipes will require formwork. The rate for concrete bedding shall include for the supply, installation and stripping of all formwork.

PSLB 8.2.4 Encasing of Pipes in Concrete

Delete the fifth and sixth lines and substitute the following:

encasing the pipe in concrete 150mm thick each side of the pipe and to 150mm above the crown of the pipe including the cost of formwork, (if any), etc. and the cost of formwork to form stop ends on either side of collars, couplings, joints etc if instructed by the Engineer.

The rate for concrete encasing shall include for the supply, installation and stripping of all formwork.

PSLB 8.2.6 Drainage Layer (New Sub-Clause)

Add the new sub-clause:
Supply and place beneath pipe, 150mm crushed stone layer as ground water drainage layer. The excavation for these drains will be measured in cubic metres at the tendered rate applying to unsuitable excavation below the bottom of the trench (SANS 1200 DB 8.3.2 c).

PSLB 8.2.6 a) The rate for stone filling shall be per cubic metre of stone fill, measured according to a width equal to the base widths and depths ordered…………………………………………………………………………..…..Unit : m^3

PSLB 8.2.6 b) Supply and installation of geofabric filter material (BIDIM Grade A4 or similar) around stone. The rate shall be per square metre of geofabric to enclose the stone material, measured net according to a width equal to the base widths and depths ordered…………………………………………………………..………Unit : m^2

PSLC CABLE DUCTS (SANS 1200 LC)

PSLC 3 MATERIALS

Add the following clause

PSLC 3.5 Classes of Excavation

"For this contract, the classes of excavation will be subdivided as follows:

(a) Labour Intensive Excavation

(i) Soft Excavation

Soft excavation shall be that excavation in material, which in the opinion of the Engineer, can be efficiently excavated and loaded by means of hand-held tools excluding pneumatic or hydraulic breaking tools. Soft excavation shall include all boulders with a volume of less than 0.125 m3 and a maximum dimension of 500 mm, which can still be removed by hand methods.

(ii) Hard Excavation/Hard Rock

Hard excavation shall be excavation in material, which in the opinion of the Engineer, can only be removed efficiently with mechanical equipment such as jackhammers, drilling & blasting etc. Hard excavation shall also include boulders with a volume > 0.125 m3 and the maximum dimension > 500 mm, which cannot be broken down and removed by hand methods.

(b) Machine Based Excavation

In cases where heavy excavation equipment is permitted, the classes of excavation will be subdivided as follows:

(c) Soft excavation

Soft excavation shall be excavation in all materials and boulders which in the opinion of the Engineer can be efficiently excavated and loaded by a 30t excavator fitted with 'rock bucket' (excavator bucket typically fitted with not more than 3 tines designed to loosen weak rock material).

(b) Hard Excavation / Hard Rock

Hard excavation shall be excavation in materials and boulders, which in the opinion of the Engineer, can only be removed efficiently with mechanical equipment larger than a 30t excavator, or with jackhammers, drilling & blasting, expanding grout etc.

PSLE STORMWATER DRAINAGE (SANS 1200 LE – 1982)

PSLE 3 MATERIALS

PSLE 3.1(a) Precast Concrete Pipes

Delete the sub-clause and substitute:
Concrete pipes shall be of reinforced concrete and shall comply with SANS 677 and be of the class as indicated on the drawings or scheduled in the Bill of Quantities.

PSLE 3.1 (d) Skewed Ends

Add to the Sub-Clause:
Wherever required skew ends may be cut on site.

PSLE 3.1 (f) Pipes for Subsoil Drains (new Sub-clause)

Add new Sub-Clause:

Pipes for subsoil drains shall have the specified internal diameter, which shall not be less than 100 mm, and shall be slotted uPVC or HDPE pipes with a wall thickness in accordance with Class 4 pressure pipes to SANS 966 or SANS ISO 4427.

The size of the perforations in perforated pipes shall in all cases be 8 mm + 1,5mm diameter and the number of perforations per metre shall not be less than 26 for 100 mm pipe and 52 for 150 mm pipe. Perforations shall be spaced in two rows for 100 mm pipes and four rows for 150 mm pipes.

Slotted uPVC or HDPE pipes shall have a slot width of 8 mm with a tolerance of 1,5mm in width. The arrangement of slots shall be to the Engineer's approval but the total slot area shall not be less than specified for the perforations.

PSLE 3.4.1 Bricks

Add to the Sub-Clause:

Cement bricks complying with the relevant requirements of SANS 1215 shall be considered as being acceptable.

PSLE 3.6 Concrete (new Sub-Clause)

Concrete shall comply with the relevant requirements of SANS 1200 G or SANS 1200 GA, whichever is included in the project specification.

PSLE 3.7 Permeable Material for Groundwater Drains

Add the following new Sub-Clause:

Permeable filter materials for groundwater drains shall consist of crushed stone of suitable grading.

Permeable materials shall conform to the following requirements:

Crushed stone shall be clean, hard single sized stone and shall be free from shale, clay and other deleterious substances.

The aggregate crushing value of the stone shall not exceed 30 when tested in accordance with TMH 1 Test Method B1.

PSLE 5 CONSTRUCTION

PSLE 5.1.4 Culvert Construction after Earthfill

Add to the Sub-Clause:

Wherever possible pipes and rectangular culverts shall be laid under trench conditions.

The compacted fill shall first be constructed to a height of 300 mm above the culvert before excavating for the culvert.

The trench width shall not exceed the outside diameter of the pipe plus 600 mm. A working width of 600 mm each side shall be allowed for rectangular culverts.

PSLE 5.2.2 Pipe Culverts

Add to the sub-clause:

The bedding for stormwater pipes shall be to the requirements of SANS 1200 LB as amended by the project specification and shown on the drawings.

The ogee joints shall be fitted with 200 mm x 6 mm rubber sealing collars conforming to the latest SANS 974 Specification and with a Shore hardness of approximately 40 degrees, or alternatively, the ogee joints shall be primed and double wrapped in accordance with the manufacturer’s recommendations with 200 mm wide impermeable wrapping tape to the Engineer’s approval.

PSLE 5.2.3 Concrete Casing of Pipelines

In second line of the Sub-Clause substitute “Grade 15/19” for “mix 15”.

PSLE 5.2.6 Construction of Groundwater Drains

Add the following Sub-Clause:

On completion of excavation the trench shall be lined with geotextile as specified or shown of the drawings.

A layer of permeable material of the class and thickness as shown on the drawings shall be placed on the bottom of the trench and lightly tamped and finished to the required gradient.

Pipes of the type and size required shall then be firmly bedded on the permeable material true to level and grades coupled where required and the trench backfilled in layers not exceeding 100mm with further permeable material to such height above the pipes as shown on the drawing or directed by the Engineer. The permeable material shall be lightly compacted and finished to the required level. The trench shall be specially protected against the ingress of water before completing the impermeable layer.

When placing successive layers the lower layer shall not be walked on or disturbed more than can be avoided. Care shall be taken to prevent the contamination of permeable material during construction of the groundwater drains and all permeable material contaminated by soil or silt shall be removed and replaced by the Contractor at his own expense.

Where plain butt joint pipes are used they shall be laid firmly together to prevent infiltration of backfill material. Perforated and slotted pipes shall be joined by couplers. Perforated pipes shall be laid with the perforations at the bottom, as instructed.

The higher end of groundwater pipe drains shall be sealed off with a cap or loose concrete cap of Class 20/19 concrete, as shown on the drawings, and at the lower end the pipe drain shall be built into a concrete headwall providing a positive outlet or connected to stormwater pipes or culverts.

PSLE 5.8 Open Drains (new Sub-clause)

Add new Sub-Clause:

Open drains are to be constructed to the details shown on the drawings, or as directed by the Engineer, to the correct line, levels and cross-sections. The material excavated from open drains is to be stockpiled for future use.

Measurement of open drain excavation shall be calculated from natural ground level or, in the case of drains within a road reserve, from the reduced level in the road excavation, and payment will be made on a rate per m^3 basis irrespective of depth. The rate is to include for all work required to trim the drain(s) to the correct lines and levels.

PSLE 5.9 Stone pitching (new Sub-Clause)

Where ordered by the Engineer, open drains, stormwater outlets, etc, shall be pitched with stone. Notwithstanding the provisions of SANS 1200 DK Clause 3.2.1 Table 2 pitching for lining drains and stormwater outlets shall have a minimum size of 100 x 100 x 75 mm deep. In all other respects the provisions of SANS 1200 DK as amended by the Project Specification shall apply. Before pitching is commenced, all slopes and surfaces to receive pitching shall be carefully trimmed and dressed to the correct lines and grades. The pitching stones are to be laid with joints broken as much as possible and are to be hammered solidly into position to present a regular and uniform surface. All joints are to be grouted to their full depth with 4:1 cement:sand mortar.

PSLE 5.10 Cutting of Pipes (new Sub-Clause)

As far as is possible culvert lengths shall be such that pipe units need not be cut. Should any straight or skew cuts be necessary, such cutting will not be measured and paid for separately in terms of Sub-Clause 8.2.4 since all additional work required in cutting the pipes as well as the wasted pipe ends shall be regarded as being included in the payment for the supply, lay, joint, bed and test of the relevant pipe culverts, as per Sub-Clause 8.2.1.

PSLE 8 MEASUREMENT AND PAYMENT

PSLE 8.2.1 Supply and Lay Concrete Pipe Culverts

Delete the title of the sub-clause and substitute:

Supply, Lay, Joint, Bed and Test Pipelines

Add to the Sub-Clause:

The bedding shall be to the requirements of SANS 1200 LB as amended by the project specification and shown on the drawings.

Add to the Sub-Clause:

The rates shall cover the cost of providing the pipes as well as the cost of laying, bedding, jointing and making connections into manholes, including dealing with stormwater flow and testing the pipeline.

PSLE 8.2.4 Extra over Items 8.2.1 and 8.2.2 for Cutting End Units for Culverts on Site

Delete this Sub-Clause as no extra payment will be made for cutting end units for culverts.

PSLE 8.2.14 Minor Drainage Structures (new Sub-Clause)

Catchpits, manholes, drop inlets and headwalls constructed will be measured and paid for as complete units.

Item : Supply, construct and install drainage unit of the type, size category and depth stated in the Bill of Quantities;:………………………………………………………………………………. Unit : No

The unit of measurement shall be the number of the particular type, size and category of drainage units supplied, constructed and installed in accordance with the drawings.

The tendered rate shall include for all materials, plant labour, supervision and incidentals for the construction of the drainage units complete and in accordance with the drawings.

The tendered rate shall further include for all necessary excavation in all materials, backfilling and disposal of surplus materials, formwork, concrete, benching, concrete finish, reinforcement, precast elements, steel channels and grids, step irons and all other items not specifically measured elsewhere, necessary for completion of the unit in accordance with the drawings.

The tendered rate shall include for all costs involved in complying with the requirements of the relevant specifications in respect of the individual types of work involved in completion of the units.

The tendered rates shall exclude for excavation in intermediate and hard material, payment for which shall be made as an extra over in the Schedule of Quantities.

PSLE 8.2.15 Stone Pitching (new Sub-Clause)

Payment for stone pitching (PSLE 5.9) will be made at a rate per unit finished area and the rate is to include for all trimming and dressing of the excavation, laying of the stones and grouting of the joints:. Unit : m^2

C3.10 General Specifications

GIBB 002 General Mechanical
GIBB 003 General Pumping Equipment
GIBB 007 Painting and Corrosion Protection
GIBB 008 Cranes, Gantries, Hoists and Winches

GENERAL SPECIFICATION

GIBB 002 – GENERAL MECHANICAL

REV 1.0

Table of Contents

1 SCOPE

1.1 General

This Mechanical General Specification gives a general description of the requirements to be met, and provides the basic quality, safety, design and materials requirements of all of the mechanical plant and equipment that is to be supplied and installed under the mechanical section(s) of the Contract.

In the event of there being a discrepancy between any specification, including those specifications dealing with civil and building works, and/or the drawings and/or the Bills of Quantities, the discrepancy shall be drawn to the attention of, and resolved by, the Employer's Agent before the execution of any work associated with the discrepancy

This Mechanical General Specification, when read together relevant sections of the Project Specifications, indicates the minimum requirements. Where no specific requirement is indicated, it does not relieve the Contractor of any statutory or common law duty and the Contractor will still be required to comply with all relevant requirements and/or standards from any statutory body that is applicable to the plant and equipment being designed, supplied and installed.

1.2 Related Specifications

GIBB-003	General Pump Specification
GIBB-007	Painting and Corrosion Protection
GIBB-008	Cranes, Gantries, Hoists, Winches

2 INTERPRETATION

2.1 Definitions

In this Section the word or words:-

- **"design"** includes, as applicable, the submission of design documentation for acceptance by the *Employer's Agent*,
- **"supply"** includes, as applicable, the purchase of materials or goods, manufacture and fabrication, any specified corrosion protection measures and any off-site inspection or testing,
- **"installation"** includes, as applicable, all handling and transport from storage, if necessary, all erection and setting to work,
- **"Tests on Completion"** includes, as applicable, the dry and wet tests as specified,
- **"gate"** is a panel closing the entire passage of a waterway and may be wheeled or sliding.
- **"stoplog"** A sliding component used to close a waterway passage.
- **"hoists"** is a collective term referring to all hydraulic, electrical and mechanical equipment and Plant specified for raising and lowering the "gates" between their fully inserted (closed) positions and their fully raised (stored) positions and any intermediate position, together with other lifting devices for general use.
- **"Employer's Agent"** and **"Engineer"** shall be synonymous.

2.2 References

References made hereinafter to specifications of the South African Bureau of Standards (SABS/SANS) or the British Standards Institute (BS) or the International Standards organisation (ISO) or the American Society of Mechanical Engineers (ASME) or the American Standard for Testing and Materials (ASTM) shall be deemed to include all revisions of and/or additions, supplements, modifications to such specifications ruling four weeks prior to the closing date of tenders, unless otherwise specified.

2.3 Supporting Standards and Specifications

The following Standards are referred to in this specification:

SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 936/7	Spheroidal graphite iron castings
SANS 1062	Pressure and vacuum gauges
SANS 1804	Induction Motors
SANS 1123	Pipe flanges
SANS 1186	Symbolic safety signs Part 1: Standard signs and general requirements
SANS 1200	Standardized Specification for Civil Engineering Construction
SANS 1431	Weldable Structural Steels
SANS 1700	Fasteners
SANS 10104	Handrailing and balustrading (safety aspects)
SANS 10108	The classification of hazardous locations and the selection of equipment for use in such locations
SANS 10111	Engineering drawings
SANS 10160	Basis of structural design and actions for buildings and industrial structures
SANS 10162	The structural use of steel
SANS 60034	Rotating Electrical Machines
SANS 61241	Electrical apparatus for use in the presence of combustible dust
BS 18	Method for tensile testing of metals (including aerospace materials)
BS 29	Specification for carbon steel forgings above 150 mm ruling section
BS 806	Design and construction of ferrous piping in connection with land boilers (used for arc welding specification of all pipe flanges)
BS 970	Specification for Wrought steel for mechanical and allied engineering purposes
BS 1649	Guards for Shaft Couplings
BS 1775	Steel tubes for mechanical, structural and general engineering purposes
BS 2633	Class 1 Arc welding of steel pipework.
BS 2971	Class II Arc welding of steel pipework.

BS 3100	Chemical composition, heat treatment and mechanical properties of cast steels.
BS 4360	Specification for Weldable Structural Steels
BS 4677	Arc welding austenitic stainless steel pipework.
BS 4080	Methods for Non-Destructive Testing of Steel Castings
BS 4124	Method for Ultrasonic Detection of Imperfections in Steel Forgings
BS 4871	Specification for Approval Testing of Welders Working to Approved Welding Procedures
BS 4872	Specification for approval testing of welders when welding procedure approval is not required.
BS 5135	Process of Arc Welding of Carbon and Carbon Manganese Steels
BS 5400	Steel, Concrete, and Composite Bridges
BS 7854	Mechanical Vibration – Evaluation of machine vibration by measurements on non-rotating parts
BS EN 1011	Arc welding carbon and carbon manganese steelwork.
BS EN 1092	Flanges and their Joints
BS EN 1563	Founding spheroidal graphite cast irons
BS EN 10025	Hot rolled products of structural steels
EN 10028-7	Flat products made of steels for pressure purposes
EN 10088	Stainless Steels
ASTM D297:	Test Methods for Rubber Products -Chemical Analysis
ASTM D395:	Test Methods for Rubber Properties - Compression Set
ASTM D412:	Test Methods for Rubber Properties in Tension
ASTM D413:	Test Methods for Rubber Properties - Adhesion to Flexible Substrate
ASTM D471:	Test Methods for Rubber Properties - Effect of Liquids
ASTM D572:	Test Method for Rubber Deterioration by Heat/Oxygen
ASTM D573:	Test Method for Rubber Deterioration in Air Oven
ASTM D1149:	Test Method for Rubber Deterioration by Surface Ozone Cracking
ASTM D2240:	Test Methods for Rubber Property-Durometer Hardness
DIN 53504:	Determination of tensile stress/strain properties of rubber
DIN 53505:	Shore A and D hardness testing of rubber and elastics
DIN 53509-1:	Determination of the resistance of rubber to ozone cracking under static load
DIN 53516:	Determination of abrasion of rubber
DIN 53517:	Testing of compression set of rubber at constant strain

3 SAFETY

3.1 Hazardous Locations

Equipment which is to be installed in areas zoned 0,1 or 2 for gasses and/or zoned 20, 21 or 22 for dusts in terms of SANS 10108, shall be designed to comply with the requirements of that Standard.

3.2 OHS Act and Safety

In addition to the safety requirements to be complied with during the construction of the Works on Site, the Contractor is responsible for ensuring that all equipment supplied and the complete installation complies with the Occupational Health and Safety Act, Act 85 of 1993, and the regulations promulgated thereunder.

Installations which do not comply with the OHS Act shall be corrected by the Contractor at no cost to the Employer.

Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard.

Hazards must be avoided or guarded to the satisfaction of the Employer’s Agent. Nip points shall be guarded. Sharp corners shall be rounded off. Items such as operating handles, supports and protrusions shall be kept clear of access ways or marked accordingly.

The Contractor shall cover all unsafe gaps and openings left in structures after installation.

Each motor driven device shall be provided with an emergency stop station in an appropriate position.

Trip wires shall be provided along the accessible side/s of moving conveyor belts, chains, etc., irrespective of operating speed and in addition to any guards provided. These shall stop the driving motor when pulled.

Any permanent fencing or other safeguards required to be erected around electrical Plant shall be completed as far as practicable before connection is made to the electricity supply, but where this is not practicable, the *Employer’s Agent* may permit the use of temporary fencing or other safeguards.

If work in the vicinity of electrical Plant has to be carried out after connection has been made to the electricity supply, the *Contractor* shall comply with any "Permit to Work" system accepted by the *Employer’s Agent*.

All equipment shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire.

4 DESIGN

4.1 Design Principles

Mechanical engineering design shall ensure safety, robust construction, reliability, durability, prevention of avoidable corrosion, neatness as well as ease of maintenance and operation.

Design shall, as applicable, be based on:

a) The full range of duties which can be reasonably anticipated;

b) The maximum pressure or vacuum which can be produced by pumps, blowers and compressors under all conditions including blocked or closed inlet and outlet circuits;

c) Conservative service and safety factors based on approved standards or laid down in the printed specifications of reputable and approved manufacturers;

d) Twenty four hour per day operation (unless specified otherwise).

e) A minimum life of 100 000 hours for large items of equipment before repair or major part replacement;

f) Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as is practical, mal-operation (assuming that these occurrences cannot be avoided by good design).

g) The power and torque transmitted by the driver system under full load and stalled conditions;

h) Machines with non-overloading characteristics shall be selected wherever possible; eg: motors shall be sized so that they cannot be overloaded by the driven machine.

i) Generally, the design shall be such as to provide the maximum reliability under all conditions of service, coupled with safety and convenience of operation and maintenance under all conditions at the Site.

j) The design, dimensions and materials of all parts shall be suitable for the specified service and be such that the stresses to which they may be subjected shall not render them liable to buckling, breaking or excessive wear.

4.2 Vibration and Design Loads

a) Design loads shall be those set out in the relevant particular specification.

b) Special care shall be taken to ensure that all items of Plant are free of harmful vibration. Special care shall also be taken to ensure that resonance of any part does not occur as a result of harmonics which, although not apparent when the item in question is tested by itself, nevertheless give rise to objectionable vibrations when it is installed in its final position.

c) The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

d) Reciprocating machines shall be designed and installed so that the machine vibrations are isolated from the floor structure. Vibration isolation mountings which will eliminate not less than 90 % of the vibrations transmitted by the equipment shall be provided between the baseplate and the concrete plinth. When mounted on the vibration isolators, distortion of the baseplate shall be negligible in comparison with the permissible and acceptable misalignment of the equipment mounted thereon.

e) Shafts shall be designed so that the critical speed is outside the operating speed range.

f) All fastenings on Plant which may, notwithstanding the above provisions, be at risk of vibration under certain combinations of loadings and operating conditions shall be designed, by means of lock washers or by other accepted means, not to work loose due to vibration or other cause.

g) The *Contractor* shall, without additional payment, take whatever steps may be necessary after erection to remedy any vibration which the *Employer's Agent* considers harmful.

4.3 Permissible Stresses – General

Allowable stresses and safety factors for steel and structural steel design shall be determined according to SANS 10162: "The Structural Use of Steel" (all parts, latest versions), taking into account also the specifications of DIN 19704-1. Allowable stresses in welded connections shall be 90% of those permitted in SANS 10162, except where furnace stress relieved and 100% radiographed, in which case 100% of the allowable stresses is permitted.

The Plant shall be designed such that no part of the *works* under any loading condition shall impose any stress greater than those set out below on or in any concrete work:

- For compressive bearing stress: 12.0 MPa;
- For shearing stress: 1.7 MPa; and
- No tensile stress shall be allowed in concrete.

Except where otherwise specified, under the most severe operating and/or erection condition, stresses in castings and forgings expressed as percentages of tensile strength shall not exceed the figures set out in the Table below.

Table 1: Maximum Stress Percentages

DISCIPLINE	TENSION	COMPRESSION	SHEAR
Grey cast iron	10%	22%	6%
Nodular cast iron	22%	22%	12%
Carbon or low alloy cast steel	22%	22%	16%
High alloy cast steel	22%	22%	16%
Carbon and high alloy forgings	25%	25%	22%

The value of tensile strength to which the tabulated percentages shall be applied shall be the tensile strength (as defined in BS 18) of the proposed grade of metal as guaranteed by the supplier of the metal on the basis of tests carried out in accordance with BS 18.

4.4 Fail Safe Operation and Protections

Where damage can occur from normal operational or other foreseeable problems, plant, equipment and systems must be designed to be fail safe; i.e. must have built in redundant elements, or be fail-to-safe; i.e. must return to a safe condition where no further damage can be done in the event of a failure, malfunction, mal-operation, overload and, as far as practical, misuse. All reasonable and economically justifiable protections to prevent or limit damage to plant and equipment, particularly in high risk situations, must be incorporated.

Protections shall:

- Be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent damage (electrical thermal type overloads are inadequate);
- Stop or prevent from starting all equipment at risk;
- Activate an alarm with a labelled indicator on the control panel whenever a protection operates;
- Operate reliably after long inactive periods exposed to corrosive and dirty conditions.

Contractors shall highlight equipment limitations which can be exceeded during operation and cannot be guarded against.

4.5 Moving Parts

The following general requirements apply not only to machines but to all equipment with moving parts such as headstocks, extension spindles, swivelling davits, heavy duty hinges, pivots and the like:

a) All rotating or swiveling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes.

b) Swiveling joints on linkages and the like shall be of the "universal" or fork and rod type with bearings or bushes fitted to the eyes or forks.

c) Abrasion resistant materials and slow speed operation shall be used for abrasive applications.

d) All applications associated with wastewater shall be regarded as corrosive and materials of construction shall be selected to suit.

e) Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures. Sharp changes in section and welding shall be avoided in components subject to fluctuating stress.

f) The locking of nuts and pins in position shall be done to the approval of the Employer's Agent.

g) Wearing parts shall be designed for ease of removal and replacement.

4.6 Arrangement and Mounting

The arrangement and general design shall take the following requirements into consideration:

a) Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.

b) Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.

c) Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.

d) The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc.

e) With plant and equipment to be mounted on or against concrete or brick structures built by others, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Documents.

5 CONTRACTORS DRAWINGS

5.1 Contractors Drawings – General

Drawings provided by the *Contractor* shall be size A1 and produced in hard copy and electronically in *.pdf and *.dxf format. Each drawing shall show the following particulars in the lower right hand corner:

- Name of *Employer*
- Name of *Employer's Agent*
- Name of *Contractor*
- Project title
- Contract number
- Title of Drawing (Location, item and detail)
- Scale
- Date of Drawing
- Details of electrical supply (where applicable)
- Drawing number
- Revision identification

Dimensions on all Drawings shall be metric.

A blank space 90 mm by 60 mm shall be provided as an extension of the title block for the *Employer's Agent*'s approval stamp. Provision shall be made for details of revisions to be recorded above the title block. Prints of Drawings shall be in the form of black lines on a white background.

5.2 Tenderer's Drawings

The Mechanical portion of the Tender Drawings provided are simply configuration guidelines to enable the *Contractor* to determine the Plant required to be designed and detailed by the *Contractor*.

Drawings submitted by the *Contractor* with his Tender shall give sufficient information to make a proper assessment of the Plant offered together with sufficient detail to enable the dimensions and general arrangement of the Plant to be determined. All the important parts shall be shown in detail, i.e. gate body, scaling arrangements, bearing arrangements, guides, wheels, etc.

They shall include details of parts to be built into, and loads to be transferred to, the civil engineering *Works*, routes and sizes of cabling, cable ducts or trunking, hydraulic pipework, description of erection methods, operating and control units, position indicators and details of connections to any other equipment.

5.3 Manufacturing / Shop Drawings

After the Starting Date but before manufacture commences, working Drawings containing general arrangements and assemblies for the Plant, including material schedules, standard parts etc., shall be provided for approval in principle by the *Employer's Agent*.

Drawings shall provide all the information required by the manufacturer to ensure full compliance with the Drawings and Specifications.

Drawings shall be prepared to acceptable industry standards complying with SANS 10111. An example of the Drawings shall be submitted for approval before draughting commences.

Approval by the *Employer's Agent* of any Drawing shall not relieve the *Contractor* of responsibility for correct fitment on site.

The *Employer's Agent* retains the right to suspend manufacture until approved working Drawings are in his possession.

5.4 Site Construction Drawings

Where appropriate, Drawings to enable site preparations to be completed shall be provided before the arrival of equipment, giving all details necessary for the programming of civil Works, including foundation details and anchor bolts. These Drawings shall be provided not later than three weeks after approval of the layout Drawings has been given in principle.

5.5 Record Drawings

A complete set in triplicate of "as built" Drawings shall be produced. The Drawings shall be complete in all respects, drawn generally in accordance with SANS 10111; containing general arrangements, assemblies, parts lists (including part numbers) and complete component details. Drawings are to be to scale and in standard sizes, but not exceeding A1.

The Drawings shall be clear, black line on white paper and unfolded. They shall be suitable for microfilming. All legends shall be in English and all dimensions in the metric system. On each

Drawing shall be stenciled in bold letters in the title block such information as is necessary to identify the equipment.

All Drawings shall also be submitted electronically in .pdf format, and in any other format required by the Employer's particular specification.

Drawings that do not conform to the above requirements will be returned to the *Contractor*.

5.6 Operation and Maintenance Manuals

6 QUALITY

All enquiries made, and contracts placed by the Contractor for critical components, shall require suppliers and/or sub-contractors to comply with the requirements of the Contract. Responsibility for, and all associated costs of, compliance shall rest with the Contractor. In instances where SANS/ISO 9001 is not applicable, Tenderers must indicate what equivalent alternative Code of Practice is being implemented.

7 SPARE PARTS

All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the Site.

Each spare part shall be clearly marked or labelled on the outside of its packing with its description and purpose, and when more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container in a waterproof transparent envelope and a detailed list enclosed.

All cases, containers and other packages shall be marked and numbered in an approved manner for purposes of identification.

All spare parts shall be inspected by the *Employer's Agent* prior to packing.

8 TOOLS AND TESTING EQUIPMENT

The *Contractor* shall supply all special tools and test equipment for the *Employer's Agent*'s approval to enable any erection, dismantling, reassembly or testing to be carried out on all parts of the Plant, whether of an electrical, mechanical or other nature during the life of the *Works*. Payment shall be at the rates entered in the Schedule of Quantities.

The tools and test equipment shall not be used for erection and except that the *Employer's Agent* may call upon the *Contractor* to demonstrate their use and effectiveness, they must be handed over to the *Employer's Agent* in a completely new and unused condition. Should the *Contractor* require any such tools and test equipment at the Site during erection, he shall provide his own.

The tools for each different type of equipment shall be contained in suitable boxes clearly marked or labelled with their description. Each tool shall be identified and a list of tools stamped on a stainless steel plate shall be affixed to the inside of the box lid. Boxing shall be deemed to be included in the rates entered for the tools. Each set of tools shall be supplied with the equipment with which it is associated.

The test equipment shall include only special purpose items essential for the testing or repair.

9 PACKAGING, TRANSPORTATION AND STORAGE

9.1 Packing and Transportation

a) Before any of the Plant is despatched from a manufacturer's *Works* it shall be properly prepared and packed and the *Contractor* shall give the *Employer's Agent* at least 14 days' notice that these preparations are to commence

b) Prior to despatch all parts shall be adequately protected by painting or by other means for the whole period of transit, storage and erection, against corrosion and incidental damage, including the effects of vermin, sunlight, rain, temperature, wind-blown sand and humid atmospheres. The *Contractor* shall be responsible for the Plant being so packed and/or protected as to ensure that it reaches the Site intact and undamaged. The Plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

c) The *Contractor* shall be deemed to have included in the Bill of Quantities for all materials and packing cases necessary for the safe packing and transport of the Plant. All transporting arrangements shall be to the satisfaction of the *Employer's Agent*.

d) No one package or bundle shall contain items intended for incorporation in more than one section of the *Works*. Cases containing small items shall not weigh more than 500 kg gross.

e) Bolts in strong hessian bags and other small components shall be labelled and crated. The bags and crates shall be tagged using metallic tags and shall indicate the following information:

- Contract number;
- Project name;
- Part numbers;
- Description;
- Sizes; and
- Quantities.

f) Each bag or crate shall have the delivery address listed on a separate metallic tag.

g) Every crate or package shall have a general description of its contents shown on a packing list in a waterproof transparent envelope attached to the outside of the crate. A duplicate copy of the packing list shall be sent by post to the *Employer's Agent*.

h) All items shall be clearly marked for identification against the packing list.

i) All crates, packages, steel fabrications and machinery shall be clearly marked with a waterproof material to show the weight, the position to which slings may be attached and shall have an indelible identification mark relating them to the packing lists. In addition, all packages shall be clearly painted with a distinctive site identification colour and sign, so that the final location of each item can be easily identified at the Site in order to avoid delay, double handling or loss. These special identification marks will be in addition to the normal shipping and transport marks.

j) Machined flanges of pipes, valves and fittings shall be protected by wooden discs attached by means of service bolts (which shall not be used on the *Works*) or by other approved means.

k) Coated items shall not be handled within the drying time recommended by the coating manufacturer, relevant to the ambient temperature. Wherever possible lifting of painted items shall be from approved lifting attachments. All coated items shall only be lifted by means of broad band slings that will not damage the coating. Slings shall not be less than 50 mm wide or as approved by the *Employer's Agent*.

l) During transport, non-packaged items shall be held securely in position on sufficient padded blocks as are necessary to give adequate and safe support and, inter-alia, to militate against the possibility of brinelling of bearings en route to site.

m) The use of ropes, wire ropes or chains without suitable padding is expressly forbidden.

n) All the necessary balks of timber or sawdust bags to support the components on soil, concrete or other hard surface and to separate them from each other in transit and at Site, shall be provided by the *Contractor* free of charge.

o) When loading onto vehicles, precautions shall be taken to support and chock the components to prevent movement. Components shall be firmly lashed or chained with padded lashing, supported on sawdust bags. The area of padded surfaces shall be adequate to prevent damage to the coating.

p) Items may be inspected on arrival at the *Contractor*'s end delivery point and any repairs necessary shall be to the cost of the *Contractor*. Any damage that occurs during the handling and storage of Plant and components at the Manufacturer/*Contractor*'s *Works*, including transportation to site, shall be repaired by the Manufacturer/*Contractor* at his own cost, in accordance with the Specification and to the approval of the *Employer's Agent*.

9.2 Off-Loading at Site

a) The *Employer's Agent* shall be notified of the delivery date and of any requirements regarding off-loading and storage at site.

b) The supplier shall be responsible for the transportation and supervision during off-loading of the equipment and other small components at the delivery site.

c) Under no circumstances shall coated equipment be allowed to rest directly on the ground.

d) The final delivery inspection and acceptance of equipment supplied shall be undertaken on site after off-loading has been completed.

e) The *Employer's Agent* has the right to reject any damaged equipment, components and materials which have been delivered and off-loaded at site.

9.3 Stacking and Storage

a) The *Contractor* shall provide all the necessary balks of timber and sawdust bags used to support the equipment and components on soil, concrete or other hard surface and to separate them from each other, both at his *Works* and on site.

b) Grass or other vegetation shall not be allowed to grow in the storage area within three metres of the Plant and components.

9.4 Attachments for Transport and Erection

a) The *Contractor* shall submit for the *Employer's Agent*'s approval proposals for such properly designed supports, lifting attachments or handling points as the *Contractor* considers necessary or desirable for assistance in handling fabricated sections for cleaning, applying protection, assembly transportation storage, erection, and subsequent maintenance. All such lifting attachments or handling points shall be such as to avoid overstressing or deforming the steel members of fabrications. Lifting attachments shall be designed for not less than the applicable mass reaction plus 50 % allowance for impact.

b) Temporary supports, lifting attachments or handling points shall be removed or filled in as required, and by approved methods to the satisfaction of the *Employer's Agent*, and the surfaces of the permanent steelwork in these localities shall be dressed, cleaned and painted as specified elsewhere. Where tapped holes are provided for lifting devices (such as eyebolts) the tapped holes shall be plugged with stainless steel socket head screws (the thread of which shall be covered with anti-seize compound).

c) Supports, lifting attachments or handling points may be left, if so approved by the *Employer's Agent*, provided that in his opinion:

- There is no deleterious long term effect on the structural integrity or operational use of the completed fabrication;
- The steelwork protective system is continuous over or around the lifting attachments or handling points and there is no undue risk of breaks or cracks occurring in the protection at such areas; and
- There is no significant effect on the visual appearance of the fabrication.

d) Attachments to the steel fabrication to assist in the future inspection and maintenance of the steelwork and associated equipment may be required. Such attachments (e.g. supports for ladders, scaffolding cradles and ropes) may be combined with the *Contractor*'s temporary handling and lifting requirements during fabrication and erection and agreement on additional attachments shall be subject to the approval of the *Employer's Agent* before fabrication of the steelwork is commenced.

10 MATERIALS AND WORKMANSHIP – GENERAL

10.1 Introduction

This part of the Specification sets out the general standards of materials to be supplied by the *Contractor* and mention of any specific material or Plant does not necessarily imply that such material or Plant is to be included in the *Works*.

All component parts of the Plant shall, unless otherwise specified, comply with the provisions of this part and be subject to the approval of the *Employer's Agent*.

The names of the manufacturers of materials and equipment proposed for incorporation in the *Works*, together with performance reports, capacities, certified test reports and other significant information pertaining to such manufacturers, shall be furnished when requested by the *Employer's Agent*, who shall have power to reject any parts which, in his opinion, are unsatisfactory or not in compliance with the Specification and such parts shall be replaced by the *Contractor* without additional payment.

10.2 Compliance with Standards

The materials, design and workmanship shall be in accordance with the appropriate Specification current at the time of manufacture unless otherwise specified. Providing the *Contractor* has stated in his Tender that any part of the Plant offered conforms to some other equal or better Standard and the *Employer's Agent* has accepted such offer, such other Standard shall prevail.

Should the *Contractor* desire for any reason to deviate from the Standards specified or the aforesaid equal or better Standard, he shall submit for the *Employer's Agent's* approval a statement of the exact nature of the deviation, fully supported by copies of the equivalent Standard (in English) and complete Specification of the alternative materials proposed. It shall be the responsibility of the *Contractor* to demonstrate that any alternative Standards proposed are equal or superior to those specified.

10.3 Materials

a) All material and Plant, where not specified, shall comply with the relevant Standard Specifications.

b) All materials incorporated in the *works* shall be the most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfection and selected for long life and minimum maintenance.

c) All parts subject to submergence or subject to relative movement, shall be of corrosion-resistant metals or other materials as appropriate. All parts in direct contact with various chemicals shall be completely resistant to corrosion and abrasion by those chemicals. All parts shall maintain their properties with minimum deterioration due to passage of time, exposure of light or any other cause. Parts bearing on each other shall have their relative hardness considered such that the part more easily replaced in the event of wear is of an appropriate lesser hardness.

d) Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, these shall be selected so that the bimetallic corrosion potential is minimised or preferably eliminated by the use of standard isolating procedures, including appropriate coatings.

e) Except where otherwise accepted by the *Employer's Agent*, all materials, supplies or articles used in the Plant shall be new products of recognised reputable manufacturers with established dealerships and/or agencies in the Republic of South Africa, and subject to the acceptance of the *Employer's Agent*. Products will be accepted only when the *Employer's Agent* shall have been notified and have satisfied himself as to their strength, reliability, durability and suitability for the application intended.

f) To assist the *Employer's Agent* in this matter the *Contractor* shall furnish performance data, references to completed works and any other relevant information together with samples of materials for acceptance. Materials, equipment and other articles incorporated in the *works* without the acceptance of the *Employer's Agent* may be subsequently rejected by the *Employer's Agent*.

g) All items shall be permanently and indelibly marked to identify each individual item as specified by the *Employer's Agent*.

10.4 Workmanship

a) Workmanship and general finish shall be of first class commercial quality and in accordance with best workshop practice and the specified or accepted Standards.

b) The fabrication, machining and finish (incl. corrosion protection finishes) of all parts shall be such that when the work is assembled both in the shop and at the Site, the appropriate tolerances and clearances shall be obtained. The clearances used shall be sufficiently small to avoid vibration but all moving parts shall operate freely and shall be such that the risk of undue wear or jamming under load or on account of debris, temperature effects, encrustation or other causes is minimised. Finished faces shall be free of any wind or twist.

c) All similar items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same type of materials as the originals and shall fit all similar items of Plant. Machinery fits on renewable parts shall be accurate and to specified tolerances so that replacements made to manufacturer's Drawings may be readily installed.

d) All equipment shall operate without harmful vibration and with minimum of noise. All revolving parts shall be statically and dynamically balanced so that when running at all operating speeds and any load up to a maximum, there shall be no vibration due to lack of balance.

e) All parts which can be worn or damaged by dust shall be totally enclosed in a dust-proof housing.

f) Manufacturers of stainless steel items shall comply with the “Stainless Steel Good Housekeeping Rules” as issued by SASSDA from time to time.

11 STEELWORK

11.1 Minimum Thickness and Corrosion Allowance

Stainless steel (except for that which is used for cladding) subject to a river water environment, an outdoor environment or an indoor environment shall have a minimum thickness of 8 mm, 6 mm and 3 mm respectively, unless otherwise specified in the drawings or schedule of quantities.

All other steel, with the exception of machinery house claddings, gear covers, etc., subject to an outdoor environment and subject to corrosion (even though painted on both faces or one face only), shall have minimum thickness of 12 mm, 10 mm and 6 mm respectively.

Steelwork (unless of stainless steel) shall be thicker, by not less than 0.8 mm for each exposed face, than that required when calculated in accordance with this Specification to resist the applied loads, to allow for corrosion.

11.2 Steel for Fabricated Construction

Mild steel for welded, riveted and bolted construction shall comply with SANS 1431: Weldable Structural Steels. Mild steel for load-bearing components shall not be inferior to Grade 300WA.

Stainless steels used in construction shall comply with EN 10088 and that used for pressure linings shall comply with EN 10028-7.

The *Contractor* shall provide the *Employer's Agent* with copies of mill rolling sheets for all sections incorporated in the *works*, together with test certificates certifying that the steel has been tested and found to comply with the appropriate Standards. The *Employer's Agent* reserves the right to test samples of steel independently and the results of these tests shall take precedence over the tests carried out by the rolling mill. Marking by the steel maker and the mills shall comply with BS EN 10025.

11.3 Stainless Steel

Unless otherwise specified, stainless steel shall have resistance to atmospheric corrosion not less than that provided by BS 970, Grade 304L.

Particular attention shall be paid to the prevention of seizure by fretting where two corrosion resistant metals are in contact, by the selection of materials of suitable relative hardness and surface finish and the application of lubricants.

Stainless steel shall be pickled and passivated after fabrication and welding; re-passivation may be ordered, post-installation, at no additional cost, should there be evidence of ferrous re-contamination. Refer also in this regard to the specification on Painting and Corrosion Protection.

Fabrication shall take place in dedicated areas separated from carbon steel. All equipment used in the forming and manipulation of stainless steel items during fabrication shall be clean and free of materials that may contaminate the metal with carbon steel. Iron contamination shall be removed by pickling and passivation, by the dipping process, after degreasing. All surfaces shall be tested for free iron contamination by the water or the ferroxyl test method. Organic contamination shall be removed by degreasing.

The manufacture of items from corrosion resistant steels shall be in accordance with the SASSDA's Information Series and the guidelines of the material supplier. Discoloration caused by welding or cutting shall be mechanically cleaned by buffing followed by pickling and passivation in accordance with the SASSDA's Information Series and the guidelines of the material supplier.

11.4 3CR12

This is the titanium stabilised, 12 % chrome steel as produced by Columbus Stainless, South Africa. 3CR12 shall always be supplied with an annealed and pickled finish. 3CR12, in cases where it is to be coated, shall be suitably abrasive blasted to ensure adherence of the prime coat.

11.5 Lamellar Tearing (cracking)

The *Contractor* shall design, detail and fabricate all junctions in steelwork in such a way as to prevent failure by lamellar tearing.

11.6 Structural Steelwork Fabrication

a) Fabrication of structural steelwork shall be generally in accordance with BS 5400 unless otherwise specified.

b) The *Contractor* shall ensure that all surfaces requiring corrosion protection are either:

- Accessible, to the satisfaction of the Employer's Agent, for maintenance of the protection by reasonable methods when in position in the works; and
- Enclosed in hermetically sealed voids, where it is structurally safe to seal such voids, and as agreed in writing by the Employer's Agent, which shall be proved to be sealed by air pressure testing if required by the Employer's Agent.

c) All surfaces shall be accessible by blast and spray equipment. Practical requirements for providing accessibility for surface preparation and coating shall be taken into consideration. Features which would prevent access to blast material and coating application shall be removed.

d) All permanently exposed edges and corners of members of fabricated steelwork shall be formed or dressed to a rounded profile with a minimum radius of approximately 3 mm to ensure an even coating of the protection to such parts of the fabrication.

e) All cutting, chamfering and other shaping of metals necessary for site connections shall be done in the shop. Adequate provision for temporary bolted site connections or clamps shall be provided to hold assemblies rigid and in proper alignment during site welding. After welding, all temporary connections and clamps shall be removed and all bolt holes shall be plugged, welded over and ground down flush with the adjacent metal on both faces, all to the satisfaction of the *Employer's Agent.*

f) Bending and pressing of plates may be by either the hot or cold process. In no case shall the internal radius of bends in cold-bent plates be less than twice the thickness of the metal. The procedures used, including temperature control in the case of hot-forming, shall be to the acceptance of the *Employer's Agent*. Where necessary, allowance shall be made in the design for possible modification of material properties.

g) Edges of all plates and members shall be square, clean, free from burrs and true to dimensions. If flame cutting is employed, edges shall be dressed smooth and true and the work shall be stress relieved, particularly for stainless steel.

h) All bolts and nuts shall be in accordance with SANS 1700.

i) All bolt holes shall be drilled, not punched. Templates shall be used where applicable.

j) Large washers of at least twice the thickness of a standard washer shall be used on all fasteners going through slotted holes.

k) Where required, lugs shall be fitted by the manufacturer to the requirements of the Corrosion specialist and the acceptance of the *Employer's Agent*. After removal the damaged coating area shall be repaired in accordance with the Specification. Lugs not intended to be removed shall be manufactured of equal or more noble grade than the base material in accordance with the Specification.

l) The Manufacturer shall be responsible for all the pre-preparation of equipment prior to surface preparation. Pre-preparation shall be carried out to the acceptance of the *Employer's Agent* and the Corrosion Protection specialist. Pre-preparation shall be carried out by competent personnel. All oil, grease or other surface contaminants shall be removed with a water soluble solvent degreaser followed by rinsing with clean soft water before the items are despatched to the Corrosion Protection specialist.

m) Stress raises are to be avoided.

11.7 Surface Defects in Fabricated Steelwork

a) All fabricated steelwork shall be free of surface defects in the steel, burrs, sharp or rough edges, crevices, cracks or discontinuities in welded joints and depressions, hollows or moisture retaining features in locations where rain, spray or condensed moisture left in contact with the structure may promote corrosion of the steel. The dressing of the steel to remove burrs and rough edges from holes or cut lines shall be carried out as soon as possible after their presence has been detected consistent with the need to clean and give initial protection to exposed steel elsewhere on the plate, section or fabrication concerned.

b) Surface defects shall be ground out. The extent and depth of laminations shall be determined before any rectification is carried out. Provided the size and extent of any surface defect or lamination is not such as to warrant rejection of the steel plate or member on structural or other grounds, the area affected by the remedial work shall be cleaned and protected to the same condition as the rest of the plate or member.

c) Where necessary (e.g. to meet dimensional tolerances) the steel surface at such defective areas may be built up by welding including any preheating that might be required and ground flush with the surrounding steel surface before being cleaned and protected. This welding is to be stress-relieved by an accepted post-weld heat treatment as accepted by the *Employer's Agent*. Appropriate Non Destructive Examination (NDE) and testing, per BS 5400 and as accepted by the *Employer's Agent*, shall to be applied 48hrs after the repair

d) All extrusions, rolled steel and castings shall be clean and free of score marks, pits, protrusions, blisters, porosity, blowholes, cracks or any other flaws which may be detrimental. Laminations, scabs or occluded scale shall be ground out. If such grinding penetrates deeper than 7% of the metal thickness, the area shall be repaired by welding or the metal shall be rejected at the discretion of the *Employer's Agent*. Repairs to be per BS 5400.

11.8 Welding

a) Standards

Standards complying with good modern practice, and acceptable to the Employer's Agent, shall be adopted. These include the following:

BS EN 1011	Arc welding carbon and carbon manganese steelwork.
BS 4677	Arc welding austenitic stainless steel pipework.
BS 2633	Class 1 Arc welding of steel pipework.
BS 2971	Class II Arc welding of steel pipework.
BS 806	Design and construction of ferrous piping in connection with land boilers (used for arc welding specification of all pipe flanges).

Welders shall be experienced artisans approved in accordance with BS 4872 or equivalent.

b) All welds shall be continuous and shall have a smooth contour. All welding shall comply with the general requirements of BS 5400 (except as amended by the Merrison Interim Design Rules should the *Contractor* wish to submit designs of gates or other parts of the *works* involving box girder construction). Double U or J welds shall be adopted where control of distortion is important.

c) All welding whether in the shop or at Site shall be accepted metal-arc processes and shall be in accordance with BS 5135 subject to the provisions of this Clause. Full details of welding procedure and detail Drawings of welds and weld preparations shall be submitted to the *Employer's Agent* for his acceptance and the *Contractor* shall carry out, without additional payment, such welding procedure tests as the *Employer's Agent* may order to prove the sufficiency of his proposed procedures. All stainless welding to be TIG welding.

d) Radiographic inspection shall be done for minimum 10% of all welds, with a weld design joint factor of 0.8 employed. Alternatively, where 100% of the welds are radiographically a joint factor of 1.0 may be used. All in-situ (field) welds shall be 100 % radiographically or ultrasonically inspected. All inspections shall be recorded.

e) No welding shall commence until all welding procedures have been accepted by the *Employer's Agent* in writing and no alteration shall be made to any previously accepted procedure without prior acceptance of the *Employer's Agent*.

f) All welders shall be qualified in accordance with BS 5400 or in accordance with such appropriate sections of BS 4871 or BS 4872 as the *Employer's Agent* may approve to. The *Employer's Agent* shall have the authority to order that any welder whose work he deems to be questionable shall be re-tested in his presence. No separate payment shall be made for such tests. Welders will be required to be re-qualified for the welding procedures in respect of which they have accepted qualifications should they have failed to be employed on work involving these procedures for a period of six months or longer.

g) All welds shall be identified and recorded to enable each weld to be traced to the welder by whom it was made. The form and location of all identification marks shall be proposed by the *Contractor* and shall be subject to the acceptance of the *Employer's Agent.*

h) The preparation of joint faces shall be by machining except as otherwise accepted by the *Employer's Agent*. Where errors in joint preparation lead to larger gaps between fusion faces than permissible, these shall not be bridged over but the faces shall be made up with weld metal and re-machined as necessary to the correct profile before welding proper commences.

i) Where deviation from true profile of fusion faces occurs due to mill tolerances in rolled sections, fitting up and welding shall be in accordance with a procedure to be agreed between the *Contractor* and the *Employer's Agent*. To this end the *Contractor*'s statement of welding procedures, including stress relieving processes, shall contain proposals for dealing with such deviations.

j) Pre-heating shall be carried out as recommended in BS 5135 or other appropriate British Standard. Welding processes used shall limit heat input to a minimum to restrict the heat affected zone.

k) The full throat thickness shall be ensured at the ends of butt welds by the use of extension pieces or by other accepted means. If extension pieces are used they shall be clamped to the work and not welded. To ensure full penetration in butt welds, the use of backing material shall not be permitted except as accepted by the *Employer's Agent*.

l) All welds shall be continuous and even, with no contact gaps, and crevices left between members or unfilled re-entrant corners which would harbour moisture or dirt and prevent the satisfactory application and retention of the corrosion protective system. Weld undercuts and cavities as well as pits in metal surfaces are not permitted. All undercuts, cavities and pits shall be ground out, re-welded and ground to a smooth contour.

m) Weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground.

n) Staggered welds, where specified, shall only be permitted with prior acceptance of the *Employer's Agent* on submission of appropriate remedial corrosion protection procedures.

o) Removal of slag from welds which will be subject to tensile stresses shall be carried out by grinding or blast cleaning. Peening shall be carried out only where accepted by the *Supervisor*. With stainless steel use appropriate grinding disk or wire brush.

p) The finish of the welded joint shall be free from irregularities, grooves and depressions. Undercutting at the welded joint shall not be permitted. Where welds are ground smooth, grinding shall where possible be in the direction of the principle stress.

q) The *Employer's Agent* shall be notified of all defects before any repair work is commenced and the repair technique shall be subject to the acceptance of the *Employer's Agent.* Where ordered by the *Employer's Agent,* repairs shall be subject to radiographic and/or ultrasonic testing and an appropriate stress relieving process.

r) All welds between plates 25 mm or greater in thickness whether carried out in the shop or at the Site shall be stress-relieved by an accepted post-weld heat treatment unless otherwise agreed in writing by the *Employer's Agent*.

s) All fabrications which are subsequently to be machined in any way shall be stress relieved prior to machining.

t) Shop and Field Fabrication Method Statements / QCP's shall be provided detailing welding distortion mitigation or elimination strategies before manufacture commences. The *Employer's Agent* reserves the right to halt any work should this issue not receive the necessary attention.

u) Use of temper beads for heat treatment will only be allowed if accepted by the *Employer's Agent.*

11.9 Welding Of Stainless Steel and 3CR12 – Additional Requirements

Fabrication of austenitic stainless steels and 3CR12 shall comply with the recommendations in "The Stainless Steel User Manual", "The 3CR12 Fabrication Guide" and the general welding requirements in "Pocket Guide – Stainless Steels" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steels to be welded shall be of the low carbon grade; e.g. 1.4306 rather than 1.4301 and 1.4404 rather than 1.4401.

The welding rods used shall be the most suitable for the metal and purpose. Only welders experienced with welding stainless materials shall be used. Welds which are accessible from only one side shall be executed in a manner to prevent heat tint or shall be post-weld treated in order to remove all traces of heat tint.

Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise approved in writing. 3CR12 shall be welded as recommended in "The 3CR12 Fabrication Guide" issued by Columbus Stainless.

All possible steps shall be taken to ensure maximum corrosion resistance and strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discolouration and steel contamination must be removed by pickling or electro cleaning as approved by the Employer's Agent but should rather be avoided by taking the appropriate measures.

12 MISCHELLANEOUS MATERIALS

12.1 Castings – General

a) Castings with defects exceeding the restrictions given in the table below shall be rejected.

b) In the case of blowholes occurring opposite each other, the combined depth shall be taken into account.

c) Blowholes and cavities not exceeding 2 mm depth shall be smoothed out by grinding.

d) Acceptance criteria for the repair of blowholes and cavities is shown in the table below:

Table 2: Blowholes

SURFACE	DEPTH OF BLOWHOLES	DIAMETER OF BLOWHOLES	REPAIR
Internal	Maximum 22% of material thickness	40% maximum of material thickness	Welding only
External	Maximum 10% of material thickness	22% maximum of material thickness	Solvent free Epoxy or welding
External	10 to 22% maximum of material thickness	40% maximum of material thickness	Welding only

e) Castings shall, after inspection by the Employer's Agent, be ground smooth.

f) Small and repaired blowholes shall be ground level and smooth.

g) All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be drop tight.

h) The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

12.2 Cast Iron

a) Cast iron shall be of the nodular or spheroidal graphite type to BS EN 1563 grade EN-GJS-400-15 or to such other grade as is accepted by the *Employer's Agent*.

b) Cast iron shall not be used for components subject to impact stresses unless otherwise accepted by the *Employer's Agent*.

c) Before proceeding with foundry work for any castings which will be subject to hydraulic pressure and for all other important components, the *Contractor* shall submit to the *Employer's Agent* for his acceptance Drawings of such castings, showing the proposed locations for taking specimens for tensile, impact, fatigue, bending and any other appropriate tests. Castings shall be clearly marked by the manufacturer.

d) The *Contractor* shall give the *Employer's Agent* not less than 14 days' notice in writing of the date when such castings will be cleaned to enable the *Employer's Agent* to inspect the castings immediately after they have been cleaned. Whether or not the *Employer's Agent* attends such inspection, no repair work shall be undertaken without the *Employer's Agent*'s prior acceptance.

e) Castings shall be true to the Drawings and any castings in which any dimension is so much reduced as to impair the strength of the casting by more than 10 % or to increase the stresses above specified limits may be rejected by the *Employer's Agent*.

f) The structure of the castings shall be homogeneous and free from excessive non-metallic inclusions and other injurious defects. Excessive segregation of impurities or alloys at critical points in a casting will be sufficient cause for its rejection.

g) The *Contractor* shall perform all tests listed in BS EN 1563 together with the following additional tests on specimens from each batch:

- Each tensile test shall include determination of the 0.2 % proof stress value; and
- Three impact tests shall be performed on samples from each batch of castings at normal ambient temperatures and 3 further tests at an ambient temperature of -30˚C. The average impact value of each set of tests shall be such as will be suitable for the operational temperatures of each item made from the batch, as agreed with the *Employer's Agent*.

h) The *Contractor* shall non-destructively test all castings using radiographic, magnetic particle, penetrant and ultrasonic flaw detection methods as appropriate, similar to those specified in BS 4080 and as agreed with the *Employer's Agent*.

i) Subject to the acceptance of the *Employer's Agent*, minor defects shall be chipped or grooved out by a carbon arc air process to sound clear metal and repaired by welding. Castings with defects which do not otherwise affect the performance of the castings but which necessitate the removal of metal resulting in a reduction in the stress-bearing cross-section of a component by more than 22 % may be rejected by the *Employer's Agent.*

j) Welding shall only be carried out by properly qualified welders and all such repairs shall, unless otherwise agreed by the *Employer's Agent*, be subject to stress relief.

k) Before carrying out any repairs the *Contractor* shall submit to the *Employer's Agent* for his acceptance a complete statement of procedure for such repairs together with, where appropriate, stress calculations and no repair work shall commence until the *Employer's Agents* written acceptance of such statement and calculations has been received.

l) In addition to tests carried out under sub-clause (12.2.7), and if so instructed by the *Employer's Agent* radiographic and/or ultrasonic testing and/or other accepted non-destructive testing shall be carried out on the areas around all defects in any casting after removal of metal to ensure that each defect has been properly removed.

m) Certified copies of the results of any test required shall be furnished to the *Employer's Agent*.

12.3 Steel Castings

a) The steel used for castings shall be of the quality appropriate to each particular item as accepted by the *Employer's Agent* and shall comply with the relevant British Standards included in BS 3100. Castings shall be heat treated as agreed in writing by the *Employer's Agent*.

b) The *Contractor* shall perform all the tests listed in BS 3100, together with the following additional tests on specimens from each batch:

- Brinell hardness tests together with copies of test certificates; and
- Impact tests

12.4 Forgings

a) Steel for forging shall be of the quality appropriate to each particular item, shall comply with BS 29 or BS 970, as appropriate and shall be subject to the acceptance of the *Employer's Agent*.

b) All forging shall be heat-treated for the relief of residual stresses before the start of machining and the *Contractor* shall submit details of his proposed method to the *Employer's Agent* for his acceptance in writing before starting the treatment. The forging shall be inspected by the *Contractor* using radiographic methods similar to those set out in BS 4080 for steel castings and also using the ultrasonic, magnetic particle and penetrant flaw detection testing techniques set out in BS 4124.

c) The *Employer's Agent* shall be informed in writing of all flaws found by the inspection and the *Contractor* shall not use in the *works* any forging containing flaws unless remedial action is agreed with the *Employer's Agent* and carried out by the *Contractor* to the satisfaction of the *Employer's Agent*.

12.5 Fabrics and Wood

a) Fabrics, cork, paper and similar materials which are not subsequently to be protected by impregnation, shall be treated with an accepted fungicide. Sleeving and fabrics treated with linseed oil varnish shall not be used.

b) The use of organic materials shall be avoided as far as possible but where these have to be used they shall be treated to make them fire resistant and non-flame propagating.

c) The use of wood shall be avoided as far as possible. If used, woodwork shall be thoroughly seasoned teak or other accepted hardwood which is resistant to fungal decay and free from shakes and warp, sap and wane, knots, faults and other blemishes. All woodwork shall be treated to protect it against damage by fire, moisture, fungus, bacteria or chemical attack, unless it is naturally resistant to those causes of deterioration. All joints in woodwork shall be dovetailed or tongued and pinned. Metal fittings shall be of non-ferrous material. Adhesives shall be specially selected to ensure the use of types which are impervious to moisture. Synthetic resin cement only shall be used for joining wood. Casein cement shall not be used.

12.6 Bronze

Where bronze is specified or used it shall be zinc free.

12.7 Bright Parts

Bright parts and bearing surfaces shall be thoroughly polished and protected from corrosion by the application of rust preventive lacquer or high melting-point grease, as accepted by the *Employer's Agent*, before the parts are packed. A sufficient quantity of the correct solvent for removal of the protective compounds shall be supplied and packed with each particular part.

12.8 Aluminium and Aluminium Alloys

Aluminium and aluminium alloys used in mechanical parts shall be for the acceptance of the *Employer's Agent.*

12.9 Adhesives

All adhesives shall be specially selected to ensure use of types which are impervious to moisture and are resistant to mould growth and other forms of attack or deterioration.

12.10 Asbestos

Asbestos and materials containing asbestos shall not be used.

12.11 Plastics

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength, and high impact strength and generally suitable for the application.

PVC is generally regarded as too brittle and shall not be used unless specified elsewhere or approved by the Employer's Agent.

12.12 Rubber Seals

Rubber, neoprene or EDPM seals shall be provided for all gates in accordance with either ASTM or DIN Standards as follows:

- ASTM D297: Test Methods for Rubber Products -Chemical Analysis
- ASTM D395: Test Methods for Rubber Properties - Compression Set
- ASTM D412: Test Methods for Rubber Properties in Tension
- ASTM D413: Test Methods for Rubber Properties - Adhesion to Flexible Substrate
- ASTM D471: Test Methods for Rubber Properties - Effect of Liquids
- ASTM D572: Test Method for Rubber Deterioration by Heat/Oxygen
- ASTM D573: Test Method for Rubber Deterioration in Air Oven
- ASTM D1149: Test Method for Rubber Deterioration by Surface Ozone Cracking
- ASTM D2240: Test Methods for Rubber Property-Durometer Hardness
- DIN 53504: Determination of tensile stress/strain properties of rubber
- DIN 53505: Shore A and D hardness testing of rubber and elastics
- DIN 53509-1: Determination of the resistance of rubber to ozone cracking under static load
- DIN 53516: Determination of abrasion of rubber
- DIN 53517: Testing of compression set of rubber at constant strain

13 CORROSION PROTECTION

13.1 Design Precautions

a) All Plant shall be designed to suppress corrosion in an exposed environment.

b) Easy access for protection and maintenance shall be provided. The use of back to back angles, partially open box sections or inaccessible stiffeners shall be avoided. Corrosion protection of areas that are unavoidably inaccessible shall be specified by the *Employer's Agent*.

c) Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible i.e. 150 mm diameter – minimum 50 mm diameter.

d) Surfaces of corrodible metals, such as the insides of tanks or hollow sections that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where not possible, be fully sealed against ingress of air and moisture.

e) The parts of all permanent installations embedded in concrete (built-in parts) that are exposed to water (e.g. seal faces and roller tracks) shall be manufactured from stainless steel as specified in the relevant section above. Where such items are connected to carbon steel parts embedded in the concrete, suitable measures as specified or as proposed by the *Contractor* and accepted by the *Engingeer* shall be employed.

13.2 Corrosion Prevention

a) The *Contractor* is referred to the Particular Specification GIBB-007 *Painting and Corrosion Protection* for corrosion prevention requirements.

b) The *Contractor* shall ensure that the following steps are taken to minimise corrosion. Where dissimilar metals are used, coat all surfaces of the whole assembly including the more noble member of the galvanic series.

c) If the noble member of the assembly cannot be entirely covered:

d) Keep the anode/cathode ratio as large as possible in the particular component.

e) Use electrical insulators between two metals. Insulation must be complete; a bolt requires a sleeve as well as washers of an insulating material.

f) Joints and crevices between metals shall be sealed.

g) Where fastening is unavoidable, the fasteners shall be more noble (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between fasteners and the base material.

13.3 Hot-Dip Galvanized Items

a) The *Contractor* is referred to the Particular Specification GIBB-007 *Painting and Corrosion Protection* for hot dip galvanized items.

14 BEARINGS

14.1 Operation

Bearing designs shall ensure safe shut down without damage following electrical supply failure.

Bearing designs for variable speed drive applications shall be suitable for the full expected speed range.

Rotational bearings shall be designed to rotate in either direction unless the design prevents reverse rotation.

14.2 Design Life for Rolling Element Bearings

Ball and roller bearings shall generally be selected for a design life of 100 000 – 200 000 hours; i.e. the bearing manufacturer's category for machines required to work with a high degree of reliability 24 hours per day.

For shaft sizes above 50 mm, the L-10 bearing life shall be at least 100 000 hours. This may be reduced if the equipment is expected to operate for less than 3 000 hours in a normal year.

14.3 Plain Bearings

Plain bearings; i.e. bearings also referred to as "slide bearings", "oil-film bearings" or "sleeve bearings"; which are oil lubricated shall have lubrication by oil ring, by rotating dish or by pumped feed.

Run down, including run down after a power failure, shall be managed without damage to the bearing.

14.4 Bearing Choice

Bearings shall be chosen primarily to suit the equipment manufacturer's requirements and the plant's design conditions but the following guidelines shall be considered:

a) Greased lubricated bearings are generally acceptable for units with power ratings up to 100 kW.
b) Units with power ratings between 100 kW and 1 000 kW shall preferably be provided with rolling element bearings.
c) Units with high speed shafts, with power ratings above 1 000 kW and with high temperature applications shall preferably be provided with plain bearings (oil film type).

14.5 Thermal Alarms

Thermal alarms on bearing systems shall be set in accordance with the equipment manufacturer's instructions. Alarm settings done on Site shall be set after at least 24 hours of operation have occurred.

If high temperature protection is specified for a bearing, the Contractor shall note the equilibrium temperature reached after 30 minutes of normal operation and shall also note the ambient temperature. The high level trip temperature shall then be calculated as follows:

$T_{trip} = T_{equilibrium} + (40^{o}C - T_{ambient}) + 10^{o}C$. This assumes that the bearing is operating correctly.

15 GEARBOXES

15.1 Motor Driven Gearboxes

a) Gearboxes shall be supplied with environmental protection to IP 55 or higher.
b) Gearboxes shall have an efficiency of not less than 96 % on two stage reduction and 95 % on three stage reduction.
c) The Contractor shall drain and replace oil in all gearboxes during the Defects Notification Period.

d) The **service factor** to be used for the design of gearboxes in uniform load duty shall be at least 1,25 for electric motor driven applications. A minimum service factor of 1,5 shall be used for moderate shock applications and a minimum service factor of 2 shall be used for heavy shock applications.

e) The service factor to be used for engine driven gearboxes shall not be less than 2.

f) Gears shall be case hardened, profile ground and lapped, helical and spiral bevel gears.

g) The gearbox housing shall be of rigid cast construction preferably split in the horizontal plane.

h) Unless close coupled, each gearbox shall be mounted on machined sole plates fitted with jacking screws to assist with alignment.

i) Bearings shall be designed for an L-10 life in excess of 100 000 hours.

j) Oil-bath gearboxes shall have suitable oil level indicators or dipsticks which indicate the allowable levels. Inaccessible oil drain points shall be provided with extensions so that the oil can be easily drained. The drain line shall be of EN Grade 1.4401 (316) stainless steel and shall be fitted with a ball valve and square head plug.

k) Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel. A breather designed to prevent moisture from entering shall be fitted.

15.2 Manual Gearboxes

a) An over-torque limiting device shall be incorporated.

b) Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

c) A breather designed to prevent moisture from entering shall be fitted.

16 LUBRICATION

Grease lubrication is preferred and all greasing points must be easily accessible. Equipment with multiple greasing points shall be provided with grease lines which are piped, separately, to a single easily accessible position.

In cases in which motorised lubrication is provided to more than one destination, a distributor shall be provided. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations.

Pipework for grease distribution shall be of stainless steel or non-ferrous metal.

Oil level indicators shall be fitted for visual checking. Drain cocks, including Grade 316 stainless steel fittings where necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1.5 litre capacity.

All lubrication systems shall be designed so as to exclude dirt and moisture. Air vents on oil reservoirs shall contain an air filter.

17 GAUGES

a) Gauges shall be of industrial construction and shall be glycerine filled for damping. The case and bezel shall be of stainless steel unless this material is unsuitable for the application.

b) Pressure, vacuum or compound gauges shall comply with SANS 1062 and shall bear the Standards mark. Gauges shall be of Accuracy class 1.6 and Durability grade A unless otherwise specified.

c) The scale shall be chosen so that the expected pressure is not less than half full scale reading but the full scale reading for a gauge on the discharge leg of a centrifugal pump shall be higher than the pump shut off head.

d) The gauge reading shall indicate gauge pressure unless absolute pressure measurement has been called for.

e) Gauges shall have a scale diameter of not less than 100 mm. Calibration shall be in kiloPascals with the full scale reading between 1,5 and 2 times maximum actual operating pressure except where otherwise specified. The units of measurement shall be clearly marked on the dial.

f) Wherever applicable, gauges shall be clearly strip marked in green to indicate the normal operating range and in red to indicate the non-permissible range of values.

g) Gauges shall be suitable for continuous operation and shall be liquid filled on all pump applications and where fluctuations in pressure may cause damage. Gauges shall not be mounted directly on equipment subject to vibration. Gauges for pipework larger than DN 250 shall be remotely mounted and isolating valves shall be provided at each end of the connecting pipework.

h) Gauges shall be mounted vertically and in such a position that they can be easily read from floor level. Flanged nozzles for gauge tappings shall be provided on the parent pipework. Nozzles shall comply with the requirements of the clause "Pipework (> DN 100)". Pressure gauges shall be fitted with an isolating and an air bleed valve.

i) A gauge for liquids containing solids shall have its nozzle on the side of the parent pipe and the configuration shall allow easy cleaning of the passageways.

j) Gauges used on wastewater, sludge, chemical, solids conveying or other applications where blockage or corrosion of the gauge is possible shall be fitted with a diaphragm type chemical seal, both being liquid filled. The portion of the seal in contact with the process liquid shall be of a suitable non corroding material.

k) Scale markings shall be radial, plain, straight, black lines on a white background and shall be spaced so that one scale division represents approximately 1,5 % of the maximum scale value in values of 1, 2 or 5 multiplied by any power of 10 to suit the maximum operating rating. On circular gauges the scale shall be concentric and the maximum and minimum scale values shall be near the bottom of the gauge, with the scale symmetrically disposed about the vertical centre line of the gauge. The tip of the pointer shall be of the knife edge type extending across the scale divisions and shall be as close as practical to the dial.

18 BASEPLATES

18.1 General

Equipment and drivers shall not be mounted directly onto a concrete base without the use of either a baseplate or soleplate.

Driven equipment and their drivers shall be mounted on common cast iron or fabricated steel baseplates of rigid construction. Common baseplates shall be provided for direct coupled and for belt driven machines.

In applications where baseplates are not practical, machined soleplates, suitably fixed and grouted into the concrete plinths, shall be provided.

The Contractor shall provide the baseplate, anchor fasteners and chemical anchor for securing the fasteners.

18.2 Design Requirements

Baseplates shall prevent pooling of water and shall be grout filled or shall be provided with drain holes in all side members.

The baseplate shall incorporate machined mounting pads at the support and fixing positions of each item of plant and equipment to be mounted on the baseplate. On fabricated baseplates this machining shall be done after fabrication, stress relieving (if applicable) and hot-dip galvanizing (if applicable) are complete. The thickness of the mounting pads shall be not less than 1.25 times the diameter of the holding down bolts. The pads shall not be provided with threaded holes for machine screws but shall be drilled for inserting through bolts and adequate provision shall made for reaching the nut with a suitable spanner. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Tectyl or equivalent, shall be applied to exposed machined surfaces and to the crevice formed at the foot of the equipment. The above design may be suitably modified if the Contractor uses a pourable resin based chocking system. Such chocks shall be at least 15 mm thick.

At least two diagonally opposed jacking screws shall be provided for belt tensioning in the case of belt driven units. Direct coupled motors above 10 kW shall be provided with jacking screws for horizontal alignment and direct coupled motors above 150 kW shall be provided with jacking screws for vertical alignment as well. Jacking screws shall be of EN Grade 1.4401 (316), or better. Drilled and tapped flat plate is not acceptable for jacking points. A jacking point shall consist of a suitable hot rolled steel section welded to the baseplate and with a captured machine nut to accept the jacking screw.

18.3 Fabrication

Fabrication shall comply with the clause "Structural Steelwork Fabrication" and welding shall comply with the clause "Welding".

Baseplates shall be manufactured of either:

- hot rolled steel sections.
- bent plate (with the overall length not more than 200 X plate thickness).

Practical requirements for providing accessibility for surface preparation and coating shall be taken into consideration. Inaccessible pockets shall be avoided. Hollow spaces which cannot be accessed by blast and spray equipment shall be avoided or shall be welded closed. All such hidden surfaces shall not be permitted.

Inspections of carbon steel fabrications will generally be done after fabrication is complete.

18.4 Materials

Baseplates shall be fabricated from Grade 300WA steel or superior.

1.1. Corrosion Protection

Steel baseplates shall be hot dip galvanized.

The requirements of the clause "Corrosion Protection" shall be followed if the item is to be hot-dip galvanised. Designs shall provide proper access for safe and proper entry of the zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided

18.5 Corrosion Protection

Anchor fasteners shall be of EN Grade 1.4401 (316), or better. Fasteners shall comply with the clause "Fasteners".

A minimum of six anchors shall be provided for pumps with an inlet of DN 150 and smaller.

Eight or more anchors shall be provided for pumps with an inlet larger than DN 150.

Pumps with an inlet of DN 100 or smaller shall have anchor bolts of at least 12 mm. Pumps with an inlet larger than DN 100 shall have anchor bolts with a diameter no less than 12 + (Ø-100)/25.

1.2. Installation

Not more than three shims may be used at any point and these must be made of a corrosion resistant material.

Concrete surfaces under baseplates shall be scabbled before the baseplate is placed and shall be blow clean using compressed air immediately before grouting.

Baseplates shall be designed and grouted to eliminate collection points for water or dirt. Except where otherwise approved in writing by the Employer's Agent, all baseplates on concrete plinths shall be fully grouted in. Grouting holes must be provided on baseplates having a continuous top plate. Tapped holes and fixing setscrew protrusions shall be suitably protected. The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if the Contractor's design requires an epoxy grout to be used. The initial grouting shall be overseen by the grout supplier's technical representative.

Preliminary alignment of equipment mounted on baseplates shall be done at the factory to ensure that the baseplate has been correctly manufactured, but final alignment shall always be done on Site after installation and grouting has been completed. Alignment shall be accurate and to the approval of the Employer's Agent and a final alignment check witnessed by the Employer's Agent must be carried out by the Contractor prior to start up.

18.6 Inspection

The Contractor shall arrange for the Employer's Agent to inspect the fabrication of the baseplate before it is hot dip galvanized.

19 MACHINE GUARDS

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended and the following points shall also be noted:

Guards are required to cover all moving or revolving components of machinery and shall:

- Be such as to adequately cover all moving protrusions such as couplings, keys, lock nuts, lock washers, sets crews, and the protrusion.
- Be neatly and rigidly constructed and fixed so as to not vibrate or cause noise during operation of the plant.
- Enable adjustments to be made where required such as on belt guards.
- Be fixed with M10 or larger hex head bolts and shall be of EN Grade 1.4401 (316) stainless steel.
- Be easily removable for maintenance purposes.
- Guards shall preferably be fabricated of EN Grade 1.4401 (316) stainless steel (uncoated) but may also be hot dip galvanized, hot metal zinc sprayed or hot metal aluminium sprayed carbon steel, coated to Specification in all these cases.

- Comply with the requirements of BS 1649 or equivalent standard.

Mesh shall not be used for chain guards but, on belt drives, the side of the guard most conveniently sited for inspection, shall be constructed of expanded metal or similar.

Mesh should similarly be used in other situations where inspection or ventilation is required. Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate.

20 SHAFT COUPLINGS

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and driven machine. Couplings shall, wherever practical, be of the rubber type or rubber compression type, keyed to the shafts.

Elastomeric elements shall be urethane based. Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used in all cases where this will assist maintenance.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Employer's Agent.

After installation, the alignment of all couplings shall be checked by the Contractor in the presence of the Employer's Agent or a person delegated by him. Alignment shall be accurate and to the approval of the Employer's Agent.

21 GRID FLOORING

21.1 General

The Contractor is responsible for the design of the grid flooring system. The Contractor shall confirm all measurements on Site prior to submitting dimensioned details to the Employer's Agent for approval. These details shall be presented on drawings which comply with the requirements of SANS 10111.

The depth of bearer bars in metal grid flooring shall not be less than 30 mm with a bearer bar pitch of not greater than 40 mm. The bearer bars shall be across the shorter span.

Panels shall be set level and fixed to angle frames to prevent rocking.

Cut outs in grid flooring for pipes, valve spindles, etc. are to be made and fully banded before any corrosion protection is done. The edges of removable grid access covers must also be fully banded.

Unless another material (such as stainless steel) is specified, grid flooring and frames shall be of carbon steel, hot dip galvanized after fabrication. Painted coatings are not acceptable.

Where grid flooring rests on painted surfaces, strips of rubber insertion material shall be secured under the grid to protect the paint.

21.2 Fixing

The fixing clip set (saddle clamp and locking plate) shall be of hot dip galvanised steel or stainless steel. Fasteners shall be of EN Grade 1.4401 (316), or better, unless otherwise specified in the drawings and schedule of quantities.

21.3 GRP Grid Flooring

GRP grid flooring is acceptable only where specified in the drawings and schedule of quantities.

The resin used for all GRP components of grid flooring shall contain a UV stabiliser.

The design shall ensure the prevention of fibre prominence for a period of at least ten years.

External grp components and all internal components subject to direct sunlight shall, in addition to the UV stabiliser in the resin, be provided with a polyurethane based UV protective coating to a thickness of at least 25 micron. A suitably stabilised flow coat will also be acceptable. The coat shall be provided over the full surface.

21.4 Installation

Grid flooring shall be mounted firm and level and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

Panels shall be set level and fixed to frames to prevent rocking. No perceptible movement will be acceptable.

The Contractor shall provide all components required for the support and fixing of the flooring.

Adjacent floor pieces shall have vertical edge alignment of within 5 mm of each other.

22 ACCESS LADDERS, PLATFORMS AND HANDRAILS

All access ladders, platforms, handrails, covers, etc., shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993 and the Drawings.

22.1 Ladders - General:

a) All ladders, platforms, cover plates, kerbings and appurtenant parts located in wet or wet/dry conditions shall be fabricated from 304L stainless steel.

b) All ladders, platforms, cover plates, kerbings and appurtenant parts located at the outside of civil structures shall be manufactured of mild steel and hot dip galvanized.

c) All internal ladders, platforms, cover plates, kerbings and appurtenant parts shall be manufactured of mild steel and hot dip galvanized.

d) Access points to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

e) No part of a ladder may project into a passageway.

f) The clear width between stringers shall be no less than 500 mm.

g) A minimum clear space of 230 mm must be allowed behind the rungs.

h) The diameter of the rungs shall be between 20 mm and 50 mm.

i) Additional rungs shall be provided in the same horizontal plane as the top rung in order to close the gap between the platform and the ladder. Sufficient rungs shall be provided to ensure a maximum gap of 75 mm. These top rungs shall be at the same level as the floor or platform to which access is being provided.

j) Stringers shall be formed from flat plate or channel sections. The vertical distance between the ladder support brackets shall not exceed 1 800 mm.

k) The stringers shall extend to 1 100 mm above the floor or platform and shall be matched with any hand rail protections at this level. Connections between hot-dip galvanised steel ladders and stainless steel hand railing shall be bolted. Unless laterally supported by the hand rails, these stringers shall be supported by vertical structural sections (not flat bar) whose bases shall comply with this specification for hand rail stanchion bases.

l) All rises in a flight shall be uniform and the surface of the top rung shall be level with the top platform or landing. The height chosen for the rise shall be between 225 mm and 255 mm.

m) Except on chimneys, the height of a ladder should not exceed 6 000 mm. Greater heights shall be provided with intermediate landings between each 6 000 mm ladder sections.

n) If the height between start and end levels is over 4 000 mm, the ladder shall be fitted with a safety cage. The safety cage shall extend at least 1 000 mm above the higher landing. The cage shall be no more than 700 mm away from the plane of the rungs and shall comprise no fewer than seven vertical elements.

o) Anchor bolts shall be of Grade 316 stainless steel and shall be no smaller than M16.

p) Stringers, rungs and anchor brackets shall be of solid structural sections (e.g. flat bar, round bar, square bar, angles, etc.) and no hollow sections will be accepted for any part of the ladder.

22.2 **Cat Ladders**

Cat Ladders: Where not shown and dimensioned on the Drawings, cat ladders shall be manufactured as follows:

a) The sides of the cat ladders shall consist of flats, the size depending on the length but in any case shall not be less than 70 mm x 12 mm, and the inside width shall not be less than 380 mm. The rungs shall consist of round bars, not less than 22 mm diameter at 250 mm centres holed through the side stringers, welded all around on both sides of the flats and ground flush on the outside. If it is not possible for any reason to adopt the rung centres stated above the pitch adopted must be not less than 230 mm and not more than 255 mm. The length of each ladder shall not exceed 7 m and shall be suitably supported over its whole length.

b) The cat ladders shall be vertical and provided with safety hoops of 700 mm diameter. The bottom safety hoops on each ladder shall be 2.50 m from the floor or landing level. The side stringers of all ladders shall be extended nominally one metre above the first rung to provide a handhold. Entries to the tops of cat ladders shall be suitably guarded by an entry bar.

22.3 **Platforms**

Platforms shall be provided where applicable. All landing covers shall be of the open grille type. This open grille shall be suitable for a floor loading of not less than 500 kg/m^2 and bar sections shall not be less than 39 mm x 3 mm and the platforms shall be designed accordingly. Kicking plates or angles shall be fixed around all platforms and shall extend 150 mm above the top of the flooring.

22.4 **Handrails**

22.4.1 General

a) Handrailing shall comply with inter alia, SANS 10104 and shall be in accordance with legislated requirements and shall be provided generally in positions where the vertical difference in level is 1 000 mm or greater.

b) Guard railing shall be designed to resist, without any damage and without excessive deflection, the loadings in Category E in Table 7 in Clause 9.4 of SANS 10160 2:2011, Edition 1.1, namely:

- A force of 1 000 Newtons in any direction (concentrated over a length of 100 mm).
- A distributed horizontal force of 1 000 Newtons per metre applied along the top rail.

c) Handrailing shall comply with inter alia, SANS 10104 and shall be in accordance with legislated requirements and shall be provided generally in positions where the vertical difference in level is 1 000 mm or greater.

d) All handrailing shall comprise hand and knee rails not less than 32 mm diameter and stanchions spaced at not more than 1,8 m except where specifically directed otherwise in writing by the Employer's Agent. All components shall be supplied in the pickled and passivated condition which may also be polished. All surfaces must be uncontaminated and unmarked to ensure maximum corrosion resistance.

e) Handrails shall be provided along the exposed edges of all platforms and elsewhere as shown on the Drawings. All handrailing shall be tubular but the standards may be tubular or solid forged. Angle irons shall not be used.

f) The height to the top handrail from the finished platform or floor level shall be 1.10 m and the height to the top of the lower handrail shall be 550 mm. All handrails shall be equivalent in size and stiffness to BS 1775 Grade 13, 33.7 mm O D heavy duty tube or equivalent standard.

g) Stanchions and rails shall be smoothly finished and free from sharp corners, edges and projections which may injure persons or damage clothing. Stanchion bases shall have the corners rounded off.

h) The tubular rails shall be joined using the slip-jointing method with separate and neatly fitting tubular inserts fitted into the railing bore. If stainless steel pins are used they shall have their ends peened over and smoothed or, if taper pins are used, they shall be filed off flush with the rail. The joints shall withstand the required loads when situated in any position including centrally between two stanchions. Joints shall preferably be located inside the stanchion balls.

i) Railings shall be ended off with positively fixed (pinned) closure bends. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically designed for such a position shall be employed. No sharp endings will be permitted.

j) Stanchions shall generally be base-mounted but can be side mounted to suit the arrangement requirements and shall be of solid or welded construction. Welding shall be compatible with the material, shall not impair the strength or corrosion resistance of the material, shall be continuous and shall be smoothly finished and then passivated.

k) Stanchions shall be self-draining to suit the mounting arrangement.

l) Holes for the rails to go through the stanchions shall have a diametral clearance not exceeding 1 mm but preferably 0,5 mm. On stairways with stanchions vertically mounted, the hole shall be angled to suit and shall accurately fit the angled rail with the abovementioned clearances.

m) Stanchion bases which are attached to metallic surfaces shall have minimum dimensions of 150 mm x 60 mm. Two fasteners, of minimum size M16, shall be used to attach the base which must have a material thickness shall be not less than 8 mm.

n) Stanchion bases which are attached to non-metallic surfaces shall have minimum dimensions of 150 mm X 150 mm. In instances where the horizontal surface to which the base is to be fastened is less than 150 mm wide, the base shall be designed to be seated on at least two surfaces. Four fasteners, of minimum size M16, shall be used to attach the base to the concrete. Base material thickness shall be not less than 10 mm. Non-shrink, cementitious grout shall be applied under the foot just prior to final tightening of nuts.

22.4.2 Mild Steel Handrails

a) Fabrication and welding shall comply with the clauses "Structural Steel Fabrication" and "Welding".
b) The guard rails shall be hot-dip galvanised in accordance with the relevant clauses pertaining to the hot-dip galvanizing of carbon steel.
c) Designs shall provide proper access for safe and proper entry of the zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided.
d) If the guard rails are welded or cut after hot-dip galvanising, they shall be returned to the galvaniser for re-galvanising.

22.4.3 Stainless Steel Handrails

Where stainless steel has been specified, all handrailing shall be of EN Grade 1.4301 unless otherwise specified.

22.4.4 Fasteners

a) All anchor fasteners, including nuts and washers shall be of EN Grade 1.4401 (AISI 316) stainless steel.
b) Fastener diameter shall not be less than M12.

22.5 Cover Plates and Kerbings:

a) Cover plates, kerbings and appurtenant parts located in wet or wet/dry conditions shall be fabricated from 304L stainless steel.
b) Cover plates, kerbings and appurtenant parts located at the outside of civil structures shall be manufactured of mild steel and hot dip galvanized.
c) Cover plates, kerbings and appurtenant parts shall be manufactured of mild steel and hot dip galvanized.
d) All open grill type covers shall be suitable for a floor loading of not less than 500 kg/m2. All raised tread non-slip type plate covers shall be of "Durbar" pattern and shall also be suitable for a floor loading of not less than 500 kg/m^2 but in any case shall not be less than 8 mm thick on the plain plate and shall be reinforced if and where necessary.
e) The covers and supports shall also be designed to take account of any special loadings that may be imposed during erection or maintenance. All heavy duty covers shall be designed for HB loading.
f) The kerbings shall consist of rolled stainless steel angles suitably anchored and the landings for the covers shall not be less than 40 mm wide. Removable supports shall be provided where necessary.

23 FASTENERS

23.1 Standards

a) Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series.
b) Nuts, bolts, studs and washers for incorporation in the works shall conform to the requirement of the appropriate British or other accepted standard.

c) Bolts shall be of such standard length that a minimum of two to four complete threads shall show through the nut when in the fully tightened condition.

d) Mating surfaces shall be adequately protected against corrosion whilst awaiting assembly of the faces and bolting all to the acceptance of the Employer's Agent.

e) Galvanized nuts and bolts shall be avoided, except for handrails and ladders. Use stainless steel in lieu of galvanized where anticorrosion properties are required, with due regard to galvanic corrosion due to dissimilar metals.

f) All bolting shall comply with the general requirements of BS 5400.

g) Double washers shall be used for all nuts and bolts.

23.2 Materials

a) Fasteners in non-corrosive areas shall, except when specified otherwise, be mild steel construction and hot dip galvanized.

b) Fasteners in corrosive areas shall be of EN Grade 1.4401 (316) or better. Corrosive areas shall be taken to include any moist or wet area such as in and above settling tanks, in or in the vicinity of open channels, where a spray can be expected.

c) M12 fasteners and smaller shall be of EN Grade 1.4401 (316) or better.

d) Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot dip galvanized.

e) Plated fasteners are not acceptable.

23.3 High Tensile Bolts

Where high tensile bolts are required by the design, they shall be hot dip galvanized and painted. The bolt holes and crevices shall be filled and sealed prior to painting.

23.4 Anchor Fasteners

a) Anchor fasteners shall be of EN Grade 1.4401 (316), or better.

b) Anchor fasteners for water retaining structures and for brickwork shall be of the chemical anchor fastening type. Other anchors may be of the expanding type or chemical anchor type.

c) Where hook bolts are used, these shall be supplied and grouted by the Contractor into pockets which will be provided in the concrete structure in accordance with the information to be supplied by the Contractor. The grouting products shall be used strictly in accordance with the manufacturer's instructions.

d) Where machinery is anchored by studs or bolts which extend through the supporting structure and is therefore fastened down with the use of nuts from both sides, the studs or bolts, together with associated washers and brackets, shall also be of EN Grade 1.4401 (316), or superior.

e) Submerged anchors shall be secured with chemical anchor designed for submersion.

23.5 Material Compatibility

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. EN Grade 1.4401 (316) bolts must be used to fasten together EN Grade 1.4401 stainless steel flanges and fabrications.

23.6 Washers

a) Flat washers shall be provided under nuts and setscrew heads.

b) Flat washers shall be provided under bolt heads on painted surfaces.
c) Flat washers shall be provided under bolt heads where the bolt is positioned in a slot.
d) Spring washers shall be used on fasteners subject to vibration (other approved locking arrangements will also be acceptable on proprietary equipment).
e) Anchor bolts for machinery shall each be provided with a flat washer and a spring washer (other locking arrangements are not acceptable).
f) Washers shall be of the same material as the fasteners.
g) Flat washers exhibiting visual deformation shall be replaced by thicker washers.
h) Washer material should match that of the bolt and nuts, or as specified elsewhere.
i) Double washers shall be used for all nuts and bolts.

23.7 Anti-Seize Compound

Before assembly, stainless steel threads shall be treated with a nickel-based, anti-seize/corrosion protection compound such as Chesterton 725: Nickel Anti-Seize Compound, or equivalent. Copper based compounds are not acceptable.

A small amount of the compound shall be applied along the full length of the exposed thread before fastening. Excessive compound visible on the thread after the nut has been applied shall be cleaned off.

23.8 Thread Projection

Bolt threads shall project no less than 3 threads and no more than 8 threads from the head of the nuts when fixed. Longer projections will only be allowed if the Contractor can show that bolts of a more suitable length are not manufactured.

23.9 Corrosion Protection

Unless otherwise specified in the Project Specifications or drawings or scheduled in the BoQ, the provisions of Particular Specification GIBB 007: Painting and Corrosion Protection shall apply.

24 SIGNAGE

24.1 General

All signs as specified below shall be installed prior to commissioning.

24.2 Operating Instructions

Operating instructions shall be framed and shall be attached to the wall in the control room. The frame shall be of aluminium with a glass front and hardboard backing. They shall include the following:

- Start up, Shut down and Operating instructions shall be comprehensive and shall indicate actions to be taken in the case of all alarm conditions. These shall be written from the point of view of the plant operator.
- A layout drawing of the equipment installation.
- A process flow diagram.
- A P&ID.

24.3 Safety Signage Requirements

Safety signs shall be suitably framed or encapsulated. Symbolic signs shall comply with SANS 1186. The wording of the signs shall be approved by the Employer’s Agent prior to final printing. They shall be provided by the Contractor in appropriate places on the walls of the plant room and shall include the following:

- All statutory and special safety warning instructions.
- Course of action during/after electrical shock.
- Any operating restrictions for equipment.
- Operating instructions in cases of plant trip and electrical supply failure.
- Spares list

25 NAMEPLATES, RATING PLATES AND LABELS

a) Where appropriate each item of Plant shall have permanently attached to it in a conspicuous position a nameplate upon which shall be engraved or stamped the manufacturer's name, type and serial number of Plant, Contract No., order no., date of manufacture, mass, material and all necessary information relating to the supply and replacement of parts and details of the loading and duty at which the item of Plant has been designed to operate. A nameplate denoting the Plant or function identification number shall also be attached. Such nameplates shall be of stainless steel.

b) Labels shall be provided for every panel to describe the duty of or otherwise identify every instrument, relay or item of control equipment mounted externally and internally.

c) Externally fitted panel labels shall be of non-plastic, durable, weather resistant material with letters and numbers engraved and filled with black.

d) Internally fitted panel labels shall be finished white and engraved letters and numbers filled with black, laminated material such as “Trifoliate” or rear engraved and filled plastic may be used. Embossed materials and techniques will not be accepted.

e) Labels shall also be provided in conformity with the above requirements or by other accepted means wherever necessary to designate panels or panel sections, to provide warnings or reminders of dangerous or potentially dangerous circumstances and wherever called for elsewhere in this Specification.

f) Danger labels, e.g. "DANGER-380V AC" shall be coloured red with white lettering.

g) Caution labels e.g. "CAUTION-ISOLATE BEFORE REMOVING COVER" shall be white with red lettering.

h) Where withdrawable equipment is provided both fixed and moving portions shall be suitably identified.

i) Labels shall be of uniform design and the display of manufacturers' standard nameplates on panel external surfaces shall be subject to the acceptance of the *Employer’s Agent.*

j) Details of proposed inscriptions shall be submitted to the *Employer’s Agent* for acceptance before any labels are manufactured.

k) All nameplates and labels shall be fixed using non-corrosive fasteners to the acceptance of the *Employer’s Agent*. Adhesive only shall not be acceptable.

26 NOISE CONTROL

26.1 General

Noise emitted by equipment shall be kept to a minimum and shall not exceed the noise levels specified in these documents.

26.2 Noise Levels

The sound power of any equipment shall not exceed 89 dB(A) (referred to 10-12 Watts) unless specifically approved by the Employer's Agent. This is approximately equivalent to a sound pressure level of 81 dB(A) at a radius of one metre from the acoustical centre assuming uniform hemispherical propagation in a free field on a hard floor. In certain instances, a lower noise level may be called for.

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc.; the Contractor shall inform the Employer's Agent so that appropriate steps can be taken to counteract the effects of noise.

26.3 Acoustic Treatment

Standard acoustic enclosures shall be provided where called for.

Acoustic treatment of high noise sources shall be provided where this can be done without greatly interfering with operation or maintenance.

If acoustic lagging of pipework or ducting is specified, this shall consist of pre-formed rockwool encapsulated in stainless steel sheet metal. Alternatively, a 100 mm thick layer of rockwool having a density of 60 kg/m3, suitably fixed in place and reinforced to prevent collapse, and covered with 25 mm thick asbestos free plaster having a density of 1 000 kg/m3 (I.P. Insultex AF720, or equivalent). The outer surface shall be finished off with scrim cloth before being painted.

It is not normally necessary to lag flow meters and cast iron valves on acoustically lagged pipelines.

Components which can move, such as those associated with expansion bellows or mechanical couplings, shall be enclosed by an effective acoustic enclosure designed to prevent sound transmission but able to cope with movement without damage.

27 ERECTION, SETTING OUT AND INSTALLATION OF PLANT AND EQUIPMENT

27.1 General

When installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb, and in proper working order.

The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of all equipment.

All pumps, pipework, valves and fittings shall be securely fixed and supported so as to impose no undue stress on any pump casing and the prices tendered shall include for the supply and installation of all supports and fixings in this regard.

27.2 Puddle Pipes

Where pipes pass through concrete walls, the Contractor shall install the pipework and shall grout the pipes into the structure using a suitable non-shrink grout approved by the Employer's Agent. The Contractor shall provide a water tight installation and shall be responsible for rectifying any leakage at the puddle pipe.

Where pipes pass through brick walls, the Contractor shall build these in achieving a finish to match the surrounding wall.

27.3 Grouting

27.3.1 General Duties

Concrete for embedding built-in parts shall be supplied, mixed and placed in accordance with specified requirements as approved by the *Employer's Agent*.

Grout for the connection between bed plates and machinery and concrete shall be non-shrink epoxy grout and shall be mixed and placed in accordance with the approved Drawings.

27.3.2 Approval of Grouting Materials and Methodology

The method proposed for anchoring and grouting equipment into concrete structures shall be submitted to the Employer's Agent for approval and shall incorporate the details of the non-shrink grout proposed. The material used for grouting shall be a non-shrink, cementitious grout such as ABE Duragrout 1000, or equivalent. ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required

Non-shrink grout shall:-

- Have a compressive strength not less than 4 times the maximum stress to be transmitted;
- Be subject only to compressive stress;
- Be such that air voids are eliminated between bed plates and machinery and concrete;
- Be completely resistant to lubricants, hydraulic fluids and diesel fuel;
- Have a bond strength to concrete exceeding the tensile strength of the concrete; and
- Have a bond strength to steel not less than (v) above.

Cavity and contact grouting behind bellmouth intake linings shall be done, following precise alignment to line, plane and level. When the grouting is complete the *Contractor* shall fill all grout holes in the lining with the screwed and welded steel plugs to give a flush surface on the inside of the lining.

27.3.3 Building in of Pipework

Pipework shall be firmly secured and checked for movement before shuttering is built. The profile of the soffit shall be prepared so that pockets of air and water will not form on the top surface of the grout. At this point, the Employer's Agent shall be called to inspect the pipe, the cleanliness of the wall penetration and the profile of the soffit. The "letter box" spout shall ensure that at least 100 mm of head is applied to the grout once the pour has been completed and shall also allow entry of a poker vibrator during the pour. The pipework shall be checked a second time for movement after the shuttering is built.

The grout mix and pour shall be done in the presence of the Employer's Agent unless otherwise required.

GENERAL MECHANICAL

27.4 **Alignment of Shafts**

Shafts for drives, such as motors, shall be accurately aligned using laser aligning equipment.

Final alignment shall be carried out after installation and an alignment certificate shall be submitted to the Employer's Agent before commissioning. Alignment shall comply with the manufacturer's recommendations and be sufficiently accurate to ensure that there are no adverse effects as a result of the out of alignment tolerances.

27.5 **Installation of Pipework**

Pipes and fittings shall be selected to suit the application and shall be neatly installed, straight to line and level, and adequately supported and shall operate without vibration. Adequate provision shall be made for expansion and contraction due to variations in temperature or pressure.

All pipework shall fit perfectly and be so arranged and supported that it shall not impart stresses to any other plant or equipment.

Unless otherwise stated in the Project Specification, drawings or schedule of quantities, all pipework to be built into or in contact with concrete structures shall be 6 mm thick Grade 304 stainless steel.

All pipework shall be suitably equipped with the requisite tapped bosses, isolating cocks, supports, fixings and everything necessary for attaching site pressure testing apparatus and controls and for satisfactory operation of the plant.

27.6 **Pipe Supports**

a) Pipe supports shall be so located that when an item of mechanical equipment is removed, the associated valves and pipework will still be adequately supported.
b) Supports shall be provided under or close to heavy items such as valves.
c) Supports shall be provided close to all heavy items such as valves of size DN 300 and larger.
d) Pipework shall not place any external loads on items of mechanical equipment such as pumps, compressors, etc.
e) Adequate provision shall be made for expansion and contraction due to variations in temperature or pressure.
f) Proposed designs of pipe supports shall be submitted to the Employer's Agent for approval prior to manufacture. The calculations for pipe supports designed to withstand the thrust from reducers, bends and check valves shall also be submitted to the Employer's Agent for approval.
g) Pipe supports which only support the weight of horizontal pipework may be of the sliding type and shall be vertically adjustable.
h) Pipe supports which resist thrust forces shall incorporate doubler plates on the pipe which are contoured to match the pipe. Other reinforcing designs are also available.
i) Low carbon steel supports shall be fabricated from heavy duty hot rolled steel sections. The complete assembly shall be hot-dip galvanised after all fabrication is completed. Welds shall be continuous "all round"; i.e. no crevices.
j) Stainless steel supports shall be fabricated of plate with a minimum thickness of 4,5 mm or shall be fully triangulated, boxed or closed sections. Welds shall be continuous "all round"; i.e. no crevices.

k) At least four anchor fasteners shall be provided for the foot of each pipe support. Anchor fasteners shall be of EN Grade 1.4401 (316) stainless steel.

l) For cantilevered pipe supports, the spacing between anchor fasteners on the foot shall be not less than one quarter of the cantilevered length. Gussets between the column and the foot are normally required and these shall be positioned so as to minimise the distance between the gusset and the bolt hole. This requirement does not apply to supports which only provide vertical support.

m) The maximum spacing between pipe supports for steel (including stainless steel) pipe of diameter, d [mm], shall be calculated as follows: Spacing (mm) = 1 000 + 10d. This applies to pipe only. Valves or other heavy fittings which shall be provided for separately as required. (Pipe support spacing distances for non-metallic pipework shall be half of the above.)

n) The maximum spacing between pipe supports for plastic pipe of diameter, d [mm], shall be calculated as follows: Spacing (mm) = (1 000 + 10d) / 2. This applies to pipe and not to valves or other heavy fittings which shall be provided for separately as required.

o) Where appropriate, 3 mm thick neoprene strips shall be placed between pipes and supports or clamps to protect the paintwork and to limit corrosion.

p) Where roller or sliding supports are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage.

q) Floor and wall mounted pipe supports shall be aligned using nuts above and below the foot. A space of at least 20 mm shall be left between the foot and the floor and this space shall be filled using non shrink grout once alignment has been completed. Grouting shall be done in accordance with the manufacturer's instructions. Alternative designs and installations may be submitted by the Contractor.

r) Concrete surfaces under foot plates shall be scabbled before the support is placed and shall be blown clean using compressed air immediately before grouting.

s) Where the Employer's Agent approves the use of concrete pipe supports, these will be constructed after installation of the pipework and temporary supports shall be provided by the Contractor in positions which will not interfere with the construction of concrete supports.

t) Fabrication and welding shall comply with the relevant sections of this specification.

u) Corrosion Protection shall comply with the relevant sections of this specification, and the related specification on corrosion protection.

v) Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon completion.

27.7 Installation of Instruments

All measuring instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer, for the particular application. Each mounting position shall be chosen to give correct operation of the equipment, faithful reproduction of the quantity to be measured, ease of operation, reading, maintenance and servicing, and freedom from any condition which could have adverse effects.

28 INSPECTION AND TESTING

Refer to GIBB-019 *Control, Integration and Commissioning* for inspection and testing requirements.

29 COMMISSIONING

29.1.1 Scope

There are two stages to commissioning:

- Commissioning of the individual electrical and mechanical systems (eg chemical dosing system, clariflocculator desluding, filtering and backwashing, spent backwash water re

As soon as the successful testing of all individual electrical and mechanical systems required to put the Works into full production (ie deliver water to consumers) has been concluded, the overall Works shall be commissioned without delay.

29.1.2 Preparation:

Before starting up any section of the Works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all ducts, pipework, tanks, etc., are clean, that all equipment is correctly aligned, lubricated and connected up, and is in all respects ready to start with safety. The Contractor shall provide initial fill requirements, such as lubricating oil.

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.

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 Employer's Agent to ensure that the plant will fulfil the functions for which it has been supplied.

29.1.3 Starting Up and Testing:

The Contractor shall arrange for the Employer's Agent to be present at initial start-up and also for any electrical and control instrumentation sub-contractors to be present.

The Contractor shall start up and test each section of the Works. These tests shall be carried out to certify that the Works is operating in accordance with the requirements specified and must be witnessed by the Employer's Agent. All necessary modifications and rectifications shall be carried out during this period.

Set points for equipment and process parameters which are required for the operation of control systems shall be confirmed and recorded.

Tests on completion shall include the following:

(i) Simulated tests for all alarm and safety cut-out equipment to prove the operation of the equipment.

(ii) 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 re-setting the controls to the design conditions and checking the operation of valves, etc. to restore the design conditions.

(iii) Operational tests on the plant to demonstrate that it is giving the rated output and efficiency.

(iv) After the plant as a whole has been put into a condition of smooth operation, the Contractor shall operate the plant for a further continuous test run. (addressed later).

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 Employer's Agent. All instruments shall be accurately calibrated before the tests commence.

29.1.4 Commissioning:

When all tests have been completed to the satisfaction of the Employer's Agent, the Works as a whole shall be commissioned. The complete plant, including all control functions and control systems shall be commissioned as a unit and the process performance requirements shall be achieved during normal operation.

29.1.5 Commissioning Report

Once the Works as a whole has been satisfactorily commissioned and put into full-time operation, the Contractor shall submit to the Employer's Agent a Commissioning Report which gives a snapshot of 'as commissioned' operating conditions, loadings, parameters and performances as compared with the 'as specified' operating ranges, limits, performances and (where applicable) efficiencies.

29.1.6 Performance Acceptance Testing

Performance Acceptance Testing shall precede the start of the Trial Operation Period. The Taking Over of equipment shall be preceded by a minimum of forty-eight (48) hour trial run by the Contractor to enable him to prove to the Engineer that all equipment and the plant as a whole perform to requirements.

Where after the equipment shall be run by the Contractor as directed by the Engineer for a further period of approximately five (5) days during which thorough inspection, testing, etc. of all equipment shall take place to be evaluated for acceptance by the Engineer. The Contractor shall schedule this period such as to allow himself enough time to remedy, replace, etc. unsatisfactory work, equipment, etc. and still meet the final completion date. Costs incurred by the Engineer for all unsuccessful acceptance tests shall be borne by the Contractor.

When the Contractor has completed all work and the plant subsequently performs to requirements, then the Contractor shall supply all manuals and drawings as called for the Employer's particular specification for Operations and Maintenance Manuals.

The Employer's Agent will only issue a Completion Certificate after all aspects of the commissioning procedures have been complied with to his satisfaction and the operation and maintenance manuals have been compiled, accepted and issued to the Employer.

30 TRIAL OPERATING PERIOD & SERVICE VISITS

31 MEASUREMENT AND PAYMENT

31.1 Design and Submit Details, Quality Control Plans and Shop Drawings

Design and submit details, QCPs and shop drawings for … (describe equipment / system / scope)	……Unit: lump sum (Sum)

The tendered sum shall cover all costs associated with preparing and submitting designs, details and Quality Control Plans and shop drawings to the Engineer and liaising with same. This item shall become payable once the Engineer approves the details, QCPs and shop drawings.

31.2 Manufacture / Procure, Supply and Deliver to Site

Manufacture / procure, supply and deliver to Site (describe equipment / system / scope)	……Unit: lump sum (Sum)

The tendered sum shall cover all costs associated with the manufacture / procurement, supply and delivery to site of the stated equipment / system / scope (including loading, transport, off-loading, storage, labour, plant, equipment, tools, consumables, attendance, overheads and profit).

Where Factory Acceptance Testing (FAT) is specified, the tendered rate above shall include for all such costs except Engineer and / or Employer's actual travel and subsistence costs to witness FAT (to be arranged and paid-for by the Contractor). Where a FAT is applicable, a Prime Cost item (but without separate % Contractor's mark-up on T&S costs) will be provided in the BoQ for actual travel and subsistence costs incurred by the Contractor on the Engineer's / Employer's behalf as below:

Employer / Engineer travel and subsistence	……Unit: Prime Cost (Sum)

31.3 Erect / Install, Test and Commission

Erect / install, test and commission (describe equipment / system / scope)	……Unit: lump sum (Sum)

The tendered sum shall all costs associated with hoisting, erection, installation, permanent supports, anchoring / fixing, making-good coatings where damaged or defective, grouting (including supply of all necessary materials), supply of all lubricants, coolants and the like ready to 'wet' test, liaison, pre-commission ('dry') testing, commission and acceptance testing ('wet' testing), attending to all issues until equipment is demonstrated to be 'fit-for-purpose' (ie operating correctly, reliably, smoothly and steadily over the required operational range, ready for when the Works as a whole can be put into operation).

31.4 Commissioning Works as a Whole

Commission Works as a whole	……Unit: lump sum (Sum)

The tendered sum shall all costs associated with successfully bringing the Works as a whole into full operation where (barring external factors outside the Contractor's control), treated water complying with SANS 241 drinking water standard is reliably being supplied to OR Tambo District Municipality's consumers and the waste sludge is successfully being dehydrated and stockpiled. The tendered sum shall include the preparation and submission of a Commissioning Report (which shall be amended / edited / revised until finally approved by the Engineer).

This sum shall become payable once the Engineer certifies that the Works has reached a state of readiness, fit for the intended purpose (reliably supply consumers and successfully dehydrating the sludge as noted above).

31.5 Supply of Consumables

Supply, deliver and offload consumable (describe) ……Unit: Prime Cost Sum

Contractor's Mark-up on above …..Unit: % of Prime Cost

Consumables listed in the BoQ shall be supplied as ordered in writing by the Engineer. Before placing the Order, the Contractor shall first submit supplier details and costing to the Engineer for approval. Where multiple suppliers are available, the Contractor shall submit three quotes to the Engineer. Payment will be made based on supply and deliver paid Invoices submitted.

All Contractor's costs associated with arranging for supply, delivery, offloading and placing in storage shall be deemed to be included in the tendered % mark-up on the Invoice/s value.

31.6 Miscellaneous Prime Cost Items

Supply and deliver (describe) ……Unit: Prime Cost Sum

Contractor's Mark-up on above …..Unit: % of Prime Cost

Miscellaneous Prime Cost items (such as supply and deliver vehicle or laboratory equipment or proprietary item of equipment) listed in the BoQ shall be supplied as ordered in writing by the Engineer. Before placing the Order, the Contractor shall first submit supplier details and costing to the Engineer for approval. Where multiple suppliers are available, the Contractor shall submit three quotes to the Engineer. Payment will be made based on supply and deliver paid Invoices submitted.

All Contractor's costs associated with arranging for supply and delivery shall be deemed to be included in the tendered % mark-up on the Invoice/s value.

31.7 Storage

No separate payment will be made for storage. All costs associated with the need to temporarily store equipment shall be deemed to be included in the scheduled rates.

GENERAL SPECIFICATION

GIBB 007 – PAINTING AND CORROSION PROTECTION

Table of Contents

Table of Revisions

Revision	Date	Change Detail	Editor
1.0	December 2020	Initial Release	M. Funnell
1.1	June 2021	Editied HDG descriptions	M. Holmes

1 SCOPE

This Specification covers the painting and corrosion protection of plant, equipment in pumpstations and water and wastewater treatment works and above ground pipelines exposed to environments with variable corrosive tendencies.

Plant and equipment shall be manufactured and corrosion protected in accordance with the requirements specified in this Specification. No deviation from the Specification will be allowed without the written approval of the *Employer's Agent*. In the case of there being conflict between Specifications, this Specification will take preference

2 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

In this document the word or words:

(a) **Abrasive blast cleaning:** The process of projecting a stream of abrasive particles at high velocity towards a surface for the purpose of removing contaminants from that surface and to produce a textured surface which will increase the surface area and thus increase adhesion of the coating.

(b) **"Coating"** shall refer to the application of a uniform protective layer of material in the specified manner to the outside of equipment or piping.

(c) **Coat:** A single uniform film of corrosion protection material applied to a substrate for corrosion protection purposes.

(d) **"Lining"** shall refer to the application of a uniform protective layer of material in the specified manner to the inside of equipment or piping.

(e) **Layer:** A uniform protective film of corrosion protection material applied to plant, equipment and piping in a specified manner consisting out of multiple coats.

(f) **Holiday:** A discontinuity in a coating or lining which exhibits electrical conductivity when exposed to a specific voltage.

(g) **"Dis-bonded area"** shall refer to an area of coating that initially did adhere to the steel substrate after application, but which subsequently became loose from the substrate as a result of mechanical, chemical or other action.

(h) **"Un-bonded area"** shall refer to an area of coating which at no stage adhered to the steel substrate.

(i) **"Water path"** shall refer to the distance along the surface of a material embedded in concrete but exposed to water measured from the concrete surface.

(j) **"Dry"** shall refer to atmospheric conditions only and includes periodic wetting by spray or rain.

(k) **"Wet"** shall refer to permanently or usually "submerged", "submersed" or "immersed" conditions and shall include dry but normally very humid conditions.

(l) **"Wet/dry"** shall refer to conditions that are intermittently dry and wet as defined above.

(m) **"SC"** shall refer to Section in this specification i.e. SC 7 is section 7

(n) **System:** A corrosion protection coating or lining consisting of multiple coats and/or layers, the type of coat, the number of coats and their thickness, the method of application and the requirements of the complete system.

(o) **Electrical insulation defect (EID)**: Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:

a) A low-voltage, wet-sponge detector
b) A high-voltage, sparking detector
c) Operated in each case within the parameters specified

Note: EID's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays.

(p) **Fusion bonded epoxy (FBE)**: A thermoset epoxy powder coat. (The powder is normally applied by electrostatic spray to a preheated surface. The powder normally melts, fuses and cures at a temperature of 220ºC to 250ºC.)

(q) **Inspector**: A person authorised by the Employer's Agent to act as his representative in examining the work and materials and drawing such samples and carrying out such tests as may be necessary to ensure compliance with the specification.

(r) **Lot**: A number of similar or related items submitted for inspection at one time by the Contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day.

(s) **Paint**: A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied.

(t) **Pinhole**: An electric insulation defect detected by the use of a wet sponge detector (see EID).

(u) **Pot life**: The period, after the contents of the packs of a two-pack paint have been mixed together, during which the paint remains suitable for use without the addition of further solvent.

(v) **Powder coat**: A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface. A powder coat is classified as thermoplastic, when the applied coat may be re melted by heating, or thermoset, when it cannot be re melted by heat. Low or medium density polyethylene powder is thermoplastic whilst FBE is a thermoset material.

(w) **Significant surface**: The part of the article covered or to be covered by the coating or lining and for which the coating or lining is essential for serviceability and/or appearance.

(x) **Steel**: This term embraces carbon steels, 3CR12 and all grades of stainless steels.

(y) **Water break free**: A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands surrounded by unwetted surfaces.

(z) **Wet film thickness (WFT)**: The thickness of a coating or lining immediately after application and before any volatile matter has evaporated.

(aa) **Quality control**: The operational techniques and activities that are employed by the Contractor to sustain the required quality of a product, process or service.

(bb) **SAHDGA**: South African Hot Dip Galvanisers Association.

(cc) **Sa**: Followed by a number refers to a photographic illustration of the standard of blast cleaning required, as shown in ISO 8501-1

(dd) **St**: Followed by a number refers to a photographic illustration of the standard of mechanical cleaning required, as shown in ISO 8501 1.

(ee) **Dry film thickness (DFT)**: The thickness of a coating or lining after it is hard dry.

2.2 Abbreviations

CI	:	Cast iron - grade 220
CS	:	Cast steel
DCA	:	Die Cast Aluminium
DFT	:	Dry film thickness
FBE	:	Fusion-bonded Epoxy
FBP	:	Fusion-bonded Polyester
HDG	:	Hot-dip galvanized
PVC	:	Polyvinylchloride
MIO	:	Micaceous Iron Oxide
MS	:	Mild steel – grade 300WA
SB	:	Solvent borne
SG	:	Spheroidal graphite cast iron – grade 420
304 SS	:	Stainless steel – EN Grade 1.4301
304 L SS	:	Stainless steel – EN Grade 1.4306/7
316 SS	:	Stainless steel – EN Grade 1.4401
316 L SS	:	Stainless steel – EN Grade 1.4404
UV	:	Ultra Violet
3Cr12	:	Corrosion resistant steel
µm	:	Micrometer
WB	:	Water borne
3LPE	:	Three Layer high density polyethylene
QCP	:	Quality control plan
GRP	:	Glass fibre reinforced polyester
FBPE	:	Fusion bonded polyethylene
Al	:	Aluminium
PVC	:	Polyinyl chloride

3. GENERAL REQUIREMENTS

3.1 Contractors Obligation

The requirements, material, surface preparation and corrosion protection systems prescribed in this Specification is regarded as a minimum requirement for the specific application. No deviation from this Specification shall be allowed without the written approval of the Employer's Agent.

The Contractor is responsible for the design of the corrosion protection system and shall provide the Employer's Agent with details of the material selection, surface preparation method and corrosion protection system he intends using as part of his design, including the Manufacturer's Instructions for each product and shall only proceed with the purchase of the corrosion protection materials/paints upon receipt of written approval from the Employer's Agent.

The corrosion protection material selection, surface preparation method and corrosion protection system shall be approved by the material manufacturer/supplier. The Contractor shall obtain a written assurance from the chosen material manufacturer/supplier that the proposed materials, surface preparation method and corrosion protection system comply with the specified requirements and are suitable for the intended purposes under the specified Environmental Conditions (refer to SC 3.3). The Contractor shall also obtain the Manufacturer's Instructions (refer to SC 3.2). The written assurance and Manufacturer's Instructions shall be submitted to the Employer's Agent for approval before commencement of the work.

Plant, equipment and pipes shall be manufactured and corrosion protected in accordance with the requirements specified in the Specification and Drawings. In the event that no corrosion protection is specified for any Plant, equipment or pipes within the Specifications or Drawings, this Specifications shall be used to agree the specific application.

3.2 Manufacturer Instructions

The manufacturer's instructions shall be regarded as the recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead.

The following details shall be made available to the Employer's Agent and the applicator:

- Brand and type of corrosion protection material
- Mixing and thinning instructions
- Recommended type and quantity of solvent required for thinning during application
- Pot life of mixed product
- Minimum and maximum recommended dry film thickness per coat
- Minimum and maximum recommended dry film thickness per layer
- Recommended time intervals between coats
- Recommended minimum and maximum steel surface temperatures during application
- Time for complete drying and curing on applicable surfaces
- Substrate surface preparation requirements
- Recommended primers for substrate
- Recommended method of coating and lining application
- Repair procedures for damaged coatings and/or linings and field joints on pipelines

- Toxicity if in contact with water
- All relevant information the Supplier wishes to submit on his product

Verbal instructions by the manufacturer's representative will not be accepted unless confirmed in writing by the Contractor.

3.3 Environmental Conditions

Environmental conditions shall be classified according to SANS 1200 HC: Part 3. The corrosion protection system design and applied by the Contractor shall be suitable for the Environmental Conditions specified.

Unless otherwise specified in the Amendment of this Specification the Environmental Conditions shall be classified as follows:

Mildly-corrosive	Dry, indoor/internal, above ground and ventilated conditions, not within 5km from the coastline or polluted industrial area. Relative humidity below 70%.
Severely corrosive	Submerged, splash-zone, underground, very moist conditions, or within 5km from coastline or polluted industrial area, or in waste water works, or close to electrical power lines. Relative humidity above 85%.
Medium Corrosive	All other conditions not included in the abovementioned definitions

Notwithstanding the abovementioned information the Contractor shall satisfy himself of the environmental conditions on site and design the final corrosion protection systems accordingly.

3.4 Workmanship

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work. All work shall be carried out under the constant supervision of a qualified supervisor.

Similarly all repair work at Site shall be done by competent personnel under the supervision of a qualified supervisor.

3.5 Compatibility of Materials

3.5.1 Design Precautions

All equipment shall be designed to suppress corrosion in an exposed environment with special reference to galvanic corrosion.

The Contractor shall ensure that metals or alloys are compatible or are adequately protected if, in the galvanic series, there is more than a 0,3 volt difference in the galvanic potential.

3.5.2 Galvanic Corrosion Prevention

The Contractor shall ensure that the following steps are taken to minimise corrosion:

a) If dissimilar metals are used: Coat all surfaces of the whole assembly including the more noble member of the galvanic series
b) If the noble member of the assembly cannot be entirely covered:
   - Keep the anode/cathode ratio as large as possible in the particular component

- Use electrical insulators between two metals. Insulation must be complete, a bolt requires a sleeve as well as washers of an insulating material

c) Joints and crevices between metals shall be sealed

d) Where fastening is unavoidable, the fasteners shall be more noble (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between fasteners and the base material.

3.6 Handling of Clean Items

After cleaning, surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces shall be clean and free from oil, grease, grit, dirt and other contamination

3.7 Machined and Matching Services

Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating or lining shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

3.8 Special Areas

Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coats shall be fully cured before assembly.

Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating and/or lining application and installation.

Friction grip areas shall be left un-coated unless otherwise specified.

3.9 Supports

During coating and/or lining application, the items shall be so supported to prevent damage to the wet coatings or linings until the coatings or linings have hardened adequately. Items shall remain supported during curing, storing and handling.

3.10 Water Retention Areas

Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible.

Surfaces of corrodible metals, such as the insides of tanks or hollow Specifications that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where not possible, be fully sealed against ingress of air and moisture.

3.11 Stripe Coats and Crevices

All complex surfaces including metal edges, up stands, welds, bolts and nuts shall be adequately coated to ensure complete corrosion protection. Additional stripe coats shall be applied after initial priming, if required or ordered by the Employer's Agent.

Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

3.12 Repair of Damaged Coats

Repair procedures shall be approved by the Employer's Agent and repairs will be subject to inspections as set out in SC 11.2. Where the damage is extensive the particular remedial procedures for each such instance shall be agreed with the Employer's Agent in writing.

All repairs shall comply with the requirements of the repair-product Manufacturer's Instructions. The Employer's Agent may at his discretion request that repaired areas undergo adhesion tests.

Any damage occurring during transit from the Contractor's premises to the Site shall be the responsibility of the Contractor. The Contractor shall repair any damage occurring on Site during handling, assembly, storage, transport and erection.

A repaired area shall be tested in accordance with Sub-Clauses 8.4 and 8.12 of SANS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of this Specification.

Paint surfaces which become streaky because paint has run, will be rejected.

Touching up of damage to the final paint coat will NOT be permitted. If final paint coat is damaged the item shall completely repainted with the finishing coat in accordance with the specifications.

3.12.1 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Employer's Agent, be carried out as follows:

- Degrease in accordance with SC 9.3.3
- Thoroughly abrade the area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper
- Vacuum-clean the surface to remove dust and debris in accordance with SANS 5769 and SC 9.4.1
- Wipe the abraded paint surface with methyl ethyl ketone and allow to dry
- Apply as many coats of repair material as necessary to achieve the specified electrical insulation thickness and finish as to conform to the adjoining corrosion protection system's requirements
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item

3.12.2 Repair Methods for Major Defects

The repair of areas showing damage down to the steel surface shall, if approved by the Employer's Agent, be carried out as follows:

- Degrease in accordance with SC .9.3.3
- Blast-clean area to Sa 3 (ISO 8501-1)
- Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper

- Vacuum-clean the surface to remove dust and debris in accordance with SANS 5769 and SC 9.4.1
- Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry
- Apply as many coats of repair material as necessary to conform to the specified adjoining corrosion protection system's requirements
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item

4 MATERIALS

The material requirements for each corrosion protections system is specified in the relevant SC 13- SC 20 and shall be read in conjunction with this clause.

4.1 General

All materials in a corrosion protection system shall be purchased from the same manufacturer unless approved by the Employer's Agent.

Materials offered and subsequently approved shall not be changed without written approval of the Employer's Agent.

All corrosion protection materials shall be delivered in the manufacturer's original containers clearly marked with the following:

- Manufacturer's name
- Product Brand and Reference Number
- Batch Number which may incorporate the date of manufacture
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application
- The SANS mark where applicable

Any conflict between the manufacturer's data sheet and the specification shall be referred to the Employer's Agent for adjudication.

4.2 Toxicity of Lining Material

Materials used for the lining of equipment that will be in contact with water shall be non-toxic and shall not impart any odour, taste, or colour to the water.

4.3 Storage

All corrosion protection materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

Usage of materials shall be on a first in, first out basis and no materials shall be used that have exceeded the shelf life recommended by the manufacturer.

5 PLANT/ EQUIPMENT

5.1 Handling and Transportation

The plant and equipment used by the Contractor for handling of pipes, valves, pumps and other equipment, for the purpose of corrosion protection shall be such that no pipe shell, valve or pump casing or any other piece of equipment is over stressed during any operations covered by this Specification.

5.2 Surface Preparation Equipment

The Contractor shall provide all the equipment required for abrasive blast cleaning, preparation and cleaning of all surfaces to be coated.

5.3 Compressor

Compressors used for abrasive blast cleaning shall be fitted with an after cooler and oil and water traps such that the air delivered at the nozzle is completely free from oil and water. The volume displacement of the compressors shall be adequate for the number and bore of blast nozzles, the spray equipment and flame spray equipment that may be necessary to carry out the specified coating operations.

5.4 Application Equipment

The Contractor shall provide all the equipment required for airless spray painting, two component hot airless spray painting, electrostatic powder coating, fluidised bed powder coating, or any other approved method of applying the corrosion protection system in the shop or required for site application and repairs to coats. All equipment shall be thoroughly cleaned on completion of each day's work and maintained in clean working order.

5.5 Inspection of Equipment

All facilities and equipment shall be subject to inspection by the Employer’s Agent or the independent inspectorate and defects in the equipment shall be rectified when so required.

The Contractor shall supply all facilities and equipment for inspecting and testing the specified preparation and corrosion protection of all items supplied under the Contract. Recent calibration certificates shall be available for all equipment requiring calibration. This equipment shall be made available to the Employer’s Agent or his independent inspectorate for the purpose of testing the specified corrosion protection systems and verifying the accuracy of the test equipment.

5.6 Inspection Procedure

Corrosion damage must be exposed by manual, mechanical or abrasive blast-cleaning for inspection. The refurbishment procedures shall then be specified by the *Employer’s Agent.*

5.7 Measuring Equipment

a) The *Contracto*r shall have the following measuring equipment at his paint shop or site at all times:

- Ambient temperature gauge
- Blast profile gauge
- Dew point instrument
- Dry film thickness gauge
- Electric insulation defect detector
- Wet film comb

5.9 Mixer

A low speed mixer, which does not introduce air into the coating material being mixed, shall be utilised.

6 QUALITY

6.1 Quality Control

6.1.1 Quality Assurance and Procedures

a) Quality procedures as specified in GIBB 002 - General Mechanical Specification shall be adhered

b) The production and application shall be in accordance with SANS 9000, Quality System

c) The Contractor shall ensure that he is fully conversant with the requirements of this Specification and the relevant coating systems

6.1.2 Responsibility for Quality

The Contractor shall accept full responsibility for the quality of his workmanship and material used, irrespective of any quality surveillance that may be carried out by the Employer's Agent or his assistants.

The Contractor and all approved Subcontractor(s) shall:

(a) Be responsible for compliance with all the Clauses of this Specification and shall carry out all inspections and tests called for in this Specification in the presence of the Employer's Agent or his assistant. The cost of these inspections and tests shall be included in the Rates.

(b) Abide by the approved Project Quality Plan (PQP) throughout all the intended stages of testing during manufacture, cleaning, preparation and application as well as hold points for independent quality surveillance.

6.1.3 Contractor Qualification

The Contractor and Subcontractor(s) shall satisfy the Employer's Agent that they have the management, facilities and equipment, skilled staff, a quality control procedure and required test methods and standards to carry out the quality control committed to in the approved PQP during manufacture and corrosion protection application. In this regard, the Contractor and his Subcontractors shall be subject to quality audits.

6.1.4 Submission for Approval

The Contractor shall submit the following to the Employer's Agent, including data sheets where applicable, for approval:

6.1.4.1 Corrosion Protection

- A programme
- The Quality Control Plan (QCP) for corrosion protection indicating hold points
- Process Method Statement
- Blast material
- Proposed corrosion protection systems
- Proposed pickling and passivating products.

6.1.4.2 Manufacture and Corrosion Protection Programmes

The manufacture and corrosion protection programmes shall state the time and place when the following will be conducted:

- Inspection of material

- Hydrostatic testing of uncoated castings, pipes and fittings
- Manufacture of components
- Fettling or dressing
- Degreasing
- Water soluble salts test
- Blast cleaning and application of the first coat
- Application of intermediate and final coats
- The commencement of Site repairs

6.1.5 Inspection by the Employer's Agent and Notice of Inspection

Inspection of Plant shall be carried out by the Employer's Agent, his appointed representative or a nominated and Approved Inspection Authority at the manufacturer's and corrosion applicator's works.

The Employer's Agent shall be notified at least seven days in advance, or as otherwise agreed, of impending inspections or when cleaning and first coat application are to be carried out as well as for witnessing the points in terms of the agreed Quality Control Plans (QCP's).

The Employer's Agent's inspection shall in no way relieve the Contractor or his Subcontractors of any of their obligations with respect to design, manufacture and supply Plant of superior quality and workmanship in accordance with the Specification.

6.1.6 Substandard Quality Control

All material, certification and records of the Contractor will be subject to examination by the Employer's Agent. This shall include the checking and testing of the Plant. If any deviation to the approved QCP or product quality is found, additional testing and quality surveillance shall be carried out at no additional cost to the Employer.

If the additional testing confirms inaccurate quality control by the Contractor, all work on that particular Plant item shall be stopped and shall only proceed after remedial action has been implemented to the satisfaction of the Employer's Agent.

6.2. Quality Plan

A detailed quality plan shall be submitted for approval and completion by the *Employer's Agent* before manufacture/coating is initiated – refer to GIBB 002 – General Mechanical Specification. The *Employer's Agent* reserves the right to approve the specific paint used before coating is initiated.

6.3 Qualified Staff

6.3.1 Application

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work. All work shall be carried out under the constant supervision of a qualified Employer's Agent.

6.3.2 Repair Work at Site

All repair work shall be done by competent personnel of the approved applicator under the supervision of a qualified *Employer's Agent*.

7 RECOMMENDED COATING SYSTEMS (WHERE APPLICABLE)

7.1 Proprietary Items

Components that are supplied painted or protected e.g. hoists, gearboxes, actuators etc., shall only be accepted provided that they meet the corrosion protection requirements of this Specification. If this Specification cannot be adhered to the *Contract*or shall submit full details of the equivalent paint systems at Tender stage for approval by the *Employer's Agent*.

7.2 Gates, Screens and Built-in Parts

Selection of all corrosion protection systems shall be submitted to the *Employer's Agent* for approval before application.

The following tables are abbreviated guidelines and the systems are not listed in order of preference.

The highlighted (Orange) rows shall be the minimum material and coating used for the Works.

7.2.1 Radial Gates

ENVIRONMENT	MATERIAL	*COATING PRODUCT	NO. COATS	DFT PER COAT (µM)	TOTAL DFT (µM)
Wet Only Non Corrosive	MS	Carboline 891 Cross Linked Epoxy	3	125	400
Wet Only Moderate Corrosive	3Cr12	Two Pack Epoxy	2	200	400
Immersible Conditions Moderate Corrosive	3Cr12	Two Pack Epoxy – plus Re-coatable Polyurethane	2 1	125 40	250 40
Immersible Conditions Moderate - High Corrosion	304 SS	SigmaCover 280 Universal Primer plus	1	100	100
		Sigmacover 300 Coal Tar Epoxy	2	200	400

7.2.2 Screens

*OR SIMILAR APPROVED COATING **ENVIRONMENT**	MATERIAL	*COATING PRODUCT	NO. COATS	DFT PER COAT (µM)	TOTAL DFT (µM)
Wet Only Non corrosive	MS	Carboline 891 Cross Linked Epoxy	3	125	400
Immersible Conditions Moderate – High Corrosion	316 SS	Picked and Passivated Slats and Frames			

*Or similar approved coating

7.2.3 Stop Logs

ENVIRONMENT	MATERIAL	*COATING PRODUCT	NO. COATS	DFT PER COAT (µM)	TOTAL DFT (µM)
Wet Only Non Corrosive	MS	Hot Dipped Galvanised		100	100
Wet Only Non Corrosive	MS	Carboguard 891 Cross Linked Epoxy or Similar Approved	3	125	375
Wet Only Moderate Corrosive	3CR12	Two Pack Epoxy	2	200	400
Immersible Conditions Moderate Corrosive	3CR12	Two Pack Epoxy – Plus Re-coatable Polyurethane	2 1	125 40	250 40
Immersible Conditions Moderate - High Corrosion	304 SS	Pickled and Passivate			
Immersible Conditions High Corrosion	316 SS	Picked and Passivated			

*Or similar approved coating

7.2.4 Guides, Built-In Parts and General Built-In Steelwork

ENVIRONMENT		MATERIAL	SYSTEM	MINIMUM DFT (µM)
Water Path	>150 mm	MS 304	Un-Coated	
	<150 mm	316 SS	Pickle and Passivate	
Concrete Cover	>75 mm	MS	Un-Coated	
	<75 mm	316 SS	Pickle and Passivate	
		MS	Two Pack Epoxy	250

7.2.5 Wire Ropes

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Dry	MS	Rope Dressing - Penetrating, Water Resistant with a Non-Sticky Surface	Refer to 7.14.1
Dry/Wet	MS	HDG to ISO 1461 Plus Penetrating and Water Resistant Rope Dressing with a Non-Sticky Surface	85 Refer to 7.14.1
	SS	Pickle and Passivate	

7.2.5 Chains

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Dry/Wet	MS	HDG TO ISO 1461	85
	SS	Pickle and Passivate	

7.2.6 Lashing Strips

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Wet	304 SS	SigmaCover 280 Universal Primer Plus Sigmacover 300 Coal Tar Epoxy	100 400

7.3 Hydraulic Oil Equipment

7.3.1 Hydraulic Cylinders

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μM)
Dry	MS	Coating	Two Pack Epoxy Plus Top Coat of Re-coatable Polyurethane	250 40
Wet	316 SS	Coating	Two Pack Epoxy	125

7.3.2 Pipes

ENVIRON MENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Dry/Wet	316 SS	Pickle and Passivate (avoid MS contact and contamination)	N/A

7.3.3 Fluid Reservoirs

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μM)
Dry	MS	Lining	Two Pack Epoxy	200
		Coating	Two Pack Epoxy Plus Top Coat of Re-coatable Polyurethane	250 40
Immersible	304 SS	Coating	Pickle and Passivate Enamel Paint	 25-50

7.3.5 Pumps (hydraulic oil pumps only)

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μM)
Wet	SG CI	Lining and Coating	Two Pack Epoxy Plus Top Coat of Pure Aliphatic Polyurethane	400 25
Dry	SG CI	Coating	Two Pack Epoxy plus Top Coat of Re-coatable Polyurethane	250 40
Wet	SG	Machined close tolerance	Long Life Molybdenum Disulphide Lubricant	10-15
Abrasive Conditions	SG CS	Lining	Abrasion Resistant Coating – To be approved by *Employer's Agent*	
Submerged	SG	Coating	Two Pack Epoxy	400

7.3.6 Motors (hydraulic oil pumps only)

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μM)
Dry	MS	Lining	Two Pack Epoxy	250
		Coating	Two Pack Epoxy Plus Coat of Re-coatable Polyurethane	250 40
	SG CI	Coating	Two Pack Epoxy Plus Coat of Re-coatable Polyurethane	125 40
	DCA	Coating	Two Pack Epoxy Plus Coat of Re-coatable Polyurethane	75 40
Immersible	SG CI	Coating	Two Pack Epoxy Plus of Pure Aliphatic Polyurethane	400 25

7.4 Pipes and Specials

7.4.1 Above Ground (refer to PSL)

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μM)
UV exposure (moderate corrosive environment) – Dry/wet	MS Pipes Larger than 150mm dia	Lining	Two Pack Epoxy	400
		Coating	Multi-purpose Epoxy Plus Tape wrap (as per SC20.7.1)	250 1250
		Coating	Multi-purpose Epoxy Plus Top Coat of Re-coatable Polyurethane	250 40
		Lining	HDG to ISO 1461	700 g/m² or 80
		Coating	HDG to ISO 1461	700 g/m² or 80
	MS Pipes Smaller than and including 150mm dia	Lining	FBE	350
		Coating	FBE	350
		Lining	HDG to ISO 1461	700 g/m² or 80
		Coating	HDG to ISO 1461	700 g/m² or 80
UV Exposure (Heavy Corrosive Environment) – Dry/wet	304 SS	Lining		
		Coating		

7.4.2 Below Ground (refer to PSL)

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μM)
Below Ground (Moderate exposure – Dry/wet)	MS Pipes Larger than 150mm dia	Lining	Two Pack Epoxy	400
		Coating	Multi-purpose Epoxy and Tape wrap (as per SC 20.7.2)	250 Tape=1250
		Lining	HDG to ISO 1461	700 g/m² or 80
		Coating	HDG to ISO 1461 and Tape wrap (as per SC 20.7.2)	700 g/m² or 80 Tape=1250
	MS Pipes Smaller than and including 150mm dia	Lining	FBE	350
		Coating	FBE and Tape wrap (as per SC 20.7.2)	350 Tape=1250
		Lining	HDG to ISO 1461	700 g/m² or 80
		Coating	HDG to ISO 1461 and Tape wrap (as per SC 20.7.2)	700 g/m² or 80 Tape=1250
Below Ground (Heavy exposure – Dry/wet)	304 SS	Lining Coating		

7.4.3 In Water

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µM)
Only Wet	MS	Lining	Two Pack Epoxy	400
		Coating	Two Pack Epoxy Plus Pure Aliphatic Polyurethane	400 25
Wet and Dry (Immersible)	316 SS	Lining	Pickled and Passivate*	
		Coating	Pickled and Passivate and Enamel Overcoat	

*If smaller than DN250

7.4.4 Internal Pipework (e.g. Pump Stations, etc)

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µM)
Moderate – Mild Conditions Dry/wet	MS Pipes Larger than 150 dia	Lining	Two Pack Epoxy	400
		Coating	Two Pack Epoxy Plus Pure Aliphatic Polyurethane	400 25
		Lining	Two Pack Epoxy	400
		Coating	Multi-purpose Epoxy Plus Top Coat of Re-coatable Polyurethane	250 40
		Lining	HDG to ISO 1461	700 g/m² or 80
		Coating	HDG to ISO 1461	700 g/m² or 80
	MS Pipes Smaller than and including 150 dia	Lining	FBE	350
		Coating	FBE	350
		Lining	HDG to ISO 1461	700 g/m² or 80
		Coating	HDG to ISO 1461	700 g/m² or 80
Severe Corrosion Conditions	304 SS	Lining	Pickled and Passivate	
		Coating	Pickled and Passivate and Enamel Overcoat	

7.4.5 Through Concrete Walls

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µM)
Above Ground – Dry conditions	MS	Lining	As per 7.4.1	
		Coating	As per 7.4.1 and Tape wrap (SC 20.7.3)	Tape=1250
Above Ground Dry-Wet Conditions	MS	Lining	As per 7.4.1	
		Coating	As per 7.4.1 and Tape Wrap (SC 20.7.3)	Tape=1250
Above Ground – Heavy corrosive environment - Dry/Wet	304 SS	Lining	Pickled and Passivate	
		Coating	Pickled and Passivate and Enamel Overcoat	
Below Ground – moderate exposure - Dry/Wet	MS	Lining	As per 7.4.2	
		Coating	As per 7.4.2 and Tape Wrap (SC 20.7.4)	Tape=1250
Below Ground (Heavy exposure – Dry/wet)	304 SS	Lining	Pickled and Passivate	
		Coating	Pickled and Passivate and Enamel Overcoat	
In water Wet only conditions	MS	Lining	As per 7.4.3	
		Coating	As per 7.4.3 and Tape Wrap (SC 20.7.5)	Tape=1250
In water Wet/dry conditions	316 SS	Lining	As per 7.4.3	
		Coating	As per 7.4.3 and Tape Wrap (SC 20.7.5)	Tape=1250
Internal Pipework moderate exposure - Dry/Wet	MS	Lining	As per 7.4.4	
		Coating	As per 7.4.4 and Tape Wrap (SC 20.7.4)	Tape=1250
Internal Pipework Heavy exposure - Dry/Wet	304 SS	Lining	As per 7.4.4	
		Coating	As per 7.4.4	

7.4.6 Fuel Conveyance (Schedule 40 as per ANSI)

If applicable, refer to GIBB 018 - Fuel Management Specification

7.6 Valves

7.6.1 Valves and Flowmeters, including Handwheels

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µM)

	MS SG	Lining	Two Pack Epoxy	400
	316 SS	Lining	Two Pack Epoxy	150
			Pickle and Passivate – See SC 7.14.1	
Dry	MS SG	Coating	Two Pack Epoxy plus Top Coat of Re-coatable Polyurethane	250 40
Wet	MS SG	Coating	Two Pack Epoxy plus Top Coat of Pure Aliphatic Polyurethane – where specified	400 25
	316 SS	Coating	Pickle and Passivate	
Refer to Clients spec or elsewhere				

7.6.2 Gearboxes

As per manufacturer's details and based on the corrosive environment grade.

7.6.3 Actuators

As per manufacturer's details and based on the corrosive environment grade.

7.7 Couplings, Flange Adaptors and Joints

Refer to PSL.

7.8 Ancillary

7.8.1 Nuts and Bolts

ENVIRONMENT	MATERIAL	SYSTEM	DFT
In Water (Only Wet)	316 SS		
Buried	MS	HDG TO ISO 1461 Plus Wrapped (discussed elsewhere)	75
Buried	316 SS		
Outdoors – Dry Only	MS	HDG TO ISO 1461	75
immersed	316 SS		
Internal (Dry Only)	MS	HDG TO ISO 1461	75
Internal (Wet/Dry)	316 SS	Pickled and Passivated	

7.9 Electrical Equipment

7.9.1 Electrical Panels and Enclosures

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Indoor	3Cr12 304 SS	FBE	100
	DCA	FBE	75
	PVC	Un-coated	
	GRP	Polyester Gelcoat	250
Outdoor	3Cr12	FBE	125
Outdoor	3Cr12	Pickled and Passivate	
Outdoor	304 SS	Pickled and Passivate	

7.11.4 Industrial Switched Socket Outlets and Light Switch Housings

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Indoor	PVC	Un-coated	
	DCA	FBE	75
Outdoor	DCA	FBP	75

7.11.5 Cable Support Systems

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Dry	MS	HDG to ISO 1461	700 g/m² or 80
	3Cr12	Pickle and Passivate	
Wet	3Cr12	FBE	100
	304 SS 316 SS	Pickle and Passivate	

7.11.6 Industrial Light Fittings

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Indoor – Dry	MS	FBE	50
	DCA	FBE	50
Indoor – Wet	DCA	FBE	75
	GRP	Polyester Gelcoat	250
Outdoor	DCA	FBP	75
	GRP	Polyester Gelcoat	250

7.11.7 Conduit

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor - Dry	MS	HDG TO ISO 1461	65
	PVC	Un-coated	
Indoor - Wet	304 SS	Pickle and Passivate	
	PVC	Un-coated	
Outdoor (Above ground)	MS	HDG to ISO 1461	700 g/m² or 80
	304 SS	Pickle and Passivate	
Underground	HDPE PVC	Un-coated	
	304 SS	Pickle and Passivate	

7.11.8 Junction Boxes

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor	DCA	FBE	75
	PVC	Un-coated	
	GRP	Polyester Gelcoat	250
Outdoor	DCA	FBP	75

7.11.9. Light Poles and Masts

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor	GRP	Polyester Gelcoat	250
	304 SS	Pickle and Passivate	
	MS	HDG to ISO 1461	700 g/m² or 80
Outdoor	MS	HDG to ISO 1461	700 g/m² or 80
	GRP	Polyester Gelcoat	250
	3Cr12 304 SS	Pickle and Passivate	

7.11.10 Cable Mounting Straps and Clamps

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor - Dry	MS	HDG TO ISO 1461	45
	PVC	Un-coated	
	304 SS	Un-coated	
Indoor - Dry and Wet	MS	HDG to ISO 1461	700 g/m² or 80

	304 SS	Un-coated	
Outdoor	304 SS	Un-coated	

7.12. Platforms, Ladders, Handrails and Flooring

7.12.1 Platforms, Walkways, Flooring and Kick Plates

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor	3Cr12	Pickle and Passivate	
	304 SS	Pickle and Passivate	
	MS	HDG to ISO 1461	700 g/m² or 80
Outdoor	3Cr12	Pickle and Passivate	
Outdoor - Wet	304 SS	Pickle and Passivate	
Outdoor - Dry	MS	HDG to ISO 1461	700 g/m² or 80
Immersed	304 SS	Pickle and Passivate	
Immersed	316 SS	Pickle and Passivate	
Immersed	MS	HDG to ISO 1461	700 g/m² or 80

7.12.2 Ladders

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor - Wet	304 SS	Pickle and Passivate	
Indoor - Dry	MS	HDG to ISO 1461	700 g/m² or 80
Outdoor - Wet Outdoor	304 SS	Pickle and Passivate	
Outdoor - Dry	MS	HDG to ISO 1461	700 g/m² or 80
Immersed	304 SS	Pickle and Passivate	
Immersed	316 SS	Pickle and Passivate	
Immersed	MS	HDG to ISO 1461	700 g/m² or 80

7.12.3 Handrails and Balustrades

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor - Dry	MS	HDG to ISO 1461	700 g/m² or 80
Indoor - Wet	304 SS	Pickle and Passivate	
Outdoor	3Cr12	Two Pack Epoxy plus Re-coatable Polyurethane	250
Outdoor - Dry	MS	HDG to ISO 1461	700 g/m² or 80
Immersed	304 SS	Pickle and Passivate	
Immersed	316 SS	Pickle and Passivate	
immersed	MS	HDG to ISO 1461	700 g/m² or 80

7.12.4 Doors, Door Frames and Steel Covers

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor – Dry	3Cr12	Multi-purpose Epoxy	125-150
Indoor – Wet	3Cr12	Two Pack Epoxy 2 Coats	250
	304 SS	Pickle and Passivate	
Outdoor	3Cr12	Multi-Purpose Epoxy	125-150
	304 SS	Pickle and Passivate	
	MS	HDG to ISO 1461	700 g/m² or 80
Indoor and Outdoor	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat of Polyurethane	250 40
OR			
Architectural	Alum	Prime Coat Zinc Chromate Plus Polyurethane Acrylic Enamel	 500

7.12.5. Louvers

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor and Outdoor	Alum	Prime Coat Zinc Chromate Plus Polyurethane Acrylic Enamel	 1500
	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat of Polyurethane Acrylic Enamel	250 40
	DCA	FBP	75

7.13 Steel Structures

7.13.1 Portal Frames

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
Indoor	MS	Red Oxide Zinc Chromate Primer Coat, Plus Universal Undercoat Top Coat Of Polyurethane	40 40
Outdoor	MS	**Portal Frame Beams and Connections**	
		Primer: One Coat with a Polyamide Cured Epoxy Primer (Sigmacover 280)	75
		Stripe Coat: One Coat with A High Build Micaceous Iron Oxide Pigmented Polyamide Cured Epoxy Coating (Sigmacover 435)	75

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
		Intermediate Coat: One Coat with a High Build Micaceous Iron Oxide Pigmented Polyamide Cured Epoxy Coating (Sigmacover 435)	125
		Finish: One Coat High Solid Containing Polymeric Urethane (Sigmadur 1800)	75
OR			
		Primer: One Coat with an Inorganic Zinc Silicate Primer	100
		Intermediate Coat: One Coat with a High Build Micaceous Iron Oxide Pigmented Polyamide Cured Epoxy Coating (Sigmacover 435)	150
		Finish: One Coat with a High Build Aliphatic Acrylic Polyurethane (Sigmadur 520 Aluminium)	75
OR			
Indoor/outdoor - dry	MS	HDG	100

* or similar approved supplier

7.13.2. Pipe Supports and Base Plates

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
Indoor and outdoor	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat of Polyurethane	250 40
OR			
Indoor and outdoor	MS	Carboline 891 cross linked epoxy x 2 coat Plus Carboline 134 polyurethane	200 40
AND			
Indoor	MS	Multi-purpose Epoxy Plus Polyurethane Sealant	250 40
Indoor	MS	HDG To ISO 1461	700 g/m² or 80
AND			
Outdoor - Wet	3Cr12	Multi-Purpose Epoxy plus Grout Under Base pus Polyurethane Sealant	250
Indoor and Outdoor - Dry	MS	HDG To ISO 1461	100
Outdoor	MS	HDG To ISO 1461	700 g/m² or 80
Outdoor -Severe	304		

*or similar approved supplier

7.14 Overhead Travelling Crane

In conjunction with GIBB 008 – Cranes, gantries, hoists and winches specification.

7.14.1 Crane Structures

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
Indoor and Outdoor	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat Of Polyurethane	250 40
OR			
Indoor and Outdoor	MS	Carboline 891 Cross Linked Epoxy X 2 Coat Plus Carboline 134 Polyurethane	200 40
AND			
Indoor	MS	Multi-purpose Epoxy plus Polyurethane Sealant	250
AND			
Outdoor	3Cr12	Multi-purpose Epoxy plus Grout Under BasePlus Polyurethane Sealant	250

*or similar approved supplier

7.14.2 Crane Structures Fixed to Concrete

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Outdoor	3Cr12	Multi-Purpose Epoxy Plus Grout Under Base plus Polyurethane Sealant	250
Indoor	MS	Multi-Purpose Epoxy Plus Grout Under Base plus Polyurethane Sealant	250

7.14.3 Rails Bolted To Concrete/Steel Girders

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor – Dry	MS	Two Pack Epoxy: Sides and Bottom Rolling surface	250 60-90
Indoor – Wet	MS	Two Pack Epoxy: Sides and Bottom Rolling Surface	250 60-90
Outdoor	MS	Multi-purpose Epoxy: Sides and Bottom Rolling Surface	250 60-90

7.14.4 Steel Girders/ Steel Support Beams

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
Indoor and Outdoor	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat of Polyurethane	250 40
		OR	
Indoor and Outdoor	MS	Carboline 891 Cross Linked Epoxy x 2 Coat Plus Carboline 134 polyurethane	200 40
		AND	
Indoor	MS	Multi-purpose Epoxy Plus Polyurethane Sealant	250 40
		AND	
Outdoor - Wet	3Cr12	Multi-purpose Epoxy Plus Grout Under Base Plus Polyurethane Sealant	250
Indoor and Outdoor - Dry	MS	HDG TO ISO 1461	100

*or similar approved supplier

7.15 Fixed Gantries and Crawl Beams for Hoists and Winches

In conjunction with GIBB 008 – Cranes, Gantries, Hoists and Winches Specification.

7.15.1 Structural Steel Girders

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
Indoor and Outdoor	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat of Polyurethane	250 40
		OR	
Indoor and Outdoor	MS	Carboline 891 Cross Linked Epoxy x 2 Coat Plus Carboline 134 Polyurethane	200 40
		AND	
Indoor	MS	Multi-purpose Epoxy Plus Polyurethane Sealant	250
		AND	
Outdoor - Wet	3Cr12	Multi-purpose Epoxy Plus Grout Under Base Plus Polyurethane Sealant	250
Indoor and Outdoor - Dry	MS	HDG TO ISO 1461	100

*or similar approved supplier

7.15.2 Rails Bolted to Concrete/Steel Girders

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µM)
Indoor – Dry	MS	Two Pack Epoxy: Sides and Bottom Rolling Surface	 250 60-90
Indoor – Wet	MS	Two Pack Epoxy: Sides and Bottom Rolling Surface	 250 60-90
Outdoor	MS	Multi-purpose Epoxy: Sides and Bottom Rolling Surface	 250 60-90

7.15.3 Steel Girders/ Steel Support Beams

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (µM)
Indoor – Dry	MS	Two Pack Epoxy	250
Indoor – Wet	MS	Two Pack Epoxy	250
Indoor/outdoor - Dry	MS	HDG TO ISO 1461	100
Outdoor	3Cr12	Multi-purpose Epoxy	250
OR			
Outdoor	MS	*Primer:* One Coat with a Polyamide Cured Epoxy Primer (Sigmacover 280)	75
		Stripe Coat: One Coat with a High Build Micaceous Iron Oxide Pigmented Polyamide Cured Epoxy Coating (Sigmacover 435)	75
		Intermediate Coat: One Coat with a High Build Micaceous Iron Oxide Pigmented Polyamide Cured Epoxy Coating (Sigmacover 435)	125
		Finish: One Coat High Solid Containing Polymeric Urethane (Sigmadur 1800)	75
Or			
Indoor	MS	Red Oxide Zinc Chromate Primer Coat, Then Universal Undercoat. Top Coat of Polyurethane	40 40
OR			
Outdoor	MS	*Primer:* One Coat with an Inorganic Zinc Silicate Primer	100

ENVIRONMENT	MATERIAL	SYSTEM*	MINIMUM DFT (μM)
		Intermediate Coat: One Coat with a High Build Micaceous Iron Oxide Pigmented Polyamide Cured Epoxy Coating (Sigmacover 435)	150
		Finish: One Coat with a High Build Aliphatic Acrylic Polyurethane (Sigmadur 520 Aluminium)	75

*Or similar approved supplier

7.15.4 Crawl Beams

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (μM)
Indoor - Dry	3Cr12	Pickle and Passivate	
Indoor - Wet	3Cr12	Multi-purpose Epoxy	250
Outdoor	3Cr12	Multi-purpose Epoxy	250
Indoor/outdoor - dry	MS	HDG TO ISO 1461	100
Indoor – Dry/wet	MS	Two Pack Epoxy	250
Indoor and Qutdoor	MS	Primer One Coat Red Oxide Zinc Chromate Multipurpose Epoxy Plus Top Coat of Polyurethane	250 40

7.16 Notes

The following items shall be approved by the *Employer's Agent*:

Hot-Dip Galvanizing:	Only for pipes up to 150 mm diameter maximum and flow less than 2 m/s. Pipes shall not be embedded in concrete. Water analysis shall be provided. Pipes over 150 mm diameter to be coated with a duplex system.
Sealant:	Interfaces Of Different Environments Shall Be Sealed With A Polyurethane Or Polysulphide Flexible Sealant To Be Applied In Accordance With The Manufacturer's Data Sheets
Un-Coated Stainless Steel:	Only To Be Used If No Galvanic Reaction And Anaerobic Conditions Are Present.
Pickle And Passivated:	If Not In Contact With Less Noble Material. If Exposed To Anaerobic Conditions Seal-Coat All Crevices With Elastoplastic Epoxy. Shall Be Done By The Dipping Process.
Galvanic Cells	Where A Galvanic Cell Is Situated Within A Water Path <150 Mm And Concrete Cover <75 Mm, The Ms, 3cr12 Or SS Shall Be Coated.
Anaerobic Conditions	SS Grade 316l Shall Be Used Under Anaerobic And Aggressive Water Conditions.
Polyurethane For	Re-Coatable Or Pure Aliphatic Polyurethane Where Required For Colour Coding.

	Only UV Resistant Polyurethane Shall Be Used.
Primers	Primers Shall Only Be Used In Special Cases I.E. Over-Coating Of Galvanized Surfaces.
3cr12:	In View Of Superior Corrosion Resistance, Coated 3cr12 Material Is Preferred.
Mild Steel:	Mild Steel May Only Be Used Where The Pipe Lining Can Be Refurbished In-Situ.
Items Subjected To High Temperatures	Items To Be Manufactured Out Of Stainless Steel Or Coated With Heat Resistant Paint.
Epoxy Primer:	Epoxy Primer May Not Be Required If Appropriate Two Pack Epoxy/ Re-Coatable Or Pure Aliphatic Polyurethane Is Being Used.
Rope Dressing	Shall Be Applied Using A High Pressure Impregnation System. Minimum Pressure Of 5 MPA Shall Be Used.

8 SURFACE PREPERATION METHODS

The requirements as specified below shall be read in conjunction with the requirements of SC 9: Preparation of Surfaces to be Coated. Each preparation method specified below shall also conform to the relevant requirements of SC 9 and its sub-clauses. Where in in conflict with SC 9 and its sub-clauses the requirements hereunder shall take precedence.

Unless otherwise specified in the Amendments of this Specifications and subject to the approval of the Employer's Agent, the surfaces of all items to be coated and/or lined shall be prepared in accordance with one or more of the following Methods.

8.1 Method 1: Mild Steel

Components manufactured from mild steel shall be degreased and blast clean before the corrosion protection system is applied. Oil and grease contamination, when present, shall be removed to a water break free surface by degreasing (Refer to SC 9.3.3) before blast cleaning (refer to SC 9.3.4 - 9.3.5).

Steel items less than 2 mm thick may distort when blast cleaned. Sheet steel items less than 2 mm in thickness shall be degreased, acid pickled and phosphated with an approved proprietary 7 or 9 stage process to produce a fine grain zinc phosphate surface complying with SANS 10064 Table 2 Lightweight or by a proprietary process approved by the Employer's Agent for the standard of cleaning specified.

All surfaces of steel 2 mm or more in thickness shall be abrasive blast cleaned in accordance with SANS 10064 Section 4.3 and cleaned to achieve the requirements given in Table 4.1 for the standard of abrasive blast cleaning specified.

8.2 Method 2: Cast Iron and Cast Alloys

Cast iron shall be abrasive blast cleaned until all sand particles, residual burnt-on sand and casting skin have been completely removed. Cast iron surfaces shall be abrasive blast cleaned in accordance with SANS 10064 Section 4.3 to achieve the requirements given in SC 9.4.1 for the standard of abrasive blast cleaning specified.

Blowholes and omegas in cast surfaces shall be opened up where necessary and filled with a two component solvent free epoxy filler. When the filler has set hard, the surface shall be abraded to be flush with the surrounding metal.

8.3 Method 3: Stainless and Corrosion-Resistant Steel

Components manufactured from stainless or corrosion-resistant steel shall be supplied in the fully passivated condition. Sheared edges, welds or surfaces subjected to any form of heat treatment or contamination with iron or mild steel, shall be pickled and passivated in terms of SC 9.5.

Surfaces shall thereafter be thoroughly degreased in terms of SC 9.3.3, then rinsed with potable water to obtain a water-break-free surface.

When it is required to paint stainless steel exceeding 2 mm thickness, the surface shall be blast cleaned in accordance with the parameters given in SC 9.4.1, using non-metallic abrasives such as iron slag, copper slag or platinum slag. The use of steel shot, steel grit or cast-iron grit is strictly prohibited. Any contamination with iron or mild steel is prohibited.

Where blasting is impractical, the surface shall be cleaned with detergent solution and roughened manually by the use of non-metallic abrasive pads, followed by washing with clean potable water to a water-break-free surface. If a water-break-free surface is not obtained, detergent cleaning shall be repeated until the surface is water-break-free. Allow the surface to dry before coating.

8.4 Method 4: Aluminium

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment. Where painting is required, the aluminium surface shall be thoroughly degreased then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water-break-free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 micrometres dry film thickness) of wash primer which complies with SABS 723, mixed and applied in accordance with the manufacturer's instructions. Note that the “wash primer” is an adhesion promoter and does not replace the primer specified in the paint system.

8.5 Method 5: Hot-Dip Galvanized Surfaces

Hot-dip galvanized surfaces shall be thoroughly degreased by scrubbing with water rinsable solvent degreaser, followed by thorough washing with clean, potable water. If the water breaks up into islands of non wetted surface, the degreasing shall be repeated until a water break free surface is obtained. Small areas may be abraded with a non metallic abrasive paper prior to painting. Large surfaces may be sweep blast cleaned, using ultra fine abrasive (particle size 0,2 to 0,8 mm) and a nozzle pressure not exceeding 300 kPa. A uniform matt surface shall be obtained. Loss of zinc thickness shall not exceed 10 µm. Cracking and flaking of the galvanized layer is indicative of excessive blast cleaning by using too coarse abrasive or too high blast pressure. Such surfaces will be rejected. The article shall then be stripped and re-galvanized.

8.6 Method 6: Painted Surfaces

8.6.1 Primer Only

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

The succeeding coats shall be compatible with the primer. Where the type of primer is unknown, a test patch shall be applied. There shall be no loss of adhesion or other defects of the primer or between primer and undercoat. If defects or adhesion loss occur, the primer shall be completely removed, feather blasted and replaced by a primer which is compatible with the specified system.

8.6.2 Recoatable Materials

Surfaces painted with recoatable paints shall be abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried to remove dust and deposits before overcoating.

8.6.3 Fully Cured Non-Recoatable Materials

Surfaces painted with fully cured non-recoatable paints that have exceeded their overcoating time shall be thoroughly abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried before overcoating. The edges of any damage shall be smoothly feathered into the sound paint. Repairs to damaged areas shall extend 25 mm beyond the damage.

8.6.4 Two Component Paints within the Overcoating Time

Surfaces painted with two component paints where the paint is still within the overcoating time specified by the manufacturer shall be recoated without special surface preparation. Where the surface has become contaminated, it shall be cleaned.

8.7. Method 7: Plastic Surfaces such as PVC and GRP

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

8.8. Method 8: Concrete and Plaster Surfaces

Concrete and plaster surfaces to be painted shall be clean, dry and free from laitance, dust or similar friable surface layers and from mould oil or similar contaminants that will interfere with the adhesion of the coating or lining.

Mould oil shall be removed by the use of a water-based detergent followed by high pressure water washing. When all contaminants have been removed, the surface shall be allowed to dry either to a damp condition or to a completely dry condition, depending on the coating or lining to be applied.

For immersion or other heavy duty applications, laitance shall be totally removed by water blast cleaning, with abrasive injection, or by mechanical scabbling of the surface, or by acid pickling, followed by very thorough washing with potable water.

Off shutter concrete usually shows surface blowholes or omegas. Omegas shall be drilled or chipped open to the full hole diameter. Blowholes and opened omegas shall be filled with a suitable filler such as acrylic or solvent-free epoxy. The use of gypsum or cellulose-based fillers is not permitted for underwater or humid conditions. Shutter kicks and similar projections shall be removed by grinding to a smooth surface.

For coatings or linings of low water permeability, such as solvent-borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth of not less than 5 mm.

The first coat of the coating or lining system may require thinning with the manufacturer's recommended solvent to assist in penetration of the substrate.

9 SURFACE PREPERATION OF STEEL

9.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1344	Medium duty solvent detergent
SANS10064	The preparation of surfaces for coating
ISO8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings
ISO8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning
SANS 5770	Cleanliness of blast-cleaned steel surfaces for painting (freedom of soluble salts)
SANS 5772	Profile of blast-cleaned steel surfaces for painting (profile gauge)
SANS 5769	Cleanliness of blast-cleaned steel surfaces for painting (freedom from dust and debris)
ISO11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives
ISO11127	Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives

9.2. Responsibility

9.2.1 Surface Preparation

a) The Subcontractor carrying out the corrosion protection shall be responsible for preparation of all surfaces to be coated.

b) On completion of the *Contract*, all plant, equipment, temporary structures and materials shall be removed from the site.

9.2.2 Personnel

a) The Subcontractor carrying out the surface preparation shall have competent personnel with the necessary technical knowledge of the processes involved.

b) All work shall be carried out under the supervision of an experienced *Employer's Agent*.

9.2.3 Equipment

a) Plant and equipment shall, to achieve the specified surface preparation, comply with the following:

   i) Equipment and air supply free of oil and moisture

   ii) Compressors shall have a capacity and pressure output to achieve the required nozzle pressures

   iii) Worn nozzles shall be replaced

b) If the correct surface preparation is not achieved due to inadequate plant and equipment, the *Employer's Agent* may order the *Contract*or to obtain such plant and equipment as may be necessary to achieve the specified results.

c) All plant, equipment and temporary structures shall at all times be maintained in good and safe working order.

9.2.4 Working Conditions

a) Surface preparation shall not take place when conditions are likely to affect the corrosion protection processes adversely.

b) The Subcontractor shall provide screens, covers, trestles or any other equipment necessary to avoid contamination of surfaces and to minimise time delays caused by inclement weather.

9.2.5 Health and Safety

The *Contract*or's shall at all times enforce health and safety measures necessary to comply with the Occupational Health and Safety Act No. 85 of 1993 and the manufacturer's requirements.

9.3 Procedure and Preparation of Items

Prior to the application of any coat, each item shall comply with the following:

- Weld splatter shall have been removed by chipping or grinding to a smooth surface flush with the surrounding steel.
- Weld seams shall have a smooth contour, free from sharp edges, protrusions and undercuts.
- Sharp edges and protrusions shall have been removed by grinding to a smooth radius. The radius shall be a minimum of 3 mm for steel of thickness 6 mm or greater, or a minimum of 50% of the steel thickness for steel of thickness less than 6 mm.
- Laminations, scabs or occluded scale shall be ground out. If such grinding penetrates deeper than 3.5% of the metal thickness, the area shall be repaired by welding or the metal shall be rejected at the discretion of the Employer's Agent.
- Articles for hot-dip galvanizing shall not have any overlapping joints. Closed sections shall be suitably vented.

9.3.1 Approval of Works and Programme

The *Contract*or programme, plant and equipment and works shall be approved by the *Employer's Agent* prior to commencement of surface preparation.

9.3.2 Initial Inspection

Before accepting items from the Fabricator, the corrosion protection Subcontractor shall check the initial condition of the surface for:

- Visible surface defects
- Corrosion or contamination
- Any required metal dressing
- Elimination of burrs and radiusing of edges
- Removing of weld spatter and weld imperfections such as blowholes
- Suitable lifting lugs

9.3.3 Degreasing

(a) All surfaces to be coated shall be tested for oil and grease contamination by the water break free test.

(b) In the event that degreasing is required, items shall be degreased by the use of a water based solvent degreaser such as that complying with SANS 1344 or, for use in enclosed systems, with SANS 1365.

(c) Oil and grease contamination shall be removed by:

- Steam-cleaning
- An emulsifiable or aqueous detergent applied in accordance with SANS 1344
- An alkaline cleaning solution

(d) Allow to react, and then rinse off with clean, potable water to remove all residues prior to surface preparation, all in accordance with Clauses 3.3 and 3.4 of SANS 10064.

(e) Items shall be thoroughly washed with clean potable water to remove all residues. The items shall then be allowed to dry.

(f) The surfaces shall be tested after degreasing and show no oil, grease and chemical contamination after degreasing.

(g) Care shall be taken to avoid entrapment of cleaning agents in recesses or other retention areas.

9.3.4 Blast Cleaning (Rough-Blast)

Blast-cleaning shall be done in accordance with the code of practice SANS 10064 to achieve a cleanliness of Sa 2. (ISO 8501-1). Any abrasive used for blast cleaning shall composed of clean, non-recycled, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water soluble salts and foreign metals.

The surface of the items to be coated or lined shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following requirements:

1. The surface condition shall be in accordance with Swedish Standard SIS 05 5900 (or ISO 8501-1) as stipulated in Clause 4.2 and specified in the Amendments and Additions of the Specification, when tested in accordance with SANS Method 767.or SANS Method 772.

2. Any laminations revealed by blast cleaning shall be ground out and re-blast cleaned to meet the above requirements. If grinding penetrates the steel to a depth greater than 3.5% of the nominal wall thickness, the item will be rejected.

3. The time interval between abrasive blast cleaning and paint application shall not exceed those given in SC 12.

The following applies to **Rough Blasting** requirements.

a) All rust, mill scale, old coating or marking paint shall be removed by rough-blasting.

b) Laminations, scabs and occluded scale which becomes visible after cleaning shall be ground out and the area re-cleaned.

c) The *Employer's Agent* shall be advised when blast-cleaning of the appropriate section will be completed so that an inspection can be carried out to determine if repairs are required.

d) The surfaces to be coated shall be tested for water soluble salts after blast-cleaning. The maximum level of salts allowable on the surfaces shall not exceed the values given in SC 9.4.2.

e) Should these values be exceeded, the surfaces shall be cleaned by:

- A liquid soluble salt remover approved by the *Employer's Agent* or
- Washing with a high pressure jet of clean potable water or
- Water injected blast-cleaning or
- Flash blast-cleaning until the soluble salts are within the specified limits.

g) Should immediate lining/coating not be possible, or should any atmospheric oxidisation take place between the completion of blast cleaning and commencement of lining/coating, such oxidisation shall be removed by flash blasting to restore the specified surface finish.

9.3.5. Final-Blast

(a) Final Blast

- Humidity and Temperature:

  All blast-cleaned surfaces shall be coated within:

  - Six (6) hours when humidity is below 50% or
  - Four (4) hours when humidity is below 70% or
  - Two (2) hours when humidity is between 70% and 85%.

  Over 85% Coating not permitted- reblast and coat when rel. humidity below 85%

  Final-blasting shall not be carried out if the steel temperature is less than 3°C above dew point.

- Blasting-Material:

  Final blast-cleaning shall be carried out using clean, uncontaminated blast-medium in accordance with SC 9.4.2.

- Cleanliness:

  All surfaces for "wet/submerged conditions" and for "dry conditions" shall be blast-cleaned to Sa 3 and Sa 2½ respectively.

- Profile:

  The required surface profile specified in SC 9.4.1 shall be achieved by final-blasting in accordance with SANS 10064 and ISO 8504-2.

- Residual Dust and Debris:

  Prior to coating, dust and debris shall be removed by vacuum-cleaning in accordance with SANS 5769. Dust and debris may only be removed by blowing with clean uncontaminated compressed air, with prior approval of the *Employer's Agent*.

- Contamination:

  After final blasting uncoated steel shall not be touched with bare hands. All applicators shall wear white gloves and shoe covers where applicable.

(b) Flash- Blast

Flash blast-cleaning shall be carried out to reinstate the surfaces specified in SC 9.4.1, in accordance with SC 9.3.5(c).

(c) Sweep-Blasting

Sweep blast-cleaning is used to create a fine, even profile on soft materials and to remove portions of a coating.

The parameters for sweep blast-cleaning are as follows:

Table 9-1: Parameters for sweep blast-cleaning

Equipment and air supply	Free of oil and moisture
Nozzle pressure	Not greater than 300 kPa
Nozzle angle to the surface being cleaned	30 to 60°
Sweeping distance	450 to 600 mm
Abrasive – ultra fine non-metallic grit	Minimum 0.2 mm – maximum 0.8 mm
Grit	Only new grit shall be used

9.3.6 Mechanical Surface Preparation

Cleaning by hand or by means of power tools (e.g. wire brushing) shall be carried out in accordance with the methods described in SANS 10064 to the standards specified in the Amendments of this Specifications and as shown in SIS 055900 and SC 9.2.

9.4 Surface Preparation Requirements

9.4.1 Surface Conditions

Before surface preparation all items to receive a coating or lining shall be in rust condition A to C of Swedish Standard SIS 05 5900. Items in rust condition D will be rejected.

Prepared surfaces shall conform to Table 9.2 below. If only surface cleanliness to ISO 8501-1 is specified in the Specifications then the corresponding values of Table 9.2 for degreasing, surface profile and soluble salts shall apply.

Table 9-2: Surface Conditions

PROPERTY	FOR DRY CONDITIONS	FOR WET/SUBMERGED CONDITIONS	TAPE WRAPPING
Cleanliness to ISO 8501-1 (min) (SIS 055900)	**Sa 2½**	**Sa 3**	**Sa 2**
Residual Dust and Debris (SANS 5769)	0.5%	0.3%	0.5%
Oil, Grease and Perspiration	Nil	Nil	Nil
Surface Profile (min) Coats up to 200 µm (max)	30 µm 50 µm	30 µm 50 µm	- -
Surface Profile (min) Coats up to 300 µm (max)	50 µm 80 µm	50 µm 80 µm	- -
Surface Profile (min) Coats up to 500 µm (max)	60 µm 100 µm	60 µm 100 µm	- -
Water soluble Salts: Maximum at any point.	500 mg/m^2	100 mg/m^2	500 mg/m^2

Average of any 250 cm.	100 mg/m^2	100 mg/m^2	100 mg/m^2

Note: The maximum surface profile shall be less than ⅓ of the coat thickness.

Unless otherwise specified in the Amendments to this Specifications the surface condition shall conform to the following requirements:

- Sa 3 for the environmental condition classified as severely corrosive,
- Sa 2 for Tape Wrapping, and
- For all other environmental conditions, the surface condition shall be Sa 2½.

9.4.2 Abrasive Material

a) Material:

The blast-cleaning abrasive shall be composed of clean, non-recycled, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water-soluble salts and foreign metals.

b) Certification:

The abrasive material supplier shall certify that all products supplied conform to all the requirements specified.

c) Shape and Size:

The individual abrasive particles shall be angular in shape and within the following sizes:

- Non-metallic material - 0.2 to 0.8 mm or 0.4 to 1.4 mm
- Metallic material - 0.3 to 0.9 mm

d) Hardness:

The minimum hardness of abrasive material shall be as follows:

- For non-metallic material - 6 on the Moh's scale
- For metallic material - 390 HV

e) Ph:

The pH of the prepared slurry mixture shall not be below 6.2.

f) Water Soluble Salts:

The conductivity of slurry shall be less than 25 mS/m in accordance with ISO 11127.

g) Moisture Content:

The moisture content for abrasive material shall not exceed 0.2%.

h) Re-cycling:

Re-cycled blasting-material shall only be used if:

(i) Blasting-materials were only used on degreased surfaces;

(ii) Dust and debris is removed from the blasting-material; and

(iii) Particles are kept angular and within specified sizes.

9.4.3 Air Supply

a) The air pressure at the nozzle shall be a minimum of 600 to 700 kPa.

b) Air supply equipment shall be fitted with efficient oil and water traps to avoid contamination of the surface.

9.5 Pickling And Passivation

Where specified the following areas shall be pickled and passivated:

- All un-coated areas
- Ground and sheared edges
- Heat affected zones caused by welding or cutting.

Where possible, pickling and passivation shall be done by the dipping process.

Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Pickling formulations made up of 15 to 20% nitric acid (HNO_3) and 1 to 2% hydrofluoric acid (HF) by volume with potable water are considered suitable. Care shall be taken not to exceed the maximum contact time recommended.

After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Repeat the process, if necessary to remove all discolouration. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

10 SURFACE PREPERATION OF OTHER MATERIALS

10.1 Corrosion Resistant and Stainless Steel

Components fabricated from stainless steel shall not be contaminated with iron or mild steel.

10.1.1 Un-Coated Surfaces

a) Stainless steel surfaces shall not be contaminated with carbon steel, scratched or stressed.

b) The following areas shall be pickled ad passivated:
   - All un-coated areas
   - Ground and sheared edges
   - Heat affected zones caused by welding or cutting.

c) It is recommended that, if possible, pickling and passivation be done by the dipping process.

d) Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended.

e) After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

10.1.2 Surfaces to be Coated

a) Degreasing:

Surfaces shall be degreased in accordance with SC 9.3.3

b) Profile:

- Corrosion resistant steel surfaces shall be blast-cleaned with stainless steel grit or non-metallic abrasive to create a profile in accordance with the table in SC 9.4.1. The use of steel shot and steel or cast iron grit is strictly prohibited.
- Where blasting is impractical, the surface shall be roughened manually with abrasive paper grade 220, disc grinders or flapper wheel abrasive pads. In all instances, clean, uncontaminated equipment must be used.
- Surface profile shall be in the range of 30 to 50 µm.

c) Dust and debris shall be removed by vacuum-cleaning SC 9.3.4.

10.2 Synthetic Materials to be Coated

10.2.1 Degreasing

Surfaces shall be degreased in accordance with SC 9.3.3

10.2.2 Profile

Abrade the surface with abrasive paper grade 220 to achieve a uniform matt finish.

10.2.3. Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

10.3 Coated Surfaces

10.3.1 Primed Surfaces to be Over-coated

a) Degreasing:

Surfaces shall be degreased in accordance with SC 9.3.3

b) Profile:

- Primers to be over coated outside the over-coating period shall be abraded with abrasive paper grade 220 to a uniform matt finish.
- All un-coated areas and all areas with micro rust shall be re-blasted to the original surface finish as specified.

c) Dust and Debris:

Dust and debris shall be removed by vacuum-cleaning.

10.3.2 Coated Surfaces to be Repaired

Spot repairs shall be carried out in accordance with the Specification or as specified by the *Employer's Agent*. Repairs shall overlap the undamaged area by a minimum of 25 mm. Repairs shall be built up to the original undamaged coating thickness.

a) Preparation of Bare Areas:

Bare areas shall be prepared by spot-blasting to Sa 3 in accordance with SC9.1. If spot-blasting is not possible, clean with abrasive paper grade 220 to a bright metal surface.

b) Soluble Salts:

The surfaces shall be tested for water soluble salts in accordance with SC 11.2.

10.3.3 Feathering of Coated Surfaces

The surrounding paint, which must be intact, shall be feathered for a minimum distance of 25 mm beyond the damaged areas.

a) Dust and Debris:

Dust and debris shall be removed by vacuum-cleaning as per SANS 5769.

10.3.4 Coated Surfaces to be Over Coated

a) Degreasing:

Surfaces shall be cleared of all contamination and degreased in accordance with SC 9.3.3.

b) Profile:

Coated surfaces to be over-coated outside the over-coating period shall be abraded with abrasive paper grade 220 to a uniform matt finish.

c) Dust and Debris:

Dust and debris shall be removed by vacuum-cleaning as per SANS 5769.

d) Solvent-wiping:

- The surfaces to be coated shall be wiped with the solvent specified by the coating manufacturer and approved by the *Employer's Agent*.
- Further coats shall then be applied as specified in the Specification.

11 COMPLIANCE WITH REQUIREMENTS

Tests, instruments, methods and criteria shall be as specified below or in the Specification.

11.1 Test Methods

11.1.1 Free of Oil and Grease

11.1.1.1 Wetting with Water

All surfaces cleaned of oil and grease shall be tested using the "water-break-free" method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

11.1.1.2 Solvent-wiping

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

11.1.2 Water Soluble Salt Contaminants

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SANS 5770 or by means of the Weber Reilly Test.

11.1.3 Standard of Mechanical Surface Preparation

Mechanical surface preparation shall be visually compared to the standard shown in ISO 8501-1.

11.1.4 Blast Profile

The blast profile of the substrate surfaces shall be determined in accordance with SANS 5772.

11.1.5 Residual Dust and Debris

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with SANS 5769.

11.1.6. Blasting Material

All blasting-materials shall be approved by the Employer's Agent.

11.1.6.1 Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

11.1.6.2 Non-Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

11.1.7. Protection of Works during Painting Operations

The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes and smirches of paint or of paint materials. The Contractor shall be responsible for any damage, paint or dirt caused by his operations to vehicles, persons or property, including plants and animals, and he will be required to provide protective measures at his expense to prevent such damage.

Any paint stains which may result in any unsightly appearance shall be removed or obliterated by the Contractor at his expense.

If passing traffic creates so much dust that it will harm or spoil the appearance of painted surfaces, the Contractor shall, at his expense, sprinkle the adjacent roads and shoulders with water for a sufficient distance, in order to keep dust away from freshly painted surfaces. The Contractor shall also furnish and post "DRIVE SLOWLY" signs at his own expense and take other necessary precautions to prevent dust and dirt from adhering to freshly painted surfaces.

11.2 Testing

Tests, instruments, methods and criteria shall be as specified below or in the Amendments of this Specification.

The requirements of SC 6 shall apply.

11.2.1 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

11.2.2 Holiday Inspection

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SABS 1217.

Except on system containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SANS 1217 for coatings and linings of thickness not exceeding 500 µm.

For sytems exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector shall be used in accordance with SANS 1217.

During the inspection procedure the Contractor shall ensure that sufficient moisture is present at all times on the surfaces to be tested.

11.2.3 Dry Film Thickness

The dry film thickness (DFT) shall also conform to the requirements of SC 12.9:

(a) Measurements shall be taken in accordance with ISO 2808.

(b) 100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

(c) Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the system is demonstrated to be sound in all respects.

(d) The method used to measure film thickness, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

11.2.4 Degree of Cure of Fusion-Bonded Materials

The degree of cure of corrosion protection material shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test)

11.2.5 Free of Oil and Grease

11.2.5.1 Wetting with Water

All surfaces cleaned of oil and grease shall be tested using the “water-break-free” method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

11.2.5.2 Solvent-Wiping

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

11.2.6 Water Soluble Salt Contaminants

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SABS Method 770 or by means of the Weber Reilly Test.

11.2.7 Standard of Mechanical Surface Preparation

Mechanical surface preparation shall be visually compared to the standard shown in

SABS ISO 8501-1.

11.2.8 Blast Profile

The blast profile of the substrate surfaces shall be determined in accordance with SABS

Method 772.

11.2.9 Residual Dust and Debris

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with SABS Method 769.

11.2.10 Blasting Material

All blasting-materials shall be approved by the Employer’s Agent.

11.2.10.1 Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

11.2.10.2 Non-Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

11.3 PIPE AND SPECIALS SPECIFIC TESTING

11.3.1 Dry Film Thickness (DFT)

Measurements shall be taken in accordance with ISO 2808.

100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

In the case of coats applied after the erection of steel work on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the Employer's Agent, and may be dictated by accessibility.

DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

DFT shall be tested within 7 days of application.

The method used to measure DFT, and the significance of the readings for each particular item, shall be agreed upon by all parties prior to commencement of the coating work.

11.3.1.1 Automated Shop Applied Lining and Coating

The film thickness on the first pipe of a production run and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The Employer's Agent may at his discretion supplement the above test by checking wet film thickness on any or all pipes during application of the coats.

11.3.1.2 Hand and In-situ Applied Lining and Coating

All the hand applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

12 APPLICATION OF CORROSION PROTECTION SYSTEM

All coatings and/or linings, irrespective of the surface preparation method or corrosion protection system used, shall be applied in accordance with the relevant following requirements.

12.1 Conditions during Application

If in the opinion of the Employer's Agent adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective system, he shall order a stoppage of work. The Contractor will be deemed to have accepted this risk and made provision for it in his rates.

12.1.1 Dusty Conditions

Coats shall not be applied in dusty or contaminated conditions.

12.1.2 Surface Temperature

Coats shall not be applied if the surface temperature of the base metal is less than 3°C above dew point or outside the range 5 - 40°C, unless otherwise recommended in the manufacturer's instructions.

12.1.3 Ambient Temperature

Coats shall not be applied when the ambient temperature is less than the minimum or greater than the maximum recommended by the manufacturer's instructions of the corrosion protection material.

12.1.4 Relative Humidity and Time Interval

The time interval between abrasive blast cleaning and paint application shall not exceed those given in SC 9.3.5.

12.2 Paints

12.2.1 Application Method

The recommendations of the paint manufacturer as per the manufacturer's instruction (refer to SC 3.2) as shown on his data sheets or given in writing on his letterhead and approved by the Employer's Agent shall be followed.

Apart from touch up, all liquid paints applied in the shop shall be applied by means of airless spray machines. Before use all paints shall be thoroughly stirred so as to be completely homogeneous. Two component paints shall be thoroughly mixed in the correct proportions as specified in the manufacturer's data sheet.

Painting on site shall be carried out to the Employer's Agent's written approval. Significant surfaces to be painted on site shall be those specified in the Specification or shown on the drawings. Site application methods shall comply with the paint manufacturer's recommendations.

12.2.2 Colour

Successive coats shall have distinctively different shades to facilitate coverage of each coat. Unless otherwise specified in the Amendments to this Specification, or directed by the Employer's Agent, the final paint colour shall be that given in SC 21 of this specification and shall be a commercial match to the appropriate colour in SANS 1091 - National Colour Standards for Paint.

12.2.3 Wet Film Thickness

The Contractor shall regularly and frequently monitor wet film thickness and shall calculate the dry film thickness from the volume solids of the paint.

12.2.4 Mixing

The Contractor shall ensure that all paints are mixed in accordance with the requirements of

BS 5493.

All paint components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

12.2.5 Degree of Cure

The degree of cure of paint will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test).

12.2.6 Overcoating

12.2.6.1 Compatibility of Coats

All primer, intermediate, finishing coats and layers shall be mutually compatible and re-coatable paints shall be used where applicable. There shall be not loss of adhesion between the consecutive coats or other defects.

12.2.6.2 Overcoating Intervals

The minimum and maximum overcoating intervals provided in the manufacturer's data instructions shall be strictly observed. Times and dates of application shall be recorded for each separate item and coat in the quality control records.

Since overcoating times are frequently quoted at 20 °C or 25 °C, longer overcoating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5° decrease (or by 100% for a 10° decrease) in the ambient temperature below the temperature quoted in the data sheet.

12.2.6.3 Thickness of Consecutive Coats

Generally a corrosion protection system will be build-up with multiple coats. The thickness of all coats, primer, intermediate or finish coats shall be strictly according to the manufacturer’s instructions. For solvent-base paints it is imperative that the applicator does not exceed the maximum film thickness per coat applied in order to prevent entrapment of the solvent and the formation of pinholes.

12.3 Powder Coats

Powder shall be applied in the shop by electrostatic spray or by fluidised bed as applicable. Items for powder coating shall after surface preparation, be pre heated to the required temperature, usually in the range 200 to 250ºC, coated by electrostatic spray or by fluidised bed, then post cured if necessary to obtain complete fusion and cure. For surfaces to be immersed the applied coating shall be tested for defects by high voltage spark testing. No defects will be permitted. Thermoset materials such as FBE shall be fully cured.

12.4 Hot-Dip Galvanizing

Hot-dip galvanizing shall be carried out in accordance with SANS 121. The coating of lining thickness shall comply with the values specified for General Applications or Heavy Duty Applications as specified in the Clause 10.8.

Galvanized surfaces which are to be painted shall NOT be passivated by the galvanizer.

Repairs to damaged galvanizing shall be carried out in accordance with the procedures specified in SANS 121 by hot metallic zinc spraying unless the use of an appropriate solder is approved. Conventional solder shall NOT be used. Solder composition shall have been approved in writing by the SANS (Metallurgy Division) or by the SAHDGA.

12.5 Cement Mortar Lining

12.5.1 Mixing of Mortar

Components of the mix shall be accurately weighed. Each batch shall be identical. Mixing shall be carried out in a suitable mechanical mixer. Aggregate and cement shall be measured in correct proportions, then dry mixed in the mixer. When homogeneous, water shall be added from a measuring vessel to achieve the correct consistency but shall not exceed the amount stated previously. When correctly mixed, the material shall be used as soon as possible and not later than 1 hour after the first addition of water. Re tempering of the mix by further addition of water or other material shall not be permitted.

From a random batch of each day's production prepare three 150 mm test cubes, in accordance with SANS 5863. After 28 days curing, the compressive strength shall not be less than 30 MPa.

12.5.2 Placing of Cement Mortar

Cement mortar shall be placed to the specified thickness by spin casting (preferred method) or by mechanical drag trowel. In either case, sufficient centrifugal force shall be used to ensure optimum bonding to the pipe wall and optimum compaction of the cement mortar, with minimum segregation of different sizes of aggregate. The finished lining shall be smooth and uniform. Hand application is not permitted except on specials or by prior agreement of the Employer's Agent.

12.5.3 Curing of Lining

After completion of placing, spinning, trowelling an end finish, the lining shall not be disturbed until set. The pipe ends shall be closed with waterproof end covers or caps and the pipe shall be left undisturbed for at least 40 hours. After 48 hours the lining shall be sprayed with a fine mist of water and the covers and caps replaced or shall be steam cured by an approved method. The lining shall be kept wet for not less than 7 days. Pipes shall not be transported within 21 days from the date of applying the lining.

During placing of the cement mortar and the whole of the curing period, the pipes shall be kept constantly in the shade or under cover. Pipes shall not be exposed to direct sunlight.

12.6 Plastic Tape Wrapping

Pipes shall be helically wrapped on site with minimum 50% overlap, using a tape wrapping machine to ensure uniform tension. Wrinkling, bubbling or other visible defects are not permitted. The tape manufacturer shall approve the tape wrapping procedure and equipment and the application shall comply with SANS 10129.

12.7 Duplex or Multi-Layer Systems

Duplex or Multi-layer systems consist of more than one corrosion protection system applied consecutively e.g. a Hot-Dip Galvanizing and Polyurethane system.

The specifications for each of the corrosion protection systems shall be strictly followed. Special attention shall be given to adhesion between the systems.

12.8 Finishing on Site

Repairs, finish painting and cleaning on the site are regarded as inherent parts of the installation. On completion of erection, all pipework, control gear and indicating gear shall be thoroughly cleaned.

After erection, paint work shall be washed down, using nylon brushes and detergent to remove all adhering contamination. It shall then be washed with clean water to remove all traces of detergent and allowed to dry. The finishing coat shall then be applied as specified in the Amendments to this Specification.

All surfaces which cannot be painted after erection shall be painted as specified before erection. The painting system so applied shall be allowed to become fully hard dry (for at least two weeks for epoxy type paints) before erection.

For coatings such as epoxies, having a limited overcoating interval as specified in the manufacturer's data sheets, the surface shall be washed and thoroughly abraded to a matt finish before application of the finishing coats in accordance with the manufacturer's instructions.

12.9 Tolerances

12.9.1 Individual Coats Film Thickness

At least 90% of all thicknesses measured shall comply with the minimum thickness of the system specification. Up to 10% of all readings may be below the specific minimum thickness, but no reading shall be less than 70% of the specified minimum thickness.

12.9.2 Total Dry Film Thickness

Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. For severely corrosive conditions, no reading shall exceed the mean specified thickness by greater than 60% of the minimum.

12.10 Corrosion Protection Systems

The requirements as specified in the following sections as listed below shall be read in conjunction with the requirements of SC 12: Application of Corrosion Protection Systems. Each system specified below shall also conform to the relevant requirements of SC 12 and its sub-clauses. Where in in conflict with SC 12 and its sub-clauses the requirements in the following sections listed below shall take precedence.

- Epoxy Coating System
- Fusion Bonded Epoxy Coating System (Heavy Duty)
- Hot-Dip Galvanizing Systems (Heavy Duty)
- Bitumen Coating Systems
- Alkyd resin based systems
- Vinyl Resin Based Systems
- Elastic Polyurethane Systems

Unless otherwise specified in the Amendments to this Specification and subject to the approval by the Employer's Agent, Plant, equipment and pipework in pump stations and water and wastewater treatment works and pipelines shall be corrosion protected with one or more of the corrosion protection systems described in the following paragraphs of this Specification.

13 TWO PACK EPOXY COATING SYSTEM

13.1 Standards

a) Equipment, materials and operational methods shall comply with the relevant SANS, ISO, BS, DIN or equivalent American Standard.

b) The *Contract*or shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this Specification.

c) Reference is made to the latest issues of the following Standard Specifications:

SANS 1091	National colour standards for paint
SANS 1217	The production of painted and powder coated steel pipes
SANS 5769	Cleanliness of blast-cleaned steel surfaces for painting (dust and debris)
SANS 5772	Profile of blast-cleaned steel surfaces for painting
SANS 2808	Determination of film thickness
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings
BSS 5493	Protective coating of iron and steel structures against corrosion
SANS 9000	Model for quality assurance in production and installation

13.2 Material

a) The *Contract*or shall have the Manufacturer's data sheets of materials to be used available.

b) Two Pack Epoxies shall be in accordance with SANS 1217. Solvent free Epoxies shall be used.

c) Two Pack Epoxies offered shall be polyamine cured.

d) Multi-purpose Epoxy shall be of the high build, modified aluminium Epoxy mastic type, containing at least 90% solids.

e) Materials and procedures shall comply with the relevant SANS Specifications and Codes of Practice.

f) All materials in a coating system shall be purchased from the same manufacturer unless approved by the *Employer's Agent*.

g) Details of coating materials to be supplied and approved.

h) The *Contract*or shall only proceed with the purchase of coating materials upon receipt of written approval from the *Employer's Agent*.

i) Materials offered and subsequently approved shall not be changed without written approval of the *Employer's Agent*.

j) Coating material selection shall also be approved by the material manufacturer/supplier. The *Contract*or shall receive a written assurance from the material suppliers that the materials comply with the specified requirements.

k) All coating materials shall be delivered in the manufacturer's original containers, clearly marked with the following:

- Manufacturer's name
- Product Brand and Reference Number
- Batch Number which may incorporate the date of manufacture
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application
- The SANS mark where applicable.

l) All coating materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

m) Usage of materials shall be on a first in, first out basis and no materials shall be used that have exceeded the shelf life recommended by the manufacturer.

13.3 Special Coating Areas

a) Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coating shall be fully cured before assembly.

b) Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

c) Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating application and installation.

d) Friction grip areas shall be left un-coated unless otherwise specified.

13.4 Acceptability of Items to be Coated

Items to be coated shall conform to Sub-Clause 4.1.1 of SANS 1217, with the proviso that "pipes" shall read "items to be coated".

13.5 Surface Preparation

a) The *Contract*or shall satisfy himself that the condition of each item to be coated is such that it is fit for coating or lining, or both, as relevant. Immediately after surface preparation each item or special shall be examined, including the inside surface, where possible, for compliance with the relevant requirements of this sub-clause.

b) Pre- and surface preparation shall conform to GIBB 002 – General Mechanical Specification and SC 9 respectively.

c) For pipes and specials intended for butt welding the prepared surfaces shall extend to the pipe ends.

13.6 Coating Thicknesses

Coating thicknesses shall conform to SC7.

13.7 Manufacturer's Instructions

a) Recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead, shall be followed.

b) The following details shall be made available to the applicator:

- Brand and type of epoxy resin
- Mixing and thinning instructions
- Recommended type and quantity of solvent required for thinning during application
- Pot life of mixed product
- Minimum and maximum recommended dry film thickness per coat
- Recommended time intervals between coats
- Recommended minimum and maximum steel surface temperatures during application
- Time for complete drying and curing on steel surfaces
- All relevant information the Supplier wishes to submit on his product
- Recommended method of coating application

c) Verbal information by the Manufacturer's representative will not be accepted unless confirmed in writing by the Company.

13.8 Coating Application

13.8.1 Environmental Conditions

a) Dusty Conditions:

Coatings shall not be applied in dusty or contaminated conditions.

b) Surface Temperature:

Coatings shall not be applied if the surface temperature of the steelwork is less than 3°C above dew point or outside the range 5-40°C, unless otherwise specified by the coating manufacturer.

c) Relative Humidity and Time of Application:

Refer to SC 9.3.5.

d) Ambient Temperature:

Coatings shall not be applied when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material.

13.8.2 Mixing

a) The *Contract*or shall ensure that all paints are mixed in accordance with the requirements of Specification BS 5493.

b) All coating components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

c) In the case of two-Pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the Manufacturer until the mixture is completely homogeneous. For two Pack materials, the use of part of the contents (split Packs) is strictly forbidden.

d) In the case of solvent based Epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period, as recommended by the manufacturer, before use.

e) During application, coating materials shall be agitated regularly to keep the solids in suspension. The preparation time, induction time and pot life of these materials shall be closely adhered to.

13.8.3 Application Requirements

a) Equipment:

Application equipment shall be maintained in a clean condition and in good working order. The use of equipment not maintained in good condition may lead to rejection of the coating.

b) Compatibility of Coats:

All primer, intermediate and finishing coats shall be mutually compatible.

c) Surface Restoration:

Should immediate lining/coating not be possible, or should any atmospheric oxidisation take place between the completion of blast cleaning and commencement of lining/coating, such oxidisation shall be removed by flash blasting to restore the specified surface finish. Removal of dust and debris shall be in accordance with SC 9.3.5(a).

d) Supports:

During coating application, the items shall be so supported to prevent damage to the wet coatings until the coatings have hardened adequately. Items shall remain supported during curing, storing and handling.

13.8.4 Method of Application

a) Application:

Epoxy coatings shall be applied by any appropriate method recommended by the manufacturer thereof, and approved by the *Employer's Agent*.

b) First Coat:

The first coat shall be applied to a minimum dry film thickness of 40 µm above the peaks of the blast profile.

c) Cleanliness:

- During application and curing of the layers, the items shall be protected against contamination by dust or other foreign matter and shall be kept dry and shaded from direct sunlight.
- All coats shall be clean and free from dust, oil, moisture and perspiration before over-coating.
- Operators handling blast-cleaned or partially painted surfaces shall wear clean gloves to avoid contamination of the surface.

d) Stripe Coat and Crevices:

- All metal edges, up stands, welds, bolts and nuts shall be adequately coated. Additional stripe coatings shall be applied after initial priming, if ordered by the *Employer's Agent*.
- Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

e) Second and Subsequent Coats:

The second and subsequent layers shall then be applied within the recommended over-coating periods.

13.8.5 Coat Colours

The colour of each subsequent coat shall be different from that of the previous coat except where two finishing coats of the same colour are necessary to achieve colour uniformity.

13.8.6 Over-coating Times

Over-coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer relevant to the ambient temperature.

Strict adherence to over-coating times is particularly important for coatings which are subsequently immersed.

13.8.7. Pipe Ends

a) Extension of Lining:

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for site welding by means of double sleeve weld-on couplings, the lining shall extend to the ends of pipes and specials including edges and shall overlap by at least 300 mm on the outside of the pipe. Coatings shall overlap epoxy surfaces on the outside by at least 25 mm.

b) Butt Weld Edges:

For pipes and specials intended for site butt-welding, lining and coating shall extend up to a distance of 50 mm from pipe ends. The unlined circumferential strip of grit blasted surface shall be temporarily protected between the works and Site with a coat of weldable primer (different colour to the lining/coating).

13.8.8 In-situ Applied Epoxy Lining

In-situ application shall only be used to make good defects. No welding whatsoever shall be performed on any pipe or special on which the lining or coating has been completed, without the approval in writing of the *Employer's Agent*. The temporary protected surfaces shall be blast cleaned before coating with the specified system. The approval shall only be considered by the *Employer's Agent* after submission by the *Contract*or of acceptable proposals for making good un-coated and damaged areas.

13.9. Over-Coating with Polyurethane

13.9.1 Wet, Submerged or High Humidity Conditions

a) Pure Aliphatic Polyurethane:

- The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish;
- The surface shall be vacuum-cleaned to remove dust and debris – refer to SC9.3.5(a);
- Contaminants shall be removed and surfaces prepared by wiping with an organic solvent
- Over-coat with a 25 to 35 µm layer of pure Aliphatic Polyurethane in accordance with the Colour Code, SC 21.

13.9.2. Dry or UV Conditions

a) Re-coatable Polyurethane:

- The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish;
- The surface shall be vacuum-cleaned to remove dust and debris – refer SC.9.3.5(a); and
- Over-coat with a 40 µm minimum layer of Re-coatable Polyurethane in accordance with the Colour Code, SC 21

13.10 Quality of Coating

13.10.1 Finish

The fully cured coating shall have a uniform, smooth, gloss finish with proper adhesion.

13.10.2 Dry Film Thickness (DFT)

The Epoxy coating shall be evenly applied to the minimum final film thickness as specified in SC 13.6 and shall be tested in accordance with SC 13.11

13.10.3 Electrical Insulation Defects

All coated surfaces intended for water immersion or where likely to be frequently wetted under normal service conditions shall show no electrical insulation defects when tested in accordance with SC 0.

13.10.4 Finishing Coat Colours

a) The finishing coat colours shall be as specified in the Colour Code, SC 21.

b) Colours shall be in accordance with SANS 1091.

c) Where not specified, the selection of final colours shall be approved by the *Employer's Agent*.

13.10.5 Solvent Entrapment

(a) Coatings showing evidence of entrapped solvents after full cure will be rejected. No inter-coat de-lamination shall be allowed.

(b) The *Contracto*r shall be hthield responsible for blistering of coatings, when shown to be caused by solvent retention.

13.11 Testing

To be read in conjunction with SC 6

13.11.1 Contractor's and Employer's Agent's Inspections

Refer to GIBB 002 - General Mechanical Specification

13.11.2 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

13.11.3 Holiday Inspection (Electrical Insulation Defects Inspection)

(a) 100% of the lining and coating of all pipes shall be tested and there shall be no electrical insulation defects on any area inspected.

(b) Except for coating containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SANS 1217 for coatings and linings of thickness not exceeding 500 µm.

(c) For films exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector shall be used in accordance with SANS 1217

(d) Inspection procedure shall ensure that sufficient moisture is present at all times on the surfaces to be tested.

13.11.4 Dry Film Thickness (Dft)

a) Measurements shall be taken in accordance with SANS 2808.

b) 100% of all coating thicknesses measured shall comply with the minimum requirements of this Specification.

c) In the case of coats applied after the erection of steel work on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the *Employer's Agent*, and may be dictated by accessibility.

d) DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

e) DFT shall be tested within 7 days of application.

f) DFT measurements taken at times beyond seven days after application shall not constitute a valid claim against the original satisfactory and documented execution of the work.

g) The method used to measure DFT, and the significance of the readings for each particular item, shall be agreed upon by all parties prior to commencement of the work.

13.11.5 Automated Shop Applied Lining and Coating

The film thickness on the first pipe and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The *Employer's Agent* may at his discretion supplement the above test by checking wet film thickness on any or all pipes during application of the epoxy resin.

13.11.6 Hand and In-situ Applied Lining and Coating

All the applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

13.11.7 Degree of Cure of Two-Component Materials

The degree of cure of a two-component material will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (methyl ethyl ketone resistance test).

13.12 Damaged Coatings

a) All repairs and procedures shall be approved by the *Employer's Agent* and subject to inspection procedures as set out in SC 13.11.

b) Where the damage is extensive the remedial procedures shall be agreed with the *Employer's Agent* in writing.

c) All repairs shall comply with the requirements of the repair-product manufacturer's data sheet. The *Employer's Agent* may at his discretion request that repaired coating areas undergo adhesion tests.

d) Any damage occurring during transit from the *Contractor*'s premises to the site shall be the responsibility of the *Contractor*. The *Contractor* responsible for installation of equipment at site shall repair any damage occurring on site during handling, assembly, storage, transport and erection.

e) The repaired area shall be tested in accordance with Sub Clauses 8.4 and 8.12 of SANS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

f) Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of the Specification.

13.12.1 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the *Employer's Agent*, be carried out as follows:

a) Degrease in accordance with SC 9.3.3.

b) Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.

c) Vacuum-clean the surface to remove dust and debris in accordance with SANS 5769 and SC 9.3.5(a).

d) Wipe the abraded paint surface with methyl ethyl ketone and allow to dry.

e) Apply as many coats of repair material as necessary to achieve the specified thickness and finish.

NOTE: 1. When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.

2. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

13.12.2 Repair Methods for Major Defects

The repair of areas showing damage down to the steel surface shall, if approved by the *Employer's Agent*, be carried out as follows:

a) Degrease in accordance with SC9.3.3.

b) Blast-clean all damaged areas to Sa 3 OR Sa 2 1/2 (ISO 8501-1).

c) Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.

d) Vacuum-clean the surface to remove dust and debris in accordance with SANS 5769 and
SC 9.3.5(a).

e) Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.

f) Apply as many coats of repair material as necessary to achieve the specified thickness and finish.

NOTE: 1. When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.

2. Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

14 FUSION BONDED EPOXY COATING SYSTEM (HEAVY DUTY)

14.1 Standards

a) Equipment, materials and operational methods shall comply with the relevant SANS, ISO, BS, DIN or equivalent American Standard.

b) The *Contract*or shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this Specification.

c) Reference is made to the latest issues of the following Standard Specifications:

SANS 1217	The production of painted and powder coated steel pipes.
SANS 5769	Cleanliness of blast-cleaned steel surfaces for painting (dust and debris).
SANS 5772	Profile of blast-cleaned steel surfaces for painting.
SANS 2808	Determination of film thickness.
ISO8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
BSS 5493	Protective coating of iron and steel structures against corrosion.
SANS ISO 9000	Model for quality assurance in production and installation.

14.2 Material

Shall conform to SANS 1217, Type 2, powder coating.

14.3 Application

14.3.1 Surface Preparation

Pre- and surface preparation shall conform to GIBB 002 – General mechanical specification and SC 9 respectively.

14.3.2 Coating Thicknesses

Coating thicknesses shall conform to SC 7 or as specified in the Specification.

14.3.3 Coating Application

a) Items shall be heated to a temperature of 200°C (only applicable to heavy items) and coated with Fusion-bonded Epoxy by means of an electrostatic powder gun.

b) The normal procedures pertaining to powder application shall apply.

c) On completion of the coating, items shall be cured for 60 minutes at 200°C (mean temperature).

14.4 Quality of Coating

Refer to SC 13.10.1.

14.5 Testing

To be read in conjunction with SC6 and SANS 1217.

14.5.1 Contractor's and Employer's Agent's Inspections

Refer to GIBB 0012 - General Mechanical Specification.

14.5.2 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

14.5.3 Holiday Inspection (Electrical Insulation Defects Inspection)

a) 100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

b) Inspection procedure shall ensure that sufficient moisture is present at all times.

c) For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SANS 1217.

14.5.4 Film Thickness

a) Measurements shall be taken in accordance with SANS 2808.

b) 100% of all coating thicknesses measured shall comply with the minimum requirements of this Specification.

c) Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the coating is demonstrated to be sound in all respects.

d) The method used to measure film thickness, and the significance of the readings for each particular item, shall be agreed upon by all parties prior to commencement of the work.

14.5.5 Degree of Cure of Fusion-Bonded Materials

The degree of cure of fusion-bonded material shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (methyl ethyl ketone resistance test).

14.6 Damaged Coatings

a) All repairs and procedures shall be approved by the Employer's Agent and subject to inspection procedures as set out in SC 13.11

b) Where the damage is extensive the remedial procedures shall be agreed in writing with the Employer's Agent.

c) All repairs shall comply with the requirements of the repair-product manufacturer's data sheet. The Employer's Agent may at his discretion request that repaired coating areas undergo adhesion tests.

d) Any damage occurring during transit from the Contractor's premises to site shall be the responsibility of the Contractor. The Contractor responsible for installation of equipment on site shall repair any damage occurring on site during handling, assembly, storage, transport and erection.

e) The repaired area shall be tested in accordance with Sub-Clauses 8.4 and 8.12 of SANS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

f) Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of the Specification.

14.7 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the *Employer's Agent*, be carried out as follows:

a) Degrease in accordance with SC 9.3.3.

b) Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.

c) Vacuum-clean the surface to remove dust and debris in accordance with SC 9.3.5(a).

d) Wipe the abraded paint surface with methyl ethyl ketone and allow to dry.

e) Apply as many coats of the following repair material as necessary to achieve the specified thickness and finish.

- Solvent free Epoxy or
- Fusion-bonded Epoxy powder repair kit.

NOTE: Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

14.8 Repair Methods for Major Defects

The total un-coated areas for renovation by the applicator shall not exceed 0.5 percent of the total surface area of a component. Each un-coated area for renovation shall not exceed 2 500 mm². If damaged areas are larger, the items containing such areas shall be re-coated.

The repair of areas showing damage down to the steel surface shall, if approved by the *Employer's Agent*, be carried out as follows:

a) Degrease in accordance with SC 9.3.3.

b) Blast-clean all damaged areas to Sa 3 (ISO 8501-1).

c) Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.

d) Vacuum-clean the surface to remove dust and debris in accordance with SANS 5769 and
SC 9.3.5(e).

e) Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.

f) Apply as many coats of the following repair material as necessary to achieve the specified thickness and finish.

- Solvent free Epoxy or
- Fusion-bonded Epoxy powder repair kit.

NOTE: Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

15 HOT-DIP GALVANIZING SYSTEMS (HEAVY DUTY)

15.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 14713	Protection against corrosion of iron and steel in structures - guidelines.
SANS 32	Internal/external protective coatings for steel tubes.
SANS 121	Hot-dip galvanized coatings on fabricated iron and steel articles.
SANS SM 5772	Profile of blast-cleaned steel surfaces for painting.
SANS 2063	Metallic and other inorganic coatings – Thermal spraying.
SANS 2808	Determination of film thickness.
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS 10374-1	The suitability of hot-dip galvanized steel piping for the transportation of water.
SANS 1344	Medium duty solvent detergent.
ISO 752	Zinc ingots.
EN 1179	Zinc and zinc alloys – primary zinc.
SANS 9000	Model for quality assurance in production and installation.

15.2 Material

a) The impurities in the molten zinc, as defined in ISO 752 and EN 1179, shall not exceed a total of 1.5%.

b) Steel to be hot-dip galvanized shall be:

i) For aesthetic appearance

- Aluminium-killed steel or

- Silicon-killed steel with a Silicon content not exceeding 0.04% and a Phosphorus content not exceeding 0.02%.

NOTE: Material certification shall be supplied.

ii) For general corrosion protection

- Aluminium killed steel or
- Silicon killed steel with a Silicon content not exceeding 0.25% and a Phosphorus content not exceeding 0.02%.

c) The condition of articles to be hot-dip galvanized shall comply with “Annexure C” of SANS 121.

d) The condition of tubes to be hot-dip galvanized on a continuous line shall comply with “Annexure A” of SANS 32.

15.3 Application

a) Shall only be done by members of the Hot Dip Galvanizers Association of Southern Africa (HDGASA) in accordance with SANS 9000.

b) Shall be in accordance with SANS 121 and SANS 32 for tubes.

15.4 Tolerances

15.4.1 Steel Specials

Shall be in accordance with Clause 6 of SANS 121.

a) Surface

- The surfaces shall be free from nodules, blisters, roughness and sharp points. Un-coated areas, flux residues, lumps and zinc ash shall not be permitted.
- Notwithstanding Clause 6.1 of SANS 121, in the case of handrails etc. a high quality surface finish is required and a bright smooth surface shall be achieved. Only materials specified in the Scope of works, drawings, specification shall be utilised unless otherwise approved by the Employer’s Agent.
- Double dipping shall not be allowed.

b) Thickness

The thickness of hot-dip galvanizing shall comply with the requirements of the table below.

Minimum coating thicknesses on items that are not centrifuged.

Table 15-1: Minimum coating thickness

ARTICLES AND ITS THICKNESS	HEAVY DUTY COATING	LIGHT DUTY COATING	
	COATING THICKNESS µM (MIN)	LOCAL COATING THICKNESS µM (MIN)	MEAN COATING THICKNESS µM (MIN)

Steel ≥ 6 mm	105	70	85
3.0 mm ≤ Steel < 6.0 mm	80	55	70
1.5 mm ≤ Steel < 3.0 mm	65	45	55
Steel < 1.5 mm	55	35	45
Castings ≥ 6.0 mm	105	70	80
Castings < 6.0 mm	-	60	70

Heavy duty coatings are required except in the following cases:

- Where a high surface finish is required
- Where otherwise specified in this Specification

15.4.2 Steel Tubes

Shall be in accordance with Clause 7 of SANS 32.

a) Surface:

The surface of the coating shall be continuous, smooth and free from flux residues.

b) Thickness:

The thickness shall comply with the requirements of the coating quality A1, in accordance with Clause 8, Table 1 of SANS 32, as specified below.

Minimum local coating thickness requirements for coating quality A1:

Table 15-2: Minimum coating requirements

REQUIREMENTS	COATING QUALITY A1
Minimum Local Coating Thickness on the Inside Surface except at the Weld Bead	55 µm
Minimum Local Coating Thickness on the Inside Surface at the Weld Bead	28 µm
Minimum Local Coating Thickness on the Outside Surface	55 µm

c) Adhesion:

The coating shall show no evidence of flaking or cracking when tested in accordance with Clause 11.4 of SANS 32.

d) Coating Qualities:

- Coating qualities shall be A1 for water installations – see Sub-Clause 8.2 of SANS 32.
- The surface of the coating on the inside shall be as smooth as can be achieved by steam blowing.

15.5 Testing

15.5.1 Steel Items

To be read in conjunction with SC 6.

a) Visual Examination:

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

b) Thickness:

Thicknesses shall be in accordance with SC 15.4.1(b) and shall be tested in accordance with Sub-Clause 6.2 of SANS 121.

15.5.2. Steel Tubes

To be read in conjunction with SC 6.

a) **Visual Examination** - Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer

b) **Thickness** -Shall be tested in accordance with Sub-Clause 11.3 of SANS 32

c) **Adhesion** - Shall be tested in accordance with Sub-Clause 11.4 of SANS 32

d) **Chemical Analysis** - Shall be tested in accordance with Sub-Clause 11.5 of SANS 32

15.6. Repair Methods

15.6.1 Steel Items

a) The total un-coated areas for renovation by the galvanizer shall not exceed 0.5% of the total surface area of a component. Each un-coated area for renovation shall not exceed 400 mm². If un-coated areas are larger, the item containing such areas shall be re-galvanized.

b) The repair method shall be approved by the Employer's Agent before repairs are initiated.

c) Repairs shall be by zinc thermal spray in accordance with SANS 2063 or three component zinc solvent free Epoxy repair system. The repair shall include removal of any scale, cleaning and any necessary pre-treatment to ensure adhesion – refer to SC 9

d) The coating thickness on the renovated areas shall be a minimum of 30 µm more than the local coating thickness specified in SC 15.4.1(b) for the relevant hot-dip galvanized coating unless otherwise specified by the Employer's Agent. The coating on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

15.6.2. Steel Tubes

a) Repairs shall not be allowed on internal surfaces of tubes. Tubes shall be re-galvanized.

b) Repairs on external surfaces shall be in accordance with SC 15.6.1

16 BITUMEN COATING SYSTEMS

Bitumen coating systems are used for corrosion protection of structural steel elements and piping, specifically focused on elements that are subject to hard sliding type abrasion and for repairs.

16.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS	1130	Glass fibre reinforcing material for pipe wrapping.
SABS	1136	Cold-applied bitumen primer for steel pipeline protection. (as withdrawn in 2000

SABS 1137	Hot-applied bitumen for steel pipeline protection. (as withdrawn in 1999).
SANS 1178	The production of lined and coated steel pipes using bitumen or coal tar enamel.
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS 9000	Model for quality assurance in production and installation.

16.2 Material

16.2.1 Hot Applied Bitumen and Primer

Shall conform to SABS 1137 (as withdrawn in 1999) and SANS 1178. In all cases where bitumen or primer is to be stored in open tanks at elevated temperatures, or the storage temperature of the bitumen in enclosed tanks exceeds 180°C, the supplier shall be consulted and certificates obtained from him indicating recommended maximum temperatures and temperature/time relationships for storage. These certificates shall be made available to the *Employer's Agent* or the Inspectorate on request.

NOTE: Bitumen that has been heated to a temperature in excess of 230°C shall be discarded.

16.2.2 Cold Applied Bitumen Primer

Shall conform to SABS 1136 (as withdrawn in 2000).

15.2.3 Glass Fibre Tissue and Woven Wrap

Shall conform to SANS 1130.

16.3 Application

16.3.1 Acceptability of Pipes

Shall conform to Sub-Clause 3.3.1 of SANS 1178.

16.3.2 Surface Preparation

Surfaces shall be prepared in accordance with SC 9 and shall conform to Sub-Clause 3.3.2 of SANS 1178 with preparation grade Sa 2½ of ISO 8501-1 and surface profile amplitude 75 micrometers (µm).

16.3.3 Lining

a) Primers shall be applied in accordance with Clause 3.5 of SANS 1178. The lining shall then be applied in accordance with Clause 3.6 of SANS 1178, except that the maximum lining thickness shall be 5 mm.

b) Where pipe ends are intended for jointing by butt welding, the lining shall be cut back 100 mm from each end of the pipe. The primer shall however extend over the full length of the pipe.

16.3.4 Coating

a) Coating Procedure:

The coating procedure shall conform to sub-clauses 3.5.2, 3.7.2 and 3.7.3 of SANS 1178 and as specified hereunder.

b) Reinforced Coating:

The reinforced wrapping shall be of glass fibre tissue and shall have a fifty (50) percent overlap from one end of the pipe to the other. On completion of the first wrap a further coat of hot bitumen shall be applied at a temperature not exceeding 230°C, whilst a second wrap shall be applied in the same manner as the first, but in the reverse direction. On no account shall the bitumen layer between two wraps be less than 1 mm thick.

The minimum cover of bitumen over the second glass fibre tissue wrap shall not be less than 1 mm. The nominal thickness of the completed coating shall be 5.5 mm. The coating surface shall be free of surface craters, crazing, laminations, and pinholes and shall have an acceptable smooth surface.

c) Armoured Coating:

Armoured coated pipes shall, where specified in the Schedule of Quantities and in the Specification, be "armoured" against mechanical damage as follows:

Immediately after completion of the second glass fibre tissue (to SANS 1130, Type 1) wrap, a further coat of hot bitumen, not exceeding 230°C, shall be applied with bitumen impregnated woven glass fibre reinforcement, (to SANS 1130, Type 2 or Type 3) as in the above paragraphs (a) and (b).

It shall be helically wound around the pipe as a single wrap from end to end, applied under tension with a minimum overlap of 35 mm.

On no account shall the minimum thickness of the bitumen layer between the outer wrap and the second tissue wrap be less than 1.5 mm.

The minimum cover of bitumen over the woven glass fibre outer wrap shall not be less than 1.0 mm.

The nominal thickness of "armoured" coatings shall be 7 mm.

d) Pipe Ends:

Treatment of pipe ends shall conform to Sub-Clause 3.7.11 of SANS 1178.

Where pipe ends are intended for jointing by slip couplings, the coating shall be cut back 250 mm from the end of the pipe.

e) Reflective Finish:

Reflective finishes shall conform to SC 16.3.7 and Sub-Clause 3.7.10 of SANS 1178.

16.3.5 Bitumen Coating of Pipes with Linings other than Bitumen

Bitumen and glass fibre reinforcement shall comply with SC 16.2.1 and SC 16.2.3. respectively. Cold applied bitumen primer shall conform to SABS 1136 (as withdrawn in 2000).

Application of Coating:

- Within four (4) hours of having been grit blasted, and provided the pipes and specials are kept dry and free of dust, cold applied bitumen primer shall be applied by brush, spray, roller or mechanical equipment. The pipe or special shall be supported on skids or in any other suitable manner to avoid damage to and contamination of the primed surface. Primer shall be applied in a uniform manner and at the coverage rate specified or as recommended by the manufacturer, but at a rate of not less than 0.8 litres per square metre of pipe surface. Particular care is required to ensure complete penetration and coverage of welds and sharp edges. All defects in priming shall be immediately touched up by brush, care being taken to overlap the joint with the correctly primed area. Care shall be taken not to contaminate the inside of the pipes or specials with the primer.

All equipment used for priming shall be maintained in a clean condition. Primer shall be stored in sealed containers and before material is drawn from containers, the contents shall be agitated or stirred to ensure uniformity. After sufficient material for application is withdrawn, containers shall be sealed immediately to prevent contamination or loss of solvent. Material shall not be kept in open containers overnight, nor shall it be exposed to the sun. Primer which has become fouled with foreign substances shall be discarded. Primer shall be maintained at the correct consistency by mechanical agitation during application. Thinners may be used as recommended by the manufacturer, provided the thinners are uniformly mixed with the primer before use.

- As soon as the primer is dry to the touch, but not later than three (3) days after application of the primer and provided primed surfaces are kept clean, dry, free from dust and shaded from sunlight, the primed pipes shall be transferred to a lathe-like coating machine. Coating shall further proceed strictly in accordance with SC 16.3.4.

  Reflective finishes shall only be applied and the specified inspections and non-destructive tests shall only be carried out after the lining, if applicable, has been completed and fully cured.

16.3.6 Lining and Coating of Specials

In the case of specials, where length and/or shape preclude the application of lining and coating by the mechanical processes as described for pipes, the lining and coating shall be applied by hand. The lining and coating shall not be inferior to that applied by machine. The standards of pre-cleaning of specials and linings and coatings applied to specials shall comply with all the requirements of this Specification.

16.3.7 Reflective Finish

Bitumen coated pipes shall be given a temporary reflective finish of white wash to minimise heat absorption in transit and prior to laying and back filling on site.

16.4 Tolerances

The minimum acceptable lining thickness shall be 2.5 mm and the maximum acceptable thickness 5 mm.

The nominal coating thickness shall be 5.5 mm with a tolerance of -0.5 mm and +0.5 mm.

The nominal thickness of "armoured" coatings shall be 7.0 mm with a tolerance of –0.5 mm and +0.5 mm.

16.5 Spare Pipes

Spare pipes shall be lined and coated in accordance with SC 7.

16.6 Testing

To be read in conjunction with GIBB 002 - General Mechanical Specification.

16.6.1 Visual Inspection

a) Linings shall have a smooth glossy finish and shall be free from ripples, runs, pinholes, craters, bubbles, laminations and visible impurities.

b) Coatings shall be free of surface craters, crazing lamination, dis-bonding, un-bonded areas, pinholes and shall have an acceptable smooth surface. No hollow sounds shall be detected when the coating is tapped. The glass fibre reinforcement of the fibre pattern thereof shall not be discernible on the bitumen surface.

16.6.2 Non-Destructive Tests

a) Holiday Testing:

Shall conform to Sub-Clause 7.2.2 of SANS 1178.

b) Thickness Testing:

On each pipe in the sample, taken in accordance with SC 16.6.4(b), the thickness of lining and coating shall be measured by means of a suitable magnetic or eddy current instrument. The instrument must be designed for non-destructive measurement of the thickness of non-metallic films on a magnetic base and be suitable for use on curved surfaces. Set zero and calibrate the instrument on steel similar to that used in the manufacture of the pipe, using a suitable shim of which the thickness is approximately equivalent to the thickness of the coating/lining under test. Take readings as specified in Sub-Clause 7.2.1 (a) and (b) of SANS 1178.

16.6.3 Destructive Tests

a) Peel Test on Lining:

Shall conform to Sub-Clause 7.3.2 of SANS 1178. Three tests shall be carried out, one of which shall be over the longitudinal or spiral weld seam, the test areas being approximately 120° apart. The lining shall not be accepted as having passed the test if the average of the three peel length readings is greater than 3 mm.

b) Condition of Bitumen:

Shall conform to sub-clause 7.3.3 (a) and (b) of SANS 1178, to the following standards:

- Fraas breaking point : no failure to +10°C
- Softening point : 100 - 125°C
- Penetration : 1.0 – 2.2 mm
- Resistance to cracking : no cracking down to –10°C.

In the event of the condition of bitumen test results not satisfying all these requirements, a series of three (3) other tests shall be carried out by the *Contract*or, and witnessed by the *Employer's Agent*. The average of the three (3) results for each test shall be determined. If the average does not comply with the requirements, then the day's production, from which lining and coating samples were obtained, shall be rejected.

16.6.4 Test Samples

a) Visual:

All pipes to be inspected.

b) Non-Destructive Testing:

(i) Holiday testing:

All pipes to be inspected.

(ii) Thickness:

On the first pipe and thereafter on at least 10 percent of the number of pipes and specials in each day's production.

c) Destructive Testing:

Sufficient lining and coating material shall be removed from the ends of at least one pipe selected at random from that day's production for the purpose of carrying out the tests. The peel test shall be carried out the next day on the same pipe.

16.7 Repair Methods

16.7.1 Damage to Substrate

Areas dis-bonded or damaged through to the substrate shall be repaired as follows:

a) The problem areas shall be stripped back to the substrate and the edges feathered back for 100 mm minimum to achieve Sa2 of ISO 8501.

b) The repair shall be effected by firstly applying a coat of primer.

c) (i) Using liquid bitumen and cut pieces of glass fibre tissue or a blanket, rebuild the coating to the original Specification. Gas heated repair irons shall be used to blend in the various layers or

(ii) Apply a layer of the “torch on” bitumen tape with 50 mm overlap by heating the side of the tape with a gas torch until the compound is glossy and just molten. Then smooth firmly onto the surface to eliminate air pockets and voids.

Overlaps and seams shall be smoothed and sealed by tooling with a heated bullnose trowel.

16.7.2 Partially Damaged

Areas partially de-laminated or damaged through the thickness shall be repaired as follows:

The de-laminated or damaged areas shall be stripped back to the lamination or bottom of the damage and using liquid bitumen and cut pieces of glass fibre tissue, the coating shall be rebuilt to the original Specification. Gas heated repair irons shall be used to blend in the various layers.

16.7.3 Electrical Insulation Defects

Electrical insulation defects (holidays) shall be repaired by hot ironing.

16.7.4 Top Coat

Completed repairs shall be protected as per SC 16.3.7.

17 ALKYD RESIN BASED SYSTEMS

Alkyd systems are intended for use in environments of low corrosiveness, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection. Defects such as runs, sags, curtaining, shrivelling or wrinkling will not be permitted.

17.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 630: Ecorative high gloss enamel paints.

SANS 681: Undercoats for paints

SANS 1319: Zinc phosphate primer for steel.

17.2 Material

- Alkyd zinc phosphate primer for steel shall comply with the requirements of SANS 1319.

- General purpose alkyd undercoat shall comply with the requirements of SANS 681 Type 2.
- Alkyd enamel shall comply with the requirements of SANS 630.

17.3 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Employer's Agent. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in SC 9.4 and Table 9.2 and the applicable Method as specified in SC 8.

17.4 Repair of Damaged Coats

Repair procedures shall be approved by the Employer's Agent and in Clause 3.12.

17.5 Testing

Testing shall conform to the requirements of Clause 11.1 and SANS 1217.

18 VINYL RESIN BASED SYSTEMS

Vinyl copolymer (PVC) paints are a single component vinyl resin-based paints have excellent resistance to water, chemicals, dilute acids and hypochlorites. Their resistance to heat is poor and they must never be used on surfaces continually subjected to a temperature of 70 °C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, grease, kerosene, petrol etc.

The main advantage of vinyls is their easy maintainability. Whereas epoxies are difficult to recoat after about one month's exposure, vinyls may be recoated after any period of time.

Vinyls are recommended for use above water and for interior and exterior use where and could be subject to chemical fumes, as in chlorination rooms.

18.1 Material

Vinyl copolymer (PVC) paints shall have a solids content of 50% by mass and 32% by volume with a viscosity of 4,5 poise +_ 0,5 poise. The paint shall be stabilised against UV radiation.

18.2 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Employer's Agent. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 9.2.

18.3 Repair of Damaged Coats

Repair procedures shall be approved by the Employer's Agent and in SC 3.12.

18.4 Testing

Testing shall conform to the requirements of Clause 11.1 and SANS 1217.

19 ELASTOPLASTIC POLYURETHANE SYSTEMS

This part of the Specification applies to two component solvent free elastoplastic polyurethane. This system shall only be used in limited approved applications.

19.1 Standards

Reference is made to the latest issues of the following Standards:

SANS1217: Internal and external organic coating protection for buried steel pipelines.

19.2 Material

The paint material shall be a solvent free two-component polyurethane hybrid based on a polyester type polyol and aromatic isocyanate. The cured paint shall comply with the following requirements:

- Tensile strength at 3 mm thickness - ASTM D 638 - not less than 15 MPa
- Adhesion to primed steel - SANS Method 776 - not less than 10 MPa
- Impact resistance (direct) - ASTM G 14 - not less than 9 Joules
- Dielectric Strength - not less than 10 kV/mm
- Elongation at break - not less than 25%
- Compressibility - not less than 25 MPa
- Surface hardness of 5 mm thick sample - not less than 60 nor greater than 80 Shore 'D'
- Water Vapour Permeability - not greater than 0.5 g/24 h/m²/mm²
- Cathodic disbonding - when tested in accordance with ASTM GB Method A, for 60 days, the dis-bonded area shall not exceed 500 mm²

19.2.1 Adhesive

Adhesive shall be a two component polyurethane adhesive designed to maximise adhesion between used polyurethane and freshly mixed polyurethane.

19.3 Application

19.3.1 Dry Film Thicknesses

Dry film thicknesses shall be at least as follows unless otherwise specified in the Amendments of this Specification

- Overcoating as duplex system
  - The dry film thickness shall be 40 µm minimum
- For corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 1.0 mm minimum
- For highly corrosive/abrasive environmental conditions:
- The dry film thickness shall be 3.0 mm minimum

19.4 Repair of Damaged Coats

Repair procedures shall be approved by the Employer's Agent and conform to the requirements of SC 3.12.

19.5 Testing

Testing shall conform to the requirements of Clause 11.1 and SANS 1217.

20. TAPE WRAPPING SYSTEM

20.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 1117	Plastic wrappings for the protection of steel pipelines.
SANS 10129	Plastics tape wrapping of steel pipelines.
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS 9000	Model for quality assurance in production and installation.

20.2 Material

Polyethylene pressure-sensitive or polyethylene laminated to an elastomeric layer of butyl rubber tapes shall conform to SANS 1117, types A, B or C.

20.3 Application

20.3.1 General

Steel pipes, fittings and specials, protected by means of tapes, shall be wrapped in accordance with SANS 10129 as amended and extended by this Specification. All pipes shall be wrapped outside the trench in accordance with acceptable factory applications. Tape wrapping may be carried out in an "over the trench" operation for pipe diameters up to 450 mm.

If in the opinion of the Employer's Agent adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective wrapping, he shall order a stoppage of work. It shall be regarded that the Contractor has accepted this risk and made provision for it in his Tender.

The production and application of the tapes shall be controlled by SANS 9000, Quality System.

20.3.2 Surface Preparation

Shall conform to Clause 3.2 of SANS 10129.

20.3.3 Priming

Immediately after cleaning but not later than 4 hours after cleaning, provided the pipe surfaces are kept dry and free from dust, a primer shall be applied according to Sub-Clause 4.2.1 of SANS 10129.

20.3.4 Normal Wrapping

Tape wrapping shall be applied with sufficient pre-tensioning immediately after priming, in accordance with sub-clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

For normal wrapping, tape shall be applied in two layers with a minimum overlap of 50% on both the inner and outer wraps.

Tape joints and repairs shall be done in accordance with sub-clause 4.2.3 of SANS 10129.

Hand wrapping shall only be allowed for short lengths that are inaccessible to a wrapping machine, specials, joints, small diameter pipes and small repairs – refer SC 20.6

20.3.5 Armouring

Where armour wrapping is specified, two layers of tape wrapping shall first be applied with sufficient pre-tensioning immediately after priming, in accordance with Sub-Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

The first layer of wrap shall overlap by half the tape width plus 25 mm and the second wrap shall overlap by not less than 50 mm.

The above-mentioned layers of tape shall be armoured by the application of a third layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometers and a minimum overlap of 50%.

Armoured wrappings shall generally be applied at the following positions:

- All road crossings through sleeves and culverts;
- All railway crossings through sleeves or culverts; and
- Wherever the *Employer's Agent* may consider that special conditions warrant such measures.

20.3.6 Wrapping of Specials

In the case of specials or pipe lengths where length and/or shape preclude the application of a protective wrapping system by any means, the protection shall be carried out either by bitumen-fibre glass or epoxy coating in accordance with SC's 16 or 14 respectively. In the case of access, scour, air valve and farmers off-take tees the special shall be deemed to incorporate at least two (2) diameter lengths either side of the main tee barrel.

20.3.7 Armour Wrapping of Coated Pipes

Where armour wrapping of coated pipes is specified, a single layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometers and a minimum overlap of 50% shall be applied.

20.4 Tolerances

20.4.1 Pressure Sensitive Tape Wrapping

The minimum thickness of the inner low-density polyethylene tape carrier component shall be 300 µm and the maximum thickness of the outer high-density tape carrier shall be 1000 µm. Total minimum polyethylene thickness of 1450 µm.

The adhesive part of the inner layer shall be a minimum thickness of 1.5 times the polyethylene tape carrier thickness. For the outer layer the adhesive layer shall be at least equal to the thickness of the polyethylene tape carrier thickness.

20.4.2 Butyl Rubber Laminates

The minimum thickness of the completed wrapping shall be 750 µm. The inner layer shall be a butyl rubber laminate of 450 µm minimum thickness of which the butyl rubber film shall not be less than 200 µm thick and the polyethylene film shall not be less than 200 µm thick.

The outer layer shall be high density pressure tape of 300 µm minimum thickness.

20.5 TESTING

To be read in conjunction with GIBB 002 - General Mechanical.

20.5.1 Visual Inspection

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

20.5.2 Non-Destructive Testing

a) Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested with an approved holiday detector equipped with a rolling ring detector around the pipe by the *Contract*or to the *Employer's Agent* satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved holiday detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The *Employer's Agent* may instruct any length of pipe or any number of specials to be re-tested using a holiday detector with a copper bristle brush detector.

b) Coating Insulation Test

The *Employer's Agent* shall carry out a conductance test on the wrapping over any section of pipeline between valves when the pipeline has been wrapped and installed in the trench with padding and back filling completed. The test shall be conducted with the valves temporarily removed from the line, at the *Contract*or's expense, to ensure complete isolation of the pipeline section under test or between gaps left for tie-ins.

The length of the section of pipeline under test shall be carefully measured and the conductance over the section tested shall not exceed 180 micro-Siemens per square metre of pipe surface under all conditions of test. If the results of the test for the section of pipeline tested are not satisfactory, two sections immediately adjacent to the testing section will be tested. If the results on one or both of these sections tested are not satisfactory, all sections of wrapped pipeline shall be tested.

20.5.3 Destructive Testing

The Employer's Agent may from time to time collect samples of 10 metres of each type of tape and one litre of primer for testing, for compliance with the Specification, by any independent laboratory appointed by the Employer's Agent. The supply of samples shall be for the Contractor's account. The Employer's Agent reserves the right to reject the whole batch of materials from which unsatisfactory samples were obtained.

20.5.4 Repairs

The Contractor shall be required to locate areas of faulty protection on all sections on which unsatisfactory results are obtained and to affect the necessary repairs. The cost of this work and all additional materials provided or supplied, including the reinstatement of the trench and the retest shall be for the Contractor's account.

20.6 REPAIR METHODS

Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

20.6.1 Small Damaged Areas

If the width of the tape being used exceeds by at least 100 mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions.

Clean and prime the exposed area in accordance with SC's 20.3.2 and 20.3.3 and apply a patch of tape, ensuring an overlap of not less than 50 mm on all sides onto the surrounding wrap.

Apply by hand-wrapping with a 55% overlap, a further layer of tape commencing two turns before and continuing for two turns beyond the patch.

20.6.2. Large Damaged Areas

Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50 mm overlap on all sides it must be completely removed from the pipe over the affected section. The area shall be cleaned and primed in accordance with SC's 9 and 10. The pipe must be re-wrapped with a 55% overlap, commencing two turns before and finishing two turns beyond the bared section.

20.6.3 Damage on Double Wrap

Where damage or a defect has occurred in a section that has been double wrapped and in the case of small holidays, the outer wrap shall be removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area.

The appropriate procedure given in SC's 20.6.1 shall be used to effect the repair of the inner wrap.

The outer wrap shall be re-instated in accordance with SC 20.3.5

20.6.4 Outer Wrap Damage

Where damage extends through an outer wrap/rockshield (see Section 6 of SANS 10129), this shall be carefully removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area without damaging the inner wrapping

The repair shall be carried out by the appropriate method given in SC's 20.6.1 and the outer wrap/rockshield re-instated in accordance with SC 20.3.5.

20.8 External Corrosion Protection Using Tape Wrap for Exposed Pipe

The following amendments to the PSL specifications describes the type of tape wrap applied at specific areas. This includes short pipe lengths usually near structures, above ground, below ground, immersed, welded joints and buried site wide pipework in wastewater and water treatment works.

20.7.1 Pipes above ground

All exposed fittings and pipes to be protected by a UV resistant polymer backing and a butyl adhesive "denso Butyl 30 or 35 Tape, Steelcoat 500" or similar approved

20.7.2 Pipes below ground

All buried fittings and pipes to be protected by "denso" petrolatum system including mastic profiling puddy, petrolatum tape and ultraflex psa 180 tape, or similar approved installed to manufacturers specifications.

20.7.3 Pipes buried and through concrete walls

All buried steel pipes cast through concrete walls, regardless of diameter, to be wrapped with Denso Acrylic Pipeline Tape "denso steelcoat 500", or similar approved.

20.7.4 Pipes above ground and through concrete walls

All exposed steel fittings and pipes cast through concrete walls, regardless of diameter, to be wrapped with Denso Acrylic Pipeline Tape "denso steelcoat 500", or similar approved.

20.7.5 Immersed (in water) Pipes

All immersed pipes be protected by polyolefin fabric laminated to a modified bitumen adhesive system "Denso MB-50 tape", or similar approved installed to manufacturers specifications.

20.7.6 Welded joints

All buried welds be protected by petrolatum system including mastic profiling puddy, petrolatum tape and PVC backing film "Denso Ultraflex 1250 tape", or similar approved installed to manufacturers specifications.

21 COLOUR CODING, LABELLING AND NUMBERING

21.1 Colour Coding

The colours for identification colour marking of pipelines and equipment shall be as indicated in the table below where a colour code is not available, the SANS10140-3 Pipe Colour Marking system must be used.

COLOUR	CODE	COLOUR	CODE
Arctic Blue	F28	Light Stone	C37
Black	GH19	Middle Brown	B07
Brilliant Green	H10	Pastel Grey	G54
Canary Yellow	C61	Primrose	C67
Cornflower	F29	Pastel Blue	E70
Crimson	A03	Salmon Pink	A40
Eau de nil	H43	Signal Red	A11
Emerald Green	E14	Strong Blue	F11
Golden Brown	B13	Verdigris Green	E22
Golden Yellow	B49	Water White (Blue)	F29
Jacaranda	F18	White	HG100
Light Grey Green	H40		
Light Orange	B26		

21.2.2 Pipelines

CONTENTS OF PIPE	BASIC COLOUR	IDENTIFICATION BAND 150MM WIDE	WORDING
Potable Cold	Brilliant Green	Cornflower	
Potable Hot	Brilliant Green	Crimson	
Raw	Brilliant Green		RAW
Sludge (All)	Brilliant Green		SLUDGE
Supernatant Return (From Sludge)	Brilliant Green	Pastel Grey	
Waste Water			
Raw Sewage	Middle Brown	Black	
Raw Sludge	Middle Brown	Golden Brown	
Humus Sludge	Middle Brown	Jacaranda	
Treated Sludge	Middle Brown	White	
Returned Sludge	Middle Brown	Crimson	

Supernatant Liquor	Middle Brown	Arctic Blue	
Final Effluent	Middle Brown	Brilliant Green	
Chemical Solutions			
Alum	Jacaranda	Arctic Blue	
Bentonite	Jacaranda		BENTONITE
Caustic Soda	Jacaranda	Black	
Copper Sulphate	Jacaranda	Light Stone	
Activated Carbon	Jacaranda	Pastel Grey	
Lime	Jacaranda	Crimson	
Polyelectrolyte	Jacaranda	Verdigris Green	
Soda Ash	Jacaranda		SODA ASH
Sulphuric Acid	Jacaranda	White	
Chlorine	Jacaranda	Canary Yellow	
Ferric Chloride	Jacaranda	Brilliant Green	
Sodium Hypochloride	Jacaranda	Canary Yellow	
Sodium Chloride	Jacaranda	Canary Yellow Brilliant Green	
Chloride of Lime	Jacaranda	Canary Yellow	
Gases			
Chlorine	Light Stone	Canary Yellow	
Ammonia	Light Stone	Signal Red	
Ozone	Light Stone		OZONE
Chlorine Dioxide	Light Stone	Canary Yellow	
Methane	Light Stone	Black	
Fuel and Oil			
Diesel	Golden Brown	White	
Petrol	Golden Brown	Signal Red	
Hydraulic Oil	Golden Brown	Salmon Pink	
Waste	Golden Brown	Black	
Air			
Blowers	Arctic Blue	Signal Red	
Compressed	Arctic Blue		
Instrument	Arctic Blue	Salmon Pink	
Vacuum	Arctic Blue	Primrose	

Where it is impractical to paint the whole pipeline the basic pipeline colour is to be painted in two 150mm wide bands on either side of the identification bands.

Where there is no identification band, but wording is specified, the specified wording shall be stencilled on the pipe, in the largest practicable lettering up to a maximum of 75mm in height, in clearly visible locations on either side of all fittings.

21.2.3 *Plant and Equipment*

Items of Equipment	Basic Colour
Pumps	According to Pipe Contents
Motors	To match supply voltage panel
Valves (Anti-clockwise Opening Valves)	
Body Bonnet, Yoke and Hand Wheel or Cap	According to Pipe Contents Brilliant Green
Valves (Clockwise opening valves)	
Body Bonnet, Yoke and Hand Wheel or Cap	According to Pipe Contents Signal Red
Electrical Switchgear	Light Orange
(Other than Starting and Stopping Devices and Emergency Stop Controls)	

Fan and Coupling Guards	Signal Red
Base Plates	Black
Exposed Moving or Rotating Machine Parts	Light Orange
Cable and Conduits	Light Orange
Starting Devices	Emerald Green
Stopping Devices	Signal Red
Emergency Stop Controls	Signal Red
Telemetry	Natural Colour
Fire Protection Equipment	Signal Red
Safety Equipment	Emerald Green
Handrails	Golden Yellow
Handrail Stanchions	Black
Crawl Beams	Golden Yellow with 50mm Black Diagonal Lines
Traveling Cranes	Golden Yellow with 50mm Black Diagonal Lines on lifting beams and rails only (i.e. not support columns)
Demarcation of Walkways	Golden Yellow
Housekeeping Markings	Golden Yellow

21.1.1 Mechanical and General

ITEMS			COLOUR
Structural Steel, Gates			Light Grey
Hydraulic Power Pack			Strong Blue
Hydraulic Oil			Salmon Pink
Hazardous Objects/areas (restricted headroom, crane hook etc)			Golden Yellow with Black Chevron
Handwheels and Levers			Golden Yellow
Handrails:	-	Vertical	Black
	-	Horizontal	Golden Yellow
Handrails on Dam Walls	-	Aluminum	Un-coated
	-	Stainless steel	Un-coated
	-	Galvanized	Light Grey
Floors:	-	safe and walking areas	Emerald green
	-	restricted areas	Golden yellow
-open flooring (gratings) –		MS galvanized	Un-coated
		3Cr12	Un-coated
		Stainless steel	Un-coated
Fire Protection Equipment			Signal Red

21.2.1 Location of identification systems

Except in a case where only a basic colour is used and is painted over the entire length of the pipeline, place identifications at all junctions, service appliances, bulkheads, wall penetrations, at both sides of valves, and at any other place where identification is regarded as necessary. Colour code indicators shall not be more than 6 m apart.

21.2.1 Labelling, Numbering of Plant, Equipment and Buildings

Room Numbers	White on Black Background
Electrical Circuits	Black on White Background
Plant Equipment Stock Numbers	Black on Yellow Background
Room Size	White on Cornflower (sky blue) Background
Distribution Board ID	Black on Yellow Background
Danger Signs	Signal Red on White Background
Information Signs	White on Emerald Green Background

21.3 Demarcation of "keep Clear" Areas

21.3.1 Refuse Bin Locations

All refuse bin locations shall be demarcated in the following manner:

The position where the "BIN" is to stand shall be indicated by a Golden Yellow (B49) circle (100mm greater than the diameter of the base of the bin) painted on the floor with the word "BIN" stenciled in black across the centre of the circle.

A 190mm x 190mm "keep Area Clean" symbolic sign shall be affixed to the wall or the other fixture next to the refuse bin to indicate its use as a refuse bin and not as a scarp (metal) bin.

21.3.2 Fire Extinguishers, Fire Hose Reels, Electrical Distribution Boards and other "Keep Clear" Areas

The demarcation shall be symmetrically 300mm greater than the maximum width of the equipment and extend 500mm from the supporting wall or fixture. An eighty millimetre wide black line, within the demarcated area shall be painted as a border to the demarcation. The remaining inner area shall be painted.

Golden Yellow and the words "KEEP CLEAR" and/or "UNGABEKI" stenciled in the yellow block. The lettering shall be 50mm high where possible.

On expanded mesh or similar perforated floor areas a solid metal plate shall be placed below the equipment on which the demarcation shall be painted.

22 MEASUREMENT AND PAYMENT

22.1 General

No separate payment shall be made for painting and corrosion protection. Payment for the requirements of this Section will be included in the payment item for the particular item supplied including painting or corrosion protection.

ANNEXURE 1

PRO-FORMA QUALITY CONTROL PLAN FOR CORROSION PROTECTION

QUALITY CONTROL PLAN FOR CORROSION PROTECTION			
PROJECT:			QCP NO.
EQUIPMENT:		SECTION:	REVISION:
DRAWING NO.:	QTY:	FACTORY ID NO.:	COMPILED BY: DATE:
CLIENT:		CONTACT NO.:	ORDER NO.:
CONTRACTOR:		CONTACT PERSON:	
APPLICATOR:		CONTACT PERSON:	
APPROVALS			
CONTRACTOR NAME: SIGNATURE: DATE:	**EMPLOYER'S AGENT** NAME: SIGNATURE: DATE:	**UW QC** NAME: SIGNATURE: DATE:	**END USER** NAME: SIGNATURE: DATE:
LEGEND			
H - HOLD POINT	W - WITNESS POINT	S – SURVEILLANCE	R – REVIEW
INSPECTION CODE			
1 – APPROVAL	3 - TESTING	5 - REPORT REQUIRED	
2 – MATERIAL CERTIFICATE	4 - VISUAL	6 - RECORD REVIEW	
QUALITY CONTROL			

OPERATION		INSP. CODE	INSPECTION INTERVENTIONS				ACCEPTANCE CRITERIA
			CONTRACTOR	ENGINEER	UW QC	END USER	
	Documentation approval						
1.1	Quality Control Plan	1					
1.2	Corrosion protection programme	1					
1.3	Coating material	1					Data sheets
1.4	Pickling and passivation material	1					Data sheets
1.5	Rough blast material	1					Data sheets
1.6	Final blast material	1					Data sheets

2	**Pre-preparation**							
2.1	Dress protrusions and pits	4					Smooth surface	
2.2	Radius sharp edges	3					______mm minimum radius	
2.3	Repair blowholes in castings	4					To be approved by *Employer's Agent*	
2.4	Fettle welds	4					Smooth contour	
2.5	Remove weld spatter, burrs, laminations, scabs and scale	4						
3	**Degreasing**							
3.1	Remove oil/grease contamination	3						
4	**Rough blast cleaning**	4						
5	**Measurement of soluble salts**						**Wet surface**	**Dry surface**
5.1	Wax at any point	3					100 mg/m^2	500 mg/m^2
5.2	Average over 250 cm^2	3					<100 mg/m^2	100 mg/m^2
5.3	Wet cleaning/Re-blasting						Clean soft water	
6	**Final blast cleaning**							
6.1	Blasting material	2						
6.2	Cleanliness: Wet surface	4					Sa	
6.3	Cleanliness: Dry surface	4					Sa	
6.4	Surface profile	3					50-100 μm	
6.5	Residual dust and debris	3					0.3%	
7	**Application of first coat**							
7.1	Dry Film Thickness (DFT)	3					μm	
8	**Application of second coat**							
8.1	Dry Film Thickness (DFT)	3					μm	
9	**Application of third coat**							
9.1	Dry Film Thickness (DFT)	3					μm	

10	**Completed system**						
10.1	Visual appearance	4					
10.2	Dry Film Thickness (DFT) - Wet surface	3					μm minimum
10.3	Dry Film Thickness (DFT) - Dry surface	3					μm minimum
10.4	Dry Film Thickness (DFT) - flange/ mating surfaces	3					μm minimum
10.5	Electrical Insulation Defect	3					Wet surface
10.6	Adhesion test	3					Where required
11	**Application of third coat**						
11.1	Degreasing	4					
11.2	Pickling	4					
11.3	Passivation	4					

ANNEXURE 2

PRO-FORMA COATING APPLICATION RECORD

COATING APPLICATION RECORD			
1. Pre-preparation			
Dress protrusions & pits:			
Radius sharp edges:			
Repair blowholes in castings:			
Fettle welds:			
Remove weld spatter, burrs, laminations, scale & scabs:			
Primary cleaning:			
2. Degreasing			
Material reference		Batch number:	
"Water break free" test			
3. Rough blast cleaning			
Date of rough blast cleaning		Blasting material:	
4. Measurement of soluble salts			
Maximum at any point mg/m^2		Average over 250 cm^2 mg/m^2	
Maximum at any point – final reading mg/m^2		Average over 250 cm^2 - final reading mg/m^2	
Wet cleaning/Re-blasting		Blasting material:	
5. Final blast cleaning			
Blasting material:		Cleanliness - wet surface: Sa	
Material certificate No.:		Cleanliness - dry surface: Sa	
Material pH	Hardness Moh's scale	Residual dust & debris: %	
Surface profile:	Maximum: μm	Minimum μm	Average μm
Date of final blast cleaning:		Time completed:	

6. Ambient conditions	**First coat**			**Second coat**			**Third coat**			**Final coat**		
Time	08:00	12:00	16:00	08:00	12:00	16:00	08:00	12:00	16:00	08:00	12:00	16:00
Rain: Yes/No												
Ambient temperature °C												
Substrate temperature °C												
Relative Humidity %												

Dew point °C												

7. Application of coats	**First coat**		**Second coat**		**Third coat**		**Final coat**	
Base : Material reference								
: Batch number								
Activator : Material reference								
: Batch number								
Thinner/solvent : Type								
: Batch number								
Application equipment:								
Colour:								
Surface preparation:								
Areas stripe coated:								
Date of application:								
Time application started:								
Time application completed:								
Wet film thickness:								
Wet surface DFT: Min / Ave	µm	µm	µm	µm	µm	µm	µm	µm
No-off readings								
Dry surface DFT: Min / Ave	µm	µm	µm	µm	µm	µm	µm	µm
No-off readings								
Flange/mating surface DFT:Min/Max	µm	µm	µm	µm	µm	µm	µm	µm
No-off readings								

8. Completed system		
Visual appearance:		
Electrical Insulation Defect at	V	
Adhesion test:		
Cure test:		
9. Stainless steel – uncoated components		
Degreasing		
Date of degreasing	Material reference:	Batch No.
10. Pickling and passivation		
Date of pickling	Material reference:	Batch No.
Date of passivation:	Material reference:	Batch No.

ANNEXURE 3

PRO-FORMA SURFACE PROFILE AND DRY FILM THICKNESS READINGS

SURFACE PROFILE AND DRY FILM THICKNESS READINGS			
PROJECT:			
EQUIPMENT:		SECTION:	
DRAWING NO.:	QTY:	FACTORY ID NO.:	
CLIENT:		CONTRACT NO.:	ORDER NO.:
CONTRACTOR:		CONTACT PERSON:	
APPLICATOR:		CONTACT PERSON:	

SURFACE PROFILE

DATE:

WET SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DRY SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DFT FIRST COAT

DATE:

WET SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DRY SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														

BOTTOM														

DFT SECOND COAT

DATE:

WET SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DRY SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DFT THIRD COAT

DATE:

WET SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DRY SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DFT FINAL COAT

DATE:

WET SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

DRY SURFACE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE
TOP														
MIDDLE														
BOTTOM														

FLANGE FACES

DATE:

FLANGE SIZE	1	2	3	4	5	6	7	8	9	10	TOTAL	MIN.	MAX.	AVERAGE

COMMENTS:

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ANNEXURE 4

PRO-FORMA TEST CERTIFICATES FOR COATING MATERIALS

TEST CERTIFICATE FOR SINGLE PACK COATING MATERIAL

The Manufacturer's test certificate shall contain the following information to be supplied with each batch of product delivered to the *Contract*or:

Tender:	
Date:	
Product:	
Reference no.:	
Batch no.:	
Colour:	
Quantity made:	
Shelf life:	
Volume solids:	

Item	Method	Parameter	Results
Fineness of grind:	SANS 5053		
Viscosity:	SANS 5153		
Mass/l:	SANS 5050		
Non-volatile mass, %:	SANS 5193		
Surface dry:	SANS 5148		
Hard dry:	SANS 5148		
Volume solids:	SANS 3233		

TEST CERTIFICATE FOR TWO-PACK COATING MATERIAL

The Manufacturer's test certificate shall contain the following information to be supplied with each batch of product delivered to the *Contract*or:

Tender:			
Date:			
Product no.:			
Reference no.:			
Batch no.:			
Colour:			
Quantity made:			
Shelf life - base:			
Shelf life – curing agent:			
Mixed volume solids:			
Mixing ratio (by volume):			
Item	**Method**	**Parameter**	**Results**
Base fineness of grind:	SANS 5153		
Base viscosity:	SANS 5153		
Base mass/l:	SANS 5050		
Curing agent viscosity:	SANS 5153		
Curing agent mass/l:	SANS 5050		
Mixed viscosity after 1/120 of pot life at 20ºC:	SANS 5153		
Mixed mass/l:	SANS 5050		
Mixed non-volatile mass, %:	SANS 5193		
Surface dry:	SANS 5148		
Hard dry:	SANS 5148		
Mixed pot life (for 1ℓ of mix):	SANS 5153		
Mixed volume solids:			

GENERAL SPECIFICATION

GIBB 008 – CRANES GANTRIES, HOISTS AND WINCHES

REV 1.2

Table of Contents

Revision	Date	Change Detail	Editor
1.1	December 2020	Initial Release	M. Funnell
1.2	June 2021	*Add revision table* *Edit section 1.2* *Edit section 2.2 EOT* *Add section 2.3 MOT* *Edit 3.6.2: add long travel drive system* *Edit 10.1*	M. Funnell/ M. Holmes
1.3	May 2025	Remove inapplicable cranes	D Shaw

1 Scope and Definitions

1.1 Scope of Work

The scope of work shall include the design, supply of all materials, manufacture, shop assembly and testing, corrosion protection, delivery to site, storage and installation at site, site painting, putting to work, testing, Tests on Completion and maintenance (other than normal operating maintenance) of lifting equipment such as cranes, gantry cranes, hoists, crawl beams winches etc

Note: This specification shall comply with the GIBB 002 - General mechanical specification as well as GIBB 007 – Painting and Corrosion Protection Specification.

This specification must be read in conjunction to the project specific specification. All crane dimensions, tonnage parameters and cable lengths discussed in the project specification.

Where any ambiguity exists, this specification shall take precedence.

1.2 Definitions

(a) **"long travel"** means motion along the rails of the crane

(b) **"cross travel"** means motion across the span of the crane

(c) **"hoist travel"** means total movement of the winch in the y-axis (up and down)

(d) **"EOT"** means electric overhead travelling Crane

(e) **"MOT"** means manual overhead travelling crane

(f) "**overslung**" means the drive system on the long travel beam is positioned on top of the beam

(g) "**underslung**" means the drive system on the long travel beam is positioned on the bottom (under) of the beam

(h) **"Stooled up**" means the cross travel beam depth increases upwards after the long travel drive system decreasing the top head clearance height

(i) **"Stooled down**" means the cross travel beam depth increases downwards after the long travel drive system decreasing the bottom floor clearance height

(j) **"Top travelling**" means the trolley drive system is positioned on the top of the cross travel beam

(k) **"Bottom travelling**" means the trolley drive system is positioned on the bottom (hung under) of the cross travel beam

2 Hoisting equipment

2.1 Electric Overhead Travelling Cranes

The EOT cranes shall be capable of spanning the distance and lifting the proposed load as specified in the bill of quantities. The crane shall be single or dual girder, depending on the manufacturer's requirements, and shall be manufactured to suit the specific installation.

2.1.1 Extent of Supply

All cranes, lifting beams, trolleys, crabs, drive systems and hoists shall be supplied strictly in accordance with this Specification (and the Drawings) and shall include the following, unless otherwise specified:

- Electric overhead travelling crane shall be single girder, unless otherwise stated, (welded box or cold rolled), configuration as detailed in the payment item. such as:
    - Overslung or underslung on the long travel beam
    - Stooled up or stooled down on the cross travel beam
    - Top or Bottom travelling trolley for the cross travel
- Motorised cross and longitudinal drives.
- Proximity limit switches on all crane motions protected in accordance with IP 65 of SANS 1222 on all electrically operated cranes.
- Festoon cable, tracks and mountings for cross travel on all electrically operated cranes.
- Push button pendant control shall be all weather proof and protected to IP 65 of SANS 1222.
- Electrical distribution box with isolator, fully weatherproofed and protected in accordance with IP 65 of SANS 1222 on all electrical cranes. The cabinet door(s) shall be fitted with suitable seals to prevent the ingress of water.
- Crane long travel rails and appropriate temporary and permanent fixings with stop blocks at both ends.
- Cross travel rails with stop blocks at both ends.
- Power supply between the isolator box and the crane distribution box. This shall include an automatic cable spooling reel with suitable trailing cable and trailing cable strain restrictor both ends or a conductor rail system as well as all switch gear.
- Suitable waterproof floodlights
- Personnel access to the crane shall be specified in the payment items. (e.g. ladder and grid platform shall be provided, if the hoist is positioned more than 4m above working level as defined by the Employer's Agent). Including all statutory safety requirements.
- There shall be safe an adequate access to the crane from floor level.

2.2 Manual Overhead Traveling Cranes

The MOT cranes shall be capable of spanning the distance and lifting the proposed load as specified in the bill of quantities. The crane shall be single or dual girder, depending on the manufacturer's requirements, and shall be manufactured to suit the specific installation.

2.2.1 Extent of Supply

All cranes, lifting beams, trolleys, crabs, drive systems and hoists shall be supplied strictly in accordance with this Specification (and the Drawings) and shall include the following, unless otherwise specified:

- Manual overhead travelling crane shall be single girder, unless otherwise stated, (welded box or cold rolled), configuration as detailed in the payment item. such as:
    - Overslung or underslung on the long travel beam
    - Stooled up or stooled down on the cross travel beam
    - Top or Bottom travelling trolley for the cross travel
- Crane long travel rails and appropriate temporary and permanent fixings with stop blocks at both ends.
- Manual chain operated cross and longitudinal drives as indicated below.
- Cross travel rails with stop blocks at both ends.
- Cross travel Trolley to be manually operated chain type geared wheel system
- Long travel manually operated chain type geared bridge wheel system. (Chain operated from single side)
- Chain block hoist mechanism to be manually operated chain type pulley system
- No positive locking devices will be required to store manually operated crane.

- The hoist mechanism and crawl shall be geared with operating chain shall correspond with the beam capacity and a manually operated block and tackle type chain hoist of the specified capacity.
- Personnel access to the crane shall be specified in the payment items. (e.g. ladder and grid platform shall be provided, if the hoist is positioned more than 4m above working level as defined by the Employer's Agent). Including all statutory safety requirements
- There will be no slack rope switch on manually hoisted lifting equipment.

2.3 Common Design Features

Below is a list of common design features for the above cranes, hoists and winching equipment.

- Lifting hooks that shall raise and lower vertically on centre.
- Non-spin wire rope and fitted sheave block with swivel hook.
- Chain hoist are preferable to rope hoists.
- Slack rope switch on all electrically operated cranes
- Positive locking devices to store the crane at any point on the rails
- Power supply between the isolator box and the crane distribution box. This shall include an automatic cable spooling reel with suitable trailing cable and trailing cable strain restrictor both ends or a conductor rail system as well as all switch gear.
- Overload protection shall be included
- Design, manufacture, delivery to Site, erection and Tests on Completion on Site. The Contractor or his representative shall supervise the off-loading of the equipment at Site.
- Operating and Maintenance Manuals including Drawings.
- It is preferred that the hoist is a chain hoist.

If the Tenderer offers his standard equipment which exceeds the specified capacity, then the crane shall be designed for this higher load.

Unless agreed otherwise with the employers agent, each vertical leg of the lifting gantry portal frame shall be provided with a flanged, bolted connection approximately one metre above floor level. The lower portion of each leg shall be permanently anchored and grouted to the concrete surface whereas the upper section shall be bolted and temporarily removable. The top horizontal member of the portal frame shall be provided with two lifting eyes suitable for lifting.

The load capacity of the crane (as offered) shall be clearly displayed on both sides as well as on the sheave block e.g. SWL 6 000 kg.

The equipment shall be supplied with all the accessories necessary to give complete working installations including all built-in parts and anchors, rail tracks, hoists, covers and frames, operating gear, controls and safety devices and electrical control panels from and including the main isolating switch on the incoming supply.

The *Contractor* shall be responsible to ascertain that the capacity of each crane is suitable for lifting the equipment in the area serviced by that specific crane. Any deviations shall be communicated to the *Employer's Agent* in writing together with the Tender.

All civil Engineering work in forming and preparing box outs, chases etc., to receive the built-in parts and in placing concrete around them or grouting in base plates and holding down bolts and the like shall be done by the *Contractor*. The *Contractor* shall be required to define his requirements for such work.

The *Contractor* shall be deemed to have taken into account, inter alia, all of the operating requirements and physical conditions in preparing his Tender in addition to the operating and climatic conditions prevailing at the Site as set out in GIBB 002 - General Mechanical Specification. Evidence satisfactory to the *Employer's Agent* shall be provided that the designs offered will meet the design and operating criteria given in the following sections/paragraphs over the operating life of the project (50 years).

3 Mechanical Details and Requirements

3.1 General

The cranes and hoists shall be, as far as possible, of a manufacturer's standard type with long and cross travel and shall comply with the Occupational Health and Safety Act (Act 85 of 1993).

The overall height shall be kept to a minimum and the general aesthetic appearance of the crane shall be pleasing with a clear, uncluttered silhouette. The minimum hook to deck level clearance shall be as indicated on the Drawings or specified in the payment item.

Unless shown on the Drawings or described in the payment item, the crane shall be capable of safely handling loads of full load capacity at all hook positions.

3.2 Design

3.2.1 Electrical Cranes and Hoists

Electrically powered cranes shall be designed in accordance with Federation European de la Manutention, Rules for the Design of Hoisting Appliances, Section 1, Second Edition, 1970 with the following duty factors:

Structures	Cranes, Hoists, etc	
Class of utilisation	A	
State of loading	2	
Group	3	
Mechanisms (all motions)		
Class of operation	$V_{0.5}$	V_2
State of loading	3	2
Group classification	$1A_m$	2_m

3.2.2 Factors of Safety

All parts of the cranes, hoists and lifting devices shall be designed to a factor of safety of at least 4 when working under full load conditions. Lifting ropes and attachments shall have a factor of safety of at least 6 when working under full load conditions. The term "full load" shall be the maximum working load rating specified for each crane.

3.2.3 Hooks and Shackles

The following standards shall apply:

- Ramshorn hooks BS 3017
- Standard hooks BS 2903
- Shackles BS 3032

3.3 Rails

Rails shall be installed complete with end stops, clamps, anchor bolts, fish plates etc. and shall be designed to permit expansion and contraction.

Cranes shall clear all walls and other constraints (as shown on the Drawings) by a minimum of 20 mm.

3.4 Crab

The crab shall as far as practicable be covered with checker plate for maintenance and access purposes. The arrangement and details of the crab and machinery shall be subject to the approval of the *Employer's Agent*.

The end carriage and crab wheels shall be double flanged, cast steel of approved diameter.

The end carriages and crab shall be provided with resilient buffers to engage with fixed stops at each extreme end of the crane travel.

3.5 Crawl Beams

Crawl beams shall be designed to BS 2853, including Amendment 3.

The capacity of each beam shall be displayed as described in Section 2.3. Each crawl beam shall be equipped with removable stops at each end.

Corrosion protection shall be as indicated and in accordance to GIBB 007 – Painting and Corrosion Protection.

3.6 Hoist, Trolley, Drums and Pulleys

3.6.1 Electric Hoist and Trolley Travel

Electric motorised hoists shall have suitable load cells (minimum 125 % of crane capacity) shall be incorporated in the hoist design to reflect the true load being manipulated by the crane at any time.

The load cell shall activate a remote digital display indicator, in metric tons, mounted in the pendant, control cabin or on the control panel.

The hoist trolley shall be fitted with four flanged stainless steel wheels or similar approved with permanently lubricated roller bearings, designed to be used on single girder parallel flanges.

The cross travel drives shall have two compact epicyclic reduction gears with pole-changing brake motors directly drive two wheels.

The electric hoist shall be monorail type to suit crawl beams where applicable.

3.6.2 Manual Hoist and Trolley Travel

Where manual hoists systems are used the following shall be adhered to:

For long travel:

- The long travel drive system shall be a manual hand operated with pulley chain, geared to wheel tracks and which shall be permanently attached, with chain guide and theft proof locking device. The long travel system shall only be operated from one side, hence there shall be a common drive shaft spanning the cross beam to each of the drive wheels
- Hand chain shall be stainless unless otherwise specified
- Double reduction gearing shall be required
- The maintenance-free sealed bearings increase reliability and reduce required pull force to lift loads

For trolley travel:

- The trolley shall be a manual hand geared trolley which shall be permanently attached, with chain guide and theft proof locking device
- Hand chain shall be stainless unless otherwise specified
- Double reduction gearing shall be required

- The maintenance-free sealed bearings increase reliability and reduce required pull force to lift loads
- Trolley track wheel shall be stainless steel or similar approved

Vertical hoist and loading chain:

- High Grade 100 nickel-plated with high-impact steel chain guide
- Hand chain shall be stainless unless otherwise specified
- The load chain shall be stainless steel unless otherwise specified
- The hoist mechanism shall be geared to reduce operator fatigue.
- There shall be an overload limiter.

3.6.3 Drums and Pulleys

Where drums are applicable, particular attention shall be paid to the design and positioning of the rope drum(s) to ensure a centre lift over the lifting points of hydro-mechanical equipment when raising and lowering. The ropes and sheave block shall not foul the wall at the extreme point of lowering.

The rope grooves in drums and pulleys shall be machined as follows:

The diameter of the drum measured at the bottom of the groove shall not be less than that given in the table below which is based upon the rope speed not exceeding 60 m per minute.

Table 3.1: Drum Diameters

Rope Construction	4 x 37	6 x 19	6 x 24	6 x 37	6 x 61
Drum Diameter	27D	24D	22D	19D	17D

*D = Diameter of rope

The contour at the bottom of the grooves shall be circular over an angle of approximately 120°. The radius of the groove shall be larger than the radius of the rope and not less than that required by BS 302 or equivalent standard. The depth of the groove shall not be less than:

- Drums: 0. 33 x diameter of rope
- Pulleys: 1. 05 x diameter of rope

and the edges shall have a radius.

The grooves shall be finished smoothly and be free from surface defects liable to damage the rope. The grooves on the drum shall be so pitched that there is a clearance of not less than 1.6 mm between the neighbouring turns of rope for 13 mm diameter rope, 2.5 mm for 13 mm to 28 mm and 3.2 mm for rope diameters above 28 mm.

The drums shall be of sufficient length to take the full amount of rope without overlapping when the load is at its highest position. When the load is in its lowest position, there shall be at least two full turns of rope remaining on each drum.

The method of attachment of the ropes shall be such that in the event of a rope unwinding completely there shall be no danger of it becoming freed from the drum. The rope anchorage shall be readily accessible.

Pulleys shall be provided with guards to retain the rope in the grooves.

The inclination between the rope and the plane perpendicular to the axis of the drum or pulley shall not exceed 1 in 12.

Rope drums shall be adjustable for rope stretch if balancing pulleys are not used.

3.7 Sheave Block, Hook and Rope

3.7.1 Sheave Block

Where applicable, the sheave block shall run parallel to the sealing face and shall be designed to suit the clearance shown on Drawings.

An advanced sheave block pulley system with multiple pulleys shall be used only if absolutely necessary and shall be at the approval of the Employer's Agent.

3.7.2 Hook

The hook shall be of the swivelling type and shall be fitted with a safety catch. The crane hook shall fit freely onto all lifting point/ lugs which include and but are not limited to of all grappling and lifting beams / cradles, hoist connections, lifting lugs, to hoist equipment. etc. The hooks shall have a positive locking device to prevent disengaging during operations in slack rope conditions.

3.7.3 Wire Rope

Ropes that will operate in water from time to time shall be IWRC galvanised and shall have a steel core.

Ropes with a fibre core shall not be acceptable.

The ropes shall be capable of supporting the maximum loads during lifting and lowering operations. The minimum breaking strengths of the ropes shall not be less than 6 times the respective maximum load. The ropes shall be impregnated with grease to resist corrosion and wear.

Where more than one fall of rope is used for the support of the load, the tension in the various parts shall be equalised by means of a pulley or equalising bar.

Eye splices, sockets, thimbles and rope anchorages shall be capable of withstanding 90 % of the guaranteed breaking strength of the ropes to which they are attached. The hoisting ropes and any slings shall be provided with a test piece to be cut for testing to destruction.

For hoist heights less than 5m a chain system shall be used, unless otherwise stated. For hoists heights including 5m and greater a wire rope system shall be used unless otherwise stated.

It is important to note that the *Contractor* shall be responsible to lower the sheave block to its bottom extreme during installation to remove all the spin in the wire rope prior to final fixing of the rope to the crane body or drum(s). All additional costs incurred by the *Contractor* to rectify spinning of the ropes and resultant damage during or after installation shall be for his account.

The wire rope shall under no circumstances interfere with the side walls while lowering equipment into the recesses.

3.8 Crane Speeds

The speeds of the various motions of the crane shall be as follows:

• Long travel:	3 to 5 m/min. (3 m/min preferred)
• Cross travel:	1 to 2 m/min. (1 m/min preferred)
• Hoisting and lowering:	3 m/min with a creep speed of 1 to 2 m/min
• Manual hoist:	10 m/min
• Trolley travel on single girder crawl beams:	3 to 5 m/min. (3 m/min preferred)

3.9 Gearing

The gears shall be designed so that all stresses are within the permissible limits when the hoists are handling the maximum load. The spur gears shall be of high grade steel with machine cut surfaces. All gears shall be quiet in operation when rotating in either direction. The gears shall have a factor of safety of not less than 6 under operating conditions. For determining this factor of safety, the formula given in BS 436 or equivalent standard shall be adopted. If the gears are based on BS 436 they shall be calculated for not less than 4 hours per day working.

Where worm gearing is used as a first motion drive, it shall be at least equal to BS 721 or equivalent standard and have the same lead and start time rating as the motor and the temperature rise of the oil bath shall not exceed 37° C above the ambient temperature. Worm wheels shall be of bronze with steel worms.

All gear wheels shall, where practicable, be a forced fit on the shaft and shall in addition be adequately secured to prevent any relative motion between the wheel and the shaft. Where gears and couplings are secured in position by means of keys, they shall be easily accessible for tightening or withdrawal. All keyways shall be machine cut and shall be at least equal to BS 46 or equivalent standard. Couplings and collars shall be of the shrouded or protected type, free from projections of any kind. All shafts shall be of adequate diameter and of suitable material for the purpose and shall be turned where necessary. Where shoulders occur, they shall be provided with adequate fillets.

3.10 Lubrication and Maintenance

Adequate provision shall be made for grease gun and oil lubrication and all lubricating points shall be easily accessible. Grease nipples shall be of the stainless steel button head type ($^1/_8$" BSP) and shall, together with oil filler caps or plugs, be painted red for easy identification.

Maintenance procedures shall be in full compliance with the Occupational Health and Safety Act. A grease gun, as well as all special tools needed for maintenance, shall be supplied with the crane. All tools supplied shall be stored in a lockable, weatherproof stainless steel toolbox attached to the crane structure.

Should more than one crane exist in the same area or in a project that require similar tools, it is the Clients preference as to how and where the tools should be stored, kept and the number of tools.

Effective means shall be provided for lubricating all moving parts by either oil or grease.

Lubrication of all lifting ropes shall be in accordance with GIBB 002 – General mechanical specification.

3.11 Bolts and Nuts

All exposed fasteners, including those used for the fixing of proprietary items to the crane body and concrete works, shall be of stainless steel 304 or better. Where strength requirements prohibit this, bolts shall be hot dip galvanised.

3.12 Supports, Connections, Holding Down Bolts Etc.

The Contractor will be responsible for the design, specification, supply and installation of all supports (where applicable), connections, holding bolts, etc) required for the safe support and operation of the crane. (when mounted directly to concrete roofs or supported by Corbel attached to concrete columns the design of the roof or corbel and columns will be done by the employers agent once the loadings have been provided by the contractor)

4 Electrical Details and Requirements

4.1 General

The electrical systems of all cranes and hoists shall be in accordance with the general electrical specification

The electrical equipment shall comprise the operating motors with their controllers and resistances, brake-magnets, limit switches, lighting, main switches, fuses, and the collectors required for supplying power to the crane.

Control systems shall be designed to achieve the operational requirements stated. In particular the controllers shall allow smooth operation without jerk or snatch on all motions from standstill, each controller being provided with an adequate number of steps in either direction to achieve smooth acceleration or retardation.

All components of the control system shall operate with adequate safety margins to ensure reliable operation under all conditions of service with the minimum of maintenance.

The *Contractor* shall provide all required motor starters, MCCs, starter boxes, electrical connection boxes, isolators, cable connections between MCCs and motors and all other cabling required to connect to the local switchboard.

4.2 Power Supply

The power supply available is 400/230 volt, 3 phase, 4 wire, 50 Hz.

The main isolator box with isolator shall be measured separately with cabling from this isolator box to form part of the crane supply. The cost of which is to be included in the tendered rate for the supply of the crane.

4.3 Power Transfer to Equipment

Electrical supplies to travelling cranes working in an outdoor environment shall be obtained through longitudinal conductors and moving pick-up arms having physical and electrical properties complying with BS 23 and completely enclosed throughout their length. Collector shoes and assemblies shall be spring-loaded.

The length of the power transfer mechanism shall enable the crane to travel the full length of the area served by the particular crane. Power conductors shall be festoon cables of the flexible circular or flat form type.

The minimum requirements for the power transfer system, regardless of the type and crane location, shall be:

- Minimum of five conductors with separate neutral and earth conductors
- Weather resistant and suitable for outdoor service in a humid and alternatively open sunshine atmosphere
- Trailing cables shall be provided with an automatic cable spooling reel with tensioning device and with a strain restrictor at each end of the cable
- Conductor rails shall provide adequate personnel safety features and shall be protected against falling objects. Protection covers shall be easily removable for maintenance purposes

A triple pole, isolator switch incorporating "On", "Off" and "Earth" positions, shall be supplied for isolating the main power supply to the crane and for earthing the longitudinal conductors.

All isolators for power transfer systems shall be heavy duty and suitable for outdoor service.

The Contractor shall provide details in his tender submission regarding the method of power transfer to the crane.

4.4 Electrical Distribution Box

A lockable stainless steel electrical distribution box, protected in accordance with IP 65 of SANS 1222, shall be supplied and installed on or near the crane by the *Contractor*. It shall contain an isolator having provision for padlocking in the "OFF" position. It shall also have provision for the hanging of a "MAN WORKING" notice, which shall be included with the supply of the crane.

Three red indicating lamps, marked L1; L2 and L3 (one per phase and which shall illuminate when the supply is on), shall be provided on the distribution box. These indicating lamps shall be of the 230 V LED multi-cluster type and shall be clearly visible in normal daylight.

A danger sign shall be provided and fixed onto the distribution box.

4.5 Electric Motors

All motors shall be of the totally enclosed fan cooled squirrel cage type. Their characteristics and construction shall be suitable for outdoor crane service.

The motor for lifting operation shall be capable of continuous operation under full load as well as "inching" duty.

The motors of the crane shall have the correct phase rotation of the power supply after the Site wiring and connections have been completed.

Separate motors shall be provided for the hoisting, long and cross travelling motions, each motor being independent of the others.

4.6 Isolation Control Panel

Crane control gear shall be enclosed in a lockable 304 stainless steel or 3Cr12 cabinet, unless specified in GIBB 007 – Painting and Corrosion Protection Specification, mounted in an approved position on the crane in such a manner as will facilitate easy maintenance and inspection.

Control and operating circuit voltages shall not exceed 110V and the control panel shall include auxiliary transformers, main and auxiliary circuit fuses, contactors and all other equipment required for the complete control system.

Contactor control gear shall include for each drive a triple pole electrically and mechanically inter-locked stator reversing contactor fitted with self-resetting adjustable inverse time characteristic over-current relays.

The electrical load on the three phases shall at all times be balanced.

4.7 Pendant

The crane, gantry and crawl beam shall be operated by means of a weatherproof pendant control by an operator standing on operating levels as indicated on the Drawings. The pendant shall be capable of being positioned at any point over the length of the girder independent of the crab. The pendant unit shall be suspended from an independent wire rope. Alternatively, where appropriate, a remote radio control shall be provided. Fixed hoists shall be operated from a control console mounted in an approved position adjacent to the hoist and on each floor serviced by the hoist.

Precise control of all functions is required to facilitate the accurate positioning of heavy components.

The complete pendant with all switches, indicators, etc., shall be weatherproof to IP 65 of SANS 1222.

Long and cross travel motions of the crane shall be arranged so that these motions may be driven simultaneously or separately without causing shock to or vibration of the crane rails. It shall not be possible to travel or traverse while raising or lowering the main hoist.

The pendant shall be provided with a lockable on/off switch with appropriate indicator light.

Controls shall be interlocked to prevent dual activation of functions and each shall be clearly marked with its function. Labels that only rely on adhesive to stay in position shall not be acceptable. All motions shall be controlled by non-latching control buttons.

All motion control push buttons shall be of the two stage type. The initial depression of the button shall select the creep speed and full depression of the button shall select fast speed. Control features shall be included to prevent fast speed being selected without first having accelerated the equipment in the slow speed range.

Where applicable, the following minimum controls shall be provided:

- On/Off switch
- Main Hoist Up/Down - Slow/Fast push buttons
- Cross Travelling Left/Right - Slow/Fast push buttons
- Long Travel Left/Right - Slow/Fast push buttons
- Emergency Stop mushroom head push button
- Floodlights On/Off

The directional orientation of the pendant horizontal motion controls (i.e. upstream / downstream; left / right) in relation to the appropriate crane shall be indicated by colour coding on the front panel of the pendant and on each crane. The colour coding on each crane shall be clearly visible from anywhere within the reach of the pendant and shall clearly contrast with the colour of the element on which it is mounted. Colour coding on the crane structure shall be by means of bolted on metal plates according to the following colour code:

- Upstream: Arctic Blue
- Downstream: Brilliant Green
- Left (looking in direction of flow): Golden Brown
- Right (looking in direction of flow): Signal Red

4.8 Fixed Control Panel

The crane, gantry and crawl beam shall be operated by means of a weatherproof control panel by an operator standing insight of the lifting equipment. The control panel shall be in full view of the hoisted load at all times. Fixed hoists shall be operated from a control console mounted in an approved position adjacent to the hoist and on each floor serviced by the hoist.

Precise control of all functions is required to facilitate the accurate positioning of heavy components.

The complete control panel with all switches, indicators, etc., shall be weatherproof to IP 65 of SANS 1222.

Long and cross travel motions of the crane shall be arranged so that these motions may be driven simultaneously or separately without causing shock to or vibration of the crane rails. It shall be possible to longitudinal and cross travel or traverse while raising or lowering the main hoist.

The control panel shall be provided with a lock and keys.

Controls shall be interlocked to prevent dual activation of functions and each shall be clearly marked with its function. Labels that only rely on adhesive to stay in position shall not be acceptable. All motions shall be controlled by non-latching control buttons.

All motion control push buttons shall be of the two stage type. The initial depression of the button shall select the creep speed and full depression of the button shall select fast speed. Control features shall be included to prevent fast speed being selected without first having accelerated the equipment in the slow speed range.

Where applicable, the following minimum controls shall be provided:

- On/Off switch
- Main Hoist Up/Down - Slow/Fast push buttons
- Cross Travelling Left/Right - Slow/Fast push buttons
- Long Travel Left/Right - Slow/Fast push buttons
- Emergency Stop mushroom head push button
- Floodlights On/Off, if specified

In all cases, the directional orientation of the control panel horizontal motion controls (i.e. upstream / downstream; left / right) in relation to the appropriate crane shall be indicated by colour coding on the front panel. Colour coding on the crane structure shall be by means of bolted on metal plates according to the following colour code:

- Upstream: Arctic Blue
- Downstream: Brilliant Green
- Left (looking in direction of flow): Golden Brown
- Right (looking in direction of flow): Signal Red

4.9 Cabling

The cabling system on the crane shall be neatly routed and enclosed in non-corrodible ducts or cable trays with covers, securely fixed to the crane frame. Brackets, fasteners and cable tie-down straps shall also be of non-corrosive materials. Plastic type cable ties are not acceptable. All cables entering electric motors shall be protected in accordance with IP 65 of SANS 1222, supported and sealed by means of a metal cable gland. The armouring shall be clamped between substantial tapered sections which form an integral part of the gland.

4.10 Wiring Code Numbers

Code numbers shall be clearly marked on all electrical cables, cable cores, wiring and terminal blocks inside switchgear panels and field devices, to enable maintenance staff to trace faults easily. The wiring diagrams to be supplied with the Operating Manual (GIBB 002 - General Mechanical Specification) shall have the same code numbers marked on them and shall be strictly in accordance with the actual wiring on the crane.

A laminated A3 sized print of the wiring diagram shall be fixed inside the electrical distribution cabinet panel for easy reference.

4.11 Safety Devices

Safety clamps and positive locking devices, automatically operated and interlocked with the long travel motion, shall be provided on either side to secure the crane on the rails at any point. These devices shall also lock automatically when the power supply is switched off.

Each motor(s) of each motion shall be provided with an electro-magnetic brake. The brakes shall be arranged to operate after a time delay to ensure that the load is held by the drive motor before the brakes are released. There shall be no slipping of loads when the drive motor is stopped or the electricity supply fails.

All lifting motions shall be equipped with slack rope and overload devices to cut out the hoist, preventing further rotation of the drums should the load jam for any reason while lowering or raising. These over-travel limit switches shall be of the double protection type with automatically self-resetting action. Creep speed only shall be available after operation of the over-travelling limit switches for long and cross travel motions, which will allow the crane to approach the end stops.

The isolator switch shall be a quick break change over type to isolate all crane conductors and it shall be possible to lock and switch in the isolated and earthed positions.

The crane structure and metal cases of all electrical equipment, including conduit and trunking shall be effectively earthed. The *Contractor* shall supply longitudinal conductors for the earthing equipment.

4.12 Weather Protection and Safety Guards

The crane shall be weatherproof regardless of whether it is intended for outdoor use or not.

The crane electrical distribution boxes and limit switches shall be weatherproof to IP 65 of SANS 1222 and all moving machinery, including electric motors, shall be guarded to the satisfaction of the *Employer's Agent*. Guards, however, shall be easily removable for access and maintenance purposes.

Since the cranes will work in a humid atmosphere, all external electrical fittings forming part of the electrical distribution panels shall be protected in accordance with IP 65 of SANS 1222. Push buttons shall be covered with rubber hoods. Isolators, switches and instruments mounted on the panel and limit switches shall have the necessary 0-rings or rubber bushes for protection against a moist atmosphere. A space heater shall also be provided in the panel.

4.13 Lightning Surge Protection

All electronic and other equipment prone to lightning surge damage shall be protected in accordance with the guidelines detailed SANS 10142-1 – Wiring Code standard as well as described on the electrical tender drawings

Earth connection for lightning protection against all structures and equipment shall comply with SANS 10313.

All power and signal circuits shall be designed to separately cope with 65 kA, 5 kV, 1/50 microsecond pulses (0.5 joule), repeated 20 times per burst of pulses in a short period of time (of the order of 20 seconds).

5 Materials and Corrosion Protection

All equipment supplied under this Specification shall conform to GIBB 007 – Painting and Corrosion Protection.

The crane hoist unit shall be completely weatherproof under all weather conditions applicable to the Site and the steelwork designed and detailed so as to obviate the possibility of rain water entrapment prejudicing the life of the corrosion protection system employed.

See Specification for mechanical works as set out in GIBB 002 - General Mechanical Specification.

The highlighted (Orange) rows shall be the preferred material and coating used for the Works.

6 Tests

The cranes shall be completely assembled for functional tests and inspection at the Manufacturer's *Works*.

Full mechanical (including welding preparation and welding) and corrosion protection inspection of the items shall be carried out at the Manufacturer's works in the presence of an Inspector appointed by the *Employer's Agent*. Workmanship and dimensional correctness shall be checked prior to corrosion protection procedures.

Each crane shall be tested at the *Contractor*'s works at the specified working load plus a 25% overload.

Preference is given to the load test being carried out in the *Contractor*'s works by his staff and with the load he provides. If the *Contractor*, however, wishes to perform the load test at Site, then he shall be responsible for providing the test load (Working load + 25% overload) and arrange such tests to be witnessed by the *Employer's Agent*.

The Manufacturer shall provide, for each crane, a certificate of examination and test that shall be signed by the *Employer's Agent* or his representative who witnessed the test.

The electrical installation of the completely assembled and installed crane shall be tested at Site for compliance to SANS 10142.

The Contractor shall further carry out a load test as laid down in SANS 4310:2002 and as required by Regulation C46(2)(h) of the Machinery and Occupational Safety Act No. 6 of 1983 to the satisfaction of the Employers agent once the equipment has been installed. The costs of all tests and re-tests shall be borne by the Contractor.

The above requirements form part of this Contract and shall be provided as part of the rates by the *Contractor*.

7 Handling and Transport

Refer to General Mechanical Specification.

8 Installation and commissioning

The *Contractor* shall be responsible for the erection of all equipment supplied under this Section as well as for installation and adjustments to ensure proper functioning of the complete unit.

The *Contractor* shall allow a full day after erection is completed for pre-testing of each unit in the presence of the *Employer's Agent* or his representative. At least two weeks advance notice of this date is required to enable the *Employer's Agent* to finalise arrangements for attendance.

After comprehensive functional tests and general inspection of cranes and lifting devices, all outstanding defects, if any, shall be attended to by the *Contractor* within three weeks.

The *Contractor* shall advise the *Employer's Agent* as soon as all the outstanding defects are remedied to set a date for final Tests on Completion of the crane and to notify all the representatives (including the *Contractor*) to be on Site.

GENERAL SPECIFICATIONS ELECTRICAL (GSE)

NOTE: See Returnable Schedules B12 in Volume 1 of the Bid Document

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GSE03 – GENERAL SPECIFICATION ELECTRICAL

EARTHING

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1. EARTHING

1.1. GENERAL RECOMMENDATIONS ON THE PRACTICAL INSTALLATION OF EARTH ELECTRODES

1.1.1. REQUIREMENTS OF AN EFFECTIVE EARTH

An effective earth must prevent dangerous overvoltages arising between metallic structures, frames, supports or enclosures of electrical equipment and the ground during fault conditions.

An effective earth must be able to permit fault currents of sufficient magnitude to flow so as to operate protective devices to isolate the fault before damage can occur.

The ohmic resistance of an effective earth must be low enough to ensure that the step potential on the ground in the vicinity of the earthing point is within safe limits under fault conditions i e a voltage gradient not exceeding 40 V/m fault durations exceeding 1s.

1.1.2. TYPES OF EARTH ELECTRODES

Three types of earth electrodes are suitable:

a) Trench earths:
Trench earths comprise a bare copper or galvanised iron conductor laid at a minimum of 500 mm below ground level, usually when underground cables are installed. This type of earth electrode provides a relatively large contact area between electrode and surrounding ground, make contact with a variety of types of soil and soils of varying moisture content enroute and is economical to install.

b) Spike earths:
Spike earths comprise rods of bare copper, copper-coated steel, stainless steel or galvanised steel designed for the purpose of penetrating ground to depths of up to several metres. A low resistance earth may sometimes be obtained by driving multiple spikes at some distance from each other in order to provide parallel paths.

In hard or rocky ground, it is usually necessary to drill holes into which earth spikes are inserted and then packed with soft soil.

c) Foundation earths:
Foundation earths comprise bare copper or galvanised iron conductors laid under the foundations of buildings, miniature substations, distribution pillars, bases of wooden, concrete or steel poles and structures. Because soil under foundations usually retains moisture, foundation earths are located to take advantage of this favourable condition. Furthermore, they are economical to install.

d) Materials for earth electrodes
Bare copper, either in stranded, strip or rod form, is considered the most suitable general purpose material for earth electrodes. Its main disadvantage is its cost and susceptibility to theft.

Bare galvanised iron and steel, either in stranded, strip or rod form, has a satisfactory record of survival in non-aggressive soils and is more economical than copper.

Bare aluminium is unsuitable as electrode material.

e) Corrosion

Because galvanised ferrous metals corrode sacrificially to copper, galvanised iron and steel electrodes should not be buried in close proximity to bare copper.

1.2. TECHNICAL REQUIREMENTS OF NEUTRAL EARTHING

The following relevant aspects have been extracted from the "AMEU CODE OF PRACTICE FOR THE APPLICATION OF NEUTRAL EARTHING ON LOW VOLTAGE DISTRIBUTION SYSTEMS"

1.2.1. DISTRIBUTION SYSTEMS

Multiple Earthed Neutral (MEN) and Protective Multiple Earthing (PME) systems.

a) Distribution equipment associated with transformer substations that are either ground mounted or pole mounted and fed by underground cable or overhead line, with or without an earth continuity conductor, (ECC), should be installed, connected and earthed in accordance with the following requirements:

b) Where the resistance to earth of the HV equipment earth is 1 ohm or less, it is permissible to earth the LV neutral to the HV earth electrode.

c) Where the HV equipment earth exceeds 1 ohm the LV neutral shall be earthed at a minimum distance of 6 m from the HV equipment earth (i e 6 m from the HV electrodes and also from any earthed metalwork connected thereto).

d) Notwithstanding the requirements of (a) above, where transformers are associated with HV overhead lines, it is considered good practice to separate the HV and LV earth electrodes. The minimum earth separation should be 6 m or 1 LV span.

e) The overall resistance to earth of the neutral of an LV distributor or distribution system must not exceed 10 ohms.

f) The LV neutral may be connected to other supply neutrals, earth electrodes, cable sheaths and armouring and these connections used to obtain the required earthing value of 10 ohms or less specified in par (d) above.

g) The neutral of underground and overhead LV distributors must be earthed at the remote ends of each distributor.

h) Where the overall resistance to earth of the neutral of the distribution system exceeds 10 ohms, the neutral shall be earthed at intermediate positions on the distributor/s to reduce its resistance to earth to below this limit.

i) The cross-sectional area of the neutral of all LV distributors must not be less than that of a phase conductor.

j) No circuit breakers, isolators, fuses, switches or removable links shall be installed in the neutral between the transformer star point and the remote end of any LV distributor or service connection.

k) All metallic sheathing and armouring of cables and all metalwork associated with meter cabinets, fuse pillars, etc, supporting or enclosing LV cables shall be bonded to the distributor neutral conductor.

l) Where a Separate Neutral Earth (SNE) cable is part of a MEN or PME system, the armouring and/or metallic sheath and any ECC shall be bonded to the neutral at the supply end of the cable.

m) To ensure the integrity of the neutral, it is recommended that all connections and joints on or to overhead line conductors be made by compression fittings or, alternatively double bolted connectors.

n) MEN or PME may be applied to any single LV distributor without alterations to other LV distributors supplied from the same transformer.

1.2.2. PROTECTIVE NEUTRAL BONDING (PNB) SYSTEM

Since the neutral is earthed at one point only, the question of multiple earthing does not arise and there is therefore no necessity to meet the MEN/PME technical requirements.

1.2.3. SERVICE CONNECTIONS

a) MEN system:

The following conditions apply to consumer's service connections as well as service connections to traffic signals, road signs, street lighting and other power-power-consuming equipment installed in public places:

- All service connections must be by means of cable with an insulated phase, an insulated neutral conductor and an ECC.
- A single phase service connection comprises a live, a neutral and an ECC.
- A polyphase service connection comprises of two or more lives, a neutral and an ECC.
- The service neutral and ECC must be solidly and separately connected to the distributor neutral at the tee-off point.
- The consumer's earthing lead is connected to the Supply Authority's earth terminal which is in turn connected to the ECC in the service cable at the consumer's supply point.
- The neutral must not be connected to earth at the consumer's supply point.
- If required by the Supply Authority, an earth electrode must be installed at the consumer's supply point.

- In a service connection to traffic signals, street lights and other power-consuming equipment installed in public places, such equipment is earthed to the ECC of the service connection.

b) PME system:

- All service connections must be by means of a cable with an insulated phase and an insulated neutral conductor.
- A single phase service comprises a live conductor and a neutral.
- A polyphase service connection comprises two or three phase conductors and a neutral.
- The consumer's earthing lead is connected to the supplier's neutral and to a mandatory earth electrode at the consumer's supply point.
- A label must be attached at the consumer's supply joint on his premises indicating that the installation is part of a PME system.

NOTE - It is not recommended that the PME system be applied to supply traffic signals, street lights or other power-consuming equipment installed in public places, because the PME system is inherently unsafe under "broken-neutral" conditions.

1.3. SUBSTATION EARTHING

In order to comply with the requirements of 1.1.1 and 1.1.2 above, an earth resistivity measurement shall be undertaken at the site of a new substation or miniature substation, preferably by a specialist firm. The Contractor shall then submit to the Engineer details of a proposed substation earth indicating whether a trench earth, spike earth or foundation earth is intended and the proposed interconnections with the installation.

1.4. FENCES OF OUTDOOR SUBSTATIONS

In cases where substations contain transformers or switchgear installed outdoors, the compulsory fence shall be earthed as follows:

a) A 70 mm^2 earth wire shall be installed 400 mm below ground level and 500 mm from the fence on the outside of the substation along the entire length of the fence. This earth wire shall be earthed at each corner by means of a 1,8 m earth rod and the rod and earth wire bonded to the fence. The earth wire shall also be bonded, at least at two points, to the main earthing system.

b) A 70 mm^2 earth wire shall also be buried at a depth of 400 mm around each transformer and switch and bonded to the main earthing system.

1.5. EARTHING CONNECTIONS AND EARTHING AT DISTRIBUTION CENTRES

1.5.1. GENERAL REQUIREMENTS

a) The preferred practice of earthing involves the separation of the MV and LV earths at all transformer installations providing a supply to a customer at voltages up to and including the intermediate voltage range (1 100 V to 3 300 V). Where the combined resistance to true earth of the MV and LV earth electrodes is less than 1 ohm, bonding thereof is permitted.

b) The preferred practice of earthing LV distribution systems involves a multiple earthed neutral (MEN) system where the supply distributor is CNE and the arrangement of the service connection is SNE.

c) The earthing systems employed in this standard are as follows:

- Three array earth electrode (main earth electrode) consisting of varying radial lengths from 6 m to 10 m vertical rod depths from 1,5 m to 6,0 m (multiples of 1,5 m rods).
  Two separate electrodes at all transformer installations (MV and LV)
  Single electrode at all surge arrester and compensating equipment installations (MV)

- Single 1,5 m earth spike (Intermediate earthing installation)
  Switchgear installations (including an equi potential grid)
  Metering installations
  Earthing of LV neutral along a 400 V distributor

- No electrode is to be installed at the customer's premises.
  At no time are electrodes other than that described above to be installed.
  The optimum depth of the horizontal array installation is 1,0 m below normal ground level.

- A detailed installation record, including the earthing arrangement, is to be kept for all main electrodes installed.

d) The use of chemicals to improve long term electrode resistance to true earth, is to be applied by exception to avoid an unnecessary burden being placed on maintenance staff for retreatment applications.

e) Counterpoise conductor and earthing leads (bare/insulated) shall have a short time rating which matches the expected earth fault current levels of the distribution system under consideration. A minimum cross sectional area of 25 mm^2 is to be used.

f) The equi potential grid is to be provided, and be connected to the earth electrode, at all equipment installations where operational activities are likely to take place. It should be installed just below the normal ground level at each operating point.

g) The earthing lead is to be continuous.

h) For concrete poles the reinforcing cage can be utilised as an earthing lead where suitable earthing ferrules are provided.

i) Where earthing of wood poles is required to attain a 300 kV BIL, the earthing lead may be galvanized steel wire and not copper. Where equipment earths are required, copper conductor must be used.

j) Each item of equipment and its supporting structure must be separately and visibility earthed. Earthing bolts, clamps, etc. should be used to secure earthing connections and shall not serve any other mechanical purpose.

k) All earthing connections must be so arranged that the temporary removal of any one individual earth will not affect the integrity of any other earth connections.

l) All normally accessible earthing terminations to equipment should be made with compression lugs or bolted clamps.

m) The number of connection in an earth conductor should be kept to a minimum.

1.5.2. CABLES

a) The armouring and lead sheeting shall be mechanically and electrically bonded to earth. Bonding is to be performed by means of an approved grip type or sweated gland with stranded copper earthing conductor of not less than 25 mm^2 unless local earth fault current levels justifies an increase in cross section.

b) Continuity of the lead sheath and the armouring must be maintained at all cable joints.

1.5.3. STAYS

All stays must be fitted with a stay insulator except in the case of a MEN distributor in which case the stay must be bonded to the neutral and the stay insulator omitted.

1.5.4. EQUIPMENT INSTALLATIONS

All accessible conductive portions of electrical plant or apparatus which do not form part of an electrical circuit and which may accidentally become alive, shall be earthed.

a) Transformer installations:

Distribution equipment associated with transformer substations that are either ground mounted or pole mounted and fed by underground cable or overhead line, (with or without an ECC), should be installed, connected and earthed in accordance with the following requirements:

- The star point of the transformer LV winding shall be earthed.
- The substation MV and LV earths may be combined where their overall resistance to earth does not exceed one (1) ohm.
- Where the combined resistance exceeds one (1) ohm, the MV (metalwork and surge arresters) earth and the LV neutral earth must be kept separate.
- Where segregation of the neutral earth is required, it can conveniently be achieved by installing a neutral earth electrode at the first LV pole a span length away from the substation. If, however, this is not practical or where LV underground cable(s) is used, the neutral should be connected by an insulated wire laid underground to a suitable earth electrode which should be separated by 5 metres so as to be outside the resistance area of the MV metalwork earth. Care shall be taken to ensure that there is no metallic or other low impedance conducting path between the MV and LV earths.

b) Pole mounted switchgear, metering and compensating installations:

- The earthing system shall consist of either a single earth spike or multiple spike (three point star) electrode (refer to 1.5.1.a) with all connections being made and bonded to the main earthing lead above ground level. The main earthing lead shall be the only connection to the earth electrode.
- In order to limit voltage gradients on the surface to safe values, an equi potential grid is to be installed at all equipment manual operating positions.
- The grid shall be located such that an operator is not exposed to dangerous voltage gradients while performing switching duties. It is to be installed near surface at the operating location and be connected to the main earth electrode as well as to the operating handle under consideration. These connection leads shall match the short time rating of the main earthing lead.

c) Lightning arresters - Earth:

- The surge arresters shall be connected to earth and to the equipment being protected by the shortest possible and most practical direct route.
- For the best performance of the surge arrester the resistance of its earth electrode should be as low as possible.
- Where arresters are provided with devices for disconnecting the arresters in the event of failure, the earth connection must be flexible enough to allow the disconnecting device to blow clear of the arrester.

1.5.5. OVERHEAD LINES

a) Medium voltage lines:
Steelwork employed on medium voltage rural overhead line structures is generally not earthed except where equipment (e g transformers, pole mounted auto reclosers, etc) is installed.

b) Low voltage distributors:
The neutral of a low voltage distributor shall be earthed according to the following:-

- At the transformer star point, and
- At all remote ends and at tee off points, and
- At intervals not exceeding 150 metres if no other earth point occurs in the run of a particular line, and
- At any other convenient points along the distributor.

So as to ensure that the overall resistance to true earth of the neutral,

- does not anywhere exceeds 10 ohm, and
- shall be such that in the event of a breakdown between the MV and LV windings of the transformer, or any other MV fault to earth at the substation, it will cause the circuit breaker protecting the MV input to the transformer to operate.

1.5.6. IMPEDANCE OF THE EARTH ELECTRODE CONNECTION

The impedance to earth of any single earth electrode used within a reticulation system should be as low as possible, preferably below 10 ohm. Due to practical constraints however, the requirements as stated below shall apply.

a) MV earth connections:

The earth connections of the MV earthing systems shall be so located, installed and maintained as to have an impedance to earth, at all times, of not more than 30 ohms.

Provided that where earthing conditions are difficult this impedance may be increased to 60 ohms if the following are met:

- all auxiliary equipment installed at a height lower than 2,4 m from ground level is to be installed in an enclosure free from any conductive material that may become alive due to contact with any component within the enclosure.
- the protection shall operate within two seconds under full earth fault conditions.
- the MV fuses have clearing times, including arcing times, not greater than 200 milliseconds at 60 amperes.

Only approved types of electrodes may be installed.

b) LV earth connections:

The LV substation earthing system shall be so maintained that the impedance of the neutral terminal to earth shall not, at any time, exceed 30 ohm for transformers rated up to and including - 500 kVA.

The combined impedance to earth of the neutral of a LV distributor (urban installation) is to be less than 10 ohm.

All exceptions where maximum effort does not attain the required resistance values, are to be recorded and be available for investigation on request.

GSE04 – GENERAL SPECIFICATION ELECTRICAL

MSS & LV KIOSKS

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1. MINIATURE SUBSTATION

1.1. GENERAL

This specification covers the manufacture and supply of miniature substations suitable for use on 11 kV (three-phase) and 420/242 Volt (three-phase and neutral), 50 Hz systems.

The substation shall comply with the requirements of SABS 1029 and SABS 1030 unless otherwise specified.

1.2. CONSTRUCTIONAL REQUIREMENTS

1.2.1. FIBREGLASS HOUSINGS

Where specified and for all substations to be installed within 50 km of the coast and in all corrosive industrial atmospheres, the roof, walls, and doors shall be manufactured of fibreglass in accordance with the following minimum requirements:

a) The laminate shall be constructed to SABS 141.
b) The fibreglass shall comply with the minimum strength requirements of Clause 3.4 of SABS 1029.
c) An outer isopthalic resin gelcoat with a minimum thickness of 0,4 mm and ultraviolet absorption properties to prevent degradation of the surface from exposure to the sun shall be provided.
d) The gelcoat shall be backed by multiple layers of chopped strand mat glass rendering not less than 1,2 kg/m^2. The strength shall be increased to 1,35 kg/m^2 on all panels larger than 500 x 500 mm.
e) The fibreglass shall be thoroughly impregnated with polyester resin. The resin should preferably be clear.
f) The resin to fibreglass ratio shall not be less than 2,5:1 and not more than 3,0:1.
g) Air entrapped between the glass mat layers shall be thoroughly worked out. The laminate must be free of air bubbles and voids.
h) All edges shall be reinforced with an additional 700 g/m^2 of fibreglass.
i) All large surfaces, wider than 300 mm, shall be reinforced or panelled to improve stiffness and rigidity.
j) A resin coat shall be applied to the inside of the panels to dover the fibre pattern.
k) Brass or steel backing plates shall be laminated into the fibreglass at hinge points, locking mechanism at support areas, door restraint fixing points and all other points which will be subjected to mechanical stress.
l) Doors shall be adequately braced, reinforced, ribbed or double laminated with an air gap between the two layers of laminate to ensure rigidity.

1.2.2. FINISH AND COLOUR OF FIBREGLASS MINIATURE SUBSTATIONS

The outside surface of the fibreglass shall have a glossy, smooth finish to ensure good weathering. To obtain this the manufacturer shall ensure that the moulds are smooth, free of voids, hairline cracks, pores or other defects.

Compound rubbing or sanding of the outside surface will not be permitted.

Pigments shall be added to the outer gelcoat to obtain a matching colour to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091.

Fibreglass panels shall not be painted.

1.2.3. SHEET STEEL HOUSINGS

Where specified, the roof, walls and doors shall be manufactured of steel.

The sheet steel construction shall comply with the minimum strength requirements of clause 3.4 of SABS 1029.

All welds shall be ground smooth in order to provide a smooth finish.

All panels, the roof and doors shall be suitably braced and stiffened to ensure rigidity and to prevent warping.

The colour of the outer coat of paint on the outer surfaces of the substation shall be an acceptable match to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091. A tin of matching touch-up paint (not smaller than 500 ml) shall be provided with each mini-substation.

1.2.4. CONCRETE PLINTH

The mini-substation shall be mounted on a concrete plinth. Plinths shall be cast on site or there shall be made use of a precast plinth.

The Contractor shall issue to the Engineer a detailed plinth drawing suitable for each type of mini-substation supplied. The top of the plinth shall protrude at least 200 mm above the final surrounding ground level. The concrete plinth shall protrude approximately 100 mm beyond the edges of the mini-substation to form an apron.

The concrete apron and plinth shall be wood float finished and shall slope from the base to permit rain water run off. A 3 mm thick gasket of approved Malthoid shall be inserted between the mini-substation and the concrete surface. The gasket shall be as wide as the base.

Cable ducts shall be provided in the plinth to accommodate all the incoming and outgoing cables. The cable ducts shall be sealed to prevent entry of rodents. The sealing shall be easily removable in the event of future cable work and may consist of a layer of 10:1 sand and cement mix, approximately 10 mm thick, and finished flush with the top of the concrete plinth.

1.2.5. BASE

Steel bases shall be supplied for the mini-substations. Bases shall be hot-dip galvanised and painted with black enamel.

1.2.6. DOORS

Long pedestal type hinges with at least two fixing bolts per hinge or similar hinges shall be used to hang the doors. The pedestal hinges shall be arranged in opposed fashion so that doors cannot be lifted off. Piano hinges are not acceptable. The hinges shall be of stainless steel or other corrosion resistant materials. Nylon or aluminium hinges are not acceptable.

At least three hinges shall be provided on doors higher than 1,2 m.

Door restraints shall be provided. Cloth or canvas straps are not acceptable.

Doors shall be fitted with stainless steel lever locks equal or similar to the "BARKER & NELSON" type with a 180° movement. The locking mechanism shall have a catch on the rear which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed by galvanised steel plates. The locking mechanism shall be padlockable.

Cadmium plates mild steel bolts and nuts shall be used to fix the hinges.

1.3. HIGH VOLTAGE COMPARTMENT

The high voltage compartment shall be equipped with a non-extensible bulk oil filled ring main unit with a fused tee-off unless otherwise specified. This unit shall be manufactured and supplied in accordance with the Engineer's standard specification for "11 kV NON-AUTOMATIC OIL SWITCHES, FUSED OIL SWITCHES AND RING MAIN UNITS".

All ring main units or other HV switchgear installed in miniature substations must be fitted with integral testing facilities. Testing by means of a separate test harness is not acceptable.

The minimum clearances between connecting cables and jumpers and any sharp metal edges or protrusions shall be at least 75 mm.

"DELARON" or "THIOLITE" resin bound synthetic wood or other suitable dielectric material shall be used to maintain the phase-to-phase and phase-to-phase spacing of the cables and jumpers. The surfaces of these spacers shall be treated to prevent surface tracking.

Stranded annealed copper conductors only shall be used for jumper cables.

All terminals shall be shrouded with "RAYCHEM", "OZOCORITE" or similar heat-shrinkable shrouds. Taping is not acceptable.

The high tension connections between the fused switch unit and the transformer shall be suitably blanked off so that they cannot be touched.

1.4. TRANSFORMER COMPARTMENT

The transformer compartment shall be equipped with a transformer as specified and in accordance with the Engineer's standard specification for "DISTRIBUTION TRANSFORMERS" and the requirements of SABS 1029.

An off-circuit tap switch shall be provided.

The transformer shall be sealed and shall not contain a silica-gel breather.

1.5. LOW VOLTAGE COMPARTMENT

1.5.1. EQUIPMENT

The equipment as specified in Part V shall be installed in the low voltage compartment.

The equipment shall comply with the Engineer's standard quality specifications.

The low voltage compartment shall be of ample size to accommodate the specified equipment and provide space for future requirements as specified.

1.5.2. EQUIPMENT SUPPORT FRAME

A rigid angle iron or folded metal support framework shall be provided.

The frame shall be bolted down on the base by at least four M16 high tensile steel bolts.

A cable gland plate shall be provided at the bottom of the frame across the full width of the compartment. The gland plate shall be at least 100 mm above the plinth height. A minimum distance as required by the bending radius of the cores of the outgoing cables shall be provided between the lowest terminals of major equipment and the gland plate.

The gland plate shall be suitably punched to accept the number and size of cables specified.

A "DELARON" or "THIOLITE" resin bound synthetic wood or other suitable dielectric material panel shall be provided for the mounting of all equipment and busbars. Impregnated hardboard or other treated or untreated wood products are not acceptable.

Alternatively, all equipment and busbars shall be flush mounted within a purpose-made sheet metal frame enclosed by a machine punched removable front panel through which the operating handles of the equipment protrude. Care shall be exercised that the rear studs of circuit breakers are properly insulated from the steel chassis. Miniature circuit breakers may be installed in clip-in-trays mounted on the frame.

1.5.3. BUSBARS

a) Application:

- Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SABS 1195 and BS 1433, where applicable.
- Although SABS 784 refers to overhead and rising busbars, busbars in miniature substations shall comply with applicable sections of this specification, especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.

- Busbars shall be supplied for the following applications:

  Distribution of supply voltage.
  Connection of equipment with ratings exceeding the current rating of 70 mm^2 conductors.
  Connection of outgoing circuits with current ratings in excess of that followed for 70 mm^2 conductors.
  Collector bars for parallel cables.
  Connection bars for neutral conductors (par 5.4.h)
  Earth busbars (par 5.4.i)
  Connections to miniature circuit breakers

b) Voltage rating:

- Busbars for system voltages up to 600 V shall be designed to withstand a test voltage of 2,5 kV for one minute.

c) Rating:

- The maximum allowable temperature of busbars (including joints) carrying full load current in an ambient temperature as specified shall not exceed 80 °C. Unless different ambient temperatures are specified, an ambient temperature of 35 °C shall be assumed with a maximum temperature increase of 45 °C.
- Table 2 may be used as a guide in determining busbar ratings where the distance between the phase busbars is at least the distance of the longer side of the cross section with a minimum spacing of 50 mm and at least 150 mm from the sheet metal enclosure. It is, however, essential that the manufacturer shall make due allowance for the "proximity and skin" effects, the effect of ferrous enclosures, ventilation, etc, for the arrangement used in his switchboard design. Manufacturers shall, where requested, prove that the busbar rating and enclosure design comply with the temperature rise specified above. The busbars can also be rated to DIN 64671 unpainted busbars.
- Neutral busbars in three phase, four wire supplies shall have a cross-section of at least 60 % of the cross-section of the phase busbars.
- Busbars may not be tapered. The rating of the bars shall be equal to the incoming current rating. In cases where the main switch is an isolator, the isolator rating may not be taken as the incoming current rating.
- In addition to the current rating, busbars shall comply with the following fault level rating:

  A = 8,2 x I x (t)1/2

  where

  A = minimum cross-section (mm^2)

  I = prospective fault current (kA)

  t = maximum time in seconds required for protection equipment to clear the fault

  (minimum allowable value for t = 0,2 seconds).

- Where a busbar consists of two or more busbars per phase (laminations), the laminations shall be separated by a minimum distance of the thickness of one lamination. The laminations shall be clamped together with copper spacers at intervals not exceeding 450 mm in order to equalise the current distribution in the laminations. The busbar ratings in Table 2 shall be multiplied by the factors shown in Table 1 to determine the total current rating per phase.

1.5.4. MOUNTING

a) All busbars shall be installed horizontally or vertically with the longer side of the section in the vertical plane. Main busbars shall be supported by "DELARON" or "THIOLITE" resin bound synthetic wood panels or other suitable dielectric material. The surface of these supports shall be treated to prevent surface tracking. The supports shall be bolted securely to the framework and busbars shall fit tightly in the supports. Alternatively, busbars may be supported on resin insulators. Porcelain insulators will not be allowed.

b) The rating and fixing of busbars shall be designed to withstand mechanical and temperature stresses during fault conditions. The busbars shall withstand a fault current under test conditions of the specified fault level. If a fault level is not specified, the busbars shall be tested at 20 times rated current for one second. The fault current shall be applied:

- between all phases,
- any two phases,
- neutral and adjacent phase, and
- earth conductor and the nearest phase conductor.

Table 1: Derating Factors for Laminated Busbars

AREA OF CROSS SECTION (mm^2)	NO OF PARALLEL BUSBARS PER PHASE		
	2	3	4
500	1,78	2,45	3,13
1000	1,72	2,36	3,00
1500	1,65	2,24	2,84
2000	1,60	2,16	2,70
2500	1,55	2,10	2,60
3000	1,52	2,02	2,52
3500	1,48	1,98	2,48
4000	1,44	1,96	2,45

Table 2: Current Rating of Single Copper Busbars (A)

WIDTH (mm)	THICKNESS (mm) 2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	

63 80 100			790 970 1160	990 1200 1430	1240 1480 1760	1370 1640 2180	
125 160 200 250 315 400				1710 2070	2100 2530	2310 2780 3290 3900 4630	2570 3090 3660 4300 5120 6230

c) The minimum clearance for system voltages up to 600 Volt is 10 mm in accordance with SABS 784 and BS 159 and shall be strictly maintained.

d) If no other methods are specified, the stresses under fault conditions shall be calculated as follows, taking into account correction factors for different configurations:

Mechanical Stresses

F = 16 x 12 x k/d x 10 000 N/m

where F = force (N/m)
I = maximum fault current (A r m s symm)
d = spacing between bars (m)
k = space factor for rectangular bars (see Fig 1)

e) The maximum allowable spacing of busbar supports for fault levels of 15 kA and more is 600 mm.

f) All secondary and "dropper" busbars shall be mounted on suitable insulators or directly on circuit breaker terminals, where practical.

g) Busbars shall be mounted at least 100 mm away from the nearest equipment. Special attention should be given to spacing between fuse-switches and busbars.

h) Busbars shall be properly insulated and sufficiently supported to withstand the maximum fault current at the points where they pass through panels or partitions. This shall preferably be achieved by means of resin-bound synthetic wood or similar material with cut-outs which fit tightly around the busbars. The insulating panel shall be firmly bolted to the frame. Busbars or "droppers" that pass through internal partitions in the L.V. compartment shall be similarly insulated and supported.

1.5.5. COVERING

All busbars shall be covered with coloured heat-shrinkable material equal to "RAYCHEM", "SIGMAFORM" or "AIRSHRINK" products. The colour shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two coats of coloured insulation paint. Busbar joints shall be covered with a suitable non-hardening compound and then taped with coloured P V C tape. Busbars shall be radius-edged where they change direction.

1.5.6. CONNECTIONS

Conductor ends shall be fitted with crimped or solid sweated lugs which are bolted to the busbar. Busbar clamps with bolted connections are acceptable for smaller circuit conductors.

Where lugs are crimped evidence shall be submitted that the crimping technique used will comply with the performance requirements of BS 4579, Part 1: "COMPRESSION JOINTS IN COPPER".

1.5.7. OUTGOING CIRCUITS

Conductors up to a maximum size of 70 mm^2 may be used for connections from equipment to external cables. The terminations shall comply with par 2.6.5. Busbars shall be provided and shall extend to approximately 900 mm above the cable gland plate for circuits with larger currents. These busbars shall be insulated over their entire length.

1.5.8. NEUTRAL BUSBARS

a) Neutral conductors for circuits protected by a single-pole circuit breaker or fuse-switch shall be connected to a neutral busbar mounted in a suitable position.

b) A separate neutral bar shall be provided for each earth leakage unit provided. These neutral bars shall have a cross-section of at least 6,3 x 25 mm and shall be long enough for the lugs of all neutral conductors to be bolted separately to the busbar without overlapping the lugs.

c) The requirements of par 2.5.6 and 2.5.11 are applicable.

d) The rating of neutral busbars for three-phase circuits is specified in par 2.5.3 c).

1.5.9. EARTH BUSBAR

An earth busbar shall be installed in a convenient position along the entire length of the LV compartment. The requirements of 1.7, 1.8, 3.1.a), 3.1.b), 3.5.a)iii), 5.4.c)iii), 5.4.d), 5.4.f), 5.4.g),..., 5.4.f) and 5.4.g) are applicable to earth busbars with the exception that earth busbars may be bolted directly to the framework. The cross-sectional area of earth busbars shall be calculated in accordance with the following formula in IEC 439 with a minimum cross section of 6,3 x 20 mm:

S = I x (t)1/2/X x (dT)1/2

where S = cross-section (mm^2)

I = the r m s value of the current (A)

X = 13 for Copper

t = operating time of protection equipment (s)
(Minimum value = 0,2 s)

dt = temperature rise (°C)

= 120 °C for insulated conductors

= 180 °C for uninsulated conductors

if t is between 2 seconds and 5 seconds then dT may be increased in the same formula to

dT = 145 °C for insulated conductors

= 215 °C for uninsulated conductors

In addition the longer side of the earth busbar shall be at least twice the diameter of the largest bolt that will be fitted to the busbar.

1.5.10. EARTHING OF METAL PARTS

All non-current carrying metal parts of the mini-substation, e g framework, panels, base, steel housing, transformer, ring main unit, etc, shall be bonded to the earth busbar.

1.5.11. BOLTS AND NUTS

Only cadmium-plated high tensile steel bolts and hexagonal nuts may be employed at busbar joints and connection points. All nuts shall be provided with spring washers or be of the "NYLOCK" type with washers. The largest possible size bolt that will fit into holes in lugs and fixing holes of equipment shall be used in every instance. Bolts shall be of sufficient length that at least two but not more than five threads protrude beyond the nut.

1.6. WIRING

1.6.1. CABLING

Incoming and outgoing cables shall be terminated on the gland plate. Cable tails with sizes up to 70 mm^2 may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. All cables larger than 70 mm^2 shall terminate on busbar studs which are connected directly to the equipment. Parallel connected cables shall be connected to a collector busbar or busbar stub without crossing the conductors.

1.6.2. CURRENT RATINGS

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit breaker or fuse protection of the circuit. The smallest conductor size to be used for power wiring shall be 2,5 mm^2.

The following table shall be applied for ambient temperatures up to 30 °C. For higher ambient temperatures the values shall be derated as prescribed by SABS 0142, Table 10.

Table 3: Conductor Ratings

NOMINAL CROSS SECTION (mm^2)	CONDUCTOR COPPER RATING (A)				
	NUMBER OF CONDUCTORS IN BUNCH				
	1	2 - 3	4 - 5	6 - 9	10 and more
2,5	28	25	22	19	16
4	37	33	30	26	22
6	47	42	38	33	28
10	64	54	51	44	38
16	85	76	68	59	51
25	112	101	89	78	67
35	138	124	110	96	88
50	172	154	137	120	103
70	213	191	170	149	127

1.6.3. INTERNAL WIRING

a) Standard 600/1 000 V grade PVC-insulated stranded annealed copper conductors to SABS 150 shall be used for the internal wiring.

b) 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.

c) Joints in the wiring are not acceptable.

d) Where conductors change direction, smooth bends shall be formed with a radius of at least five times the outside diameter of the conductor

1.6.4. END CONNECTIONS

The supply end connections to equipment shall be at the top and the load end connections at the bottom.

1.6.5. CONDUCTOR TERMINATION

Conductors connected to terminals complying with the Engineer's standard specification shall also be soldered or ferruled.

All conductors terminating on equipment with screwed terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor with the correct amount of insulation removed from the end to fit into the lug. Strands may not be cut from the end of the conductor.

Connections to circuit breakers, isolators or contactors shall be installed by one of the following methods:

a) A ferrule of the correct size,
b) Soldering the end of the conductor.

1.6.6. IDENTIFICATION

The colour of the conductors for all 220/250 V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors for control circuits, etc, shall be coded in colours other than those specified above. The devised colour codes shall be shown on a wiring diagram. Coloured PVC or other tape will not be acceptable for colour coding.

1.7. MOUNTING OF EQUIPMENT

The mounting of equipment shall comply with SABS 1180 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers. Self-tapping screws will not be accepted.

Equipment shall be arranged and grouped in a logical fashion.

All equipment shall be flush mounted behind panels with only circuit breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position by 6 mm studs and hexagonal chromed brass dome nuts and washers or hank nut or "DZUS" or "CAMLOC" fasteners. Self-tapping or similar screws are not acceptable.

Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed so that fixing holes do not need to be drilled through the front panel.

1.8. ACCESS

All equipment, busbars and wiring shall be completely accessible with the front cover panel removed.

1.9. LABELLING

All equipment shall be fully labelled and accurate descriptions and safety warning notices shall be given in both official languages.

Engraved treffolite shall be used for internal labels. The labels shall bear white lettering on a black background. Painted or printed labels are not acceptable. External labels shall be anodised aluminium.

The following labels shall be supplied as a minimum requirement:

a) Designation of mini-substation

e g KERKSTR MINI-SUB
CHURCH ST MINI-SUB

(Lettering: At least 30 mm high. Label on the outside in a prominent position on both the front and back of the substation).

b) Designation of circuit i e circuit breaker, isolator, meter, etc

e g HOUSE 473
HUIS 473

POMPTOEVOER
PUMP SUPPLY

(Lettering: At least 5 mm high. One label installed directly below each item of equipment pertaining to the particular circuit shall be provided).

c) The main switch shall be labelled in accordance with the regulations.

d) The function and circuits of all other equipment shall be clearly identified. Flush mounted equipment within the front panel shall be identified by labels fixed to the front panel. The labels for all equipment installed behind panels shall be fixed to the support panel close to the equipment.

e) The labels shall be secured by means of brass nuts and bolts, self-tapping screws, pop-rivets or slotted label holders. Engraved labels shall be secured to facilitate a neat alteration of the designation of the labels. Labels shall not be glued to their mounting positions. Sufficient fixing points shall be provided to prevent labels from warping.

f) All label designations shall be confirmed with the Engineer before manufacture.

1.10. NOTICES

The notices in terms of the Machinery and Occupational Safety Act (Act 6 of 1983) and labels as required on the outside of the mini-substation, shall be riveted to the steel door or panelling so that they cannot be easily removed. Brass rivets shall be used. In the case of fibreglass housings, the notices shall be laminated into the fibreglass except for the designation label.

1.11. INSPECTION

The Engineer shall be notified at least two weeks in advance of the completion of the mini-substation in order that an inspection may be carried out before delivery.

The mini-substation roof shall be removed for inspection.

1.12. DRAWINGS

1.12.1. DRAWINGS FOR APPROVAL

A set of three prints of the shop drawings of the mini-substations shall be submitted to the Engineer for approval before manufacture commences. The following information shall be presented:

a) Schematic and wiring diagrams.

b) A complete layout of the internal arrangement of the mini-substations showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall be shown.

c) All labelling information in both the official languages on a separate sheet.

d) The makes, catalogue numbers and capacities of all equipment scheduled on a separate sheet.

e) A detail drawing of the concrete plinth showing concrete mixes, dimensions, opening sizes, steel reinforcing details and holding down bolts fixing details.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the mini-substations according to the requirements of this Specification.

1.12.2. FINAL DRAWINGS

A complete set of "as built" transparent drawings of the mini-substations shall be submitted to the Engineer within two weeks after delivery. The information called for in par 5.11 i) to v) above shall be provided.

1.12.3. COMPLETION

The contract shall be regarded as incomplete until all drawings have been handed to the Engineer.

2. LOW VOLTAGE DISTRIBUTION CUBICLES (KIOSKS)

2.1. GENERAL

This specification covers the manufacture and supply of distribution kiosks for general reticulation and distribution systems in normal environmental conditions for three-phase, four-wire, 400/231 V, 50 Hz systems.

2.2. SIZE

Kiosks shall be of ample size to accommodate the specified equipment and provide space for future requirements as specified.

2.3. MOISTURE AND VERMIN PROOFING

Kiosks shall be weatherproof. To prevent the ingress of water into live equipment, the door entry surrounds shall have a channel shape, at least 12 mm deep, to accommodate the door edge.

The roof shall be constructed with an overhang above non-continuous panelling and shall be provided with a drip-edge.

2.4. VENTILATION

Two ventilation grills for slots, approximately 150 x 125 mm, vermin proofed and insect proofed by means of 1,5 mm brass mesh or perforated steel plate spot-welded on the inside, shall be provided on the top and bottom of both side panels.

The construction of the grills shall prevent the ingress of rain or water.

2.5. FIBREGLASS CANOPIES

2.5.1. APPLICATION

Where specified and for all substations to be installed within 50 km of the coast and in all corrosive industrial atmospheres, the canopy and doors shall be manufactured of fibreglass.

2.5.2. CONSTRUCTION

The laminate shall be constructed to SABS 141.

The fibreglass shall comply with the minimum strength requirements of clause 3.4 of SABS 1029.

An outer isopthalic resin gelcoat with a minimum thickness of 0,4 mm and ultraviolet absorption properties to prevent degradation of the surface from exposure to the sun shall be provided.

The gelcoat shall be backed by multiple layers of chopped strand mat glass rendering not less than 1,2 kg/m^2. The strength shall be increased to 1,35 kg/m^2 on all panels larger than 500 x 500 mm.

The fibreglass shall be thoroughly impregnated with polyester resin. The resin should preferably be clear.

The resin to fibreglass ratio shall not be less than 2,5:1 and not more than 3,0:1.

Air entrapped between the glass mat layers shall be thoroughly worked out. The laminate must be free of air bubbles and voids.

All edges shall be reinforced with an additional 700 g/m^2 of fibreglass.

All large surfaces, wider than 300 mm, shall be reinforced or panelled to improve stiffness and rigidity.

A resin coat shall be applied to the inside of the panels to cover the fibre pattern.

Brass or steel backing plates shall be laminated into the fibreglass at hinge points, locking mechanism at support areas, door restraint fixing points and all other points which will be subjected to mechanical stress.

Doors shall be adequately braced, reinforced, ribbed or double laminated with an air gap between the two layers of laminate to ensure rigidity.

The fibreglass canopy shall be fixed to the internal equipment support frame with bolts accessible through the door only.

a) Finish and colour of fibreglass kiosks

The outside surface of the fibreglass shall have a glossy, smooth finish to ensure good weathering. To obtain this the manufacturer shall ensure that the moulds are smooth, free of voids, hairline cracks, pores or other defects.

Compound rubbing or sanding of the outside surface will not be permitted.

Pigments shall be added to the outer gelcoat to obtain a matching colour to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091.

Fibreglass kiosks shall not be painted.

2.6. SHEET STEEL CANOPIES

2.6.1. GENERAL

Where specified, the canopy and doors shall be manufactured of steel to the following requirements:

A metal framework shall be manufactured from solid angle iron, channel iron or 2,0 mm minimum folded sheet steel.

Joints shall be non-continuously butt-welded. Welds shall be ground smooth in order to provide a smooth finish.

Side panels, doors and the roof shall be manufactured from 2 mm minimum sheet steel. Panels shall have upturned edges which are recessed in the frame or which fit over lips on the frame. The side panels may be either bolted or welded to the frame or form part of the folded metal frame.

The roof of the cubicle shall be removable and shall be fitted by means of bolts which shall be accessible from inside the cubicle only.

All panels and doors shall be suitably braced and stiffened to ensure rigidity and to prevent warping.

The steel canopy and framework shall be fixed to the base frame by four M16 high tensile steel bolts.

2.6.2. FINISH AND COLOUR OF SHEET STEEL KIOSKS

Metal components of the framework, panels and doors shall be painted in accordance with the "Standard Painting Specification" hereof.

The colour shall be an acceptable match to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091. A tin of matching touch-up paint (not smaller than 500 ml) shall be provided with each consignment.

2.7. CAST IRON KIOSKS

2.7.1. GENERAL

Where specified the cubicle panels shall be manufactured from cast-iron to the following requirements:

A metal framework shall be manufactured from solid angle iron or channel iron. Cast iron panels shall be bolted to the framework and shall be replaceable with standard cast iron panels.

The panels shall be bolted to the frame from the inside of the cubicle. Bolts or nuts on the outside of the cubicle are not acceptable.

The roof of the cubicle shall be one casting and shall be bolted in position from inside the cubicle.

The minimum thickness of the cast-iron panels and doors shall be 6 mm.

All cast-iron panels and doors shall be fettled prior to painting.

2.7.2. FINISHING COLOUR OF CAST-IRON KIOSKS

Metal components of the framework, panels and doors shall be painted in accordance with the "Standard Painting Specification" hereof.

The colour shall be an acceptable match to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091. A tin of matching touch-up paint (not smaller than 500 ml) shall be provided with each consignment.

2.8. DOORS

Doors shall be fitted to the front and rear of each cubicle. The doors shall provide free access to equipment which has to be operated and shall provide a full view of all meters. Cubicles wider than 700 mm shall be provided with double doors.

Door shall have well returning edges to fit into the channel of the door entry surrounds.

Door shall swivel through 135 °C.

Stainless steel hinges shall be used to hang the doors.

The hinges shall be bolted to the canopy with cadmium plated mild steel bolts and nuts. Bolt head or nuts shall not protrude beyond the outer surface of the kiosk. Nylon, aluminium or piano hinges are not acceptable.

Doors shall be fitted with stainless steel lever locks equal or similar to the "BARKER & NELSON" type with a 180° movement. The locking mechanism shall have a catch on the rear which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed by galvanised steel plates. The locking mechanism shall be padlockable.

The locking mechanism shall be made of brass or stainless steel.

Door restraints shall be provided. Cloth or canvas straps are not acceptable. The fixing points of the restraint at both the door and canopy shall be reinforced.

At least three hinges shall be supplied on steel doors higher than 1,2 m.

Doors shall be fitted with neoprene or equivalent seals.

Metal doors shall be earth bonded to the frame by means of a copper braided strap, tooth washers, bolts and nuts.

2.9. EQUIPMENT SUPPORT FRAME

A free standing, angle iron or similar type rigid support framework shall be provided.

The frame shall be bolted down on the base by four M16 high tensile steel bolts. The holding-down bolts shall be accessible from the inside of the cubicle only. The frame of sheet steel canopies may be bolted to the canopy framework.

A galvanised steel cable gland plate shall be bolted to the bottom of the frame across the full width of the cubicle to cover the cable entry opening in the base.

The gland plate shall be suitably punched to accept the number and size of cables specified.

All steelwork shall be hot-dip galvanised in accordance with SABS 763.

A panel of "DELARON" or "THIOLITE" resin bound synthetic wood or other suitable dielectric material shall be provided for the mounting of all equipment and busbars. Impregnated hardboard, other treated or untreated wood products are not acceptable.

Alternatively, all equipment and busbars shall be flush mounted within a purpose-made sheet metal frame enclosed by a machine punched removable front panel through which the operating handles of the equipment protrude. Care shall be exercised that the rear studs of circuit breakers are properly insulated from the steel chassis. Miniature circuit breakers may be installed in clip-in trays mounted on the frame.

2.10. CONCRETE BASES AND BASE FRAMES

To ensure stability of the kiosk after installation, it shall be mounted on a base frame which, in turn, shall be bolted to a concrete base cast into the bottom of the cable trench.

The base frame shall be constructed of angle iron, at least 50 x 4 mm thick and shall be of welded construction hot-dip galvanised and coated with epoxy resin tar.

The vertical height of the box frame shall be at least 900 mm and the construction shall be such as to provide a rigid support for the kiosk.

The base frame shall protrude to a maximum height of 200 mm above ground level. Provision shall be made for the protection and concealing of the cables entering the kiosk and to prevent access of animals and vermin.

The base frame shall be secured by at least four M16 bolts to the support frame of the kiosk and four M16 anchor bolts and nuts to the concrete base. The bolts, nuts and washers shall be galvanised and supplied with the kiosk.

All galvanising shall be to SABS 763.

The kiosk manufacturer shall supply a detail drawing of the base frame and the concrete base required.

Alternative designs and materials for the base (or root) of the kiosk will be considered but full details must be submitted for approval by the Engineer.

2.11. BUSBARS

2.11.1. MATERIAL

Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SABS 1195 and BS 159 and BS1433, where applicable.

Although SABS 784 refers to overhead and rising busbars, busbars in distribution cubicles shall comply with applicable sections of this specification, especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.

2.11.2. VOLTAGE RATING

Busbars shall be designed to withstand a test voltage of 2,5 kV for one minute.

2.11.3. CURRENT RATING

The maximum allowable temperature of busbars (including joints) carrying full load current in an ambient temperature as specified shall not exceed 80 °C. Unless different ambient temperatures are specified, an ambient temperature of 35 °C shall be assumed with a maximum temperature increase of 45 °C.

Table 2 may be used as a guide in determining busbar ratings where the distance between the phase busbars is at least the distance of the longer side of the cross section with a minimum spacing of 50 mm and at least 150 mm from the sheet metal enclosure. It is, however, essential that the manufacturer shall make due allowance for the "proximity and skin" effects, the effect of ferrous enclosures, ventilation, etc, for the arrangement used in his switchboard design.

Manufacturers shall, where requested, prove that the busbar rating and enclosure design comply with the temperature rise specified above. The busbars can also be rated to DIN 64671 unpainted busbars.

Busbars may not be tapered. The rating of the bars shall be equal to the incoming current rating. In cases where the main switch is an isolator, the isolator rating may not be taken as the incoming current rating.

In addition to the current rating, busbars shall comply with the following fault level rating:

$$A = 8{,}2 \times 1 \times \sqrt{t}$$

where

A = minimum cross-section (mm^2)

I = prospective fault current (kA)

t = maximum time in seconds required for protection equipment to clear the fault.

(Minimum allowable value for t = 0,2 seconds).

Where a busbar consists of two or more busbars per phase (laminations), the laminations shall be separated by a minimum distance of the thickness of one lamination. The laminations shall be clamped together with copper spacers at intervals not exceeding 450 mm in order to equalise the current distribution in the laminations. The busbar ratings in Table 2 shall be multiplied by the factors shown in Table 1 to determine the total current rating per phase.

Table 4: Derating Factors for Laminated Busbars

AREA OF CROSS SECTION (mm^2)	NO OF PARALLEL BUSBARS PER PHASE		
	1	2	3
500	1,78	2,45	3,13
1000	1,72	2,36	3,00
1500	1,65	2,24	2,84
2000	1,60	2,16	2,70
2500	1,55	2,10	2,60
3000	1,52	2,02	2,52
3500	1,48	1,98	2,48
4000	1,44	1,96	2,45

Table 5: Current Rating of Single Copper Busbars

WIDTH (mm)	THICKNESS (mm) 2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	
63			790	990	1240	1370	
80			970	1200	1480	1640	
100			1160	1430	1760	2180	
125				1710	2100	2310	2570
160				2070	2530	2780	3090
200						3290	3660
250						3900	4300
315						4630	5120
400							6230

2.11.4. MOUNTING

Busbars shall be supported on resin insulators. Porcelain insulators are not acceptable. The rating and fixing of busbars shall be designed to withstand mechanical and temperature stresses during fault conditions. Minimum clearance as specified in SABS 784 for system voltages up to 600 V is 10 mm and shall be strictly maintained.

2.11.5. NEUTRAL BUSBARS

The neutral busbar shall have a cross-sectional area equal to that of a phase busbar. The neutral bar shall be insulated from earth.

2.11.6. EARTH BUSBAR

An earth busbar shall be installed in a convenient position along the entire length of the kiosk. Earth busbars may be bolted directly to the framework. The cross-sectional area of earth busbars shall be calculated in accordance with the following formula in IEC 439 with a minimum cross section of 4 x 20 mm:

$$S = I \times \sqrt{t}/X \times \sqrt{dT}$$

where

S = cross section (mm^2)

I = the r m s value of the current (A)

X = 13 for Copper

t = operating time of protection equipment (s).
(Minimum value = 0,2 s).

dT = temperature rise (°C)

= 120 °C for insulated conductors

= 180 °C for uninsulated conductors

if t is between 2 seconds and 5 seconds then dT may be increased in the same formula to

dT = 145 °C for insulated conductors

= 215 °C for uninsulated conductors

In addition the longer side of the earth busbar shall be at least twice the diameter of the largest bolt that will be fitted to the busbar.

2.11.7. BUSBAR CONNECTIONS

Conductor ends shall be fitted with crimped or solid sweated lugs which are bolted to the busbar. Busbar clamps with bolted connections may be provided for neutral and earth busbars but tapped terminal strips with screws are not acceptable. Where lugs are crimped, evidence shall be submitted that the crimping technique used will comply with the requirements of BS 4579, Part I: "COMPRESSION JOINTS IN COPPER".

2.11.8. BOLTS AND NUTS

Only cadmium-plated high tensile steel bolts and hexagonal nuts may be employed at busbar joints and connection points. All nuts shall be provided with spring washers or be of the "NYLOCK" type with washers. The largest possible size bolt that will fit into holes in lugs and fixing holes of equipment shall be used in every instance. Bolts shall be of sufficient length that at least two but no more than five threads protrude beyond the nut.

2.11.9. BUSBAR COVERING

All busbars shall be covered with coloured heat-shrinkable insulating material equal to "RAYCHEM", "SIGMAFORM" or "AIRSHRINK" products. The colours shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two layers of coloured insulating paint.

2.11.10. EARTHING OF METAL PARTS

All non-current carrying metal parts of the cubicle e g framework, steel canopy, etc, shall be bonded to the earth bar.

2.12. WIRING

2.12.1. CABLING

Incoming and outgoing cables shall be terminated on the gland plate. Cables up to 70 mm^2 may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. All cable sizes larger than 70 mm^2 shall terminate on busbar stubs which shall be connected to the associated equipment. Parallel incoming and outgoing cables shall be connected to a collector busbar without crossing the conductors.

2.12.2. CURRENT RATINGS

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit breaker or fuse protection of the circuit. The smallest conductor size to be used for power wiring shall be 2,5 mm^2.

The following table shall be applied for ambient temperatures up to 30 °C. For higher ambient temperatures the values shall be derated as prescribed by SABS 0142, Table 10.

Table 6: Conductor Copper Rating

NOMINAL CROSS SECTION (mm^2)	CONDUCTOR COPPER RATING (A)				
	NUMBER OF CONDUCTORS IN BUNCH				
	1	2 - 3	4 - 5	6 - 9	10 and more
2,5	28	25	22	19	16
4	37	33	30	26	22
6	47	42	38	33	28
10	64	54	51	44	38
16	85	76	68	59	51
25	112	101	89	78	67
35	138	124	110	96	88
50	172	154	137	120	103
70	213	191	170	149	127

2.12.3. INTERNAL WIRING

a) Standard 600/1 000 V grade PVC-insulated stranded annealed copper conductors to SABS 150 shall be used for the internal wiring.

b) 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.

c) Joints in the wiring are not acceptable.

d) Where conductors change direction, smooth bends shall be formed with a radius of at least five times the outside diameter of the conductor.

2.12.4. END CONNECTIONS

The supply end connections to equipment shall be at the top and the load end connections at the bottom.

2.12.5. CONDUCTOR TERMINATION

All conductors terminating on equipment with screwed terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor with the correct amount of insulation removed from the end to fit into the lug. Strands may not be cut from the end of the conductor.

Connections to circuit breakers, isolators or contactors shall be installed 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.

2.12.6. IDENTIFICATION

The colour of the conductors for all 220/250 V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors for control circuits, etc, shall be coded in colours other than those specified above. The devised colour codes shall be shown on a wiring diagram. Coloured PVC or other tape will not be acceptable for colour coding.

2.13. MOUNTING OF EQUIPMENT

The mounting of equipment shall comply with SABS 1180 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers. Self-tapping screws will not be accepted.

Equipment shall be arranged and grouped in a logical fashion.

All equipment shall be flush mounted behind panels with only circuit breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position by 6 mm studs and hexagonal chromed brass dome nuts and washers or hank nuts or "DZUS" or "CAMLOC" fasteners. Self-tapping or similar screws are not acceptable.

Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed so that fixing holes do not need to be drilled through the front panel.

2.14. ACCESS

All equipment, busbars and wiring shall be completely accessible with the door open and the back door and front cover panel removed.

2.15. LABELLING

All equipment shall be fully labelled and accurate descriptions and safety warning notices shall be given in both official languages.

Engraved treffolite shall be used for labels with black letters on a white background. The labels shall be riveted to the kiosks.

The following labels shall be supplied as a minimum requirement:

a) Number and allocation of kiosk,
e g KIOSK B26

(Lettering: At least 30 mm high. Label on the outside in a prominent position).

b) Designation of circuit i e circuit breaker, isolator, meter, etc.

e g HOUSE 473
HUIS 473

POMPTOEVOER
PUMP SUPPLY

(Lettering: At least 5 mm high. One label installed directly below each item of equipment pertaining to the particular circuit shall be provided).

The main switch shall be labelled in accordance with the regulations.

The function and circuits of all other equipment shall be clearly identified. Flush mounted equipment within the front panel shall be identified by labels fixed to the front panel. The labels for all equipment installed behind panels shall be fixed to the support panel close to the equipment.

The labels shall be secured by means of rivets. Self-tapping screws are not acceptable. Labels shall not be glued to their mounting positions. Sufficient fixing points shall be provided to prevent labels from warping.

All label designations shall be confirmed with the Engineer before manufacture.

2.16. NOTICES

At least one lightning type notice shall be mounted outside on the front of the kiosk. This notice shall be riveted to the steel or cast iron door so that they cannot easily be removed. Brass rivets shall be used. In the case of fibreglass housings, the notices shall be laminated into the fibreglass except for the designation label.

2.17. INSPECTION

The Engineer shall be notified at least two weeks in advance of the completion of the kiosks in order that an inspection may be carried out before delivery.

2.18. DRAWINGS

2.18.1. DRAWINGS FOR APPROVAL

A set of three prints of the shop drawings of the kiosks shall be submitted to the Engineer for approval before manufacture commences. The following information shall be presented:

a) Schematic and wiring diagrams.

b) A complete layout of the internal arrangement of the kiosks showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall be shown.

c) All labelling information in both the official languages on a separate sheet.

d) The makes, catalogue numbers and capacities of all equipment scheduled on a separate sheet.

e) A detail drawing of the concrete plinth showing concrete mixes, dimensions, opening sizes, steel reinforcing details and holding down bolts fixing details.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the mini-substations according to the requirements of this Specification.

2.18.2. FINAL DRAWINGS

A complete set of "as built" transparent drawings of the kiosks shall be submitted to the Engineer within two weeks after delivery. The information called for above shall be provided.

2.18.3. COMPLETION

The supply contract shall be regarded as incomplete until all drawings have been handed to the Engineer.

GSE05 – GENERAL SPECIFICATION ELECTRICAL

MINIATURE SUBSTATIONS (MSS)

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1. GENERAL

The general requirements for Miniature Substations are covered by SANS1029:2016. In an attempt to achieve a national standard, Miniature Substations shall further comply with Eskom Standard 34-1621 Rev2 (unique identifier 240-56062752). The general minimum requirements for Ring Main Units and Distribution Transformers to be installed within the Miniature Substation, are covered by SANS1874 and SANS780 respectively. The detail project requirements shall be covered in the Project Specification, Drawings and Bill of Quantities.

2. NOTICES

The notices in terms of the Machinery and Occupational Safety Act (Act 6 of 1983) and labels are required on the outside of the mini-substation, shall be riveted to the steel door or panelling so that they cannot be easily removed. Brass rivets shall be used. In the case of fibreglass housings, the notices shall be laminated into the fibreglass except for the designation label.

3. INSPECTION

- The Engineer shall be notified at least two weeks in advance of the completion of the mini-substation in order for an inspection to be carried out before delivery.
- The mini-substation roof shall be removed for inspection.

4. DRAWINGS

4.1. DRAWINGS FOR APPROVAL

A set of three prints of the shop drawings of the mini-substations shall be submitted to the Engineer for approval before manufacture commences. The following information shall be presented:

- Schematic and wiring diagrams.
- A complete layout of the internal arrangement of the mini-substations showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall also be shown.
- All labelling information in both the official languages on a separate sheet.
- The makes, catalogue numbers and capacities of all equipment scheduled on a separate sheet.
- A detailed drawing of the concrete plinth showing concrete mixes, dimensions, opening sizes, steel reinforcing details and holding down bolts fixing details.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the mini-substations according to the requirements of this Specification.

4.2. FINAL DRAWINGS

A complete set of "as built" transparent drawings of the mini-substations shall be submitted to the Engineer within two weeks after delivery. The information called for in 4.1 above shall be provided.

4.3. COMPLETION

The contract shall be regarded as incomplete until all drawings have been handed to the Engineer.

GSE06 – GENERAL SPECIFICATION ELECTRICAL

LOW VOLTAGE DISTRIBUTION CUBICLES

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1. LOW VOLTAGE DISTRIBUTION CUBICLES (KIOSKS)

1.1. GENERAL

This specification covers the manufacture and supply of distribution kiosks for general reticulation and distribution systems in normal environmental conditions for three-phase, four-wire, 415 V, 50 Hz systems.

1.2. SIZE

Kiosks shall be of ample size to accommodate the specified equipment and provide space for future requirements as specified.

1.3. MOISTURE AND VERMIN PROOFING

Kiosks shall be weatherproof. To prevent the ingress of water into live equipment, the door entry surrounds shall have a channel shape, at least 12 mm deep, to accommodate the door edge.

The roof shall be constructed with an overhang above non-continuous panelling and shall be provided with a drip-edge.

1.4. VENTILATION

Two ventilation grills for slots, approximately 150 x 125 mm, vermin proofed and insect proofed by means of 1,5 mm brass mesh or perforated steel plate spot-welded on the inside, shall be provided on the top and bottom of both side panels.

The construction of the grills shall prevent the ingress of rain or water.

1.5. FIBREGLASS CANOPIES

1.5.1. APPLICATION

Where specified and for all substations to be installed within 50 km of the coast and in all corrosive industrial atmospheres, the canopy and doors shall be manufactured of fibreglass.

1.5.2. CONSTRUCTION

The laminate shall be constructed to SABS 141.

The fibreglass shall comply with the minimum strength requirements of clause 3.4 of SABS 1029.

An outer isopthalic resin gelcoat with a minimum thickness of 0,4 mm and ultraviolet absorption properties to prevent degradation of the surface from exposure to the sun shall be provided.

The gelcoat shall be backed by multiple layers of chopped strand mat glass rendering not less than 1,2 kg/m^2. The strength shall be increased to 1,35 kg/m^2 on all panels larger than 500 x 500 mm.

The fibreglass shall be thoroughly impregnated with polyester resin. The resin should preferably be clear.

The resin to fibreglass ratio shall not be less than 2,5:1 and not more than 3,0:1.

Air entrapped between the glass mat layers shall be thoroughly worked out. The laminate must be free of air bubbles and voids.

All edges shall be reinforced with an additional 700 g/m^2 of fibreglass.

All large surfaces, wider than 300 mm, shall be reinforced or panelled to improve stiffness and rigidity.

A resin coat shall be applied to the inside of the panels to cover the fibre pattern.

Brass or steel backing plates shall be laminated into the fibreglass at hinge points, locking mechanism at support areas, door restraint fixing points and all other points which will be subjected to mechanical stress.

Doors shall be adequately braced, reinforced, ribbed or double laminated with an air gap between the two layers of laminate to ensure rigidity.

The fibreglass canopy shall be fixed to the internal equipment support frame with bolts accessible through the door only.

1.5.3. FINISH AND COLOUR OF FIBREGLASS KIOSKS

The outside surface of the fibreglass shall have a glossy, smooth finish to ensure good weathering. To obtain this the manufacturer shall ensure that the moulds are smooth, free of voids, hairline cracks, pores or other defects.

Compound rubbing or sanding of the outside surface will not be permitted.

Pigments shall be added to the outer gelcoat to obtain a matching colour to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091.

Fibreglass kiosks shall not be painted.

1.6. SHEET STEEL CANOPIES

1.6.1. GENERAL

Where specified, the canopy and doors shall be manufactured of steel to the following requirements:

A metal framework shall be manufactured from solid angle iron, channel iron or 2,0 mm minimum folded sheet steel.

Joints shall be non-continuously butt-welded. Welds shall be ground smooth in order to provide a smooth finish.

Side panels, doors and the roof shall be manufactured from 2 mm minimum sheet steel. Panels shall have upturned edges which are recessed in the frame or which fit over lips on the frame.

The side panels may be either bolted or welded to the frame or form part of the folded metal frame.

The roof of the cubicle shall be removable and shall be fitted by means of bolts which shall be accessible from inside the cubicle only.

All panels and doors shall be suitably braced and stiffened to ensure rigidity and to prevent warping.

The steel canopy and framework shall be fixed to the base frame by four M16 high tensile steel bolts.

1.6.2. FINISH AND COLOUR OF SHEET STEEL KIOSKS

Metal components of the framework, panels and doors shall be painted in accordance with the "Standard Painting Specification" hereof.

The colour shall be an acceptable match to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091 as indicated in the project specification. A tin of matching touch-up paint (not smaller than 500 ml) shall be provided with each consignment.

1.7. CAST IRON KIOSKS

1.7.1. GENERAL

Where specified the cubicle panels shall be manufactured from cast-iron to the following requirements:

A metal framework shall be manufactured from solid angle iron or channel iron. Cast iron panels shall be bolted to the framework and shall be replaceable with standard cast iron panels.

The panels shall be bolted to the frame from the inside of the cubicle. Bolts or nuts on the outside of the cubicle are not acceptable.

The roof of the cubicle shall be one casting and shall be bolted in position from inside the cubicle.

The minimum thickness of the cast-iron panels and doors shall be 6 mm.

All cast-iron panels and doors shall be fettled prior to painting.

1.7.2. FINISHING COLOUR OF CAST-IRON KIOSKS

Metal components of the framework, panels and doors shall be painted in accordance with the "Standard Painting Specification" hereof.

The colour shall be an acceptable match to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SABS 1091. A tin of matching touch-up paint (not smaller than 500 ml) shall be provided with each consignment.

1.8. DOORS

Doors shall be fitted to the front and rear of each cubicle. The doors shall provide free access to equipment which has to be operated and shall provide a full view of all meters. Cubicles wider than 700 mm shall be provided with double doors.

Door shall have well returning edges to fit into the channel of the door entry surrounds.

Door shall swivel through 135 °C.

Stainless steel hinges shall be used to hang the doors.

The hinges shall be bolted to the canopy with cadmium plated mild steel bolts and nuts. Bolt head or nuts shall not protrude beyond the outer surface of the kiosk. Nylon, aluminium or piano hinges are not acceptable.

Doors shall be fitted with stainless steel lever locks equal or similar to the "BARKER & NELSON" type with a 180° movement. The locking mechanism shall have a catch on the rear which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed by galvanised steel plates. The locking mechanism shall be padlockable.

The locking mechanism shall be made of brass or stainless steel.

Door restraints shall be provided. Cloth or canvas straps are not acceptable. The fixing points of the restraint at both the door and canopy shall be reinforced.

At least three hinges shall be supplied on steel doors higher than 1,2 m.

Doors shall be fitted with neoprene or equivalent seals.

Metal doors shall be earth bonded to the frame by means of a copper braided strap, tooth washers, bolts and nuts.

1.9. EQUIPMENT SUPPORT FRAME

A free standing, angle iron or similar type rigid support framework shall be provided.

The frame shall be bolted down on the base by four M16 high tensile steel bolts. The holding-down bolts shall be accessible from the inside of the cubicle only. The frame of sheet steel canopies may be bolted to the canopy framework.

A galvanised steel cable gland plate shall be bolted to the bottom of the frame across the full width of the cubicle to cover the cable entry opening in the base.

The gland plate shall be suitably punched to accept the number and size of cables specified.

All steelwork shall be hot-dip galvanised in accordance with SABS 763.

A panel of "DELARON" or "THIOLITE" resin bound synthetic wood or other suitable dielectric material shall be provided for the mounting of all equipment and busbars. Impregnated hardboard, other treated or untreated wood products are not acceptable.

Alternatively, all equipment and busbars shall be flush mounted within a purpose-made sheet metal frame enclosed by a machine punched removable front panel through which the operating handles of the equipment protrude. Care shall be exercised that the rear studs of circuit breakers are properly insulated from the steel chassis. Miniature circuit breakers may be installed in clip-in trays mounted on the frame.

1.10. CONCRETE BASES AND BASE FRAMES

To ensure stability of the kiosk after installation, it shall be mounted on a base frame which, in turn, shall be bolted to a concrete base cast into the bottom of the cable trench.

The base frame shall be constructed of angle iron, at least 50 x 4 mm thick and shall be of welded construction hot-dip galvanised and coated with epoxy resin tar.

The vertical height of the box frame shall be at least 900 mm and the construction shall be such as to provide a rigid support for the kiosk.

The base frame shall protrude to a maximum height of 200 mm above ground level. Provision shall be made for the protection and concealing of the cables entering the kiosk and to prevent access of animals and vermin.

The base frame shall be secured by at least four M16 bolts to the support frame of the kiosk and four M16 anchor bolts and nuts to the concrete base. The bolts, nuts and washers shall be galvanised and supplied with the kiosk.

All galvanising shall be to SABS 763.

The kiosk manufacturer shall supply a detail drawing of the base frame and the concrete base required.

Alternative designs and materials for the base (or root) of the kiosk will be considered but full details must be submitted for approval by the Engineer.

1.11. BUSBARS

1.11.1. MATERIAL

Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SABS 1195 and BS 159 and BS1433, where applicable.

Although SABS 784 refers to overhead and rising busbars, busbars in distribution cubicles shall comply with applicable sections of this specification, especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.

1.11.2. VOLTAGE RATING

Busbars shall be designed to withstand a test voltage of 2,5 kV for one minute.

1.11.3. CURRENT RATING

The maximum allowable temperature of busbars (including joints) carrying full load current in an ambient temperature as specified shall not exceed 80 °C. Unless different ambient temperatures are specified, an ambient temperature of 35 °C shall be assumed with a maximum temperature increase of 45 °C. The busbar current density shall not exceed 1.5A/mm^2.

The table as included herein may be used as a guide in determining busbar ratings where the distance between the phase busbars is at least the distance of the longer side of the cross section with a minimum spacing of 50 mm and at least 150 mm from the sheet metal enclosure. It is, however, essential that the manufacturer shall make due allowance for the "proximity and skin" effects, the effect of ferrous enclosures, ventilation, etc, for the arrangement used in his switchboard design.

Manufacturers shall, where requested, prove that the busbar rating and enclosure design comply with the temperature rise specified above. The busbars can also be rated to DIN 64671 unpainted busbars.

Busbars may not be tapered. The rating of the bars shall be equal to the incoming current rating. In cases where the main switch is an isolator, the isolator rating may not be taken as the incoming current rating.

In addition to the current rating, busbars shall comply with the following fault level rating:

$$A = t8{,}2I\sqrt{t}$$

Where,

A = minimum cross-section (mm^2)

I = prospective fault current (kA)

t = maximum time in seconds required for protection equipment to clear the fault.

(Minimum allowable value for t = 0,2 seconds).

Where a busbar consists of two or more busbars per phase (laminations), the laminations shall be separated by a minimum distance of the thickness of one lamination. The laminations shall be clamped together with copper spacers at intervals not exceeding 450 mm in order to equalise the current distribution in the laminations. The busbar ratings in Table 2 shall be multiplied by the factors shown in the table below to determine the total current rating per phase.

Table 1: Derating Factors for Laminated Busbars

AREA OF CROSS SECTION (mm^2)	NO OF PARALLEL BUSBARS PER PHASE 1	2	3
500	1,78	2,45	3,13
1000	1,72	2,36	3,00
1500	1,65	2,24	2,84
2000	1,60	2,16	2,70
2500	1,55	2,10	2,60
3000	1,52	2,02	2,52
3500	1,48	1,98	2,48
4000	1,44	1,96	2,45

Table 2: Current Rating of Single Copper Busbars (A)

WIDTH (mm)	THICKNESS (mm) 2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	
63			790	990	1240	1370	
80			970	1200	1480	1640	
100			1160	1430	1760	2180	
125				1710	2100	2310	2570
160				2070	2530	2780	3090
200						3290	3660
250						3900	4300
315						4630	5120
400							6230

1.11.4. MOUNTING

Busbars shall be supported on resin insulators. Porcelain insulators are not acceptable. The rating and fixing of busbars shall be designed to withstand mechanical and temperature stresses during fault conditions. Minimum clearance as specified in SABS 784 for system voltages up to 600 V is 10 mm and shall be strictly maintained.

1.11.5. NEUTRAL BUSBARS

The neutral busbar shall have a cross-sectional area equal to that of a phase busbar. The neutral bar shall be insulated from earth.

1.11.6. EARTH BUSBAR

An earth busbar shall be installed in a convenient position along the entire length of the kiosk. Earth busbars may be bolted directly to the framework. The cross-sectional area of earth busbars shall be calculated in accordance with the following formula in IEC 439 with a minimum cross section of 4 x 20 mm:

$$S = I\frac{\sqrt{t}}{x}\sqrt{dT}$$

Where,

S = cross section (mm^2)

I = the r m s value of the current (A)

X = 13 for Copper

t = operating time of protection equipment (s).
(Minimum value = 0,2 s).

dT = temperature rise (°C)

= 120 °C for insulated conductors

= 180 °C for uninsulated conductors

If t is between 2 seconds and 5 seconds then dT may be increased in the same formula to

dT = 145 °C for insulated conductors

= 215 °C for uninsulated conductors

In addition the longer side of the earth busbar shall be at least twice the diameter of the largest bolt that will be fitted to the busbar.

1.11.7. BUSBAR CONNECTIONS

Conductor ends shall be fitted with crimped or solid sweated lugs which are bolted to the busbar. Busbar clamps with bolted connections may be provided for neutral and earth busbars but tapped terminal strips with screws are not acceptable. Where lugs are crimped, evidence shall be submitted that the crimping technique used will comply with the requirements of BS 4579, Part I: "COMPRESSION JOINTS IN COPPER".

1.11.8. BOLTS AND NUTS

Only cadmium-plated high tensile steel bolts and hexagonal nuts may be employed at busbar joints and connection points. All nuts shall be provided with spring washers or be of the "NYLOCK" type with washers. The largest possible size bolt that will fit into holes in lugs and fixing holes of equipment shall be used in every instance. Bolts shall be of sufficient length that at least two but no more than five threads protrude beyond the nut.

1.11.9. BUSBAR COVERING

All busbars shall be covered with coloured heat-shrinkable insulating material equal to "RAYCHEM", "SIGMAFORM" or "AIRSHRINK" products. The colours shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two layers of coloured insulating paint.

1.11.10. EARTHING OF METAL PARTS

All non-current carrying metal parts of the cubicle e g framework, steel canopy, etc, shall be bonded to the earth bar.

1.12. WIRING

1.12.1. CABLING

Incoming and outgoing cables shall be terminated on the gland plate. Cables up to 70 mm^2 may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. All cable sizes larger than 70 mm^2 shall terminate on busbar stubs which shall be connected to the associated equipment. Parallel incoming and outgoing cables shall be connected to a collector busbar without crossing the conductors.

1.12.2. CURRENT RATINGS

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit breaker or fuse protection of the circuit. The smallest conductor size to be used for power wiring shall be 2,5 mm^2.

The following table shall be applied for ambient temperatures up to 30 °C. For higher ambient temperatures the values shall be derated as prescribed by SABS 0142, Table 10.

Table 3: Conductor Copper Rating (A)

NOMINAL CROSS SECTION (mm^2)	CONDUCTOR COPPER RATING (A)				
	NUMBER OF CONDUCTORS IN BUNCH				
	1	2 - 3	4 - 5	6 - 9	10 and more
2,5	28	25	22	19	16
4	37	33	30	26	22
6	47	42	38	33	28
10	64	54	51	44	38
16	85	76	68	59	51
25	112	101	89	78	67
35	138	124	110	96	88
50	172	154	137	120	103
70	213	191	170	149	127

1.12.3. INTERNAL WIRING

Standard 600/1 000 V grade PVC-insulated stranded annealed copper conductors to SABS 150 shall be used for the internal wiring.

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.

Joints in the wiring are not acceptable.

Where conductors change direction, smooth bends shall be formed with a radius of at least five times the outside diameter of the conductor.

1.12.4. END CONNECTIONS

The supply end connections to equipment shall be at the top and the load end connections at the bottom.

1.12.5. CONDUCTOR TERMINATION

All conductors terminating on equipment with screwed terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor with the correct amount of insulation removed from the end to fit into the lug. Strands may not be cut from the end of the conductor.

Connections to circuit breakers, isolators or contactors shall be installed 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.

1.12.6. IDENTIFICATION

The colour of the conductors for all 220/250 V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors for control circuits, etc, shall be coded in colours other than those specified above. The devised colour codes shall be shown on a wiring diagram. Coloured PVC or other tape will not be acceptable for colour coding.

1.13. MOUNTING OF EQUIPMENT

The mounting of equipment shall comply with SABS 1180 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers. Self-tapping screws will not be accepted.

Equipment shall be arranged and grouped in a logical fashion.

All equipment shall be flush mounted behind panels with only circuit breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position by 6 mm studs and hexagonal chromed brass dome nuts and washers or hank nuts or "DZUS" or "CAMLOC" fasteners. Self-tapping or similar screws are not acceptable.

Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed so that fixing holes do not need to be drilled through the front panel.

1.14. ACCESS

All equipment, busbars and wiring shall be completely accessible with the door open and the back door and front cover panel removed.

1.15. LABELLING

All equipment shall be fully labelled and accurate descriptions and safety warning notices shall be given in both official languages.

Engraved treffolite shall be used for labels with black letters on a white background. The labels shall be riveted to the kiosks.

The following labels shall be supplied as a minimum requirement:

a) Number and allocation of kiosk,

e g KIOSK B26

(Lettering: At least 30 mm high. Label on the outside in a prominent position).

b) Designation of circuit i e circuit breaker, isolator, meter, etc.

e g HOUSE 473
HUIS 473

POMPTOEVOER
PUMP SUPPLY

(Lettering: At least 5 mm high. One label installed directly below each item of equipment pertaining to the particular circuit shall be provided).

The main switch shall be labelled in accordance with the regulations.

The function and circuits of all other equipment shall be clearly identified. Flush mounted equipment within the front panel shall be identified by labels fixed to the front panel. The labels for all equipment installed behind panels shall be fixed to the support panel close to the equipment.

The labels shall be secured by means of rivets. Self-tapping screws are not acceptable. Labels shall not be glued to their mounting positions. Sufficient fixing points shall be provided to prevent labels from warping.

All label designations shall be confirmed with the Engineer before manufacture.

1.16. NOTICES

At least one lightning type notice shall be mounted outside on the front of the kiosk. This notice shall be riveted to the steel or cast iron door so that they cannot easily be removed. Brass rivets shall be used. In the case of fibreglass housings, the notices shall be laminated into the fibreglass except for the designation label.

1.17. INSPECTION

The Engineer shall be notified at least two weeks in advance of the completion of the kiosks in order that an inspection may be carried out before delivery.

1.18. DRAWINGS

1.18.1. DRAWINGS FOR APPROVAL

a) A set of three prints of the shop drawings of the kiosks shall be submitted to the Engineer for approval before manufacture commences. The following information shall be presented:

b) Schematic and wiring diagrams.

c) A complete layout of the internal arrangement of the kiosks showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall be shown.

d) All labelling information in both the official languages on a separate sheet.

The makes, catalogue numbers and capacities of all equipment scheduled on a separate sheet.

A detail drawing of the concrete plinth showing concrete mixes, dimensions, opening sizes, steel reinforcing details and holding down bolts fixing details.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the mini-substations according to the requirements of this Specification.

1.18.2. FINAL DRAWINGS

A complete set of "as built" transparent drawings of the kiosks shall be submitted to the Engineer within two weeks after delivery. The information called for above shall be provided.

1.18.3. COMPLETION

The supply contract shall be regarded as incomplete until all drawings have been handed to the Engineer.

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GSE08 – GENERAL SPECIFICATION ELECTRICAL

PVC INSULATED CABLES

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1. GENERAL

This section covers the requirements for PVC-insulated cables for general installations under normal environmental conditions for distribution purposes. All distribution cables shall comply with the general minimum requirements are specified in NRS074-1:2016, NRS074-2:2011

2. CONSTRUCTION

Cables shall be manufactured in accordance with SANS 1507, shall come only from fresh stocks, and shall be constructed as follows:

a) Unarmoured cables: PVC-insulated/PVC-sheathed
b) Armoured cables : PVC-insulated/PVC-bedded/armoured/black extruded PVC outer sheath
c) Single core cables : PVC-insulated/unsheathed.

The conductors shall be of high conductivity annealed stranded copper and the cores may be shaped or circular.

The insulation shall be general purpose PVC, 600/1 000 V grade.

The bedding shall consist of a continuous impermeable sheath of PVC extruded to fit the core or cores closely and in the case of multi-core cables, to fill the interstices between the cores.

When armouring is specified it shall consist of one layer of galvanised steel wire in the case of multi-core cables and non-magnetic metallic wire in the case of single core cables. Aluminium strip or tape armouring is not acceptable.

Where specified, an earth continuity conductor shall be provided in the armouring in accordance with SANS 1507.

The preferred conductor sizes are as follows:

Table 1: NRS074-1:2017 Preferred conductor sizes

1	2
Number of cores	**Conductor size** mm^2
2	16
3	25 and 70
4	16, 25, 35, 70, 120, 150, 185 and 240

3. CABLE TERMINATIONS AND JOINTS

3.1. HEAT-SHRINKABLE MATERIALS

Heat-shrinkable materials may only be used in exceptional circumstances with the written permission of the Engineer.

The complete kit shall be packed in a container that is marked for the type of cable insulation and construction as well as the voltage range for which the materials are suitable.

An illustrated set of instructions for the installation of the materials shall accompany every kit.

The joints and terminations shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk onto the termination or joint, is preferred above other methods.

The heat-shrinkable and other materials used for the terminations and joints shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

3.2. TERMINATIONS WITH HEAT-SHRINKABLE MATERIALS

Terminations shall be made of a material that gives lasting protection against ultraviolet radiation.

The cores of all cables terminated outdoors and the cores of 3,3 kV and higher voltage cables terminated indoors, shall be completely covered with a shrunk-on protective layer against surface tracking, ultraviolet radiation and weathering.

Outdoor terminations shall be designed to prevent flashover under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk-on insulating spacers and rain shields.

3.3. JOINTS WITH HEAT-SHRINKABLE MATERIALS

The electrical continuity of all the conductors, screens and armouring shall not be impaired by the joints and the earth continuity shall be accomplished within the joints, i e no external earth continuity conductor that will be subject to corrosion, is acceptable. The joints shall be completely covered by a watertight sheath to prevent corrosion.

In the case of joints in cables with an outer PVC anti-electrolysis sheath, the joints shall be subject to the same electrical insulation test as the outer sheath of the cable.

3.4. RESIN FILLED JOINTS

The resin filled joint kit shall comprise a self sealing plastic mould of high mechanical strength having sufficient connector space.

The exact amount of cold hardening resin shall be provided in a two-compartment plastic bag.

The resin shall have absolute minimum shrinkage.

The mould and resin shall be completely waterproof and non-hygroscopic and shall be resistant to ultraviolet radiation.

Joint kits shall be "SCOTCHCAST", "CELLPACK" or similar.

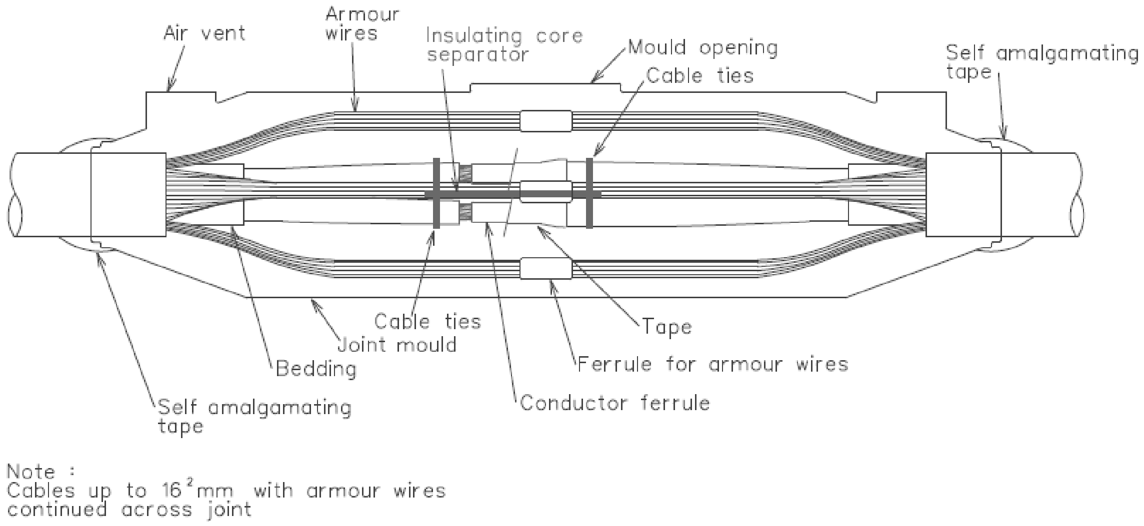

Figure 1: NRS074-2:2011 Cast resin joint up to 16mm^2

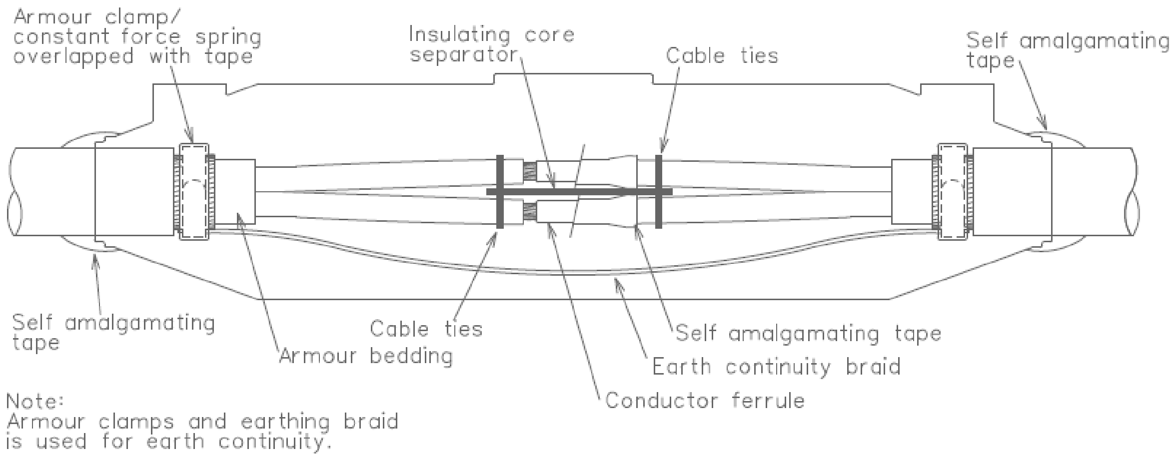

Figure 2: NRS074-2:2011 Cast resin joint

3.5. CABLE BOX JOINTS

Cable boxes shall be manufactured of die cast aluminium material for normal conditions or glass fibre reinforced thermosetting compound where exposed to corrosive conditions.

The lid shall provide an absolute moisture barrier.

Boxes shall contain 2, 3 or 4 entries as required.

Unused entries shall be sealed with watertight blanking plugs.

Earth continuity shall be maintained through the box by means of the material of the box in the case of aluminium boxes or by means of earth straps and studs in the case of glass fibre reinforced boxes.

Cable boxes shall be "PRATLEY", "CCG HANDIFIT" or similar manufacture.

3.6. GLANDS FOR PVC-INSULATED CABLES

Glands to be used for terminating PVC/PVC/SWA/PVC cables shall be of the adjustable type.

Glands shall be suitable for general purpose 600/1 000V grade cable with steel armouring.

The glands shall be made of nickel-plated bronze or brass.

The glands shall consist of a barrel carrying a cone bush screwed into one end and a nickel-plated brass nipple carrying a nickel-plated brass or a heavy galvanised steel locknut screwed into the other end. The galvanising shall comply with SANS 763.

Non-watertight glands must be easily converted to watertight glands by means of a waterproofing shroud and inner seal kit. On the cable entry side of the barrel a concave groove shall be provided to accommodate the top rim of the waterproofing shroud.

The shrouds shall be made of non-deteriorating neonprene or other synthetic rubber, and shall be resistant to water, oil and sunlight. The shrouds shall fit tightly around the glands and cable.

Glands shall be provided with ISO threads and shall be suitable for the specified cable sizes.

Flameproof glands shall comply with SANS 808, Groups 1, 2a and 2b.

Suitable accessories shall be provided with glands to be used on ECC armoured cables to facilitate a bolted lug connection of the earth continuity conductors. Grooves cut into the barrel or cone bush to accommodate the earth continuity conductors are not acceptable.

For unarmoured cables the cone bush and compression ring of the gland shall be replaced with a synthetic rubber compression bush and ring to provide the required grip on the outer sheath of the cable.

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GSE09 – GENERAL SPECIFICATION ELECTRICAL

INSTALLATION OF CABLES

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1. GENERAL

It shall be duly noted that any specific requirements in the Project Specification, drawings or Bill of Quantities shall take precedence over the General Specification.
Cable installations shall comply with the requirements outlined in all parts of SANS 10198 (latest).

1.1. CABLE TYPES

a) All cables and jointing and termination accessories used for power distribution shall comply with the Project Specifications contained herein.

b) All unarmoured cables shall be installed in metal trunking, sleeves or conduit unless clearly specified to the contrary.

1.2. COMPETENCE OF PERSONNEL

It is a definite requirement that the Contractor shall only employ personnel fully conversant with cable manufacturer's recommendations for joining and terminating cables.

2. IDENTIFICATION OF CABLES

Cables shall be identified at all terminations by means of punched metallic bands or marked with labels or tags. The use of PVC tape with punched characters is not acceptable.

The identification numbers of cables shall be shown on "as built" drawings of the Installation.

Phase colour clicks shall be installed to all MV pole terminations and MV switchgear terminations shall be clearly marked with coloured tape and painted discs. Painted stickers shall not be accepted.

3. TRENCHING

3.1. GENERAL

The Contractor shall be responsible for all trenching excavations unless specified to the contrary.

The Contractor shall appoint a professional land surveyor to peg all cadastral boundaries, servitudes and any R.O.W. As trench excavation progresses the contractor's surveyor shall survey the trench position and submit in CAD format to the Engineer for approval prior to any cable being installed. Following installation of the cable the contractor's surveyor shall survey the coordinates of all bends, joints and terminations and submit to the Engineer to include into the as-built information.

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.

The Contractor shall acquaint himself with the position of all the existing services such as storm water pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose he shall approach the Engineer's representative, the local municipal authority and any other authority which may be involved, in writing.

The Contractor will be held responsible for damage to any existing services brought to his attention by the Engineer and shall be responsible for the cost of repairs.
The Contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.
The Contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site constructions or other property.

3.2. MECHANICAL EXCAVATORS

Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to the 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.

3.3. 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 Engineers and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

3.4. 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 and shall be clearly marked by the Contractor on the as-built information.

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.

3.5. 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 Machinery and Occupational Safety Act.

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.

3.6. 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 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. Excavated material shall be placed at least 500 mm from the edge of the boundary side of the trench to prevent material falling back into the trench and to allow space to move along the trench.

Surplus material shall be removed from site and disposed of at the cost of the Contractor.

Trenches across roads, access ways or footpaths shall not be left open. If cables cannot be laid immediately the Contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.

The Contractor shall ensure proper repair of all surfaces to its prior condition (i.e. tar, paving, gardens, etc.)

In the event of damage to other services or structures during trenching operations the Contractor shall immediately notify the Engineer and institute repairs.

Prior to cable laying the trench shall be inspected thoroughly 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 other damage or electrolytic action, the Engineer shall be notified before installing the cables.

The Contractor shall appoint a Surveyor to peg all cadastral boundaries along the route. The Surveyor's cost will be for the Contractor's account.

Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyor's pegs are disturbed, they shall be replaced by a person qualified to do so at the Contractor's cost.

The Contractor shall be responsible in ensuring that adequate barricading is installed and maintained until the trenches are backfilled. The maximum length of trench to be opened at any point in time is 400m after which the respective cable shall be laid. 24hr armed security shall be provided by the Contractor where cables are installed.

3.7. DIMENSIONS OF TRENCHES

Cable trenches for one or two cables shall not be less than 300 mm wide and need not be more than 450 mm wide. Depending on the cable spacing specified the dimension shall be valid for the total trench depth.

The width shall be increased where more cables are installed to allow for the spacings.

Where trenches change direction or where cable slack is to be accommodated, the Contractor shall ensure that the requirements of the relevant SANS Specification regarding the bending radii of cables are met when determining trench widths.

Trench depths shall be determined in accordance with cable laying depths and bedding thickness.

Excavation and backfill shall be certified in linear meter according to the trench dimensions specified, volumetric claims will not be entertained.

3.8. JOINT HOLES

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.

3.9. BEDDING

The bottom of the trench shall be filled across the full width with a 50 mm layer of suitable soil sifted through a 2 mm mesh and levelled off.

Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1,2 °C m/W) may be used for this purpose. Sea or river sand, ash, chalk, peat, clinker or clayey soil shall not be used. Building sand is preferred.

Where no suitable soil is available on site, the Contractor shall import fill from elsewhere and make all the necessary arrangements to do so. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations. Where local excavated soil is used for bedding and adequate thermal resistivity is proven, the saving shall be given through to the Employer.

After cable laying a further layer of bedding shall be provided to extend to 50 mm above the cables.

The bedding under joints shall be fully consolidated to prevent subsequent settling.

3.10. CABLE SLEEVES

Where cables cross under roads, railway tracks, other service areas, etc. and where cables enter buildings, the cables shall be installed in Class 6 HDPE/HPVC pipes.

Pipes shall be joined in accordance with the manufacturer's instructions.

Sleeves shall cross roads and railway tracks at right angles.

Sleeves shall have a minimum diameter of 110 mm. They shall extend at least 2 m beyond the tracks of a railway line or of the outermost tracks where there is more than one line. In the case of roads, the sleeves shall extend at least 1.5m beyond the road edge or kerb on both sides of the road.

All sleeves shall be graded 1:400 for water drainage.

Galvanised metallic sleeves up to and including 76 mm dia. shall also be supplied and installed by the Contractor.

Where main MV supply cables are installed into sleeves, such sleeves shall be filled with a bentonite mixture to assist with thermal dissipation.

The ends of all sleeves shall be supplied and installed by the Contractor.

The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

Sleeve ends shall be fixed to natural ground by means of an approved method (concrete fixtures/heavy sand bags with metal “droppers”) to prevent slippage during installation.

3.11. 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 all electric cables a coloured plastic marking tape shall be installed 400 mm above the cable. The tape shall be yellow, with a red skull and crossbones with the words "ELECTRIC CABLE/ELEKTRIESE KABEL". These markings shall not be more than 1 m apart from centre to centre.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material is 75 mm.

The Contractor shall have allowed in his tender for the importation of suitable backfill material if required.

The backfill shall be compacted in layers of 150 mm 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.

A water cart shall be used during backfilling to moisten backfill material.

On completion, the surface shall be made good to match the surrounding area. DCP test certificates shall be provided to prove compaction is equal or harder than undisturbed natural ground. Positions for tests shall be indicated by the Engineer, the Contractor shall allow for a DCP test every 200 m.

In case of roadways or paved areas the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

3.12. CABLE MARKERS (FOR MV CABLES ONLY, EXCEPT WHERE OTHERWISE SPECIFIED)

Cable markers shall be provided along all MV cable routes but need only be provided along LV cable routes where specified.

Cable markers shall consist of concrete blocks in the shape of truncated pyramids, approximately 300 mm high, 150 x 150 mm at the top and 250 x 250 mm at the bottom.

Metal plates shall be cast into the tops of the blocks in such a manner that they cannot be prised loose. The wording "ELECTRIC CABLE/ELEKTRIESE KABEL" shall be stamped on the brass plates as well as direction arrows and the cable voltage rating.

Cable markers shall be installed on the surface along all the underground routes and shall project 35 mm above normal ground level unless the projected markers could be a hazard to pedestrian or other traffic in which case they shall be installed flush with the surface.
Cable markers shall be installed at the beginning and end of a cable run (e.g. where a cable enters a substation or building) at all changes of direction, above all joints, above cable pipe entries and exits and at intervals not exceeding 50 m along the cable route.

The position of cable markers shall be indicated on the "as built" drawings.

3.13. PROVINCIAL ADMINISTRATION AND NATIONAL ROAD OR RAILWAY CROSSINGS

The Contractor shall not trench beneath any railway tracks without the SAR Administration's supervision. The Contractor shall request the Engineer timeously to arrange for the necessary supervision. The cost of such supervision will be paid for by the Engineer.

The Engineer will arrange for the necessary wayleaves and permission to cross SAR property and railway tracks, or Provincial or National road reserves and Postal Authority approval of proposed cable routes. The Contractor shall be responsible for all wayleave costs, conditions and maintenance of wayleave validity.

The Contractor shall carry out the crossing installation in strict accordance with the SAR and Provincial Administration's requirements and stipulations. Where these requirements are in contradiction with this specification, the Engineer's ruling shall be sought.

The Contractor shall ensure that he will comply with the various Administrations' requirements regarding crossing of Provincial and National roads, especially with regard to the safeguarding of the public. The Contractor shall also provide proof of adequate insurance cover against any claim from any accident as a result of work done by the Contractor during the crossing operation. The Engineer shall also be indemnified from all liability in this regard.
The Contractor shall liaise with the various Administrations well in advance regarding the intended dates, times and expected duration of the crossing operations and obtain their approval of the programme and method of operation before commencing with the work.

4. INSTALLATION OF UNDERGROUND CABLES

4.1. INSTALLATION DEPTHS

Cables shall be installed at the following minimum depths below final ground level:

Up to 1 kV	:	600 mm
Up to 11 kV	:	1 000 mm

All cable depth measurements shall be made to the top of the cable when laid directly in ground or to the top of the duct or sleeve where these are provided.

The above depths shall apply to the top layer where cables are installed in layers.

The Contractor may only deviate from the above depths provided prior authority in writing has been obtained from the Engineer. In this event the cables shall be protected with a suitable concrete covering.

The depth of cable pipes or ducts beneath railway lines or roads shall be not less than 1,1 m below the formation level.

4.2. CABLE SPACINGS

Cables installed in the same trench shall be laid parallel to each other with the following minimum spacings between cables (LV: up to 1 kV; HV: 1 kV to 11 kV):

LV/LV: 2 cables diameters

LV/MV: 300 mm minimum

MV/MV: 300 mm minimum

Where MV and LV cables have to be installed in the same trench, the MV cable shall be laid on the one side of the trench at a depth of 1000 mm and then covered with 300 mm of soil. The LV cable shall then be laid on the other side of the trench, i.e. not above the HV cable, and then completely backfilled.

Cables for telephones, communication systems and other low voltage systems (less than 50 Volt) shall be separated from power cables by at least 1 m. All control or pilot cables shall be laid at least 300 mm from power cables.

Cables shall not be buried on top of each other unless layers are specified. The minimum spacing between layers shall be 200 mm.

Shielding specifications shall be requested by the Contractor from the Engineer where the cable installation crosses or runs parallel to non-electrical services.

4.3. CABLE LAYING

Except where ducts, tunnels or pipes are provided, cables shall be laid directly in the ground.

The cable shall be removed from the drum in such a manner that the cable is not subjected to twisting for tension exceeding that stipulated by the cable manufacturer.

Cable rollers shall be used as far as possible to run out cables. Rollers shall be spaced so that the length of cable in the trench will be totally suspended during the laying operation and sufficiently close to prevent undue sagging and the cable from touching the ground. Rollers shall also be placed in the trench in such a manner that they will not readily capsize. Laying of the cable next to the trench at N.G.L. and “dropping” / installing into the trench, shall not be accepted.

Cable rollers shall have no sharp projecting parts liable to damage the cables.

Winches with a pilot draw cable for cables 7/50mm^2, shall be compulsory.

Where cables have to be drawn around corners, well-lubricated skid plates shall be used. The skid plates shall be securely fixed between rollers and shall constantly be examined during cable laying operations.

Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used and particular care shall be exercised to avoid abrasion, elongation or distortion of any kind. In the case of oil filled cables, a cable sock may never be used. Special eyes giving access to the interior of the cable must be utilised.

The maximum allowable tension when pulling a cable is 70 N/mm^2 of conductor area.
It will be assumed that the price or rates contained in the tender includes for the installation of cables in pipes and ducts or below existing or newly installed services. The Engineer shall be informed timeously of the intention to carry out all cable laying operations to allow an inspection of the works by the Engineer if so required.

5. INSTALLATION OF CABLES IN CONCRETE TRENCHES

5.1. GENERAL

This paragraph covers the installation of cables in building trenches, service ducts, etc. The trenches, ducts, etc. inside buildings will be constructed and installed by others.

5.2. INSTALLATION

Cables shall be installed in one of the following ways:

a) On horizontal cable trays.

b) On horizontal metal supports with suitable clamps.

c) On vertical cable trays or metal supports fixed to the side of the trench. The cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of the building trenches.

5.3. COVERS

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. The Contractor shall, however, be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other coverings as required.

Cables shall enter and exit the trench through sleeves protruding 300 mm beyond the covering. The sleeves shall be permanently secured in position and the open space between the cable and sleeves shall be sealed with a non-hardening, watertight compound.

5.4. FILLED TRENCHES

Where specified floor trenches shall be filled with sand.

If a sand filling is specified, the cables shall be fixed to non-corroding supports.

Sand-filled trenches other than in substations shall be covered in one of the following ways:

a) Reinforced concrete covers.

b) Sand and cement screed.

c) Removable chequer plates in steel edge frames.

Method a) above shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified allowance for a mass of 2 tons shall be made.

6. FIXING OF CABLES TO TRAYS OR STRUCTURES

6.1. INSTALLATION

Cables may be installed in one of the following ways:

a) On horizontal cable trays.

d) Against vertical cable trays with suitable clamps.

e) Against horizontal or vertical metal supports or brackets with suitable clamps.

f) On clamps which are fixed to the structure.

6.2. CLAMPS

Suitable clamps (cleats) which will secure cables without damage shall be used. Metal clamps or drilled hard wood blocks (Meranti/Teak) shall be used. Due to heat, metal clamps will not be approved for outdoor installations. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves that are bolted together. The correct clamp size to fit the cable shall be used (clamps to be pre-filed for specific cable O/D). Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

6.3. SPACING OF SUPPORTS

Two methods of supporting cables are found in practice. The most generally known method is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable. The alternative method is the unrestrained installation where the distance between supports should be great enough to ensure that there will be obvious sag in each span between supports.

6.4. SPACING OF SUPPORTS OF UNRESTRAINED CABLES

Large single core cables shall always be installed according to this method. Generally, single core cables with conductors exceeding a cross sectional area of 185 mm^2 should be supported at spacings in excess of 2 m since the sag between supports will safely accommodate any thermal expansion.

Reducing the spacing between the supports to 1,5 m or less shall be avoided at all costs, as expansion cannot be taken up by a change of sag and chances of sheath failure become considerable.

6.5. SPACING OF SUPPORTS OF RESTRAINED CABLES

The maximum spacing between cleats (clamps) to which cables are fixed in horizontal and vertical cable routes shall be determined from Table 1 below. Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multicore control cables shall be 20 times the outside diameter of the cable with a maximum spacing of 550 mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 900 mm for armoured cables.

Table 1: Cleat spacing

CROSS SECTIONAL AREA OF CABLE CONDUCTORS (mm^2)	MAXIMUM SPACING OF SUPPORTS (CLEATS) (mm) FOR RESTRAINED CABLES			
	WIRE ARMOURED CABLES AND UNARMOURED CABLES		OTHER THAN WIRE ARMOURED CABLES AND UNARMOURED CABLES	
	HORIZONTAL CABLE ROUTE	VERTICAL CABLE ROUTE	HORIZONTAL CABLE ROUTE	VERTICAL CABLE ROUTES
1,5	450	750	300	400
2,5	450	750	300	400
4,0	600	750	300	400
6,0	600	750	300	400
10,0	750	900	400	450
16,0	750	1000	400	550
25,0	900	1000	450	550
35,0	900	1000	450	550
Bigger than 35,0	900	1000	450	550

7. GROUPING AND SPACING OF CABLES IN BUILDINGS AND STRUCTURES

7.1. SPACING CORRECTION FACTORS

Cables shall be as a rule spaced two cable diameters apart, for which no grouping correction factor need be applied.

7.2. CABLES ON DIFFERENT LEVELS

Where parallel cable runs are installed at different levels (e.g. on parallel cable trays) and where the spacing of the layers is not specified, a minimum spacing of 300 mm shall be maintained.

7.3. SINGLE CORE CABLES

Where single core cables are installed along a three-phase circuit, the cables shall be installed in trefoil formation and shall have a non-metallic bound at 300 mm intervals.

7.4. MEDIUM VOLTAGE CABLES

Medium voltage cables shall be separated from other cables and services throughout the installation and shall as far as possible be installed in separate floor trenches, pipes or metal channels. Where this is not feasible a minimum spacing of 500 mm shall be maintained.

7.5. CABLES FOR OTHER SERVICES

Cables for telephones, communication systems and other low voltage systems (less than 50 V) shall be separated from power cables. In building ducts a physical barrier shall be provided between power cables and cables for other services. Where armoured cables are used for such other services, they shall be installed on separate cable trays or shall otherwise be at least 1 m away from power cables. Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

8. TERMINATION AND JOINTING OF CABLES

8.1. GENERAL

Cable ends shall be terminated with glands or in cable boxes with the associated accessories such as clamps, shrouds, etc. complying in all respects to the Engineer's quality specification.

Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear will be in the following positions:

No 1 conductor: left (red) (A)

No 2 conductor: centre (white) (B)

No 3 conductor: right (blue) (C)

Exposed armouring shall be covered with bitumen-based paint.

All cable ends shall be supplied with the necessary earth connection.

A P4000 "SANKEYSTRUT" channel or other approved means of support shall be provided to remove mechanical stress from the glands.

Cable cores shall be marked with heat-shrunk sleeves where necessary to identify the phases.

The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

Cables shall be determined in accordance with the recommendations laid down by the manufacturers of the cables and glands employed.

8.2. TERMINATION OF PAPER-INSULATED CABLES

Where compound filled cable terminations are specified such ends shall be terminated in cable end boxes filled with bituminous, cold filling or resin oil semi-fluid compound or heat-shrinkable terminations. The cable box compound / Penetrox shall be penetrol cable ends - soft solid petroleum jelly based insulating compound type LECTROL-DG Penetrol complete with Rand Mine type cable end with linen tape soaked in Mineral Insulating Oil as manufactured by Fuchs and distributed by CENTRALEC (Cable accessories & distributors). Guroflex MV is not compatible with PILC cables and shall only be accepted with the application to XLPE cables.

Before terminating or jointing paper-insulated cables, a test to establish the presence of moisture must be carried out.

The following procedure may be followed:

a) Place an adequate quantity of cable impregnating oil in a suitable container and heat up to 130 °C ± 5 °C.

b) Cut a small length (± 300 mm) of the cable concerned and remove the armouring and sheath, taking care not to handle the dielectric in any way.

c) Dip a section of the outer insulating impregnated paper (belt paper) in the heated oil, taking care not to contaminate the tapes with moisture from the hands. If frothing appears on the surface of the oil, this is a clear indication of the presence of moisture in the paper.

d) The same procedure should then be repeated on the insulating impregnated paper around the cores (especially those layers closest to the cores). Frothing will also indicate the presence of moisture.

e) Should only a small number of bubbles appear on the surface of the oil, this is an indication of air bubbles on the paper and not moisture since the presence of moisture will result in a series of bubbles rising to the surface of the oil for a number of seconds, until all the moisture has been removed.

The armouring shall be bonded to the main earth bar of the switchgear or transformer, but the bond shall be easily removable for testing purposes.

The lead sheath shall be wiped against the conical wiping gland.

All cut cable ends which will be exposed to the atmosphere for more than 2 hours shall be sealed and wiped to prevent penetration of moisture.

8.3. TERMINATION OF XLPE CABLES

A prefabricated system based on pre-moulded slip-on EPR stress cones is allowed.

The copper tapes of the earth screen on the cable shall be bonded to the main earth bar of the switchgear or transformer but the bond shall be easily removable for testing purposes.

The cable shall be firmly secured on the switchgear by means of a clamp to prevent mechanical stress on the cable and terminations.

8.4. TERMINATION OF PVC-INSULATED CABLES

The glands shall be fitted in accordance with the cable and gland manufacturer's instructions.

The correct size and type of gland shall be used for the particular cable and application.

8.5. CONNECTION OF CABLE CONDUCTORS

Suitable lugs shall be used, preferably solidly sweated to the cable conductor ends. 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".

Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug.
Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductor, need not be lugged but the correct terminal size shall be used.

Ferrules shall be used as far as possible where cable conductors are connected directly to equipment with screws against the conductor strands.

When cutting away insulation from cable conductors to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs.

8.6. JOINTS

Joints in cable runs will not be allowed unless specified in the Project Specification or authorised by the Engineer.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions and by personnel competent in jointing the types of cables used.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. Where necessary a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the hole shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The joint shall not impair the anti-electrolysis characteristics of the cable.

The Contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer at the cost of the contractor.

Cable joints on XLPE-insulated cables shall be of the heat shrinkable type and shall be based on a pre-prefabricated system utilising pre-moulded slip-on stress cones.

LV cable joints shall be of the epoxy-resin type.

Joints shall be fully water- and air tight and shall be free of voids and airpockets.

The crossing of cores in joints will not be permitted under any circumstances.

9. TESTING

Factory test certificates for all MV cables shall be provided prior to delivery.
Type test certificates shall be provided by the contractor for cables to be used, certificates shall be in accordance with SANS 1507-3 (up to 1 kV) for PVC cables and SANS 97 (up to 11 kV)

for XLPE cables and SANS 1339 for paper cables as well as the requirements of the Local and Supply Authorities.

All commissioning tests in accordance with SANS10198-13 shall be performed following installation.

LV cables shall be tested by means of a suitable megger at 1 kV and the insulation resistance shall be tabulated and certified.
HV cables shall be pressure tested in accordance with the table below and the exact leakage current shall be tabulated and certified.

The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The cost of testing shall have been included in the tender price.

The Contractor shall notify the Engineer timeously so that a representative of the Engineer may witness the tests.

Table 2: Commissioning test voltages for newly installed individually screened MV cables

1	2	3	4
Cable operating voltage kV	**VLF test voltage sine** kV	**VLF test voltage cosine rectangular** kV	**Power frequency test voltage** kV
6.6	11	16	8
11	19	27	13
22	38	54	25
33	57	80	38
NOTE 1: The voltages given are root mean square (r.m.s) values. The r.m.s. value of a cosine rectangular voltage is equal to the peak voltage. NOTE 2: Where test levels cannot be achieved or where limitations are placed on the maximum test voltage by the equipment (e.g. switchgear) connected to the cable, a reduced voltage for an extended duration may need to be considered and agreed to.			

Table 3: Commissioning test voltages for newly installed belted MV cables

1	2	3	4	5	6	7
Cable operating voltage kV	**Test Voltage**					
	Belted Cables					
	Between conductors			**From conductor to sheath**		
	VLF test voltage sine kV	**VLF test voltage cosine rectangular** kV	**Power frequency test voltage** kV	**VLF test voltage sine** kV	**VLF test voltage cosine rectangular** kV	**Power frequency test voltage** kV
3,3/3,3	10	14	7	10	14	7
3,8/6,6	16	22	11	16	22	11
6,6/6,6	20	28	13	20	28	13
6,35/11	27	38	18	27	38	18
11/11	33	47	22	33	47	22
NOTE 1: The voltages given are root mean square (r.m.s.) values. The r.m.s. value of cosine rectangular voltage is equal to the peak voltage.						

NOTE 2: Where test levels cannot be achieved or where limitations are placed on the maximum test voltage by the equipment (e.g. switchgear) connected to the cable, a reduced voltage for an extended duration may need to be considered and agreed to NOTE 3: Single-phase test voltages used on site dictate that during the test on each core, the other cores, metallic screen and armouring should all be earthed. The test voltage will therefore be applied between the tested phase and the other phases, and at the same time between the tested phase and the metallic screen. Consequently, the between-conductors and from-conductor-to-sheath test voltages are equal.

On completion of the tests on any cable, the Contractor shall without delay, submit three copies of the certified Test Reports to the Engineer.

10. MEASUREMENTS

All measurements for payments shall be made jointly by the representatives of the Engineer 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 of the trench sides, other earth movements or for trenches excavated in excess of the stipulated dimensions.

The classification shall be as follows:

Very hard rock: shall mean rock that can only be excavated by means of explosives.

Hard rock: shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness, solid shale and boulders in general requiring the use of jack hammers and other mechanical means of excavations.

Soft rock and earth: shall mean rock and earth that can be loosened and removed by hand-pick and shovel.

Where very hard rock and 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.

All cable lengths indicated in the Detail Technical Specification and/or shown in the cable route drawings shall be regarded as estimates and are given for tendering purposes only. The successful tenderer shall measure actual cable lengths on site before ordering.

The final price for the supply and installation of all cables will be adjusted, on the basis of the actual lengths of installed cables, in accordance with the unit rates quoted at the time of tendering. Cable lengths shall be measured on site to the nearest 500 mm for this purpose and surplus cable will not be paid for.

11. COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. Such inspections will, however, not deem the portions inspected as being complete or accepted and the Contractor shall remain responsible for completing the installation fully in accordance with the Contract Documents.

The Contractor shall carry out a final "as built" survey of the cable routes and present to the Engineer "as built" route plans of the complete installation. The following information shall be reflected on the plans or submitted as separate schedules with the plans:

a) Overall length of each cable.

b) Locations (surveyed co-ordinates) of all joints (if any) in relation to permanent reference points. Dimensions shall be shown and the method of triangulation i.e. two dimensions to each joint, shall be used.

c) Identification of each cable and transpositioning points. The works will be deemed to be incomplete until all tests have been conducted successfully and all "as built" drawings and schedules have been handed to the Engineer.

d) Any deviations from a linear straight line due to obstructions.

SIGNED ON BEHALF OF TENDERER : ________________________________

COMPANY NAME : ________________________________

SIGNATURE : ________________________________

NAME IN BLOCK LETTERS : ________________________________

DATE : ________________________________

GSE14 – GENERAL SPECIFICATION ELECTRICAL

INSPECTION, TESTING AND HANDOVER

TABLE OF CONTENTS

1. DEFINITIONS

1.1. For the purposes of this document, terms used herein or in accompanying documents shall have the following meaning:

1.2. **“Agreement”** shall mean the agreement entered into between the Employer and the Contractor for the execution of the accepted Tender Price or accepted quotation;

1.3. **“Schedule of Quantities”** or **“Pricing Schedules”** or **“Bills of Quantities”** shall mean the document attached to a Tender Document or Quotation in which the quantities of work, labour, materials and articles required for the execution of the Contract will be entered , together with the rates or prices for such items;

1.4. **“Schedule of Prices for Variations”** shall mean the schedules attached to a Contract Document or Quotation in which the amounts to be added to, or deducted from the Contract Amounts are entered according to whether the items mentioned in the said schedule are extra to or omitted from the Contract as may be provided for in the General Conditions of Contract;

1.5. **“Contract” or “Contract Documents”** shall mean and include the Conditions of Tender, General Conditions of Contract, Special Conditions of Contract, Project Specifications, Schedules of Quantities or Pricing Schedules or Bills of Quantities, Schedule of Prices for Variations, Drawings, Form of Tender, Letter of Acceptance and the Agreement to follow there on and shall include such printed matter or explanatory memorandum submitted by a Tenderer with his tender as may be acceptable to the Employer;

1.6. **“Contract Price”** or **“Contract Sum”** shall mean the amount entered in the Form of Tender for the whole of the Works done or materials supplied for the Works, subject to additions or deductions as may be made in terms of the Contract;

1.7. **“Contractor”** shall mean the person or persons, partnership, firm or company, whose tender for the work referred to in the Contract has been accepted by the Employer or who has or have signed the Contract, and shall include his or their heirs, executors, administrators, judicial managers, trustees, successors in title and duly appointed representatives.

1.8. **“Employer”** or the **“Client”** shall mean the Owner of the completed Works or the official body who acts as the representative of the Owner and shall include their duly appointed representatives.

1.9. **“Drawings”** shall mean the drawings, sketches, diagrams, maps, plans, sections and other delineations which accompany or are referred to in the Contract Documents, and which have been signed by the Engineer and such further drawings as may be issued or approved by the Engineer relating to the works, whether such further drawings indicate variations of the Works, whether by way of addition, alteration or omission, or merely elaborate the signed Drawings in greater detail.

1.10. **"Engineer"** shall mean the Engineer duly appointed by the Employer to act on his behalf for the purpose of a Contract.

1.11. **“Order in Writing”** shall mean any printed, typewritten or written document or letter signed by the Engineer and addressed to the Contractor for the purpose of his guidance and directions.

1.12. **“Site”** shall mean the land and/or place to which Works is to be delivered or where work is to be executed or carried out under a Contract and any other land and/or place acquired or used by the Contractor in connection therewith, and includes any place wherever anything is manufactured, excavated or stored for the purpose of carrying out a Contract, together with so much of the area surroundings the said place or places as the Contractor shall with the consent of the Engineer actually use in connection with the Works otherwise than merely for the purpose of access to the said place or places;

1.13. **“Specification”** shall mean the section in the Contract document in which the detail method and standard of executing the Work and the nature of the materials to be used or supplied are described;

1.14. **“Plant”**, **“Work”** or **“Works”** shall mean all equipment, plant, materials, articles, matters and items comprised by, described in, or referred to in the Contract Documents and which are to be manufactured and/or delivered, constructed, erected and completed. These shall include all those details which are not particularly mentioned in the aforesaid Documents, nor shown upon the Drawings, but which are requisite for the perfect completion of each and every one of the several parts, and all additional Works that may be ordered to be executed according to the true intent and meaning of the Contract plus the maintenance for the prescribed period;

1.15. **“Standard Practice”** shall mean the methods and means of working normally as employed by the Employer;

1.16. **“Sub-Contractor”** shall mean the person or persons, partnership, firm or company named in the Contract for any part of the Work or to whom any part of the Contract has been sublet with the consent in writing of the Engineer and the legal representatives, successors and assigns of such person or persons, partnership, firm or company and all specialists, merchants, tradesmen or others executing any Work or supplying any goods for which prime cost prices or provisional sums are included in the Specification or Bill of Quantities and Prices who may at any time be nominated, selected or approved by the Engineer;

1.17. **“Tests on Completion”** shall mean such tests as are prescribed by the Specification to be made by the Contractor before the Works is taken over by the Employer;

1.18. **“Construction Equipment”** shall mean all the materials, machinery, implements, tackle, vehicles, barrows, tools, etc. provided by the Contractor, for the due performance of the Contract, but not essentially forming part of the Contract.

1.19. “**OEM”** shall mean the Original Equipment Manufacturer for any product or equipment required as part of this project.

1.20. **“In writing”** shall mean type written script or printed communication matter transmitted via land mail or via e-mail, or delivered by hand, to the Engineer.

1.21. Words imparting the singular only shall also include the plural and vice versa where the context so requires. The headings or notes in these General Requirements shall not be deemed to be part thereof, or be taken into consideration in the interpretation or construction thereof or of the Contract.

2. RESPONSIBILITY OF THE CONTRACTOR

2.1. Until the Contract Works have been completed or deemed to have been completed, the Contractor shall be responsible (subject to the Memorandum of Agreement and the Conditions of Contract) for the Contract Works, whether under construction, during tests, or in use for service.

2.2. The handling and storage of materials and equipment near the erection site prior to installation shall be done in a tidy and safe manner. The Contractor shall at his own expense, keep the site area allocated to him, and the erection area of the Contract Works, reasonably clean and shall remove all waste material as it accumulates, and as directed by the Engineer from time to time. There shall be no Safety, Health, Environmental or Quality impact due to the installations carried out and the Contractor shall take full responsibility for all construction methodologies.

2.3. Storage of materials shall not be permitted without prior approval, and the Contractor shall take all necessary steps to protect any materials stored on the site.

2.4. The Employer reserves the right to be under no obligation to pay for material delivered to or off site, and shall take preference for payment to the Contractor after commissioning of the works. When the work is completed, the Contractor shall remove all rubbish and debris, unused materials, temporary erections and plant and shall leave the site of the work clear. The Contractor shall also make good at his own expense, any damage caused to buildings, plant or property belonging to the owner of the works.

2.5. Damage to any existing infrastructure will result in major repairs, for which Empoyer did not allow for in their budgets for this Contract.

3. RE-LABELLING

3.1. The Contractor shall be responsible to attend to all labelling requirements that arise with any system installation as the root cause. All labelling requirements shall be allowed for in the unit rates of the Contractors priced bill of quantities. A schedule of labels shall be compiled by the Contractor and submitted to the Engineer for approval.

4. ORDERING OF MATERIAL AND EQUIPMENT

4.1. Contractors must note that materials and equipment on long delivery shall be ordered well in advance as late deliveries will be the Contractors sole responsibility. Any applicable escalation on equipment or materials ordered late will be calculated using indices suitable to the Employer. If, for some reason, late deliveries are found to be to the advantage of the Employer, the Contractor will be instructed in writing regarding the delay in ordering of such materials.

4.2. The successful Tenderer shall attend meetings at venues and at times, as may be arranged by the Engineer, after having been advised that his/her Tender has been accepted, for the purpose of coordinating the technical requirements and the time frame of the project, so that orders can be placed for the correct materials.

4.3. Unless otherwise indicated or stated, all units of measurement indicated in the Pricing Schedules, Schedule of Quantities or Bills of Quantities are metric units.

4.4. The linear quantities of wire, conduit, trunking, cables, switchgear, fittings etc. as given in the Pricing Schedules, Schedule of Quantities or Bills of Quantities are normally measured from scaled drawings for Contract document compiling purposes. Contractors can thus not accept that such quantities are accurate when materials are ordered and Contractors shall measure such quantities on site before orders are placed, as they will not be paid for excess material on site after the completion of the Contract.

4.5. If such measurements cannot be taken at the onset of the Contract, the Contractor shall obtain approval from the Engineer to order the required materials that may cause delays or additional cost due to escalation before ordering such materials as allowed for in the Pricing Schedules, Schedule of Quantities or Bills of Quantities.

5. DELIVERY OF EQUIPMENT

The Contractor shall make the necessary arrangements to get all equipment delivered to site in accordance with the Programme of the Works and in an undamaged condition.

5.1. The Contractor shall pack equipment and material for transport and delivery in soundly constructed crates or other packages fitted with removable lids or openings for inspection.

5.2. All parts of the equipment prior to packaging, shall have been thoroughly protected to preclude damage during transport and storage.

5.3. Any damage that may occur in transit or storage must be repaired, corrected or replaced by the Contractor before such materials or equipment is installed. Any parts of items found to be defective after installation on site, shall be replaced or repaired at the Contractor's expense, to the Engineer's approval.

5.4. The Contractor shall be responsible for the acquisition of any insurance cover that may be required for equipment in transit and temporary storage on and off site.

5.5. All the lifting and erection equipment required by the Contractor to off-load, install or erect equipment on site is deemed to have been allowed for by the Contractor in the Contract price, as no assistance in this regard will be provided by the Employer or other Contractors.

5.6. If no item has been measured in the Pricing Schedules, Schedule of Quantities or Bills of Quantities for such handling equipment, the rate of the item to be handled shall include such handling costs.

5.7. Materials stored off-site must be repacked or protected, after inspection, to provide the necessary protection thereof for transport to site.

6. PAYMENT FOR STORED MATERIALS

6.1. The Engineer will not issue any certificate for interim payment of any equipment and material that is stored on or off site in such a way as to hinder inspection thereof.

6.2. The Employer reserves the right to be under no obligation to pay for material delivered to or off site, and shall take preference for payment to the Contractor after commissioning of the works. The Contractor shall price the preliminary and general section if the bill of quantities adequately allowing for all overhead costs during the construction period.

6.3. Materials or equipment stored on or off site and packed in crates or boxes must be opened for inspection and the serial numbers, types or quantities must be easily identifiable by the Engineer before payment for such materials will be processed.

6.4. Payment will further not be certified for small materials such as short pieces of cable, conduit, wire, conduit boxes, saddles, screws, etc., that are stored on or off site. Payment for such materials will only be certified once the materials have been built in, installed or commissioned. In special cases, 80% payment for material on site may be considered subject to approval.

6.5. Interim payment will only be considered subject to the following conditions:

a) The equipment must be complete and in a ready state for installation or commissioning. Loose components which are not yet built into or which will form part of the large materials mentioned in the previous paragraph, will not be considered for payment. (An example hereof is, for instance, instruments that must be fitted in a cabinet and are still in separate storage.)
b) The materials which are to be type tested, performance tested or safety tested should have already passed inspections and/ or tests by the Contractor and/or the supplier of the equipment.
c) The Contractor shall, prior to submitting interim payment claims, procure financial assurance by means of the guarantee from a registered bank, on the form provided by the Engineer, and equal to the total amount of payments to be made to the Contractor.
d) The total value of such guarantee, provided by the Contractor to the Employer, may be varied by the Contractor, with the consent of the Employer, from time to time provided that the Employer will be covered at all times to the total amount paid by the Employer to the Contractor for items not yet built into the Works.

6.6. The guarantee will lapse 24 months after signed acceptance without reservation by the Engineer and Employer and all the said equipment and/or materials have been built into the permanent Works.

6.7. The material must be stored in a cordoned off area in the stores of the Contractor and a notice must be affixed to this area stating that the materials stored in that area are the property of the Employer.

6.8. The area must be safe and not near flammable liquids or explosive equipment and must be kept clean and dry.

7. WORKSHOP ASSEMBLY

7.1. To avoid problems with the erection and installation activities on site, components, equipment and sub-assemblies must be pre-assembled in the place of manufacture to ensure proper fitting and operation on site.

7.2. Such pre-assemblies which are to be tested in the place of manufacture, shall be set up in a simulated mode, using the specified peripheral equipment as far as possible in a temporary connected condition to simulate site conditions as accurately as possible. This requirement is, in particular, applicable to field equipment for electrical and electronic installations.

7.3. The purpose of such preliminary testing, shall further be done to check whether the equipment complies with predetermined set values and shall produce certain predetermined set results, as set out in the various parts of the document.

7.4. Measurements of equipment shall be taken into consideration to ensure that such equipment and materials can be handled on site and can be placed into the specified positions.

7.5. Additional costs or delays resulting from failure on the part of the Contractor to check access conditions, positions, openings, etc., will be for the Contractors account.

7.6. Individual units of equipment shall be clearly marked by employing an identification code in such a manner that actual re-assembly, erection and installation on site can be done in the minimum of time with a minimum of fitting and adjusting on site.

7.7. Equipment should be delivered to site in the largest sub-assemblies that are practical.

7.8. Equipment of the same type shall all be obtained from one manufacturer and sub-components shall be changeable. Prior to manufacture, the Contractor shall ascertain the critical dimensions of points of entry to the building.

7.9. The Engineer may, upon request by the Contractor, inspect existing installations of prototype assemblies in the factory to determine whether the extent and workmanship of such units are of the required standard for the particular Contract. This may be done to obviate the possibility of having to replace unacceptable equipment already installed.

8. CONSTRUCTION METHODS

8.1. Before initiating any construction, the Contractor shall compile a list of all defects per sectional area and verify such defects alongside a duly authorized representative. The repair of any damage not listed shall be the full responsibility of the Contractor, the Employer shall under no circumstances be held responsible for payment of damages done by the Contractor or damages not listed prior to initiating construction.

8.2. Where the Contractor will perform trench work, it shall be the Contractor's responsibility to request that the employer scans the trench for any existing services, especially cables at substations. The Contractor shall mark the trench positions clearly by means of chalking. The Contractor shall ensure that all wayleaves are approved prior to commencement of any work and shall be responsible for marinating any pre-approved wayleaves.

8.2.1. FIXING OF MATERIALS IN BUILDINGS AND ON STRUCTURES

8.2.1.1. The Contractor shall fix cabinets and wire ways for cabling, saddles, conduit accessories, brackets, braces, wiring channels and all other metal and non-metal surface mounted material and equipment as described hereunder, unless otherwise stated:

Into Concrete: Expanding type bolts, or gun-bolted with sizes and lengths as permitted by the Engineer or as specified.

Into Brickwork: Expanding type bolts or built-in metal fixings of size as approved by the Engineer or as specified.

Onto Steelwork: Drilled, tapped and screwed with specified or approved sizes of machine screws or by means of welding where so permitted by the Engineer.

Onto woodwork: Fixed by means of wood screws of quantity and sizes as specified or approved by the Engineer.

Into Hollow Tiles: Spring toggles of not less than 6 mm dia. and then only upon specification or approval by the Engineer.

Onto ceiling board: Spring toggles of not less than 6 mm dia.

Onto false ceilings: Spring toggles of not less than 6 mm dia. and only when the false ceiling tiles can support the weight of the equipment.

8.2.1.2. Gun bolting into concrete will only be allowed into cast concrete and then only after written permission has been obtained from the Engineer.

8.2.1.3. No gun bolting shall be undertaken into ash-bricks, brickwork, gas concrete or pre-cast concrete except where written permission has been granted by the Engineer. The Contractor will be held responsible for any damage to builder's work due to unauthorised gun bolting.

8.2.1.4. **Note:** The use of plastic plugs, wooden plugs or any other soft substance type fixing plugs is strictly prohibited and the use of these materials will not be approved by the Engineer.

8.2.1.5. All cable ladders, cable trays, power skirting, brackets, etc., shall be fixed in a neat manner and shall be fixed vertically or horizontally and shall follow building structure lines.

8.2.1.6. Fixing of such items that will carry heavy loads must be fixed in accordance with the requirements of the manufacturer thereof.

8.2.1.7. Sufficient space must be allowed for on cable ladders and trays as multi layers of cables on cable trays are not acceptable.

8.2.1.8. Cables on outdoor cable ladders shall be fixed with UV resistant fixing materials or stainless steel banding straps in such a way that cables are not damaged.

8.2.1.9. Outdoor cable shall, as far as possible, be protected from direct sunlight.

8.2.1.10. Underground sleeves and cables shall be installed at specified depths and in approved bedding materials (≤1.2m.K/W bedding soil). Sleeves for cable entry in buildings shall be placed in position before foundations are cast to ensure proper entry depths of cables. Appropriate matching of cables with cable sleeves shall be determined with the Engineer prior to construction.

9. HANDLING OF MATERIALS AND SAFETY

9.1. OFF-SITE HANDLING

9.1.1. Equipment and materials stored off site for a Contract shall be stored in a clean and safe area. Damaged equipment and materials, stored in factories or stores of the Contractor, will be rejected upon inspection. Electrical and electronic equipment shall not be assembled, stored or tested in areas where grinding, welding or painting work takes place.

9.1.2. Areas in stores or places of manufacture for testing or inspections of equipment and materials by the Engineer shall be clean and safe for the purpose of testing or inspections. Floors must be free of loose materials, dirt and debris.

9.1.3. Equipment and materials will not be inspected in noisy or dirty environments and also not in areas where welding, grinding, and painting or any other manufacturing processes are underway. Testing or inspections will not be undertaken in hazardous or explosive atmospheres.

9.1.4. Materials stored in the stores of the Contractor or in alternate storage space, and which is acceptable to the Engineer for off-site certification for payment, shall only be certified for payment under the conditions as laid down in this document.

9.2. ON-SITE HANDLING

9.2.1. Equipment and materials stored on site shall be stored in a safe, dry and clean environment and shall be protected against damage, from the elements and theft.

9.2.2. Heavy materials shall be stored in a manner as not to create a danger to other Contractors or to the Employer or the Engineer.

9.2.3. Small materials shall not be left lying around on site. Expensive, small items such as instrumentation or electronic components shall be kept under lock and key until the installation thereof.

9.2.4. Store rooms used by the Contractor shall be kept locked to prevent unnecessary loss of materials.

9.2.5. Redundant material, which is the property of the Employer, shall be removed from site and either be reused elsewhere or returned to the Employer through the relevant processes. If clear directions are not available in this regard, the Contractor shall obtain instructions for the removal of the equipment from the Engineer. No redundant material shall become the property of the Contractor or any other party and shall remain the property of the Employer unless decided otherwise by the Employer.

9.2.6. The Contractor will be responsible for the transporting of all materials and equipment to and on the site and will provide the off-loading, rigging, lifting, handling and placement thereof into the permanent position as planned for the equipment. The Employer will not provide any assistance or equipment for the placing of equipment into position or materials.

10. SITE SAFETY

NOTE: Tenderer’s and Contractors must ensure that they have read and understood the requirements of this document.

10.1. The requirements of the Occupational Health and Safety Act, Act 85 of 1993 and the requirements of SANS 10142-1 (or the latest edition thereof) shall be complied with as far as site safety is concerned.

10.2. Excavations shall be barricaded, backfilled and compacted as soon as possible after excavating to allow safe passage for persons and traffic on site.

10.3. Contractors shall not allow any workers to work in excavations deeper than 1m, unless the sides of the excavations are properly shored and supported, especially in sandy or wet soil conditions.

10.4. Open manholes shall be barricaded.

10.5. Deep waterlogged excavations shall be pumped empty as soon as possible after flooding or shall be solidly barricaded until pumped dry.

10.6. Open, live or unsafe power connections shall not be left unguarded or unprotected.

10.7. The construction site shall be kept clean and tidy on a daily basis.

10.8. Off-cuts and rubbish shall be removed from the site and deposited in the designated dumping place on a daily basis.

10.9. The Contractor shall adhere to all safety rules and regulations as may be in existence on a site or as may be required by the Employer or the Engineer. The Contractor shall also ensure that their workforce on site adhere to safety rules.

10.10. Contractor shall not drive or allow a vehicle or machine to be driven close to excavations.

10.11. Contractor shall keep all power connections and/or live equipment with voltages above 50V, temporary or permanent, in a good and safe condition and shall keep all doors, shutters and covers closed on such equipment, during construction, testing and commissioning and shall take all steps to prevent accidental contact of live equipment by any person.

10.12. The Contractor shall take control over any power cable or power circuit connected from equipment installed by him, or under his control and which operates at a voltage higher than 50V. The Contractor shall not energise such a cable or circuit and shall not grant permission to any other person on the site to energise such a cable or circuit without first having made sure that such action does not create a dangerous situation.

10.13. The Contractor shall not connect any portion of an installation to the point of supply of a Supply Authority without first having complied with the requirements and regulations of such an Authority as far as tests, certification or clearance from the Authority is concerned and also not until permission is obtained from the Engineer in this regard.

10.14. Any damage to equipment of other contractors or the Employer due to equipment being supplied by such an unauthorized power connection shall be for the account of the Contractor for this Contract.

10.15. The Contractor shall not energise any portion of an installation until the earth points of power equipment in such installation have been properly bonded and earthed to a known good earth point with a value of 5 ohm or less, referred to zero, as tested with a null balance megger.

11. MANUALS AND DATA RECORDS

11.1. All data pamphlets packed with equipment and other pamphlets, handbooks of equipment, operating instructions of equipment, drawings, etc., shall be kept in safe storage by the Contractor during the Contract period.

11.2. The Contractor shall also keep accurate records of all tests carried out on equipment and cables and of the test results achieved.

11.3. Records shall be kept of setting values of instrumentation and all readings taken during testing and commissioning, as well as records of all final adjustment readings or changed settings done during the maintenance period.

11.4. A comprehensive operational and maintenance **hard copy manual** shall be built up by the Contractor, using the data mentioned well as other data and descriptions as specified herein.

11.5. All drawings and diagrams shall be done in AUTOCAD 2010 (or later) format and all text shall be submitted on the latest edition of Microsoft Word format. All tabular data shall be submitted on the latest edition of Microsoft Excel format. All pamphlet and brochure data shall be submitted in PDF format.

11.6. DXF files of other CAD programs can also be submitted, if these are suitable for conversion to AutoCAD format, without scrambling of text or graphics upon conversion.

11.7. The number of copies as scheduled in the Pricing Schedules or Bill of Quantities, of the manuals described herein, shall be made up by the Contractor. The quantity of copies required is normally not less than five (5).

11.8. The manuals shall be presented to the Engineer on the first day of “wet commissioning”, if handover of the Works takes place on that day. The manuals shall be neatly housed in lever arch files and shall be in typewritten and/or printed format, properly indexed, with appropriate 2 or 3 layer card dividers between each section to facilitate ready reference.

11.9. A main index shall be placed in the beginning of each manual. The project name and project description shall appear at the top on the main index of the manual. Coloured dividers shall preferably be used.

11.10. The manuals and drawings shall cover all installation, operation, and maintenance schedule aspects of each item of equipment and all circuitry provided under this Contract, as specified.

11.11. The manuals, if approved, will be handed to the Employer or the representative of the Employer, so that the Works can be operated correctly and safely.

11.12. Any changes which may be necessary to the contents of the manual after the commissioning of the Works shall be done by the Contractor and sufficient copies of the altered data shall again be submitted to the Engineer for binding into the manuals. This process shall be repeated for the duration of the maintenance period or until the final certificate is issued by the Engineer for the project.

11.13. A “Practical Completion Certificate” and subsequent “Certificate of Commissioning” / “Handing over Certificate” will only be issued on receipt of accurate and final “as-built” drawings and documentation to the approval of the Engineer. Such documentation shall be presented to the Engineer on the first day of commissioning of the works. Any certification of “Practical Completion”, “Commissioning” or

"Handing Over" of the works is subject to final approval of such documents and drawings by the Engineer.

11.14. Wherever manufacturer's manuals refer to types of equipment other than the exact type as installed, the exact type shall be highlighted throughout such manuals.

12. DOCUMENTATION AND DRAWINGS

12.1. All documentation and drawings as specified in the general or equipment specification shall apply to this contract.

12.2. GENERAL REQUIREMENTS

12.2.1. A stringent requirement of a Contract is to have "as built" data when a contract is complete to ensure that:

- The Employer knows where all the equipment and materials are installed
- Fault finding in the system can be done in future
- Alterations and additions can be undertaken in future by referring to the drawings to determine the built in capacity of the system without having to determine this data on site.

12.2.2. It is therefore imperative for the Contractor to produce acceptable manufacturing drawings at the onset of a project so that equipment can be manufactured and ordered. Drawings such as layout drawings, single line diagrams, block diagrams, typical control diagrams, etc. are normally issued by the Engineer together with documents for tender purposes.

12.2.3. If no drawings or limited drawings are issued by the Engineer at tender stage or thereafter, the Contractor shall arrange a technical meeting or meetings with the Engineer to determine the exact scope of the work and shall then prepare the necessary drawings to enable him to manufacture the specified equipment. This shall include "shop" drawings, diagrams and/or constructional detail drawings.

12.2.4. The drawing or drawings prepared by the Contractor shall obviously make provision or include the drawings or standards normally used by the Contractor to produce acceptable quality of work. The Contractor shall further keep all drawings and diagrams prepared during the course of production and installation of the Works and shall present this to the Engineer on completion of the Contract. Such drawing shall at least consist of all the drawings the Contractor used for construction and installation work as well as all data of final positions and final settings of equipment.

12.2.5. All cable positions on the site of the Works shall be shown on layout drawings, together with dimensions taken on site from fixed points to show exact location of underground cables. Any diagrams (standards or specific) issued by the Engineer shall not be used by the Contractor for making up his own design drawings by adding data or wiring and terminal numbers to such diagrams.

12.2.6. The Contractor shall draw up and submit his own diagrams and general arrangement drawings in the formats and quantities as required by the Engineer. Hand drawn drawings will not be acceptable, except in the case where formal site layout plans are not available to mark-up equipment and cable positions. Drawings shall preferably be done in A3 booklet format and on the standard border and title block sheets of the Employer or the Engineer, unless permission is granted in writing by the Engineer for other formats of title blocks.

12.2.7. All drawings shall be properly numbered with the numbering system required by the Employer or the Engineer and the number of the particular sheet and the total number of sheets shall be shown on each drawing.

12.2.8. The Contractor may use his own reference number in a separate block if the Engineer requires a special drawing numbering system. Standard drawing sheets in electronic format can be obtained from the Engineer, if available.

12.2.9. Electronic copies (soft copy), of all "as built" drawings prepared by the Contractor during the course of the Contract, as well as all electronic copies of software and descriptions of equipment, handbooks or sales data shall also be handed to the Engineer, together with the hard copy "as built" drawings and manuals, in quantities and formats as specified in the Project Specifications

12.3. DRAWINGS FOR APPROVAL

12.3.1. A set of three (3) prints of the shop drawings for all equipment shall be submitted for approval before any of the aforementioned are manufactured.

12.3.2. 3D Survey drawings of the existing infrastructure is available in .dwg format for this project. These drawings shall be made available to the contractor on which detail designs are to be populate for approval by the Engineer.

12.3.3. The following information shall be presented:

12.3.4. Single line diagrams for electrical, electronic and power circuits, showing rating of wiring, cables, switchgear, power supplies, current rating of all circuit breakers and fuses, VA rating of all power supplies, sizes, specifications and quantities of cables and cable cores with:

- the rating, type number, catalogue number, ratio, class, etc. next to each component with the abbreviated reference number
- the functions of each control circuit or section of control circuit, above each control group of components
- the functions of each component on control diagrams below the component
- wire and cable numbers for all control and power wiring together with the colours of all wires.

12.3.5. A general arrangement block diagram of the whole of the Works.

- Overall dimensions together with material type and thickness used for the framework, doors and covers as well as the type and colour of finish of the material;
- Front elevations and sections for all the panels and devices;
- Positions of door locks, hinges, handles, vermin proofing, ventilation facilities, seals on doors and covers, etc.;
- The IP ratings;

- Placement positions of all front panel components on panels;
- All labelling information for each component shall be shown in tabulated form on general arrangement drawings.

12.3.6. All drawings shall be done using NRS symbols and the applicable **SANS** standards for drawings plus any further requirements for drawings which may be bound into this document and which may be required by the end user of the equipment.

12.3.7. The approval of drawings shall not relieve the Contractor of his responsibility to supply the works in according to the requirements of this specification and/or Project Specifications.

12.4. FINAL DRAWINGS AND INFORMATION

12.4.1. At least five (5) complete sets of “as built” drawings of all panels shall be submitted to the Engineer prior to the installation being handed over to the Employer.

12.4.2. A professional portfolio consisting of still images and details of the entire installation in operation shall be submitted.

12.4.3. A professional overview narrated video shall be submitted in editable soft copy format for marketing purposes

12.4.4. The drawings submitted shall preferably be in A3 format (in hard copy and on CD) and shall also be bound into the “Operational and Maintenance Manuals” as specified herein.

12.4.5. The following information shall be presented:

a) All the information as described in the section “Drawings for Approval”, hereinbefore.
b) The final, updated drawings and diagrams specified showing the latest revisions after commissioning of the Works.

c) All final terminal strip numbers, numbers and colours of conductors connected to the terminal strips and numbers and colours of the conductors utilized for the internal wiring.

d) A separate schedule of all equipment with the name, manufacture, type, model-catalogue number of equipment, as well as the name, address and telephone number of the supplier of each component.

e) All site and building layout drawings, showing sizes and positions of cables and equipment.

f) The site layout drawings showing cables shall be dimensioned using fixed points on site such as buildings, beacons, boundary walls, canals, poles, sumps, etc.

12.5. OPERATIONAL AND MAINTENANCE MANUALS

12.5.1. SCOPE

12.5.1.1. A minimum of five (5) complete sets (or as scheduled in the Schedules of Quantities) of operational and maintenance manuals for all specified Works.

12.5.1.2. Also refer to the section “Final Drawings” herein, regarding binding in of “as built” drawings into the required manuals.

12.5.2. DETAILED OPERATIONAL AND DESCRIPTIVE MANUAL

12.5.2.1. This manual shall contain the detailed descriptions of all equipment i.e. all proprietary assemblies, shall be provided to assist the user personnel of the Employer with advanced knowledge of the equipment for short, medium and long term maintenance and operations of Works.

12.5.2.2. The descriptions must be complete in all respects and the Contractor shall also ensure that these manuals are prepared in such a manner that, in the opinion of the Engineer, a competent and qualified technician can trace any fault, identify any defective component, replace it with the correct spare part and follow, without difficulty, the exact function of every component.

12.5.2.3. To this end, care must be exercised to correlate the text with the circuit diagrams, to relate the diagrams one with another and to provide a simple method of diagnosis and test to be used wherever breakdowns occur. The manuals shall also include block diagrams giving the layout of equipment as well as a description of the function and operation of every unit in the system.

12.5.2.4. The manuals shall be neatly prepared, in typewritten and/or printed format, indexed, with appropriate dividers between each section to facilitate ready reference. All documentation shall be presented in the English language.

12.5.2.5. The description shall, as a minimum requirement, include:
Operational and maintenance data, details of all assemblies or components of electrical and electronic equipment installed in the Works. Copies of operational manuals of manufacturers can be inserted in these descriptions. In the case of insufficient descriptions in manuals of manufacturers, the Contractor shall provide additional descriptions to enable maintenance of the equipment.

12.5.2.6. The descriptions shall include:

a) Technical details of all equipment installed.

b) A complete description of the operation of all equipment.

c) A parts and spares list of every item of equipment together with a description of the item, the name, address and telephone number of the original supplier or wholesaler of the equipment. Brochures may be added as additional information but must not replace the data required.

d) Complete equipment schematics

e) All manufacturers' handbooks having reference to the equipment

f) Installation test and alignment procedures

g) All circuit diagrams

h) All interconnection and inter cabling diagrams

i) Complete trouble shooting procedures and any other information deemed necessary to permit rapid and efficient maintenance of any part of the equipment by a qualified technician.

12.5.2.7. The operating procedures contained in the manuals shall contain the following detailed features in fully descriptive format:

a) Operating Procedures
   1) Pre power-up checks of all equipment
   2) Routine running attention
   3) Shutting down the works or parts thereof
   4) Prolonged shut-down of the works
   5) Re-commissioning of the works after repairs, maintenance or prolonged shut-down.

b) Maintenance
   1) Routine maintenance procedures
   2) Description
   3) Schedule
   4) Preventative maintenance

c) Fault Finding Procedures
   1) Power supply faults
   2) Control faults
   3) Investigation procedure for detection of faults and remedies:
   4) Symptom
   5) Probable fault
   6) Remedy

d) Safety Precautions
- The nature of each hazard
- The level of seriousness
- How to avoid the hazard
- The possible consequences of not avoiding the hazard

12.5.2.8. In the case of sealed assemblies or advanced assemblies of equipment that cannot be opened or maintained or repaired onsite, the Contractor shall provide sufficient data and instructions for the replacement of the assembly and shall further describe the measures which the user or operator of the works can follow to operate the Works in an emergency and, if necessary, operate the works manually, to overcome total shut-down or non-operation of the Works until a new replacement can be installed.

12.5.2.9. The descriptions for operational measures shall be of sufficient nature to enable **safe operating conditions** of the works and shall further not be of a nature which shall cause damage to other parts or sections of the Works.

a) A schedule of every item of equipment in the Works or panels together with a description of the item, part number, catalogue number, etc., as well as the name, address and telephone number of the original supplier or wholesaler of the equipment. Brochures may be added as additional information but must not replace the data required.

b) All as-built record drawings, including AC and/or DC schematic and wiring diagram drawings for the equipment. The wiring diagrams shall contain all the terminal numbers and wire numbers of all wiring in the Works. Also refer to *"12.4* FINAL DRAWINGS*"* hereof. A4 drawings may be used in manuals but all text must be clearly legible. A3 drawing sizes are preferred.

c) Technical brochures and pamphlets of equipment as additional information.

d) Routine and type test certificates issued by factories.

e) All calibration and setting data of electronics and instrumentation. This data shall also contain all the embedded software, on disc or CD, issued together with the instruments as part and parcel of the selling price of instruments where the instruments cannot be purchased without the embedded software.

13. PHYSICAL INSPECTION PROCEDURE

13.1. Once the Contractor has completed the installation, written notice shall be given to the Engineer in order that a mutually acceptable date can be arranged for a joint inspection.

13.2. During the course of the inspection, the representative of the Engineer will compile a list of items (if any) requiring further attention. A copy of this list will be provided to the Contractor who will have a period of 7 days in which to rectify the offending items of the installation.

13.3. The Contractor shall then provide written notice that he is ready for an inspection of the remedial work to the offending items.

13.4. This procedure will continue until the entire installation has been completed to the satisfaction of the Engineer.

14. TESTING AND TEST EQUIPMENT

14.1. GENERAL REQUIREMENTS

14.1.1. All materials and workmanship shall be of the respective kinds described in the Contract and in accordance with the Engineer's instructions and shall be subjected from time to time to such tests and by such persons as the Engineer may direct at the place of manufacture or fabrication or on the site or at all or any of such places. Except as otherwise provided in the Specification the Contractor shall supply such assistance, accommodation, instruments, machines, labour and materials as are normally required for examining, measuring and testing of any work and the quality, mass or quantity of any materials used and shall supply samples of materials before incorporation in the works for testing as may be selected and required by the Engineer.

14.1.2. All samples shall be supplied by the Contractor at his own cost if the supply thereof is clearly intended by or provided for in the Specification but if not, then at the cost of the Employer.

14.1.3. The cost of performing any test shall be borne by the Contractor if such test is clearly intended by or provided for in the Specification and (in the case of a test under load or a test to ascertain whether the design of any finished or partly finished work is appropriate for the purposes which it was intended to full fill if such is particularised in the Specification in sufficient detail to enable the Contractor to price or allow for the same in his Contract Price.

14.1.4. If any test is ordered by the Engineer which is either -

a) not so intended by or provided for; or
b) not so particularised; or
c) though so intended by or provided for is ordered by the Engineer to be carried out by an independent person or body at any other place than the site or the place of manufacture or fabrication of the materials or equipment tested;

Then the cost of such test shall be borne by the Contractor if the test shows the workmanship or materials not to be in accordance with the provisions of the Contract or the Engineer's instructions, but otherwise by the Employer.

14.1.5. The Contractor shall keep records of all the data of tests and shall submit this data to the Engineer upon completion of all tests. Tests carried out in the factory of the manufacturer or at a testing facility shall be done in accordance with the prescribed standards for such tests.

14.1.6. The applicable standards for such tests shall be SANS, BSI, IEC, DIN, NEMA or such acceptable standard as may be applicable to the product or equipment or assembly.

14.1.7. The Engineer will have the right to obtain a quotation from the Contractor for any special tests which are required by him and to instruct the Contractor to carry out such tests.

14.1.8. If equipment should fail a standard or prescribed standard test by a testing authority, the cost thereof shall be for the account of the Contractor.

14.2. FACTORY TESTS AND INSPECTIONS

14.2.1. The Contractor shall inform the Engineer of equipment tests or any part of an installation in the place of manufacture or on site is ready for inspections or tests. The Engineer shall be given sufficient notice in advance of inspections or tests and final dates and times of such inspection will then be confirmed with the Contractor by the Engineer. The inspection or testing of manufactured equipment in a factory by the Contractor or by any other test facility in the presence of the Engineer must not be regarded as acceptance of responsibility by the Engineer for the correct performance of such equipment on site.

14.2.2. The Contractor shall provide a clean and safe testing area in the place of manufacture of any equipment to be tested and inspected by the Engineer. The area shall be open and accessible and tests or inspection will not be carried out in cramped or dangerous areas. No tests or inspections will be carried out in areas where overhead cranes or hoists are in operation.

14.2.3. All live equipment shall either be screened off or enclosed so that inspecting persons are not endangered during such tests or inspections. Inspections or tests will not be carried out near paint areas, paint booths, ovens, grinding or polishing areas or on equipment which are still under construction.

14.2.4. Tests will not be done by the Engineer in areas where a normal conversation cannot take place due to background noise. Test equipment, test leads, clean writing top space and all other facilities shall be provided for the Engineer during such tests. The Engineer reserves the right to instruct the Contractor to carry out the re-testing of any equipment which does not pass the first inspection or test.

14.2.5. The time and travelling cost of the Engineer for the purpose of any re-testing of equipment which failed to pass the first or a previous test will be for the account of the Contractor. Any delays in Contract time caused by failures of inspections or tests will also be for the account of the Contractor

14.2.6. The factory tests shall be done as far as possible with full control conditions as may be experienced on site. All remote controls of equipment must be simulated during these tests by using temporary connected toggle switches to replace remote field devices such as sensors, switches, contacts, etc. Temporary simulated signals for the future field instrumentation or signals for future controls and field instrumentation must be available during the factory tests and must be fully operative and all field signals must be simulated during these tests by using appropriate signal generators or signal sources.

14.3. SITE TESTS AND INSPECTIONS

14.3.1. The inspections of the Engineer of any part of an installation or Works on site does not exempt the Contractor from his responsibilities in terms of the Contract. The Engineer will only accept the completed installation work after having received all test results, commissioning results and certificates of compliance or test certificates on completion of the whole of the Works.

14.3.2. Any abnormal condition, beyond the control of the Contractor, which may come to the attention of the Contractor during any preliminary or final tests or commissioning procedures shall immediately be reported to the Engineer.

14.3.3. The Contractor shall not allow equipment of other contractors to stay connected to, or operate with electric power from his installation if any equipment of other contractors do not operate normally or within the limits laid down by the manufacturer of equipment for other contractors.

15. COMMISSIONING

15.1.1. Commissioning on site shall include the following actions and shall be done with the Engineer present and shall require the presence of the Contractor for as long as it is necessary to carry out all the actions hereunder or as may be further required by the Engineer or the Client.

a) The system shall be connected to the power supplies and shall operate and communicate as specified in the Project Specification.

b) Power protection equipment shall be set by the Contractor in the presence of the Engineer. All the settings shall be recorded by the Contractor for handing over to the Engineer after commissioning.

c) All earthing installation work must be completed.

d) Communication signals and/or remote control signals shall be tested to ensure that Works are integrated as a complete system and functioning correctly. The communication of signals between the site Works and a remote control room or station shall be verified.

e) All safety checks and tests of power equipment must be completed.

f) The number of required maintenance and operational manuals (complete in all respects) shall be handed over to the Engineer.

g) The spares and tools (if applicable), shall be on site together with inventory sheets, ready for signature of the recipient party.

h) All panels and electronic equipment shall be clean and neat and wiring shall be neat and strapped. No loose hanging wiring will be acceptable.

i) All labelling shall be complete.

j) All cable trunking lids or covers shall be in place and all draw box covers and lids shall be screwed down.

k) A Certificate of Compliance for all 230V work shall have been handed to the power supply authority with a copy on site for the Engineer.

l) The Contractor shall hand all the test results of equipment which was logged by him together with the settings of such equipment to the Engineer. This information shall be made available on properly structured test sheets and log sheets and shall be dated and signed by the Contractor.

m) Any small items such as alterations to labels, faulty electronic equipment, etc. shall be recorded for repairs.

n) The Contractor shall then proceed with training of the operating personnel of the Employer as may be required in the Project Specification.

15.1.2. No last minute repairs or installation work shall be done by the Contractor on the day of commissioning of the Works:

15.1.3. The successful completion of all the above shall be regarded as the “first hand over day” of the Works to the User or Owner of the installation. The retention period of the Works normally starts on that day, unless abnormal conditions prevent the handing over of the Works to the Client.

15.1.4. An abnormal occurrence preventing handing over will not be seen as failure of the Contractor in this respect. If the commissioning should have to be stopped or abandoned due to the failure of the Contractor to complete the Works and have the Works ready for inspection or as stated above, then the further costs for re-commissioning later will be for the Contractor’s account. Such costs will include all the travelling, accommodation and time rate costs of the Engineer or the Client.

15.1.5. The Works will not be regarded as being commissioned if all of the above requirements are not met on the day of commissioning of the Works.

15.1.6. The Contractor shall only apply for inspection by the Engineer once the Contractor have completed his own inspections and rectified snags identified. For Site Acceptance testing should the works or equipment not be in a ready state to be commissioned the Engineers cost for all re-inspections shall be for the Contractors account according to the latest gazetted fee scales as provided by the Engineering Council of South Africa.

16. TRAINING OF PERSONNEL

16.1. The training of personnel of the Employer or User of the Works shall only be applicable to the Contract.

16.2. Training provided by the Contractor and OEM shall be directly applicable to the actual equipment to be used at the installation. Training shall be carried out on site and at the OEM’s works. The priced unit rates in the bill of quantities shall allow for all travel, accommodation and living expenses.

16.3. All of the training shall be presented by the OEM and allowed for by the contractor in the bill of quantity’s unit rates.

16.4. Operators of the installed equipment shall be trained by The Contractor to safely and successfully operate the equipment and controls.

16.5. This training course shall include the training of technical personnel of the Employer during the installation period and commissioning stages of equipment on site to make the technical staff and or skilled operators completely conversant with the installed equipment and the use thereof.

16.6. The Employer thus reserves the right to appoint certain staff to the Contractor's team during the installation and commissioning phase of the work for training as described in the previous paragraph. The Employer will bear the cost of salaries, accommodation and other allowances and traveling expenses of its personnel, but all other expenses to allow the personnel to attend the said training on site shall be borne by the Contractor.

16.7. The Employer may also decide to request the Contractor to make use of the ability of the staff of the Employer to assist with physical installation and commissioning work, and in such instance the Engineer will instruct the Contractor accordingly.

16.8. The Contractor shall provide all course material including manuals and training data in this case, and shall present well prepared lectures of the courses in locations which suite the Employer.

16.9. Advanced training courses shall proceed within one month after date of first hand-over of the particular section of the Works.

16.10. The Contractor shall price the items allowed for training in the Bill of Quantities of the tender document.

16.11. At conclusion of any training period, either for the operation and maintenance of equipment, or for advanced software and programming, the Contractor shall issue the necessary certificates at the end of the course and/or a signed statement to the effect that these training sessions were adequate.

SIGNED ON BEHALF OF TENDERER:

COMPANY NAME :……………………………………………………………………

SIGNATURE :……………………………………………………………………

NAME IN BLOCK LETTERS: ………………………….……………………………………

DATE : ……………………………………………………………………………….

17. APPENDIX A - ELECTRICAL TESTS

To ensure the safe and reliable operation the power system the following visual inspections, and tests must be done before and after energising. Results must be recorded on the attached record sheets.

17.1. INSULATION RESISTANCE TESTS

Disconnect the LV Feeders at the Transformer. With all kiosk MCB's switched off use a 5 kV Megger and Megger between each phase and Earth as well as between phases. Care must be taken to discharge the cable before disconnection of Megger leads. Record Readings in attached test results sheet.

Expected results is 5 MΩ between phases and 5 MΩ between phase and neutral.

17.2. VOLTAGE LEVEL TESTS

With the kiosk MCB's switched off the feeder shall be energized and the voltages measured at the terminal poles and recorded.

The individual kiosk MCB's can now be switched on and the polarity of all the installations from each pole tested as well as the Voltage level in each house.

Polarity at the kiosk shall be tested by measuring the Voltage between the phase bar and the earth stud on the kiosk as well as between the earth bar and the earth stud and the neutral bar and the earth stud **only in the first instance a voltage should be measured**.

After all consumers are switched on the voltage at the terminal poles must be recorded again.

17.3. EARTH ELECTRODE RESISTANCE TEST

17.3.1. MEASUREMENT OF EARTH RESISTANCE

The best and most accurate method for measurement of relatively small earth electrode systems is described below and the method illustrated in Figure C.2, Connections for earth electrode resistance measurement - 61,8 % method.

- Identify the earth electrode to be tested. Establish the physical layout of the earthing system and type of electrodes being used, for example in the figure the earth electrode is a combination of horizontal counterpoise (trench) electrodes and vertical rods.

- Disconnect the earth electrode from the earthed equipment, preferably at the point where the wire from the equipment connects to the earth electrode.

- Identify the position of the current probe C2. Measurement should be exercised away from the line of any known trench earth, metallic pipe or underground cables. The distance between the electrode under test and the current probe C2 should be five times the biggest of the earth spike length, counterpoise length or the longest diagonal of the earthing system but not less than 30 m.

- Set the potential probe P2 in line with the tested electrode and the current probe C2 at a distance equal to 0,6 of the distance to the current probe. Water the area around the current probe C2 to reduce its resistance thus reducing its influence on the measurement.

- Connect the Earth Tester terminals C1 and P1 to the tested electrode, terminal P2 to the potential probe P2 and the terminal C2 to the current probe C2. Operate the Earth Tester and obtain the resistance reading.

- Repeat the measurements for potential electrode set up at the distances shown in the illustration, i e 0,2; 0,4; 0,5; 0,7 and 0,8 of the distance to the current electrode.

- The values obtained by measurement at the six positions (R2 to R6) should be recorded (Table C.1: Earth electrode resistance - 61,8 % method measurement results).

- The resistance of the electrode under test is equal to the value obtained from the graph and corresponding to the distance of 0,618X.

  Alternatively calculate four values of R using the following formulas:-

  a) $R = -0{,}1187R1 - 0{,}4667R2 + 1{,}9816R4 - 0{,}3961R6$

  b) $R = -2{,}6108R2 + 0{,}0508R3 - 0{,}1626R4 - 0{,}2774R6$

  c) $R = -1{,}8871R2 + 1{,}1148R3 + 3{,}6837R4 - 1{,}9114R5$

  d) $R = -6{,}5225R3 + 13{,}6816R4 - 6{,}8803R5 + 0{,}7210R6.$

  Four values of R, obtained from calculations, should substantially agree and an average of the results may then be calculated. However it is possible that the result from equation (a) will be less accurate than the others. If the result of (a) does prove to be at variance with the others it can be ignored and an average obtained from the three more agreeable figures (Table C,2; Earth electrode resistance - 61,8 %, method calculated results).

17.4. TRANSFORMER INSTALLATION

RETICULATION SCHEME: ____

DATE:________________________ **TESTERS NAME:** __________________________

ADDRESS:____________________ **TEL NR:** __________________________________

TRANSFORMER NR: _________

MV VOLTAGE: __________**kV**

17.5. LV ABC INSULATION RESISTANCE

R-W	....	MΩ	at	5 kV
W-B	....	MΩ	at	5 kV
B-R	....	MΩ	at	5 kV
R-N	....	MΩ	at	2,5 kV
W-N	....	MΩ	at	2,5 kV
V-N	....	MΩ	at	2,5 kV

Instrument used .... Instrument Nr ....

17.6. VOLTAGE LEVEL TESTS

17.6.1. NO LOAD VOLTAGE LEVELS AT TERMINAL POINTS ON

FEEDER 1

R-N	....	Volts	R-W	....	Volts
W-N	....	Volts	W-B	....	Volts
B-N	....	Volts	B-R	....	Volts

FEEDER 2

R-N	....	Volts	R-W	....	Volts
W-N	....	Volts	W-B	....	Volts
B-N	....	Volts	B-R	....	Volts

FEEDER 3

R-N	....	Volts	R-W	....	Volts
W-N	....	Volts	W-B	....	Volts
B-N	....	Volts	B-R	....	Volts

17.6.2. VOLTAGE TESTS AT HOUSES

Is it within statutory limits. .... YES .... NO

17.6.3. FULL LOAD VOLTAGE LEVELS AT TERMINAL POINTS ON

FEEDER 1

R-N	....	Volts	R-W	....	Volts
W-N	....	Volts	W-B	....	Volts
B-N	....	Volts	B-R	....	Volts

FEEDER 2

R-N	....	Volts	R-W	....	Volts
W-N	....	Volts	W-B	....	Volts
B-N	....	Volts	B-R	....	Volts

FEEDER 3

R-N	....	Volts	R-W	....	Volts
W-N	....	Volts	W-B	....	Volts
B-N	....	Volts	B-R	....	Volts

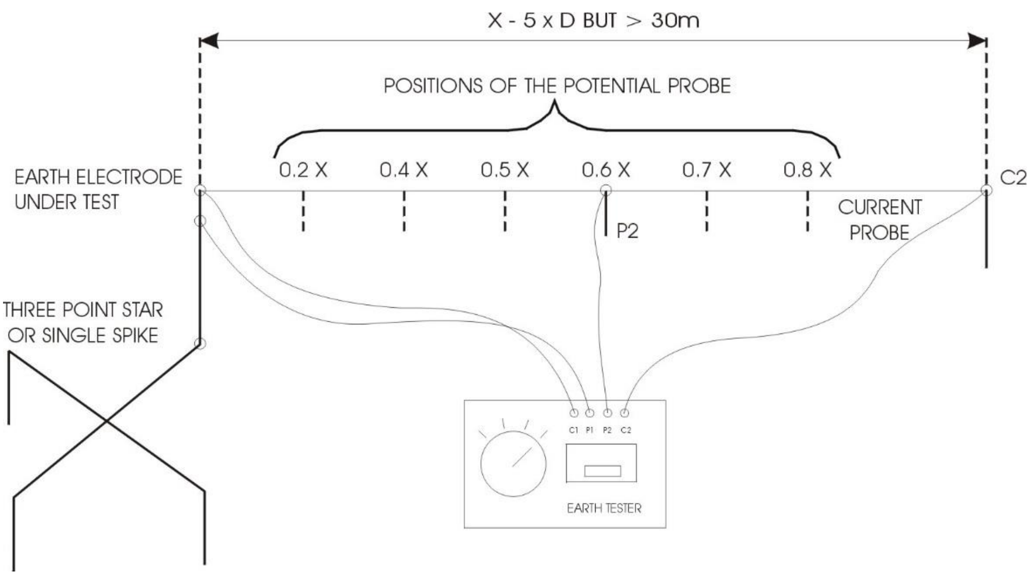

Figure 1: Connections for earth electrode resistance measurement - 61,8 % method

Table 1: Earth electrode resistance - 61,8 % method

COMMENTS	REFERENCE	POSITION	DISTANCE (M)	RESISTANCE (M)
	R1	0,2X		
	R2	0,4X		
	R3	0,5X		
	R4	0,6X		
	R(T)	0,618X		
	R5	0,7X		
	R6	0,8X		

Table 2: Earth electrode resistance - 61,8 % method measurement results

R	=	0,1187 R1 - 0,4667 R2 + 1,9816 R4 - 0,3961 R6 = ... ohm
R	=	2,6108 R2 + 0,0508 R3 - 0,1626 R4 - 0,2774 R6 = ... ohm
R	=	1,8871 R2 + 1,1148 R3 + 3,6837 R4 - 1,9114 R5 = ... ohm
R	=	6,5225 R3 + 13,6816 R4 - 6,8803 R5 + 0,7210 R6 = ... ohm

17.7. FOOTING RESISTANCE MEASUREMENT GUIDELINE

This guideline provides the minimum requirements for the measuring of the footing resistance of steel poles

17.7.1. METHOD

17.7.1.1. SHORT FALL-OF-POTENTIAL

The short version fall-of-potential method can be used by the contractor. The drawings show the equipment layout and how the measurements must be taken.
Three resistance values are measured, namely R1, R2 and R3. If the three values agree reasonably, the average can be calculated for the final resistance value. If not, the 61,8% method must be used.

17.7.1.2. 61.8% METHOD

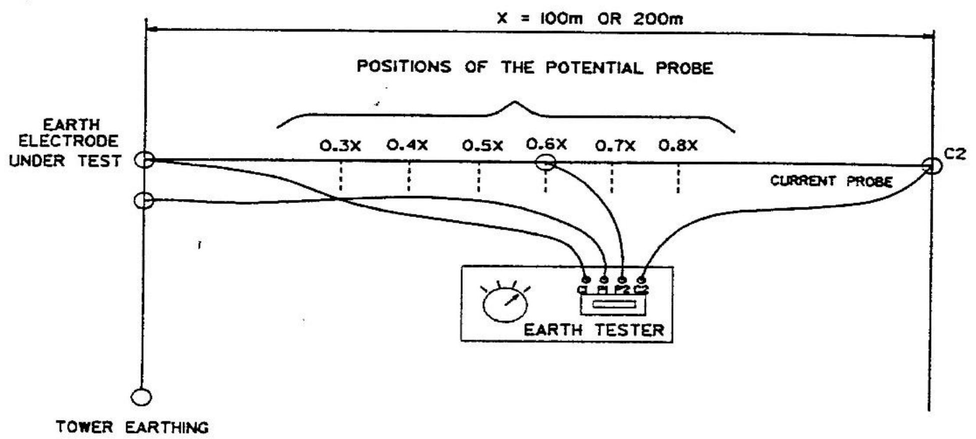

Figure 2: Connections for Earth Electrodes Resistance Measurement -61.8% Method

Table 3: Earth Electrode Resistance -61.8% Method Measurement Results

DEFINITION	POSITION	DISTANCE (m)	RESISTANCE (Ohm)
R1	0.2X		
R2	0.4X		
R3	0.5X		
R4	0.6X		
R5	0.8X		

Table 4: Earth Electrode Resistance -61.8% Method Calculated Results 2. Steel Poles

R =	-0,1187R1 -0,4667R2 + 1,9816R4 -0,3961R6 =	________	Ω
R =	-2,6108R2 + 4,0508R3 -0,1626R4 -0,2774R6 =	________	Ω
R =	-1,8871R2 + 1,1148R3 + 3,6837R4 -1,9114R5 =	________	Ω
R =	-6,5225R3 + 13,6816R4 -6,8803 R5 + 0,7210R6 =	________	Ω
TOTAL		________	Ω
AVERAGE		________	Ω

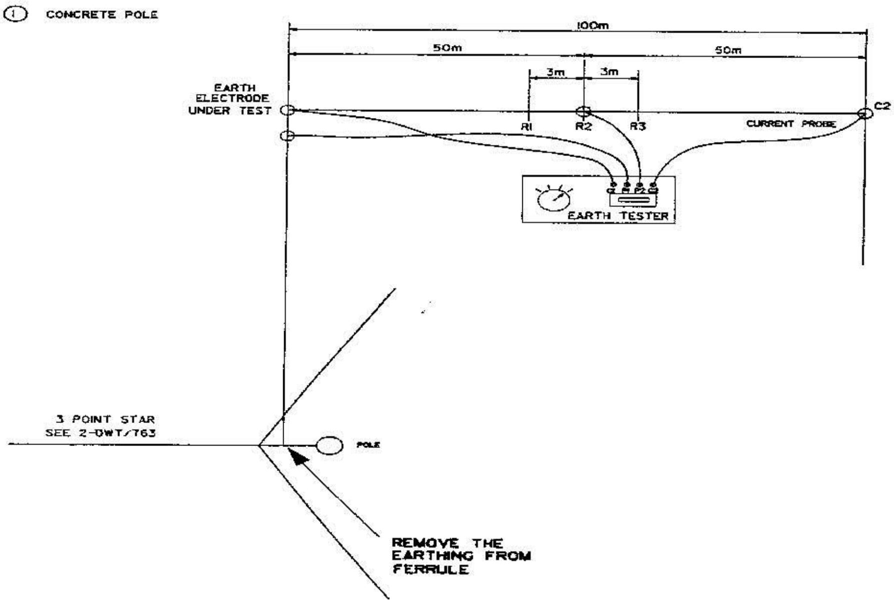

Figure 3: Connections For Earth Electrode Resistance Measurements Fall-Of¬Potential Method

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GSE15 – GENERAL SPECIFICATION ELECTRICAL

STANDARD PAINT

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1. FINISH REQUIRED

Metalwork of electrical equipment such as switchboards, equipment enclosures, sheet steel luminaire components, purpose-made boxes, etc., shall be finished with a high quality paint applied according to the best available method. Baked enamel, electrostatically applied powder coating or similar proven methods shall be used.

2. CORROSION RESISTANCE

Painted metal shall be corrosion resistant for a period of at least 168 hours when tested in accordance with SANS Method 155.

3. EDGES

Care shall be taken to ensure that all edges and corners are properly covered.

4. SURFACE PREPARATION

Surface preparation shall comply with SANS 064. Prior to painting, all metal parts shall be thoroughly cleaned of rust, millscale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

5. BAKED ENAMEL FINISH

Immediately after cleaning all surfaces shall be covered by a rust inhibiting, tough, unbroken metal-phosphate film and then thoroughly dried.

Within forty eight (48) hours after phosphating, 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.

The enamel finish on metal luminaire components shall comply with SANS 783, Type III.

Other metal parts e.g. switchboard panels, etc., shall comply with SANS 783, Type IV with a minimum paint thickness after painting of 0,06 mm. In coastal areas, the dry film thickness shall be increased to at least 0,1 mm.

The paint shall have an impact resistance of 5,65 on cold-rolled steel plate and a scratch resistance of 2 kg.

6. POWDER COATED FINISH

Immediately after cleaning the metal parts shall be pre-heated and then covered by a microstructured paint powder applied electrostatically.

The paint shall be baked on and shall harden within 10 minutes at a temperature of 190°C.

The minimum paint thickness after baking shall be 0,05 mm. The dry film thickness shall be increased in coastal areas. The paint cover shall have an impact resistance of 5,65 J on cold-rolled steel plate and a scratch resistance of 2 kg.

7. TOUCH-UP PAINT

In the case of switchboards and larger equipment enclosures, a tin of matching touch-up paint not smaller than 1 litre shall be provided.

8. COLOURS

The colour of HV switchboards and HV switchgear enclosures shall be "DARK ADMIRALTY GREY", colour G12 of SANS 1091.

The colour of LV switchboards and equipment enclosures in buildings shall be "LIGHT ORANGE", colour B26 of SANS 1091 as recommended in SANS 0140, Part II unless specified to the contrary.

The colour of LV distribution kiosks and miniature substations shall be "AVOCADO GREEN", colour C17 or "LIGHT STONE", colour C37 of SANS 1091.

The standby power section of LV switchboards in buildings shall be coloured "SIGNAL RED", colour A11 of SANS 1091.

Switchboards for No-Break Power Supplies or sections of switchboards containing No-break power supplies, shall be coloured "DARK VIOLET", colour F06 or "OLIVE GREEN", colour H05 of SANS 1091.

In addition to the above, the Contractor shall have the complete installation tested and approved by the local authorities where applicable.

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GSE17 – GENERAL SPECIFICATION ELECTRICAL

TELEMETRY

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1. TELEMETRY INSTALLATION

1.1. APPLICABLE STANDARD SPECIFICATIONS

The following standards will apply to this contract over and above the specification requirements further herein.

SANS 14713-2:2011	Zink coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures. Part 2.
ISO 14713-2:2009	Hot dip galvanizing.
SANS 10313:2012	Protection against lightning – Physical damage to structures and life hazard (use in conjunction with SANS 62305 services).

1.2. STATUTORY REQUIREMENTS

The installation of telemetry equipment shall always comply with the requirements, stipulations and regulations contained in the following Acts:-

Occupational Health and Safety Act 85 of 1993.

The Electricity Act, No 41 of 1987.

Code of Practice for the Wiring of Premises - SABS 10142-1:2012

Radio Act, Act 3 of 1952 and all TELKOM requirements and regulations for radio equipment.

1.3. DESIGN AND CONSTRUCTION

1.3.1. QUALITY OF EQUIPMENT.

The equipment required under this contract shall be of the latest manufactured equipment of its kind on the market.

The equipment must preferably be manufactured in the RSA and equivalent- or replacement equipment must also be available in the RSA.

Equipment of which only a single unit has been imported will not be acceptable.

Equipment for which no equivalent units are available in the RSA will also not be acceptable.

Tenderer's must indicate in their tenders whether replacement units are available for the tendered equipment and must also indicate whether complete maintenance of equipment can be undertaken in the RSA.

Equipment must be assembled in such a way that maintenance can easily be undertaken. All units of equipment shall be fitted with nameplates containing information such as serial numbers, model numbers, type numbers, manufacturer's name, etc., and this information, together with the description of each and every piece of equipment, shall be listed in the maintenance manual which must be handed to the Engineer at the first take-over inspection of the installation.

All components and PC boards shall also be marked with type numbers and with descriptions and this information shall be contained in the maintenance manual.

"Home-made" equipment and component assemblies are not acceptable and the latest technology shall be applied during the construction of equipment.

Cable connections between equipment shall make use of standard plugs and sockets as used internationally and connections shall be made and clamped in such a way that the cores of cables are not damaged where these are soldered to contact terminals and also that cable connections cannot work loose due to the movement of cables.

1.3.2. PRINTED CIRCUIT BOARDS

Equipment shall be manufactured, making maximum use of plug-in type PC boards. PC boards shall contain reliable, high quality components. PC boards shall also be designed for continuous duty under severe service conditions. All PC boards shall be of the modular plug-in type and all plug-in contacts shall be gold plated and shall have sufficient contact pressure to ensure the unimpaired transfer of digital signals.

PC boards shall consist of laminated, copper-clad, high quality, epoxy glass material and shall be of the double- or single sided type. Phenolic resin or Bakelite boards will not be acceptable.

PC boards shall be of sufficient thickness for the size and weight of components mounted there-on and shall not be thinner than 1,5 mm.

PC boards shall be laminated with a minimum copper thickness of 600 g/m^2.

PC boards shall be thoroughly cleaned and washed and shall be chemically de-activated after etch work is completed. The boards shall thereafter be covered with a protective fluxing agent and steps shall be taken to ensure that fluxing agent does not cover the plug-in portions or contacts of the board. The protective layer shall also be a preventative measure for the growth of fungi on the board.

The contact surfaces of all PC boards, edge connectors, plugs and sockets shall be hard gold plated. The plug-in and plug-out forces and the contact wiping action of each make of contact shall be dependable under all circumstances.

Physical forms of plugs and connectors shall ensure that circuit boards are not inserted incorrectly. This physical device shall be a permanent fixture on the board and shall not be removable and it shall not be possible to damage this device to such an extent that boards can be plugged in incorrectly. If such preventative measures cannot be taken on circuit boards, the circuit board contacts shall be arranged in such a manner that no damage can take place to components on the circuit board or components on other equipment in the system, if the circuit board should accidentally be plugged in incorrectly.

The framework or supports into which the circuit boards are inserted shall be sturdy and the board shall fit positively in the frame or guides. The plugs and sockets for the plugging in of PC boards shall be accurately aligned to avoid radial pressure on boards when boards are plugged in. Tracks guiding PC boards shall also be installed over the full length of the board.

Component identification is very important and PC boards shall be marked by means of silk-screen printing or other positive means of identification so that the number and the type of component which is mounted on the board is also clearly indicated on the printed pattern, together with the polarity of terminals where multi-terminal components are mounted. Each printed circuit board shall contain the following data:

a) The name or the purpose of the printed circuit board.
b) The drawing number or type number of the PC board.
c) Component identification congruent with the identification of the particular circuit diagram.

Component placement drawings shall also be submitted together with diagrammatic drawings for positive component identification as part of the maintenance manuals.

It is a condition of tender that tenderer's shall submit the following drawings of each PC board:

a) Complete circuit diagrams containing component values, types and code numbers.
b) A block diagram showing the connections between each and every circuit board.
c) Component layout drawings with cross references to the drawings mentioned under (a) above.
d) A drawing showing the etch pattern of each PC board .

These drawings shall form part of the maintenance manual which shall be supplied for each and every contract.

It is a further requirement of the tender that each type of printed circuit board be supplied together with an extension board or extension cable which will enable maintenance personnel to maintain the system whilst in operation.

1.3.3. COMPONENTS

Components shall be used for which at least one or preferably two replacement components are available.

Preference will be given to systems using a large scale manufactured type PC boards and components and "home-made" boards or a single purpose board, for which no immediate replacement is available, will not be acceptable. Specially designed boards shall also be avoided as far as possible.

No thermionic components shall be used. All components shall be of the semi-conductor type (silicone, germanium, gallium, metal oxide, etc.). Integrated circuits shall preferably all be locally available and shall be marked with an acceptable number such as CD 4011, LM 721, 7000, etc. Central processor units (CPU) shall also be of the locally available type.

No "in-house" numbers shall appear on integrated circuits.

Integrated circuits shall preferably be soldered onto printed circuit boards except EPROM's or ROM's or CPU's which shall be plug-in unit.

No aluminium to copper connections shall be used in electrolytic condensers.

Condensers shall also not be used in clock-pulse generating circuits.

Heat generating components such as stabilised power supply components or components for local supply stabilisation at PC boards shall be fitted on suitably sized heat sinks and shall not be mounted directly onto PC boards or shall not use the copper lamination of the circuit board as a heat sink. Sufficiently long component terminals shall be used in such cases and no other component which is temperature sensitive, or which can deteriorate due to high ambient temperatures, shall be used in close proximity of such heat generating components. Printed circuit boards shall also not be subjected to abnormal temperatures or temperatures which may influence the bonding of the copper lamination.

No unmarked and properly shielded mains voltage equipment shall be mounted on PC boards. All mains power equipment shall be terminated in shielded compartments or -power supplies so that normal maintenance can be carried out in safety. No mains power equipment or terminals thereof shall be in close proximity to, or come into contact with, digital supply voltages or components.

Standard or high intensity LED's shall be used throughout. LED's mounted in panel face-plates shall be mounted in chromium plated bezels. Integrated circuits driving LED's shall be suitably rated for the lamp load. All indicated circuits shall be fitted with two parallel LED's and all labels shall have letter sizes with a minimum of 2,5 mm.

Display units shall be of the liquid crystal type (LCD) or the plasma (PDP) or electro-luminance (EL) type. Seven segment or fourteen segment alphanumeric displays may be used but the power consumption of the panels shall be clearly indicated in tenders.

<u>Systems which require necessary large battery capacities to function, will not be acceptable</u>.

All equipment shall be suitably shielded and damped for immunity against radio frequency radiation.

Opto-couplers shall be used on outgoing circuit terminals if such terminals are to be used for connections of circuits between two separate buildings.

1.3.4. SOFTWARE IN PANELS

The requirements stipulated here-under in connection with the availability and the usage of software for computer-based equipment which is to be supplied to Employer per contract, shall be adhered to:

a) Computer based systems shall not become unserviceable due to the loss of, or damage to software.
b) It shall be possible to reinstate software after maintenance or after possible damage to the software.

The Employer requires assurance that equipment can function continuously, also in the case where the firm which supplied the system originally, can no longer supply the relevant software.

The Employer requires assurance that any software can be loaded immediately regardless of the supplier's availability.

The Employer must be able to reload software on systems which are far removed from metropolitan areas. Time is of the essence.

The Employer is only interested to reload software into a system for which the software was originally written and is not interested in the copying of software from one system to another.

The Employer will use the original contractor or supplier of the system to reload software, where at all possible or practicable.

1.3.5. SOFTWARE IN INTEGRATED CIRCUITS

Where software is loaded in ROM's or in EPROM's, the standby software shall be supplied as follows:

Two (2) each of each individual integrated circuit (IC's), pre-programmed, as spare parts together with the equipment.

All IC's containing program data shall plug into a DIP socket, and shall not be soldered onto PC boards.

All IC's containing program data and which are mounted on printed circuit boards shall be clearly marked. These markings shall consist of a number or letter or a combination of both, such as IC 3, etc.

The markings on the printed circuit board shall appear next to the DIP base in a clearly visible position and the markings shall be by means of etch work, silkscreen printing work, etc.

The spare IC's, as mentioned above, shall be pressed into a piece of antistatic material and shall be sealed in an antistatic plastic bag. A separate antistatic plastic bag, with the contents as described hereunder, shall be used for each and every separate PC board containing such circuits.

Every IC shall be provided with the sticker and this sticker shall contain the same number as mentioned above.

The antistatic plastic bag shall contain a card with the following information:

a) The project number.
b) The date of the tender.
c) The name, address and telephone numbers of the firm.
d) A block diagram showing the component layout of the printed circuit board and the position of the IC thereupon.
e) The number of the IC next to it's position on the block diagram.
f) The number and position of the printed circuit board in the panel or control board, if more than one printed circuit board is used in the system.
g) The number, position and description of the panel or control board for which the component or components are earmarked.
h) Complete instructions for the removal of IC's from the PC board and for the installation of new IC's on the board, together with the preventative measures so that IC's are not destroyed by static electricity during handling thereof.
i) The necessary tweezers, holders or equipment for the extraction and replacement of IC's.

If more than one antistatic plastic bag is delivered for a single project, these plastic bags shall all be placed in a larger antistatic plastic bag with a marked card in the bag which shall contain the data of (a), (b) and (c) above.

The UV windows of EPROM's supplied on PC boards or as spares, shall be sealed with stickers.

1.3.6. CENTRAL PROCESSOR UNITS (CPU)

CPU integrated circuits shall also be supplied in the form of spare parts as specified.

1.3.7. SOFTWARE IN RAM

Program software stored in RAM will not be acceptable, even when protected by means of battery back-up power supplies, in whatsoever form of batteries.

1.3.8. OTHER MATERIALS AND PROCESSES FOR EQUIPMENT

3CR12 Powder coated pad lockable cabinets shall be used to house outdoor equipment.

A solid gland plate for mounting cables shall be provided for termination of cables in this case and cables shall enter and leave the cabinets from the bottom only, in the case of outdoor equipment.

All cabinet panels shall be removable to facilitate access to installed equipment for maintenance purposes.

All internal cabinet wiring shall be carried out with PVC insulated conductors. All wiring shall be grouped and laced and placed in PVC lip trunking. No joints shall be allowed in internal wiring and all connections to terminals or earth bars shall be made with tinned copper lugs soldered or crimped to the ends of the conductors. All wires in the system shall be clearly marked at all termination points and wire ends shall be lugged.

1.4. SYSTEM CHARACTERISTICS

1.4.1. PERFORMANCE CHARACTERISTICS (END-TO-END)

The final quantities of I/O facilities shall be in accordance with the SCADA equipment offered by the Contractor.

The radio link shall be designed for a fade margin better than 25 dB.

The availability of the data link shall be 99,5%. This implies that a total interruption of the digital bitstream or a Bit Error Rate (BER) of 10^{-3} for periods exceeding 10 seconds can be tolerated.

The system shall utilize protocol which shall employ error detection and correction techniques to ensure transmitted data integrity.

The audio frequency response of the radio channel shall be within ± 0,5 dB over the frequency range 300 Hz to 3300 Hz relative to a reference frequency of 1kHz.

The reaction time of the system from the time of a status change of a sensing signal until such time as the output relays are activated, shall be less than 20 seconds.

The system shall be able to operate, without degradation of performance, for at least 72 hours in the case of a mains power failure, by means of battery back-up systems.

The antenna shall withstand the same wind loading the mast is designed for.

The system shall be protected against lightning and electrical surges and insured by the Sub-Contractor for both the construction and defects liability periods.

1.4.2. PHYSICAL CHARACTERISTICS

All functions of the system shall be performed via standard design plug-in circuit boards.
The system boards shall be 19" rack mounted.

The radio carrier equipment, data acquisition equipment and battery charger shall also be mounted on PC boards or unit construction which shall fit into the slide-in frame and plug into the PC board slots in the 19" rack frame.
The equipment shall be completely modular at this level, i.e. a card such as, for instance, the power supply, must not contain any other system component.

The rack system shall be easily expandable and the cards for the systems shall be interchangeable.
All the stations in the system shall utilise the same modules.

The batteries shall be housed in a separate acid proof and ventilated enclosure, manufactured from a non-corrosive material.

Cooling of the equipment shall be by normal convection. Adequate ventilation for this purpose shall be provided.

All wiring connections and instruments shall be mounted inside cabinets.

1.4.3. EARTHING AND LIGHTNING PROTECTION

1.4.3.1. GENERAL

The system shall withstand, without permanent damage, voltage and/or current surges occurring indirectly as a result of lightning strikes. In order to protect the system, i.e. data acquisition equipment, radio carrier equipment, power supplies, antennas and masts the following basic requirements shall be adhered to:

a) A point of preferential strike termination on air terminations (antenna masts) shall be provided, which shall be capable of intercepting and withstanding a discharge, while effectively shielding adjacent objects requiring protection.
b) Interconnecting low impedance paths, termed down-conductors, which effectively conduct the lightning current from any air terminations to the earth shall be provided.
c) A low impedance connection for dissipation of the discharge shall be provided between the down-conductors and the body of the earth, i.e. in the form of an effective ground earth system.
d) Input and output connections to the system shall be equipped with arrestors (protectors) to protect the electronic equipment against transients and surges.

Protection of the mast and antenna

a) A vertical steel or copper clad steel rod shall be bonded to the mast foot by means of bolting a heavy duty lug under one of the mast foundation bolts.

b) The mast shall extend above the antenna as to provide a 30° cone of protection for the antenna.
c) The rod shall have 15 mm diameter as a minimum.
d) The rod shall be at least 3 metres in length.
e) The zero potential point of the antenna shall be directly connected to the metal work of the mast.
f) A heavy solid copper bonding conductor with a cross sectional area of at least 70 mm^2, shall run from the mast foot earth point to the ground earthing system of the site.
g) Sharp or re-entrant bends shall be avoided.

The following lightning protection equipment shall also be built into the system:

a) Optical isolation contact inputs.
b) Relay contacts, gas arrestors and transorbs on analog inputs and outputs.
c) Relay contacts on contact outputs.

1.5. SYSTEM ELEMENT CHARACTERISTICS

1.5.1. RADIO CARRIER EQUIPMENT

1.5.1.1. GENERAL

The radio carrier equipment comprises the following:

a) Transceivers.
b) Antennas.
c) Feeder cables.

1.5.2. APPROVAL AND APPLICATION.

The equipment shall be approved by the Postmaster General for use in the Republic of South Africa in terms of the Radio Act, Act 3 of 1952. The successful tenderer shall submit an application to TELKOM for a frequency allocation for the system as soon as he is advised that his tender is accepted. Copies of the application shall be handed to the Engineer timeously.

1.5.3. TRANSCEIVERS

The design criteria of transceiver equipment shall comply with the following requirements:

a) Frequency range	:	VHF 141 MHz, 146 MHz - 160 MHz or UHF 450MHz - 470 MHz
b) Class of Modulation	:	Phase modulation. Hundred percent modulation shall cause 5 kHz deviation. Distortion less than 10%.
c) Channel Spacing	:	12,5 kHz VHF. 12,5 kHz UHF
d) Transmitter Power Output	:	5 Watt nominal, adjustable down to 1,0 Watt.
e) FM hum and noise	:	- 40 dB
f) Suppression of spurious and harmonic radiation	:	-65 dBW.
g) Frequency control	:	Crystal or synthesized controlled.
h) Frequency stability	:	0,0005%.
i) Pre-set Channels	:	12.

j)	Transmitter bandwidth	:	4 MHz (No degradation) 10 MHz (3 dB degradation)
k)	Receiver sensitivity	:	0,4 µvolt or less for 12 dB Sinad.
l)	Receiver Selectivity	:	Adjacent channel - 70 dB.
m)	Receiver Spurious and Image Rejection	:	- 70 dB.
n)	Intermodulation Rejection	:	- 60 dB.
o)	Audio output	:	500 mW.
p)	Modulation Acceptance Bandwidth	:	> 5 kHz
q)	Receiver frequency stability	:	0,0005%
r)	Transmitter bandwidth	:	4 MHz (No degradation) 6 MHz (3 dB degradation)
s)	Audio frequency distortion	:	Less than 5% at an audio output of 300 m Wr.m.s. when the RF carrier is modulated by a 1000 Hz audio tone to a modulation depth sufficient to produce a frequency deviation of 3300 Hz.

1.5.4. ANTENNAE

a) Carrier reflector Yagi type antennae shall be used.
b) The gain of the antennae shall not be less than 10 dB relative to the gain of a half wave dipole.
c) Antenna standing wave ratio shall not exceed 1,2: 1.
d) The front to back ratio shall be better than 15 dB.
e) The beam width shall be 46° horizontal and 60° vertical.

1.5.5. COAX CABLES

The loss in the feeder cables shall not exceed 3 dB per 30 m and shall preferably be RG213. If foam helix cables are offered, this shall be clearly stated in the offer.

Coax cables shall not be damaged upon installation, shall not be bent around shorter radius than 500 mm. Connectors shall be of the "N" type.

The coax cable between mast not mounted on buildings (free standing masts) and pump stations shall be hung from a stainles steel wire rope catenary or shall be installed underground in a PVC sleeve by the Telemetry Sub-contractor.

1.5.6. DATA ACQUISITION EQUIPMENT

1.5.6.1. GENERAL

The purpose of the data acquisition equipment at the monitoring site is to gather data from the different inputs (dry contacts and analog signals), encode the information and transmit it via a modem over the radio link to the receiving site. At the receiving site the data acquisition equipment shall decode the data, check it for errors and correct it. The data shall then be routed to the output interface which shall activate control relays. The data link shall be full duplex, asynchronous and operating at1200 baud.

1.5.6.1.1. ACQUISITION EQUIPMENT

The data acquisition equipment consists of the following:

a) Input interface at the monitoring site.
b) Control equipment.
c) Modem
d) Output Interface at the receiving site.

1.5.6.1.2. INPUT INTERFACE

The input interface shall detect the status of the digital contact inputs or 4 - 20 mA signals, encode the information and store it in a buffer. A change of status of any input shall be routed to the output side of the interface to so that the system can transmit the changed data status.

1.5.6.1.3. CONTROL EQUIPMENT

The function of the control equipment is to detect any change of status of the input data , set up the data link and transmit (PTT the transmitter) the information via the modem to the other site. Timing diagrams shall be supplied as part of the proposal as well as message formats and structures.

1.5.6.1.4. MODEM

The modem shall utilize the radio link for data communication. The data speed shall not exceed 1200 bits per second and the modulating frequencies shall fall within the 300 Hz to 3300 Hz frequency band. The modem shall have built in test facilities and sufficient RF filtering components to eliminate distortion and errors caused by RF interference from the radio transmitter. The modem shall employ automatic phase equalizing techniques.

<u>The protocol of data transfer shall be such that error detection takes place continuously and correction techniques shall be applied to ensure transmitted data integrity.</u>

1.5.6.1.5. OUTPUT INTERFACE

The output interface shall receive the data status information from the associated modem, decode it and activate the necessary controls or instruments. The output switched via activated relays which shall be able to switch currents up to 5 amps.

<u>The telemetry system interface outputs shall not operate in such a way as not to hold control circuits in case of a failure of the telemetry system but shall fail to safety (switch off). Temporary communication failures shall also not result in the repetitive switching of any control equipment or "hunting" of the system.</u>

1.5.6.1.6. SPEECH CHANNEL

Normally only telemetry data signals shall be transmitted between the monitoring and receiving site, however a speech facility for set-up, testing and maintenance purposes shall be supplied. This shall allow maintenance technicians to call and receive calls from the receiving or monitoring sites. The channel shall consist of an interface to the telemetry equipment, a hand set and a hook up switch to disable the data transmission when speech is transmitted. Under normal conditions the hand set shall be on the hook-up switch disabling the microphone and PTT switch- The earphone shall be connected to the circuitry. This will allow the maintenance staff to listen to the transfer of data. When the hand set is removed from the hook-up switch a signal shall be sent to the data acquisition control equipment informing it of this action. The control equipment shall then enable the microphone and PTT switch allowing speech.

1.5.7. POWER SUPPLY

1.5.7.1. GENERAL

The radio telemetry system shall operate from a battery power supply system. Normal 230 V.AC.+ 10% will be available for the power supply equipment but solar cells are also required as a back-up system for the charging of batteries. The power supply system shall consist of the following:

a) Mains/solar operated battery charger. (Solar for repeater stations without auxiliary LV power)
b) Storage batteries.
c) Solar panels(as back-up supply source where applicable)

1.5.7.2. BATTERY CHARGER

The battery charger shall be a mains-/ solar panel operated charge type regulator. The charger shall be equipped with a double pole circuit protection on the incoming line capable of breaking the full load incoming AC current and a two pole isolating switch capable of breaking the charger output current. The rectifier diodes and thyristors shall be protected with high speed fuses mounted on the front panel. The charger shall be equipped with a DC Voltmeter and Ammeter to indicate output voltage and current. The charger shall not overheat or be damaged delivering maximum output current at the maximum pre-set voltage to the designed load for a continuous period of 72 hours. The output of the charger shall be short circuit protected. The charger shall be able to handle the charging current of a discharged battery as well as the transmitter current.

<u>A discharged battery shall not prevent the system from resetting itself automatically</u> after a power failure of longer duration than 72 hrs. The system shall start operating immediately upon mains power restoration whilst the battery is undergoing charging.

1.5.7.3. BATTERIES

The battery shall be of the deep cycle, high reliability <u>sealed</u> lead acid type or vented nickel cadmium complete with terminals, connectors, etc. and suitable acid proof housing. The battery shall be capable of keeping the equipment operative without any degradation in performance for a minimum period of 72 hours in case of a mains failure.

Batteries shall not be housed in the same cabinet as electronic equipment but shall be mounted in a separate acid resistant lockable cabinet. The battery charge and - discharge characteristics shall be suitable for telemetry (small current) work. Motor vehicle batteries will not be acceptable.

1.5.8. NAMEPLATES AND MARKING

All cabinets and equipment installed shall be clearly marked.

Safety warning notices shall be in English.
All terminal blocks inside cabinets shall be marked, indicating number and type of circuits connected.
All switches, relays and fuses shall be marked, indicating function and fuse rating.

Black letters on white background shall be used for normal labels and red letters on white or yellow background for danger notices. All labels used shall be engraved traffolite.

All labels shall be fixed by means of stainless steel machine screws and nuts, or poprivets.

1.5.9. SOLAR PANELS.

Solar panels shall be self-contained, hermetically sealed units, mounted in aluminium surround frames and shall be suitable for outdoor operation.

The number of panels used shall be determined in accordance with the charging capacity of the system required.

Mounting frames shall be suitable for the fixing of the panel to mounting brackets without distortion of the frame.

The efficiency of the panel shall not be affected by ambient temperatures up to 60 °C.

The no-load voltage of panels shall be not more than 18 Volts and panels shall always be connected through voltage regulating equipment to batteries to avoid batteries reaching "gassing" voltages.

Panels shall be mounted at ± 50° angle with the vertical on substantial galvanised steel brackets and shall face ± 15 ° West of North.

1.6. LOCATION AND TEST

<u>The sites or buildings may not all be placed in ideal positions as far as placing of antennae, or transmission paths are concerned, and it is a specific requirement that signal surveys are done on all sites to make sure that the submitted tenders represent workable telemetry systems.</u>

The results of such tests, polar diagrams, received signal strengths, etc., shall be submitted together with tenders and the costs of any masts shall be shown separately in pricing or in covering letters.

The tests on site shall further determine the frequency band (VHF or UHF) of operation, before the tender is submitted.

1.7. HIGH MASTS (IF REQUIRED)

1.7.1. GENERAL AND CONSTRUCTION.

High masts are required for radio telemetry systems where the site dictates that a mast is required.

High mast must be self-supporting, either the monolithic type or lattice type.

No welding, drilling or machine work must be necessary to assemble the masts on site.

All auxiliaries shall be supplied with the mast.

All welding shall comply with SABS requirements and the steel used shall be high tensile steel.

All parts of the mast shall be hot-dipped galvanised inside and out, and no welding or drilling shall be done on the mast after galvanising. Where indicated, sections shall be painted and warning devices (flasher) shall be installed.

The masts as supplied by "Sectional Poles" will be acceptable.

1.7.2. WORKING LOAD

The mast shall be suitable to carry 150 kg at the top of the mast.

The Tenderer shall supply full information to indicate deviation at the top of the mast under maximum wind velocity. Oscillation movements of the mast under wind conditions shall be given by the Tenderer. Full details of the mast and calculations must accompany the tender.

1.7.3. FOUNDATION BOLTS

Each mast must be provided with a set of mounting bolts and templates. Bolts shall be hot dipped galvanised.

Two nuts and washers must be provided with each bolt.

The foundation shall be designed by the supplier and must take site ground conditions into account. Foundations shall be certified by the ECSA Registered Pr Eng following completion.

The mast foundation shall be able to carry the mast safely under all conditions and foundation details together with calculations and reinforcing steel information shall be submitted to the Engineer timeously before erection of the foundation. The designer of the foundation is to provide adequate proof of professional indemnity insurance for such design.

Tenderer's must allow in their tender for installing of the foundations for the mast, accepting site ground conditions.

1.7.4. CLIMBING DEVICE

A safe climbing device shall be provided to enable maintenance of the mast and antenna to be carried out without the need to lower the mast. A caged ladder on the mast shall comply with the MOS Act.

1.8. ENVIRONMENTAL SYSTEM

The system shall operate, without degradation of performance, in the following ambient conditions:

a)	Altitude	:	0 to 2500 meters
b)	Temperature	:	-5 to +45°C

c) Relative humidity : Max 95% below 35°C, Max 75% above 35°C

The equipment will be required to operate without degradation of performance in these conditions and on the particular sites.

1.9. APPROVAL AND APPLICATION

The telemetry equipment offered shall be approved by TELKOM for use in the Republic of South Africa in terms of the Radio Act, Act 3 of 1952.

The successful tenderer shall submit an application to TELKOM for a frequency allocation for the system as soon as he is advised that his tender is accepted. Copies of the application shall be handed to the Engineer. The successful tenderer shall further obtain any necessary signatures of the Employer on application forms, fill out forms, submit these to TELKOM and follow up the progress of the application on a fortnightly basis to ensure that the frequency is granted early during the contract period so as to avoid delays during the execution of the Contract.

1.10. COMMISSIONING OF SYSTEM

Requirements are not necessarily laid down for smaller specialised items but the Engineer requires that the whole system shall comply with the highest quality as far as design and installation practice of radio telemetry systems are concerned.

The testing of the system shall be done to the satisfaction of, the Engineer.

Tests shall include:

a) Site tests to determine the type of antenna and whether towers are necessary, before submission of a tender.
b) Simulation tests in the works of the telemetry contractor for the equipment as may be regarded necessary by the Engineer.
c) The final operational tests shall take place on site as may be required or instructed by the Engineer.
d) Visits to site every two weeks for a period of 3 months to check that operation is normal, after successful commissioning and then 3 quarterly visits for the remainder of the 12-month period.

The telemetry contractor shall further attend all site meetings, commissioning- and commissioning tests, as may be instructed by the Engineer.

All equipment, material, etc., which may be necessary for these tests shall be supplied by the telemetry contractor.

1.11. TRAINING

1.11.1. TRAINING PROGRAM

Tenderer's shall allow in their tender prices for a training course to train at least four (4) persons on site. The training shall take place over a period of one (1) full working day of eight (8) hours, and in this period the staff shall be made fully conversant with the operation of the system. The training shall be of a standard which will enable the Employer to carry out further in-house training. This period shall be during the last week of the commissioning period.

The training course shall only start after first take-over of the system.

1.11.2. TRAINING COURSE IN MANUAL

The operational and maintenance manual of the contract shall also contain a full description of the contents of the training course. Full descriptions of the maintenance aspects and the operational aspects of the complete system shall also form part of the descriptive material.

Advanced technical information of the system may also be bound into the manuals as additional information.

1.12. OPERATORS MANUAL

1.12.1. SCOPE

This specification covers the requirements for the supply of five sets of Operator's Manuals, applicable to the systems installed.

1.12.2. GENERAL

Five sets of Operator's Manuals shall be handed to the Engineer prior to commissioning of the systems. The manuals shall be neatly bound, in typewritten and/or printed format, indexed, with appropriate dividers between each section to facilitate ready reference. All documentation shall be presented in the English language.

1.12.3. REQUIREMENTS FOR MANUAL CONTENTS

Each operator's manual shall contain the following:

a) A complete set of "as built" drawings of the contract.
b) A complete set of "machine shop" drawings of the contract, showing dimensions, finishes, general arrangements of panels, equipment assemblies, etc.
c) A complete set of wiring diagram drawings of all equipment, showing component identification, types and values.
d) A complete set of PC board etch pattern drawings, containing component layouts, identification markings for components. PC board identification markings, descriptions or names shall also be indicated on the drawings.
e) A block diagram drawing for each piece of equipment containing more than one PC board, showing the inter-connections of boards complete with connector- and plug numbers, together with PC board identification markings, as specified in (d) above.
f) A complete list of all equipment containing the following information :
    - Name of the equipment (or description thereof).
    - Serial number of equipment.
    - Type number of equipment.
    - Manufacturer of equipment.
    - Equivalent replacement model of equipment (where applicable).

- Names, addresses and telephone numbers of firms supplying equipment.

g) A complete and comprehensive description of the operation of the system and of each individual piece of equipment.
h) A complete and comprehensive description of the maintenance and fault finding procedures of the system and of each individual piece of equipment i.r.o. daily-, weekly-, monthly- or annual maintenance.

The Contract will not be regarded as being complete and will not be taken over during the first take-over inspection if the specified data and equipment is not handed to the Engineer.

1.13. MAINTENANCE

1.13.1. FREE MAINTENANCE

The tenderer for this contract shall allow in his tender price for the maintenance of the complete installation for a period of twelve (12) months, starting from the date of the take-over of the works by the Employer.

It is a specific requirement of this contract that the contractor shall allow for the prescribed inspection visits during the first 3 months of the maintenance period as well as visits every 3 months during the further 9 months and that the contractor shall submit full reports for each inspection. The reports shall contain the status of the system as well as the faults which occurred on the system during the previous period.
A log book shall be supplied by the contractor and shall be kept on site in charge of the responsible person, appointed by the Employer for this purpose. The contractor shall complete the log book as far as maintenance done by him, is concerned, and as far as repairs of faults which may have occurred.

The log book shall allow for the following information:

a) Date.
b) Type of fault reported and by whom.
c) Date of fault report.
d) Work done.
e) Name and signature of person carrying out the work.
f) Name and signature of Employer's representative.

The log book shall be filled out in triplicate and two pages shall be removed of which one page shall accompany the monthly report to the representative of the Employer whilst the other copy shall be sent to the Engineer. The third copy shall remain in the book.

The reports shall be submitted in typewritten form to the specified persons within seven (7) days of the inspection. Serious faults shall immediately be reported to the representative of the Employer and the Engineer by e-mail.

No maintenance or repair work shall be done on site without the knowledge and the approval of the responsible person in charge on the site.

1.13.2. MAINTENANCE PROGRAM

The contractor shall draw up a complete maintenance program instruction document for the system which shall enable the Employer to maintain the system on short-term basis, if the design of the system requires this.

This document shall indicate clearly the basic steps to be taken to prevent failure of the system.
The normal short-term maintenance which is, for example, necessary for the maintenance of batteries in the system, shall be clearly indicated in the documentation.

1.13.3. MAINTENANCE CONTRACT

The contractor for this contract shall submit a comprehensive maintenance agreement for consideration to the Employer before six (6) months of the free maintenance period has lapsed. The maintenance contract shall contain all rates and conditions so that the Employer can give the document proper attention. The Employer may then negotiate with the contractor for the signing of a maintenance agreement after the free maintenance period has lapsed.

1.14. SPARES

A lockable wall mounted steel cabinet of dimensions 600 x 600 x 200 mm deep shall be supplied and installed as indicated on site by the Engineer. The steel cabinet shall be manufactured from 2,6 mm 3CR12 and finished in powder coating.

The cabinet door shall have a heavy duty "Barker & Nelson" handle for padlocking and shall swing on two heavy duty pedestal hinges.

The cabinet shall be provided with a steel shelve which shall rest on adjustable "Shelvit" type supports, two supports at each end.

The cabinet shall contain the following spares:

a) A radio transceiver.
b) One of each type of PC board used.
c) All the packets with software EPROMS and tools as specified in the Universal Specification.
d) Two of each type removable relay used.
e) One power supply.
f) One of each type and colour of LED used.

A typed inventory, of everything in the cabinet, shall be mounted behind a "Perspex" window on the inside of the cabinet door. The inventory shall have space for the date and signature of the Clients representative.

GSE27 – GENERAL SPECIFICATION ELECTRICAL

HIGH MAST LIGHTS

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1. CONSTRUCTION

The 40 m high mast shall be constructed to form a continuously tapered, 12 sided shaft. It must be manufactured from BS 4360, grade 43 A steel, with a minimum wall thickness of 4 mm and hot-dip galvanised to SABS 763.

The mast shall consist of sections, using site slip-joints to fit them together. No welding on site is allowed. Each section shall be approximately 12 m long to facilitate galvanising and easy transport to site.

The mast, when fully equipped with two point suspension, steel wire ropes, trailing cable(s), raising and lowering gear and all the luminaires, must be designed in accordance with SABS 0160 to withstand a wind velocity appropriate to the site, with a mean return period of 50 years and terrain category 2 class B. The deflection of the mast top shall not exceed 2,5 % of the mast height when subjected to two thirds of the maximum wind velocity.

2. ACCESS DOOR

A door with a ventilation opening and padlock must be provided in the base of the mast for easy access to the electrical distribution board, ancillary equipment and the quick and safe attachment of the portable winch to mast and hoisting ropes. The opening perimeter must be reinforced to restore the section modules of the mast shaft and have a curved top and bottom to prevent stress concentrations.

3. RAISING AND LOWERING GEAR

The raising and lowering gear must, in complete safety, facilitate the raising and lowering of the luminaire cluster for maintenance purposes by means of a portable winch.

4. HOIST EQUIPMENT

Two 6 mm diameter suspension ropes of stainless steel 7/19 construction and a neoprene trailing cable must run over large, 280 mm diameter aluminium pulleys, having nylon bushes and running on stainless steel shafts. A separator must be provided between the pulleys while two close fitted guides and a separator bar must be provided on the outside of the pulleys. The stainless steel ropes must be in tension at all times.

The top pulley assembly must have guides and docking stops designed and constructed in such a way that the luminaire ring is always in the same position after raising it to the top of the mast and that jamming of the ring is not possible.

The complete pulley assembly must be enclosed with a fibreglass top cover, fixed with a bolt incorporating a lightning arrestor, to prevent ingress of water.

One end of the wire rope in the bottom of the mast must be attached to the rope lock bar in such a manner that accidental lowering of the luminaire ring, without the use of the winch, is not possible.

A portable double drum winch suitable for external mounting must be supplied. The self sustained winch, with worm and worm-wheel operating in an oil bath and with a gear ratio of 50:1, must be suitable for both hand and electric power tool operation.

5. ELECTRIC WINCH POWER TOOLS

The multi-speed reversible power tool must incorporate a torque limiting device. Additional facilities must be provided to support the power tool for proper and safe operation.

Standard Tool - 2 speed, reversible
Rated supply 220 V, 50 Hz

Lifting capacity	Operating speed	Lifting rate (50:1 winch)
250 kg	400 rpm	2,5 m/min
500 kg	160 rpm	1,0 m/min

6. CABLES AND CABLE CONNECTIONS

A 5 core flexible neoprene mains supply trailing cable shall be provided. One end of the cable shall be terminated in a 5 pin plug, with the matching socket outlet on the electrical board installed at the base of the mast. The other end of the cable shall be terminated in a terminal block installed in a weatherproof aluminium junction box on the luminaire head ring. The junction box shall be fitted with earth and neutral bars and the required number and size of cable glands. A test lead shall be provided to supply power to the luminaires on the head ring for testing lamps and control gear when in the lowered position.

7. EARTHING TERMINAL

A 12 mm diameter stud shall be welded to the mast structure adjacent to the distribution board. Incoming cables must be earthed by this stud.

8. DISTRIBUTION BOARDS

A totally enclosed fibreglass power distribution board shall be mounted in an easily accessible position in the base compartment of the mast. The board shall be provided with a front cover panel with only the operating toggles of isolator and circuit breakers protruding.

The distribution board shall be equipped as follows:

a) One three phase, neutral and earth socket outlet for connection of the supply cable to the luminaires protected by the circuit breakers.

b) One 15 A, 3 pin industrial type, switched socket outlet for the power tool.

c) One adequately rated triple pole isolator.

d) One 15 A single pole and neutral moulded case circuit breaker with integral 20 A earth leakage protection device for control on the switched socket outlet.

e) Three adequately rated single pole moulded case circuit breakers for control of the luminaires.

f) One 4 way neutral bar.

g) One 4 way earth bar.

h) Contactor controlled by photocell mounted on top of the mast.

i) Three single phase kWh meters for energy consumption.

9. LUMINAIRE RING

The luminaire ring shall be manufactured in two sections, bolted together to allow the removal from the mast. The ring shall be of a welded construction, hot-dip galvanised after all drilling and welding has been completed. The required number and type of spigots or brackets, supporting the luminaires, shall be welded to the outer face of the ring.

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GSE30 – GENERAL SPECIFICATION ELECTRICAL

LV ELECTRIC CABLES, GLANDS & TERMINATIONS

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ELECTRIC CABLES, CABLE TERMINATING GLANDS AND EARTHWIRES

Low voltage cables shall be for service in a 400/230 V, 3 phase, 50 Hz system and shall be PVC insulated, PVC sheathed, steel wire armoured, PVC covered, 660/1000 V grade, complying with the requirements of SABS 150. The cores shall be stranded copper.

Cables and earth conductors for a specific application shall be selected strictly in accordance with the requirements laid down in SABS 0142 in respect of current rating and voltage drop. Where practicable the earth continuity conductors shall form an integral part of the cable.

Each cable connection shall be terminated at each end by means of a suitably sized adjustable chromium plated, brass terminating gland complete with armour clamp and neoprene shroud. Cable terminating glands for outdoor use shall be provided with waterproofing inner seals as well as waterproofing seals on nipples. Cable armouring shall be earthed at each end but may not be used as earth continuity conductor.

Each current and earth conductor shall be terminated at each end by means of a suitably sized bolted lug crimped onto the conductor. The lugs shall be bolted onto the relevant bus bars, earth bars or earthing terminals.

Cables and earth conductor shall be installed along the routes indicated on the drawings.

Control wiring/cables shall be of minimum thickness of 0,5 mm square. The cores shall consist of at least three strands of copper conductors unless otherwise specified. The core of each pair of conductors of multicore cables shall be twisted. Screened cables shall be provided for all signal cables e g cables for flow meters.

No joint will be allowed in any run of cable or earth conductor.

The Contractor shall be responsible for the excavation, bedding back-filling, consolidating and making good of all cable trenches along the routes indicated on the drawings, with the exception of those sections of the cable routes where it is specifically indicated on the accompanying drawings that open cable ducts will be provided by others. Ducts inside new buildings will be provided by others.

The cable trenches for the electrical cables under the electrical contract will be provided by that responsible contractor.

NOTE: Tenderers shall acquaint themselves fully with the nature and formation of the ground in which the cables are to be laid, before submitting a tender. No subsequent claim for extras due to lack of knowledge in this respect will be entertained by the Client.

Cable trenches for LV power and street lighting cables shall be deep enough to facilitate the laying of these cables at a depth of 750 mm below final ground level. The floors of all cable trenches shall be smooth and free from boulders and sharp rock projections.

Each cable shall be laid in a bedding of river sand of sifter soil 75 mm over and 75 mm below the cable - clayish soil will not be accepted as bedding. No cable trench shall be back-filled before the cable(s) in the trench has been inspected and approved by the Engineer.

Backfilling of cable trenches shall be done in stages not exceeding 150 mm with thorough consolidations at each stage to prevent subsequent subsidence.

a) Marking Tape

Yellow PVC marking tape, 150 mm wide, with the wording "Buried Electrical Cable - Caution" in both English and Afrikaans, printed in Red or Black, shall be laid approximately 300 mm below ground level above the cables.

b) Cable Markers

- Cable markers shall consist of 150 mm x 100 mm x 500 mm high concrete blocks with 50 mm high letters cast in the concrete and marked "HV or LV Cable". The concrete block must not protrude more than 150 mm above the finished pavement level.

- Cable markers are to be installed at each end, each cable through joint position at each change of cable direction and at 100 m intervals along the high voltage cable route.

Cables to be installed on walls and structures shall be properly supported and firmly fixed at suitable regular intervals to prevent it from sagging under its own eight or snaking.

All exposed cable runs shall be installed neatly horizontally and vertically and all exposed vertical cable run between ground level and 2 m above ground level shall be installed in cable sleeve pipes or conduits. These pipes or conduits shall extend to at least 300 mm below ground level. Intervals between fixing points for sleeves and conduits shall not exceed 1 m.

Only plugging materials of an approved type may be used for fixing to brick walls and concrete - wood will not be acceptable. Plugging in joints of brick walls will not be acceptable.

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GSE32 – GENERAL SPECIFICATION ELECTRICAL

ELECTRICAL DISTRIBUTION & MCC BOARDS

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1. TYPE AND CONSTRUCTION

All electrical distribution boards and motor control boards shall be of the outdoor, weatherproof, surface mounting type with IP 65 insect proofed enclosure and consisting of a hinged door(s), a removable front panel and chassis all constructed of at least 2 mm thick 3CR12 steel plate, powder-coated in electrical orange paint.
Damaged paint work will not be repaired on site but will be returned to the factory for re-painting. It remains the Contractor's responsibility to protect the panels during transit and on site against damage until the final acceptance thereof on site. Sufficient provision shall be made for heat dissipation and ventilation of the board.

These boards shall comply with the requirements of SABS 1180: Part I where applicable.

Doors shall be rigid and shall be secured in position by means of robust grade 304 stainless steel hinges. No single door shall be wider than 600 mm.

The doors shall each be provided with at least two "square key" panel locks - one at the top and one at the bottom of the lock side of the door.

The chassis shall be rigid and facilities shall be provided on the chassis for mounting all the relevant equipment. No equipment shall be mounted on the rear panels of boards.

The panel shall be rigid and readily removable without necessitating the disturbance of any of the equipment on the board. Panels shall be mounted in such a way that all equipment are flush behind the panel with only operating handles, instrument faces and indicator lights and push buttons projecting through net machine punched slots and holes in the panel. All panels shall be provided with chromium plated brass handles to facilitate removal and shall be secured in position by means of knurled captive thumb screws.

Each board shall be provided with a suitably rated main isolator mechanically interlocked with the removable front panel in such a way that it will be impossible to remove the front panel without switching off the main isolator.

It shall be possible to adjust adjustable control equipment e g time switches without having to remove the front panel.

All screws, studs, bolts, nuts and washers used for these boards shall be rustproofed. The use of self tapping screws will not be permissible.

a) A suitable galvanised gland plate of 3 mm thickness shall be provided for termination of cables.
b) Front connected boards shall make due allowance for access to the terminations without any physical difficulties.

2. BUSBARS FOR SWITCHBOARDS AND MOTOR CONTROL BOARDS

The board shall be provided with one set of four solid, copper busbars in the top section and extending over the entire length of the board as indicated in table 14.1 & 14.2. Provision shall be made at the end of each busbar for future extensions.

Busbars shall comply with the requirements of SABS 784, BSS 1433 and the relevant clauses of BSS 159.

Busbars shall be mounted on substantial insulators at suitable intervals to prevent undue damage resulting under short circuit conditions. Substantial impact plastic or epoxy busbars insulators shall be used. The busbars shall be arranged horizontally with the longer sides of the cross-sections in the vertical plane and one above the other, in the horizontal plane.

Busbars shall be clearly and indelibly marked Red, Yellow and Blue for the three phases and Black for Neutral.

Connections to busbars shall be effected by means of Cable lugs and suitably sized cadmium-plated, high tensile steel bolts and nuts with cadmium-plated cup washers or lock washers.

A solid copper earthbar shall be provided along the bottom back side of the entire length of the board.

The earthbar shall be drilled and provided with the required number of 6 mm dia and 10 mm dia cadmium-plated, high tensile steel bolts and nuts, complete with cadmium-plated washers and cup washers or lock washers, for making the earth connections. The earthing positions shall be evenly spaced along the entire length of each busbar.

Table 1: Derating Factors for Laminated Busbars

Area of Cross Section (mm^2)	No of parallel busbars per phase		
	2	3	4
500	1,78	2,45	3,13
1 000	1,72	2,36	3,00
1 500	1,65	2,24	2,84
2 000	1,60	2,16	2,70
2 500	1,55	2,10	2,60
3 000	1,52	2,02	2,52
3 500	1,48	1,98	2,48
4 000	1,44	1,96	2,45

Table 2: Current Rating of Single Copper Basbars (A)

WIDTH (mm)	Thickness (mm)						
	2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	
63			790	990	1240	1370	
80			970	1200	1480	1640	
100			1160	1430	1760	2180	
125				1710	2100	2310	2570
160				2070	2530	2780	3090
200						3290	3660
250						3900	4300
315						4630	5120
400							6230

3. INTERNAL WIRING FOR SWITCHBOARDS AND MOTOR CONTROL BOARDS

The internal wiring of the boards shall consist of coloured PVC insulated conductors of adequate copper cross-section but minimum of 1,5 mm square, which shall be neatly installed horizontally and vertically and grouped and laced where possible by means of cable ties. PVC trunking with slotted sides shall be used for wiring. (String will not be acceptable). Numbered ferrules of an approved type, shall be provided on each end of each wire, to facilitate the tracing of circuits in accordance with the manufacturers wiring diagram. Wiring shall be fitted with lugs before terminating onto equipment on terminals. Wiring for external circuits shall be terminated on suitably sized DIN rail mounted "Klippon RSF 1" or equal terminal blocks at the bottom.

4. LABELLING OF SWITCHBOARDS AND MOTOR CONTROL BOARDS

A screwed on engraved label of the black on white "trefolite" type shall be provided below each item of equipment on the front panel of each board as well as on the chassis in close proximity to the relevant equipment to identify such equipment in both official languages in 6 mm high lettering.

Each board shall further be provided with a screwed on reverse engraved yellow perspex nameplate with black 20 mm high lettering to identify the board in both official languages on the outside of the door at the top thereof.

All safety warning notices shall be in both the official languages and the lettering shall be red on a white background.

5. EQUIPMENT FOR DISTRIBUTION BOARDS AND MOTOR CONTROL BOARDS

Each distribution board or motor control board shall be provided with all the necessary equipment to ensure proper functioning of the plant controlled by it. A main isolator as specified above and a busbar connected voltmeter with 7 position selector switch to measure busbar voltage on all three phases and switch the voltmeter of in the remaining position

The equipment shall comply with the specifications below where applicable:

a) A direct-on-line air break contactor type starter shall be provided for each motor. This starter shall be complete with the following:
- A suitably rated isolating isolator (pad lockable in off position).
- Adjustable thermal overload trip relays in each phase. The overload relay shall have suitable inverse time current characteristics to match the motor thermal damage curve. Hand reset contacts shall be provided.
- Protection against undervoltage and single phasing - the operation of which shall be independent of the settings of the overload trip relay.
- HRC back-up protection fuses.
- An ammeter in one of the phases for all motors rated above 1 kW as well as a running hour meter. Associated current transformers for non direct reading ammeters.
- A selector switch to facilitate the selection of either local manual control or remote automatic control where applicable.
- A set of normally open and a set of normally closed potential free auxiliary contacts on the starter contactor wired for remote indication of "Running", "Available" and "Tripped" conditions.
- A set of "STOP" and "START" push buttons for local manual control.
- A set of "GREEN", "AMBER" and "RED" indicator lights for local indication of motor "Available", "Tripped" and "Running" conditions respectively.

b) Distribution- and Control Board Components
- Isolators
  All isolator shall be of the "Load-breaking" and "fault making" type and shall comply with the requirements of BS 5419-1977 and SABS 152 where applicable. The fault level of the isolators shall be equivalent to or higher than the fault level at the associated busbar or incoming cable.

- Fuse switch units
  All fuse switch units shall be of the "load-breaking" and "fault making" type complying with BS 3185 where applicable and fitted with HRC cartridge fused links to BSS 88.
  - Fuse switch units shall be of the double air-break, quick make type and shall have a spring mechanism smoothly driven by springs on both sides of the mechanisms.

- The fixed contacts shall be shrouded.
- The hand operated lever shall be mechanically interlocked with the door and shall be padlockable in the off position.

- Moulded case circuit breaker

  All moulded case circuit breakers shall comply with the requirements of SABS specification No 156-1977 and shall be equal and similar to Merlin Gerin manufacture with a rupturing capacity of at least 5 kA or for the fault level for the distribution board.

  These circuit breakers shall be fitted with copper terminal collector bars where more than one cable tail has to be terminated on the same terminal.

- Airbreak contactors

  All contactors shall be of the totally enclosed three pole, double air break per pole, automatic magnetic type complying with the requirements of SABS 1092 and/or IEC 158-1 for Class AC 3 contactors of Intermittent Duty Class 0,3. The contactors shall be rated for at least 130 % of the associated load current.

  All contactors shall be provided with arc extinguisher and readily replaceable silver or silver-alloy contacts rated for a 2 million "on" and "off" switching operations at rated current.

  Each contactor shall be capable of carrying and making and breaking at a recovery voltage of not less than 90 % of the system voltage.

  Each contactor shall be provided with a closing coil suitable for continuous operation and at least 15 closing operations per hour.

  At least two normally open and two normally close auxiliary contacts shall be fitted.

  The contactor may not hum or chatter in service and the contacts may not bounce on closing.

  All contactors shall preferably be equal or similar to Merlin Gerin manufacture especially the MA range involving motor starting protection.

- Current transformers

  All current transformers shall be of the air insulated type complying in all respects with the requirements laid down in BS 3938 : 1973 and/or IEC 185.

  The Contractor shall carefully select the ratio, burden and accuracy class to suit its specific application in accordance with the recommendations and requirements of BS 3938 and/or IEC 185.

  The following classes of current transformers shall be used:

DESCRIPTION	CLASS
1. General Protection (over-current/thermal overload	10P15
2. Differential Protection	X
3. kVA, kW, kWh meters and ammeter	0,5

- Indicating instruments
  All indicating instruments shall comply with the requirements laid down in BS 89 : Part 1: 1970 for instruments of a 2,5 Accuracy Class. All indicating instruments shall have 96 mm square dials.

  The maximum demand ammeters shall be of the 6 A combined maximum demand registering and instantaneous indicating type having MISC movement and thermal demand indication with a integrating time lag of 15 minutes. The ammeter scales shall be direct reading with a full scale a deflection corresponding to 120 % of the rated primary current of the relevant current transformer. Each ammeter shall be clearly and indelibly marked to indicate the colour of the phase to which it is connected.

  The ammeters for motor starters shall be instantaneous indicating meters with MISC movement and direct reading scales. The meters shall be able to withstand overcurrents resulting under starting conditions and the full load current of the relevant motor shall be clearly marked in red on the face of the meter.

  Voltmeters shall be of the direct reading moving iron suppressed zero type.

  The running hour meters shall have cyclometer dials indicating up to 5 digits and two decimals.

- Selector switch
  A rotary type instrument selector switch shall be mounted in such a way that only the selector knob and indicator plate are on the panel, and the switch itself is behind the panel.

  The selector knob shall consist of substantial material, and shall have an arrow engraved on it, indicating the switch position.

  The switch shall have a positively driven switching mechanism.

  The indicator plate shall have the positions for the three phases and "OFF" engraved on it in 5 mm high lettering.

- Indicator lights
  All indicator lights shall be equal and similar to 22,5 mm dia KRE 22 LED's as supplied by MIMIC Crafts.

Auxiliary relays shall be adequately rated for their respective duties and shall be silent in operation. All switching relays shall be fitted with robust silver of silver-alloy self-cleaning contacts which shall not bounce or chatter on closing and which shall be designed and manufactured to limit arching, welding and pitting to an absolute minimum.

Earth leakage relays for low voltage distribution boards shall comply with the requirements of SABS 767 and shall have a sensitivity of 30 mA.

Information to be submitted with tenders in respect of distribution boards and motor control boards.

The following information shall be submitted with each tender in respect of all boards offered:

a) Full technical details and descriptive literature regarding all equipment and instruments offered; and
b) Three paper prints of an outline drawing of each board indicating the main overall dimensions and general layout of the boards.

Information to be submitted by the successful tenderer in respect of all boards.

The successful tenderer shall submit three paper prints of each of the following drawings, in respect of each of the boards to the engineer for approval prior to manufacture:

a) Outline and general arrangement drawings, showing main overall dimensions and construction details;
b) A wiring diagram; and
c) A schematic line diagram.

Plastic transparent prints of the following drawings shall be supplied by the successful tenderer in respect of each of the final layouts of the boards:

a) Outline and general arrangement drawings of each board;
b) A wiring diagram of each board;
c) A schematic line diagram of each board;
d) A paper print of the schematic line diagram for that specific distribution board, shall be framed and installed behind perspex on the inside of the door of each of the switchboards; and
e) A paper print of the schematic line diagrams for each LV starter panel shall be installed behind perspex on the inside of the door of each starter panel.

Testing for distribution/motor control boards at the manufacturer's works

Each distribution/motor control board shall be subjected to the following tests in the manufacturer's works after manufacture:

a) A thorough inspection shall be carried out to ensure compliance with the specification and approved drawings and wiring diagrams and to ascertain that all connections are properly made.
b) A high voltage test on all primary connections to check the insulation between phases mutually and between each phase and earth.
c) The polarities and ratios of all potential and current transformers shall be checked.
d) Primary and secondary injection tests shall be carried out on all switching, protection, metering interlocking and indication circuits.

The manufacturer shall submit three copies of test certificates giving details of conditions and results of tests carried out to the Engineer.

Testing and commissioning of distribution/motor control boards after installation on site

After installation on site but prior to commissioning the following inspections and tests shall be performed on each distribution/motor control board:

a) Check all components to ensure that they are free from dust and protective packing material;
b) Check the operation of all components liable to damage in transit such as meters and protection relays;
c) The insulation of all primary circuits between phases mutually and between each phase and earth shall be measured;
d) All fuse links shall be checked for electrical continuity; and
e) All control supplies shall be checked.

All adjustable protection devices shall then be set and the boards commissioned all in consultation with and to the instruction of the Engineer.

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GSE33 – GENERAL SPECIFICATION ELECTRICAL

EXTERNAL SENSING UNITS WITH DISTRIBUTION BOARDS AND CONTROL BOARDS

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1. MATERIAL AND EQUIPMENT

1.1. EMERGENCY STOP PUSH BUTTON STATIONS (ONLY WHERE MOTOR STARTERS ARE PROVIDED UNDER THIS CONTRACT).

Each of these units shall consist of a totally enclosed outdoor weatherproof type heavy duty "push and turn to lock" stop push button station with a cable gland entry at the bottom to accommodate a 3 core, 1,5 mm^2 LV PVC SWA cable. The unit shall have an IP 55 insect proofed enclosure.

This push button station shall be mounted on an approved rigid 1 meter high grade 304 stainless steel pedestal designed to be bolted to a concrete slab or against the structure at a height of 1,0 m above ground level where practicable.

1.2. LEVEL SWITCHES

All level switches shall be equal and similar to the Flygt ENH 10 and shall be supplied complete with integral cable connections of sufficient length to eliminate joints in water or moist surroundings.

1.3. LEVEL SENSORS

Level sensors shall be of the ultrasonic type with a minimum environmental rating of IP 65. They shall be capable of operating without degradation of performance in direct sunlight and highly corrosive conditions (organic acids from sewerage work).

1.4. FLOW AND PRESSURE SWITCHES

a) Flow Switches
Flow switches shall be of the paddle type equal and similar the McDonnel flow switch with adjustable paddles to suit the relevant pipe diameters.

b) Pressure Switches
Details of tendered equipment must be submitted with the tender.

2. INSTALLATION AND COMMISSIONING

2.1. EMERGENCY STOP PUSH BUTTON STATIONS (ONLY WHERE MOTOR STARTERS ARE PROVIDED UNDER THIS CONTRACT)

An emergency stop push button station as specified shall be installed at the coupling between each motor and its associated driven equipment and shall be connected to the relevant starter panel via 1,5 mm^2 x 3 core PVC SWA PVC cable to stop the motor.
Where a mounting pedestal is used the pedestal shall be securely bolted to the concrete slab by means of foundation bolts grouted into the concrete and care shall be taken to ensure that it is installed plumb.

2.2. FLOAT SWITCHES

Each float switch shall be suspended from a grade 304 stainless steel hook bolt in such a position that it will be readily accessible for adjustment and cleaning purpose, that it will be able to float freely without the possibility of obstruction of any sort and that it will not be influenced by turbulence in the liquid.

At least 2 m slack shall be provided in the cable connection to each float to facilitate future lowering thereof. This slack shall be neatly coiled and bound at the point of suspension.

2.3. LEVEL SENSORS

The transmitter section of each of these units shall be installed in the associated distribution or control board.

The positions in which these sensors are to be installed shall be determined in consultation with the engineer on site and shall be such as to ensure accessibility for maintenance and adjustment and to avoid the effects of turbulence in the liquid.

2.4. FLOW AND PRESSURE SWITCHES

Shall be installed as and where required and shall be connected to the relevant starter panels by means of the necessary multicore PVC SWA PVC cables for the operational functions required.

2.5. ELECTRIC ACTUATORS FOR CONTINUOUS VALVE AND SLUICE GATE CONTROL

Electric actuators for valve and sluice gate control shall be equal or similar to the Rotork Syncropak complete with "Millipot" stabilised current position transmitter providing a 4-20 mA signal for remote position indication and "Folomatic Control Unit" suitable for remote control by means of a 4-20 mA signal.

NB:
Gears of synthetic materials will not be acceptable in these units.

2.6. ELECTRIC ACTUATORS FOR OPEN/CLOSED AND THREE-WAY PLUG VALVE CONTROL

Such actuators shall be equal or similar to Rotork Syncropak units which shall provide for remote control by internally sourced 24 V DC signals and for remote monitoring by means of voltage free contracts.

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GSE34 – GENERAL SPECIFICATION ELECTRICAL

INSTRUMENTATION

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1. GENERAL

This Part of the tender documents describes the scope of works to be done.

Exceptions to the Standard Specifications are given here and these exceptions shall take precedence over the standard conditions.

Should tenderers wish to offer equipment which deviate from the specification, they must complete the Schedule of Quantities as for an installation which is exactly per specification and then spell out the alternatives and their financial implications in a covering letter.

Tenderers shall be prepared to enter into a maintenance agreement with the Employer, which shall run for at least five years. A fully specified and priced proposal for such an agreement shall accompany this tender. This agreement does not form part of this contract, but its contents will be taken into account during the evaluation of this tender.

The circuit diagrams shown are believed to be correct. The Contractor shall, however, satisfy himself that this is the case and remain responsible for correct functioning of the equipment supplied and installed by him.

The contractors' project documentation shall consist of the material as specified in the Standard Specification (SS) Clause SS3.5 as well as a comprehensive set of cable schedules, loop diagrams and termination lists.

2. PROJECT OVERVIEW

A simplified block diagram of the system for this plant is given in drawing no W39-SP1 which is bound in.

A central computer with peripherals as indicated on the block diagram and as further elaborated on elsewhere, shall be supplied.

The computer shall communicate with a programmable logic controller (PLC), located where indicated on the Electrical layout diagrams, through a twisted wire pair.

The status of all motors and control valves shall be monitored and displayed by the system.

The system shall cater for the regulation of the dissolved oxygen contents in the reactor by controlling the number of aerators running, the period for which they run, and direction of rotation i e forward or reverse.

Apart from the automated functions of PS2.5, the system shall facilitate the remote control of some plant motors and motorized valves from the central computer.

Local/remote control and manual control facilities shall be provided at these motors and valves.

The system shall include all the instrumentation needed, as indicated on the piping and instrumentation diagram, Drawing W39SP-SP2 and as specified elsewhere.

The computer and I/O hardware shall cater for 20 % expansion of the system at no extra computer hardware cost to the client.

All the necessary cabling shall be supplied and installed as part of the contract.

The system shall include complete and comprehensive operating and maintenance documentation.

The contract price shall include for the training of operating staff.

3. COMMUNICATING / SIGNALLING DETAILS

3.1. BINARY INPUT / OUTPUT SIGNALS

Binary input signals generated by field equipment and motor control circuits shall be voltage free, floating contacts.

Binary output signals shall be voltage free (relay type) signals generated by the control system.

The ratings on all voltage free contacts shall be such that one million operations in the system context can be guaranteed.

Low voltage interfaces will be preferred (typically 24 V).

All binary signals shall terminate in not more than 10 k Ohms impedances.

All binary I/O's, both on the control system and on the field equipment side, shall be able to survive 8/20 microsecond current impulses of any polarity, with maximum amplitude of 5 kA when applied in common mode, i e between the signal lines connected together and earth.

In addition, the equipment shall be able to survive 8/20 microsecond current impulses of any polarity with maximum amplitude of 1 kA when applied in the differential mode.

Ten surges of any of the above types shall be withstood during any 60 second period.

The Engineer may, at his discretion, arrange to have equipment tested for conformation. The costs of such tests will be carried by the employer unless the equipment fails any test, in which case the cost of the test(s) will be for the account of the contractor.

It shall be possible to replace I/O modules on line without the need for powering down or removing any field wiring.

3.2. ANALOGUE INPUT / OUTPUT SIGNALS

All analogue input/output signals shall be 4-20 mA current loop signals.

All analogue signals shall only be earthed at the PLC side. If any of the instruments offered can only supply an earth referenced signal, suitable loop isolating devices shall be supplied and installed.

The same degree of surge protection as specified for binary I/O's shall be provided. See Paragraphs above.

3.3. INTER PLC COMMUNICATION PORTS

As indicated elsewhere, communication between PLC and host Computer shall be by screened twisted wire pair. Communications speed shall be 19200 bps with CRC 16 (Cyclic Redundancy Check) error checking. The tender price shall be for this specification, but an alternative price for optical fibre communication between PLC's shall also be supplied.

The same surge protection as specified for analogue and binary I/O's, shall be supplied.

3.4. MOTOR MONITORING AND CONTROL

Motor I/O signals shall be terminated on the relevant terminal strips in the substations. For all practical purposes these terminal strips will be adjacent to the PLC's. The wiring to motor monitoring and control circuits shall be done by others.

All motors will be monitored for:

a) Running
b) stopped
c) tripped

Controlled motors will have the following as extra signals:

a) Available
b) Remote
c) Run (Control) or Forward / Reverse

An alarm shall be raised when a particular motor goes faulty.

Drawing No W39EE-11 illustrates the proposed motor control and monitoring circuits.

It shall be possible to control the aerators and screw pumps from the supervisory system. Other motors are monitored only.

The total kVA of the biological reactor shall also be monitored. Transducers (4-20 mA) will be provided under Volume I of the Contract.

4. FIELD INSTRUMENTATION: GENERAL

Field instrumentation to be supplied under this contract includes flow meters, level meters and dissolved oxygen transducers.

Some instrumentation will be supplied by others as indicated in the Schedules.

A field instrument will generally consist of a measuring element and a signal processor or transmitter.

All equipment must be suitable for the application. The measuring elements must generally be able to survive flooding conditions, and the transmitters, which will be mounted outside the flood zone, shall be protected to IP 65. The price of all equipment shall - if such equipment is not inherently protected to the degree specified above - include for weatherproof, UV resistant housings to facilitate this.

As specified in Clause 34.3.1 and Clause 34.3.2, all field equipment shall be suitably surge protected.

Only instruments of well-known manufacturers, with proven South-African installation history shall be offered. All information regarding such instruments and the service facilities available shall be supplied. <u>Failure to comply with this requirement may lead to the disqualification of a tender</u>.

All transmitters shall as far as possible be of the two wire current loop type with 4-20 mA output, supply voltage shall be 24 VDC.

The PLC shall be housed in an equipment cabinet complementing the switchgear panels. Ideally the electronic equipment will be mounted in extensions of the switchgear panels, but if this is not preferred, details of what is offered shall be supplied.

5. FLOW METERS

Flow meters shall be supplied and installed in the positions indicated on the drawings forming part of this specification.

Two types of flow meters are required:

a) Magnetic type flow meters of 316SS body with soft rubber lining and 316SS electrodes.

b) Ultrasonic open channel type flow meters shall be supplied and installed over parschall flumes or wiers which will be supplied by others.

All flow meters shall include all the necessary signal processing circuitry to supply the monitoring equipment with the required 4-20 mA signal and flow totalizing pulses. The voltage free pulse contact shall switch 24 V DC to a 10 k ohm load (maximum).

All flow meters shall include local indications of low rate and totalized flow.

The circuit to monitor the pulses produced by the flow integrators shall be suited to the application and tenderers shall guarantee that pulses will not be missed by the PLC.

6. LEVEL MEASUREMENT

Level switches will be used in the inlet channel and secondary sedimentation tanks. These switches shall be of the ultrasonic type with high and low limits plus multiple sampling to eliminate echo's generated by rotating vanes and bridges. A suitable proximity detector can be used as a detector to sense the bridge then blank the level switch output.

All level sensors shall include all the necessary signal processing circuitry required to complete the installation.

Lever Transmitters will be used in the inlet sump to the works. The level transmitter shall be an ultrasonic type with 4-2- mA output.

All level transducers shall include local level indications.

7. DISSOLVED OXYGEN TRANSDUCERS

Dissolved oxygen transducers as indicated on the drawings and in the Schedules are required under this contract. These shall be Zullig self cleaning types as supplied by Bestobell and their 4-20 mA output signal shall be used by the computer to optimize the aeration cycle of the biological reactor.

Environmental ratings for equipment and surge protection shall conform to standards for other measuring equipment. Please refer to Paragraph SS24. "General Specifications For and Electronics Installation."

Dissolved oxygen probes shall be supplied with three sets of mounting brackets and connection points.

8. POWER METER

A kVA power meter and transducer will be supplied and installed for the reactor aerator motors under Division I of the Contract. This will have a 4-20 mA output, representing the power consumed by the aerator motors collectively. This power measurement shall be monitored and recorded by the system. By comparing the power consumed with the volume of sewage treated, the Client will be able to finely tune the plant to function at optimum efficiency.

9. OTHER EQUIPMENT

The supervisory system shall monitor the indicated chlorine dosing plant signals.

A chlorine leak detector will be supplied by others complete with siren and auxiliary contacts to enable remote monitoring.

10. PROGRAMMABLE LOGIC CONTROLLERS (PLC'S)

The PLC is to function as a data concentrator and local control units shall be supplied and installed in the positions indicated on the drawings.

The PLC shall be Modicon 984 or engineers approved equivalent.

The PLC functions are indicated on the block diagram and in the Schedules of I/O signals.

PLC shall operate on a nominal 220 VAC but shall also be able to operate from a 24 Dc battery supply.

The PLC shall be capable of peer to peer communication as per paragraph PS 3.3.

The PLC shall have on board Lithium battery maintained RAMS.

It shall be possible to program the PLC by means of an IBM-type PC which is coupled to the PLC and a suitable Software eg Modsoft which the tenderer shall supply as part of this contract.

It shall be possible to run the programming program in the supervisory computer, and download programs to the PLC via the data highway mentioned in paragraph 34.2 and 34.3.3.

11. SUPERVISORY COMPUTER

The supervisory computer shall be an IBM PC with 80386 CPU type from one of the following manufacturers:

a) AEG
b) Hewlett Packard
c) ICL
d) Siemens

The supervisory computer shall have an on-board memory of at least 1 Mega byte or as per software requirements and the following peripherals:

a) QWERTY keyboard with numeric pad and ten function keys
b) VGA colourgraphics VDU and driver
c) 1,2 M byte 5,25 inch floppy disk unit
d) 1,44 M byte 3,5 inch floppy disc unit
e) 40 M byte (min) sealed disk unit
f) A Fijitsu 2200 or Epson EX 1000 printer or engineers approved equivalent.
g) UPS with 2 hour (min) capacity for the computer and its peripherals only. Output power shall be 3 kVA at 0,8 P F. Supply and output voltages shall be 220 V, single phase, 50 Hz nominal.

Dial up modems shall be provided to operate on standard Post- and Telecommunication lines. After completion of this contract, it is intended to connect this computer into a network with other computers. No further provisions beyond those specified above need be supplied at this stage.

12. SOFTWARE

12.1. SYSTEM SOFTWARE

A MS-DOS disk operating system shall be supplied with the computer. DOS version 5 or latest version shall be supplied.

A colour-graphics package shall be supplied. This package shall have the facility to define picture elements such as motors, valves, etc, store these picture elements in a library and to re-call them for use without reprogramming. The package shall have pixel graphics capability. Character graphics systems are not acceptable.

A process control package with programs to do numerical and logical operations on data, store and retrieve historical data, print process reports at preset intervals, print an event log, raise an alarm on specified signal conditions and to draw trend graphics on the VDU, shall be supplied.

Suitable SCADA packages include TURBOLINK, FACTORY LINK, IN TOUCH or ENGINEERS approved equivalent.

A communication driver package between the supervisory computer and the PLC and the computer and the dial up modems shall be provided.

The communication protocol between the PLC's and the computer shall incorporate a 16 Bit CRC error checking code.

It shall be possible to monitor all binary and analog input signals to the PLC as well as all internal registers of the PLC's from the computer and it shall be possible to set all binary and analog PLC output signals as well as all internal registers from the computer.

The PLC shall be capable of functioning independently of the supervisory computer. In particular, the control of the dissolved oxygen level in the reactor shall reside in the PLC. Functional requirements are specified in paragraph 11.

12.2. PROCESS CONTROL PLC PROGRAMMING

The process control PLC shall be programmed by the Engineer.

12.3. SUPERVISORY COMPUTER PROGRAMMING

Using the Graphics and Process Control package supplied under paragraph 13 the supervisory computer shall be programmed to:

Display dynamic mimics of the entire plant. Assume there will be seven such displays.

Download control constants such as setpoints, time intervals, etc to the process control PLC's from the keyboard.

Generate and display the required PID faceplates, etc.

Generate alarms and maintain a current alarm file.

Generate trend graphics.

The printer shall print logs of all operator interactions with the system and of all major changes which are observed on the plant.

Print current status and trend reports on demand.

Prepare and print a shift report and monthly report.

This work will also be undertaken by the engineer.

12.4. COMBINATION COMPUTER / PRINTER STAND ("COMBO STAND")

A combo stand shall be supplied so that computer and peripherals can be neatly accommodated.

13. CABLING

All cables shall have conductors of 1,0 sq mm core size minimum.

All signals shall only be transmitted on individually screened overall screened twisted wire pairs.

All cables shall provide for 10 % spare capacity or at least 2 wire pairs / 4 cores.

All cable shall be steel wire or Decabond armoured.

Cables shall be PVC insulated with a 300 V minimum breakdown voltage.

All trenches required shall be allowed for in the Electrical Part of this contract.

Cable lengths given in the Bill of Quantities are preliminary figures for tendering purposes only. Tenderers shall measure the required lengths on site before ordering material.

See Part IV/II, Clause 43.3. Instrumentation field cabling shall be buried in the same trenches as the electrical cabling.

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GSE36 – GENERAL SPECIFICATION ELECTRICAL

EMERGENCY GENERATOR SET

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1. GENERAL

This section covers the General Specification for the supply, delivery and complete installation on site in full working order of diesel / alternator generating sets.

Any deviation from this Standard Specification or additional information will be given in the Project Specification. In case of contradiction between this General Specification and the Project Specification, the Project Specification shall be given preference.

Full particulars, performance curves and illustrations of the equipment offered, must be submitted with the Tender. Tenderers may quote for their standard equipment, complying as closely as possible with this Specification, but any deviation from the Specification must be fully detailed.

The schedule following this Specification must be completed by Tenderers in all respects.

2. DELIVERY

Tenderers must confirm that the space is sufficient for the installation of the generating set, fuel tank and the control board and shall indicate the proposed layout of their equipment on a layout drawings.

The successful Tenderer shall inform the Engineer, when the set is ready for installation.

Delivery shall be effected after confirmation by the Engineer that the site is ready for installation and approval of the Factory Acceptance Testing by the Engineer.

3. CONSTRUCTION

The engine and alternator of the set shall be built together on a common frame, which must be mounted on a skid base on anti-vibration mountings. The set must be placed direct on the concrete floor of the generator room or plinth. A drip tray must be fitted under the engine. The tray must be large enough to catch a drip rom any part of the engine.

The frame must be of the "DUPLEX" type.

4. OPERATION

The set is required to supply the power requirements in the case of a mains supply failure.

The set shall be fully automatic: it shall start when any one phase of the mains supply fails and shall shut down when the normal supply is re-established. In addition it shall be possible to manually start and stop the set by means of pushbuttons on the switchboard.

The automatic control shall make provision for three consecutive starting attempts. Thereafter the set must be switched off, and the start failure relay on the switchboard must give a visible and audible indication of the fault.

To prevent the alternator being electrically connected to the mains supply when the mains supply is on, and visa versa, a safe and fail proof system of suitably interlocked contractors shall be supplied and fitted to the changeover switchboard.

The Generator Set shall have self-check functionality which shall be programmed to start and run the generator for 30 minutes every month.

IMPORTANT NOTE

The Tenderer must submit, together with his offer, the design of the control system to comply with the requirements for automatic starting, stopping, interlocking and isolation as specified.

GSE43 – GENERAL SPECIFICATION ELECTRICAL

SWITCHBOARDS (UP TO 1kV)

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1. SWITCHBOARDS (UP TO 1 KV)

1.1. GENERAL

1.1.1. SCOPE

This section covers the manufacturing and testing of flush mounted, surface mounted and floor standing switchboards for general installations in normal environmental conditions and for system voltages up to 1kV.

1.1.2. SIZE

All switchboards shall be of ample size to accommodate the specified switchgear and provide space for future switchgear. For every 4 (or part of 4) 5kA circuit-breakers on a switchboard, space for an additional 5 kA circuit-breaker shall be allowed unless future space requirements are clearly specified. For circuit breakers above 5kA, this factor shall be 15%. The clearance between adjoining switchgear openings shall be as specified below.

1.1.3. EXTERNAL DIMENSIONS

The maximum allowable height of free-standing switchboards is 2,2m. Cubicle type boards may be up to 2,4 m high if they can be fully dismantled into individual cubicles. Where, due to space restrictions, a board exceeds 2,2 m in height, equipment not normally requiring access, shall be installed in the top section, enabling equipment normally requiring access to be installed lower down in the board. All other specified external dimensions for switchboards shall be strictly adhered to. If the clearances specified below cannot be adhered to as a result of restricting external dimensions, the Contractor shall obtain the approval of the Client before manufacturing the switchboards.

1.1.4. MOISTURE AND VERMIN

All switchboards shall be rendered moisture proof and vermin proof and shall be adequately ventilated.

1.1.5. LOAD BALANCE

The load shall be balanced as equally as possible across multiphase supplies.

1.2. CONSTRUCTION OF FLUSH MOUNTED SWITCHBOARDS

1.2.1. STANDARD

Flush mounted switchboards shall comply fully with SABS 1180, Part I. Unless the depths of the switchboards are specified, the depths shall be determined in accordance with par. 1.6.

1.2.2. EXPANDED METAL

Where switchboards are to be built into 115 mm thick walls, expanded metal shall be spotwelded to the rear of the bonding trays. The expanded metal shall protrude at least 75 mm on each tray side to prevent plaster from cracking.

1.2.3. KNOCK-OUTS

Knock-outs shall be provided in the top and bottom ends of each switchboard tray to allow for the installation of conduits for the specified and future circuits. Knock-outs shall be provided for an equal number of 20 mm and 25 mm dia. Conduits.

1.2.4. PANEL

Front panels shall have machine punched slots for housing the specified and future flush mounted switchgear. The distance between the inside of the closed doors and the panel shall not be less than 20mm. No equipment may be mounted on the panel unless the panel is permanently hinged to the switchboard frame.

1.2.5. FIXING OF FRONT PANELS

The front panel shall be secured to the architrave frame by means of 6 mm studs and chromium-plated hexagonal domed nuts, hank nuts or captive fasteners similar to “DZUS” or “CAMLOC”. Alternatively, the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws will not be allowed. All front panels shall be provided with a minimum of one chrome plated handle.

1.2.6. DOOR HANDLES AND CATCHES

Switchboard doors shall be equipped with handles and catches. Locks shall only be provided when specified. In all cases where lockable doors are required and, in all cases, where the switchboard doors are higher or wider than 450 mm, handles consisting of a pushbutton-and-handle combination shall be installed. Switchboard doors smaller than 450 mm in height and width may be equipped with spring loaded flush mounted ring type latches. Square key operated catches are not acceptable unless specified.

1.3. CONSTRUCTION OF SURFACE MOUNTED SWITCHBOARDS

1.3.1. STANDARD

Surface mounted switchboards shall comply with to SABS 1180, Part II.

1.3.2. SWITCHBOARD TRAY

Surface mounted switchboards shall be equipped with a 1,6 mm minimum sheet steel reinforced tray, suitable braced and stiffened to carry the chassis, door and equipment. Lugs to secure the switchboard to a vertical surface shall be provided.

1.3.3. CONSTRUCTION

All joints shall be welded or securely bolted. The tray shall be square and neatly finished without protrusions. The front tray sides shall be rounded with and edge of at least 20 mm to accommodate flush doors.

1.3.4. CHASSIS

A sheet steel chassis for the mounting of equipment shall be bolted to the tray and shall comply with the requirements of par 1.6.2 and 1.6.4.

1.3.5. FRONT PANEL AND DOOR

The front panel and door shall comply with par 1.2.4 to 1.2.6 above. Doors shall fit flush in the tray when closed.

1.3.6. DIMENSIONS

Unless the depth of the switchboards is specified, the dimensions shall be determined in accordance with the requirements of par. 1.2 and 1.3.

1.4. CONSTRUCTION OF FREE-STANDING SWITCHBOARDS

1.4.1. FRAMEWORK

A metal framework for free standing switchboards shall be manufactured from angle iron, channel iron or 2 mm minimum folded metal. A solid U-channel base frame, sufficiently braced to support all equipment and span floor trenches and access holes shall be provided. Switchboards shall be of cubicle design with 2 mm side panels forming divisions between cubicles. The maximum allowable cubicle width is 1,5 m. (Refer also to par. 1.7). Joints shall be non-continuously butt welded. Welds shall be ground smooth and the joint wiped with plumber’s metal in order to provide a smooth finish. Switchboards wider than 2 m shall be fitted with screwed eyebolts attached to the framework to facilitate loading and transportation of the board.

1.4.2. REAR AND SIDE PANELS

The rear panels shall be removable and shall be manufactured from 2 mm minimum sheet steel. The panels shall have returned edges which are recessed in the frame, or which fit over lips on the switchboard frame. The panels shall be secured to the frame by means of studs and chromium-plated hexagonal domed brass nuts or hank nuts or captive fasteners equal or similar to “DZUS” or “CAMLOC”. Where switchboards are intended for installation in vertical building ducts or against walls, the rear and side panel may consist of a single folded sheet which is either bolted or welded to the frame or which forms part of the folded metal frame.

1.4.3. FRONT PANELS

a) The front panels of floor standing switchboards shall preferably be hinged except where flush mounted equipment prevents this. Alternatively, panels shall be secured by means of the methods described in par. 1.2.5. The panels shall be arranged in multi-tiered fashion to allow for the logical grouping of equipment in accordance with par. 1.6.

b) The hinged front panels shall have a dished appearance with 20 mm upturns which fit over a lip on the switchboard frame. Alternatively, the hinged panels shall have folded edges and shall be fitted flush or slightly recessed in the switchboard frame. The latter method shall be used where doors are required. (Also refer to par. 1.4.6). Corners shall be welded and smoothed.

c) The panels shall be of 2 mm minimum sheet steel with machine punched slots to allow for the flush mounting of instrumentation, switchgear toggles and operating handles. A minimum clearance of 50 mm shall be maintained between the rear of equipment mounted on the panels (taking into account terminals or other projections) and the frame and chassis of the switchboard. Separate panels shall preferably be provided for the mounting of instrumentation and for covering flush mounted switchgear. Enclosed switchgear with front panels e.g. combination fuse-switch units, may be flush mounted in the board in lieu of separate hinged panels.

d) Hinged panels shall be suitably braced and stiffened to carry the weight of flush mounted equipment and to prevent warping.

e) Hinged panels with flush mounted equipment and panels higher than 600 mm shall be supported by hinges of adequate strength to ensure smooth and reliable operation. 16 mm pedestal or similar heavy-duty hinges with single fixing bolts may be used on panels smaller than 600 mm. On the larger panels long pedestal type hinges with two fixing bolts per hinge are preferred. Piano hinges are not acceptable for this application.

f) A tubular chromium-plated handle shall be fitted on each panel. The handle may be omitted if “DZUS” or “CAMLOC” fasteners are used.

g) Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed in a manner which does not require the drilling of holes through the front panel. Dummy circuit-breakers may be fitted where applicable.

h) Front panels containing live equipment such as instrumentation or control switches, shall be bonded to the switchboard frame with a braided copper earth strap with an equivalent cross-sectional area of at least 4 mm^2.

1.4.4. SECURING OF FRONT PANELS

Hinged panels shall be secured in position by means of square key operated non-ferrous fasteners designed to draw the panels closed or by “BARKER & NELSON” or similar quick-release fasteners. Self-tapping screws are not acceptable. Where non-hinged removable panels are specified, they shall be secured in position by means of 6 mm studs and hexagonal chromed brass dome nuts and washers or hank nuts or “DZUS” or “CAMLOC” or similar captive fasteners. Non-hinged removable panels may alternatively be secure in position by means of two pins at the bottom and a latch or lock at the top.

1.4.5. CHASSIS

A suitably braced chassis for the mounting of switchgear and equipment shall be firmly secured to the frame of the switchboard. The chassis shall be designed so that the switchgear can be installed in accordance with par. 1.6. Circuit-breakers and isolating switches which are not of the molded-case air-break type and the insulators of busbars for ratings of 200 A and more may be secured directly to the framework. (Refer to par. 1.6.4).

1.4.6. DOORS

a) Doors need only be provided when specified. Doors shall be arranged in multi-tiered fashion to allow for the logical grouping of equipment in accordance with par. 1.6.
b) Doors shall have a dished appearance with a minimum of 20 mm upturns which fit over a lip on the switchboard frame or shall fit flush in the switchboard frame. Corners shall be welded and smoothed.
c) Doors shall be of 2 mm minimum sheet steel with machine punched slots to allow for the flush mounting of instrumentation, control and protection equipment. Switchgear shall be flush mounted in the front panels behind the doors unless specified to the contrary. A minimum clearance of 50 mm shall be allowed between the rear of equipment mounted on doors (including terminals and projections) and the frame, front panel and chassis.
d) Doors shall be suitably braced and stiffened to carry the weight of the equipment and to prevent warping.
e) Hinges for doors shall be provided as described in par 1.4.3. At least three hinges shall be provided on doors higher than 1,2m.
f) Doors shall be fitted with handles consisting of a pushbutton-and-handle combination with spring loaded catch or a rotary handle-and-catch combination. Flush mounted ring type handles or square key operated latches are not acceptable.

The same key shall fit all locks on the switchboard in cases where locks are required.

g) Doors shall be fitted with hypalon or neoprene seals.

h) Doors containing any electrical equipment shall be bonded to the switchboard frame with a braided copper earth wire with an equivalent cross-sectional area of at least 4 mm^2.

1.4.7. SECTIONS

For ease of transportation and to facilitate access to the allocated accommodation, switchboards may be dismantled into cubicles or sections. Each section shall be rigidly manufactured to ensure that damage to the switchgear will not occur during transportation and handling. Where required, switchboards shall have temporary wood or steel bracing to protect switchgear and facilitate handling.

1.4.8. GROUPING OF SWITCHGEAR

The switchgear shall be logically arranged and grouped as described in par. 1.6. Depending upon the number and size of components, a common front panel may be installed over one or more groups of equipment. all equipment shall be installed in accordance with the requirements of par 1.6.

1.4.9. CABLE GLAND PLATE

A cable gland plate shall be installed across the full width of each power cubicle at a minimum height of 300 mm above the bottom of the switchboard to house the cable glands. A P4000" SANKEY STRUT" channel or other approved support shall be provided to carry the weight of the cable and remove mechanical stress from the cable glands. A minimum distance as required by the bending radius of outgoing cables shall be provided between the lowest terminals of major equipment and the gland plate.

1.4.10. VENTILATION

Switchboards shall be properly ventilated, especially cubicles containing contactors, transformers, motor starters, lighting dimmers and other heat producing equipment. Louvers shall be fitted to provide adequate upward or cross ventilation. All louvers shall be vermin proofed with 1,5 mm brass mesh or perforated steel plated internally spot welded over the louvres. The internal ambient temperature shall not exceed 40^{o}C.

1.4.11. VERMIN PROOFING

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.

1.5. CONSTRUCTION OF MAIN LOW VOLTAGE SWITCHBOARDS

a) Main low voltage switchboards and sub-main low voltage switchboards heavily equipped shall comply with par. 1.4.1 to 1.4.11 as well as the following exceptions or additions:
b) These boards shall be fully extensible with removable busbar cover plates in the side panels.
c) Doors shall not be supplied unless specifically called for.
d) Switchgear and equipment shall be installed in accordance with the requirements of par. 1.6.
e) Provision for metering equipment shall be made in accordance with requirements of local authorities where applicable.

1.6. MOUNTING OF EQUIPMENT

The mounting of equipment shall comply with SABS 1180 where applicable. Equipment to be mounted on the chassis shall be mounted by bolts, washers and nuts or by bolts screwed into tapped holes in the chassis plate. In the latter case the minimum thickness of the chassis plate shall be 2,5 mm. The latter method shall not be used where boards will be subject to vibration or mechanical shocks. Self-tapping screws will not be accepted.

1.6.1. SPACE REQUIREMENTS

In designing the switchboards, the following requirements shall be strictly adhered to:

a) A minimum of 50 mm between any piece of equipment and the frame or internal partitioning. This minimum space is required on all sides of the equipment. In the case of a single row of single-pole circuit-breakers the spacing on one side of the row may be reduced to 25 mm if the incoming side of the circuit-breakers is bus bar connected.
b) A minimum of 75 mm between horizontal rows of equipment. The maximum outside dimensions of equipment shall be considered.
c) Circuit-breakers up to a fault rating of 10 kA may be installed adjacent to each other. For higher ratings a minimum of 40 mm shall be allowed between circuit-breakers or isolators.

d) Sufficient space shall be provided for wiring allowing for the appropriate bending radius.
e) Space for future equipment shall be allowed as described in par.1.1.2.

1.6.2. MOUNTING OF CHASSIS

The chassis of flush mounted and smaller surface mounted boards shall be mounted in accordance with SABS 1180. For all free standing switchboards and surface mounted switchboards where the main switch rating exceeds 100A (triple-pole), space for wiring shall be provided between the chassis and tray. This space shall be adequate to install the supply cable behind the chassis and terminate on the main switch without sharp bends in the cable cores.

1.6.3. GROUPING OF EQUIPMENT

a) Equipment shall be arranged and grouped in logical fashion as follows:
   - Main switch – to be installed either at the top or bottom of the board.
   - Short circuit protection equipment – fuse gear or fuse-switches.
   - Change-over contactors or other contactors controlling the supply.
   - Motor supplies.
   - Fuse-switches for outgoing circuits.
   - Other circuits and equipment.

b) 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.
c) Where earth leakage units are required, the associated circuit-breakers shall be installed adjacent to the unit.

1.6.4. MOUNTING OF CIRCUIT-BREAKERS

All molded-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”.

1.6.5. INSTRUMENTATION

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.

1.6.6. MOUNTING OF FUSES

a) 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.
b) Where equipment requiring fuses is specified on a board (fuse switches etc), a ruling shall be obtained from the Client on the quantity of spare fuses to be provided.

1.6.7. EQUIPMENT IN MAIN BOARDS

Equipment in main low voltage switchboards and sub-main boards shall be grouped in individual compartments. Equipment shall be installed as follows:
a) Rack-out type air circuit-breakers shall be mounted in the bottom section, flush behind the panel with the handle only protruding. If this is not possible, the panel shall be omitted, and the air circuit-breakers installed behind a door.
b) If the main switch is a moulded-case circuit-breaker or isolator it shall be flush panels.
c) Contactors controlling the supply shall be installed behind separate front panels.
d) 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 as described in par 1.6.
e) All circuit-breakers and fuses (with the exception of fuse-switches) may be grouped together behind one or more panels as described in par 1.8.
f) 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.

1.6.8. STANDBY SUPPLIES

a) Where standby power from a diesel-generator set or other sources is available and must 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.
b) Standby and normal supply shall each have its own incoming isolator or circuit-breaker.
c) The two sections of the switchboard shall be labelled “ESSENTIAL” and “NON-ESSENTIAL) respectively.
    - The front panels of standby and no-break supply sections shall be painted in distinctive colours as follows:

Normal supply	- “LIGHT ORANGE”, colour B26 of SABS 1091
Standby power	- “SIGNAL RED”, colour A11 of SABS 1091
No-break supply	- “DARK VIOLET”, colour F06 or “OLIVE GREEN”, colour H05of SABS 1091

1.7. BUSBARS IN SWITCHBOARDS

1.7.1. APPLICATION

a) Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SABS 784, SABS 1195 and BS 159 and BS 1433, where applicable.

b) Although SABS 784 refers only to overhead or rising busbars, busbars in switchboards shall comply with applicable sections of this specification especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.

c) Busbars shall be supplied for the following applications:
- Distribution of supply voltage.
- Connection of equipment with ratings exceeding the current rating of 70 mm² conductors (par 1.8.3.3).
- Connection of outgoing circuits with current ratings in excess of that allowed for 70 mm² conductors (par.1.8.1).
- Collector bars for parallel cables (par. 1.8.1).
- Connection bars for neutral conductors (par. 1.7.9).
- Earth busbars (par. 1.7.10).
- Connections to miniature circuit-breakers (par. 1.8.3.3).

1.7.2. VOLTAGE RATING

Busbars for system voltages up to 600 V shall be designed to withstand a test voltage of 2,5 kV for 1 minute.

1.7.3. CURRENT RATING

a) The maximum allowable temperature of busbars (including joints) carrying full load current in an ambient temperature as specified shall not exceed 80°C. Unless different ambient temperatures are specified, an ambient temperature of 35°C shall be assumed with a maximum temperature increase of 45°C.

b) Table 2 may be used as a guide in determining busbar ratings where the distance between the phase busbars is at least the distance of the longer side of the cross section with a minimum spacing of 50 mm and at least 150 m from the sheet metal enclosure. It is however essential that the switchboard manufacturer shall make due allowance for the “proximity and skin” effects, The effect of ferrous enclosures, ventilation, etc. for the arrangement used in his switchboard design. Manufacturers shall, where requested, prove that the busbar rating and enclosure design comply with the temperature rise specified above. The busbars can also be rated to DIN 43671 for unpainted busbars.

c) Neutral busbars in three-phase, four wire supplies shall have a cross-section of at least 60% of the cross-section of the phase busbars.

d) Busbars may not be tapered. The rating of the bars shall be equal to the incoming current rating. In cases where the main switch is an isolator, the isolator rating may not be taken as the incoming current rating.

e) In addition to the current rating, busbars shall comply with the following fault level rating: $A = 8{,}2 \times I \times (t)^{1/2}$ where A = minimum cross-section (mm^2) I = prospective fault current (kA) t = maximum time in seconds required for protection equipment to clear the fault (Minimum allowable value for t = 0,2 s)

Table 1: Derating Factors for Laminated Busbars

Area of Cross Section (mm^2)	No. of parallel busbars per phase		
	2	3	4
500	1,78	2,45	3,13
1000	1,72	2,36	3,00
1500	1,65	2,24	2,84
2000	1,60	2,16	2,70
2500	1,55	2,10	2,60
3000	1,52	2,02	2,52
3500	1,48	1,98	2,48
4000	1,44	1,96	2,45

Table 2: Current Rating of Single Copper Busbars

Width (mm)	Thickness (mm)						
	2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	
63			790	990	1240	1370	
80			970	1200	1480	1640	
100			1160	1430	1760	2180	
125				1710	2100	2310	2570
160				2070	2530	2780	3090
200						3290	3660
250						3900	4300
315						4630	5120
400							6230

f) Where a busbar consists of two or more busbars per phase (laminations), the laminations shall be separated by a minimum distance of the thickness of one lamination. The laminations shall be clamped together with copper spacers at intervals not exceeding 450 mm in order to equalize the current distribution in the laminations. The busbar ratings in Table 2 shall be multiplied by the factors shown in Table 1 to determine the total current rating per phase.

1.7.4. MOUNTING

a) All busbars when installed horizontally shall have the longer side of the section in the vertical plane. Main busbars shall be supported by “DELARON” or “THIOLITE” resin bound synthetic wood panels or other suitable dielectric material. The surface of these supports shall be treated to prevent surface tracking. The supports shall be bolted securely to the framework and busbars may be supported on resin insulators. Porcelain insulators will not be allowed.

b) The minimum clearances between current carrying parts and between current carrying parts and other metal parts for system voltages up to 600 V is 10 mm in accordance with SABS 784 and BS 159 and shall be strictly maintained.

c) The rating and fixing of busbars shall be designed to withstand mechanical and temperature stresses during fault conditions. The busbars shall withstand a fault current under test conditions of the specified fault level for 1 second. If a fault level is not specified, the busbars shall be tested at 20 times rated current for 1 second. The fault current during tests shall be applied:

- between all three phases,
- any two phases,
- neutral and the adjacent phase, and
- earth conductor and the nearest phase conductor.

d) If no other methods are specified, the stresses under fault conditions shall be calculated as follows, considering correction factors for different configurations:

Mechanical stresses

$$F = \frac{16 \times I^2 \times k}{d \times 10\,000} \text{ N/m}$$

where F = force (N/m)
I = maximum fault current (A r.m.s. symm.)
d = spacing between bars (m)
k = space factor for rectangular bars (see Table. 1)

e) The maximum allowable spacing of busbar supports for fault levels of 15 kA and more is 600 mm.

f) All secondary and “dropper” busbars shall be mounted on suitable insulators or directly on circuit-breaker terminals where practical.

g) Busbars shall be mounted at least 100 mm away from the nearest equipment. Special attention should be given to spacing between fuse-switches and busbars.

h) Busbars shall be properly insulated and sufficiently supported to withstand the maximum fault current at the points where they pass through panels or partitions of the switchboard. This shall preferably be achieved by means of resin bound synthetic wood or similar material with cut-outs which fit tightly around the busbars. The insulating panel shall be firmly bolted to the frame. Busbars or “droppers” that pass through internal partitions in the switchboard shall be similarly insulated and supported.

1.7.5. COVERING

All busbars shall be covered with coloured heat-shrinkable material equal to “RAYCHEM” or “SIGMAFORM” products. The colour shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two coats of coloured insulation paint. Busbar joints shall be covered with a suitable non-hardening compound and then taped with coloured PVC tape. Busbars shall be radius edged where they change direction.

1.7.6. BUS BAR SECTIONS

Busbars shall be divided into actions and jointed to overlap for a distance equal to twice the width of the bar to prevent localized heating. Contact surfaces shall be tinned (acid-base flux may not be used) or silver-plated and bolted down by cadmium-plated bolts and nuts with an applied torque in accordance with SABS 784. Busbars shall be prepared for extension where they terminate at the ends of switchboards.

1.7.7. CONNECTIONS

Conductor ends shall be fitted with solidly sweated or crimped lugs which are bolted to the busbar. Busbar clamps with bolted connections are acceptable for smaller circuit conductors. Where lugs are crimped, evidence shall be submitted that the crimping technique used will comply with the performance requirements of BS 4579, Part I: “COMPRESSION JOINTS IN COPPER”.

1.7.8. OUTGOING CIRCUITS

Conductors up to a maximum size of 70 mm^2 may be used for connections from equipment to external cables. The terminations shall comply with par. 1.8.3.4. Busbars shall be provided for circuits with larger currents and shall extend to approximately 900 mm above the cable gland plate. These busbars must be insulated their entire length.

1.7.9. NEUTRAL BUSBARS

a) Neutral conductors for circuits protected by a single-pole circuit-breaker or fuse-switch shall be connected to a neutral busbar mounted in a suitable position.
b) A separate neutral bar shall be provided for each earth leakage unit provided on the switchboard. These neutral bars shall have a cross-section of at least 6,3 x 25 mm and shall be long enough for the lugs of all neutral conductors to be bolted separately to the busbar without overlapping. Only one neutral conductor is allowed per nut and bolt combination.
c) The requirements of par. 1.7.7 and par. 1.7.12 are applicable.
d) The rating of neutral busbars for three-phase circuits is specified is paragraph 1.7.3

1.7.10. EARTH BUS BAR

a) An earth busbar shall be installed in a convenient position along the entire length of the switchboard. The requirements of par. 1.7.4, 1.7.7, 1.7.8 and 1.7.12 are applicable to earth busbars with the exception that earth busbars may be bolted directly to the framework.
b) The cross-sectional area of earth busbars shall be calculated accordance with the following formula in IEC 61439 with a minimum cross-section of 6,3 x 20 mm:

$$\begin{aligned} S &= \underline{I} \qquad \underline{(t)}^{\frac{1}{2}} \\ &= X \;\times\; (dT) \end{aligned}$$

where S = cross-section (mm^2)

I	=	the r.m.s. value of the current (A)
X	=	13 for Copper
t	=	operating time of protective equipment (s) (Minimum value = 0,2 s.)
dT	=	temperature rise (^{o}C)
	=	120^{o}C for insulated conductors
	=	180^{o}C for uninsulated conductors

If t is between 2 s and 5 s, then dT can be increased in the same formula to

dT	=	145^{o}C for insulated conductors
	=	215^{o}C for uninsulated conductors

c) In addition to the above considerations, the longer side of the earth busbar shall be at least twice the diameter of the largest bolt that will be fitted to the busbar.

d) Earth terminal strips with screws will only be accepted in flush mounted boards and will not be accepted for any other board unless approved by the Client. Earth terminal strips, where allowed, shall have two bolts per connection point.

1.7.11. EARTHING OF METAL PARTS

All non-current carrying metal parts of the board, e.g. framework, panels, transformer cores, metal covers, etc. shall be bonded to the earth busbar. Refer to par. 1.4.3 and 1.4.6 (h) as well.

1.7.12. BOLTS AND NUTS

Only cadmium-plated high tensile steel bolts and hexagonal nuts may be employed at busbar joints and connection points. All nuts shall be provided with spring washers or be of the “NYLOCK” type with washers. The largest possible size bolt that will fit into holes in lugs and fixing holes of equipment shall be used in every instance. Bolts shall be of sufficient length that at least two but not more than five threads protrude beyond the nut.

1.7.13. PREDRILLING

Where busbars terminating at the ends of switchboards are intended for future extension, these busbars shall be predrilled to accommodate the extension. Where prefitted space is specified for future equipment, the busbars in the proposed position shall be predrilled and nuts and bolts shall be provided to accommodate the future busbars or cables feeding the equipment.

1.8. WIRING

1.8.1. CABLING

Cables connected to incoming or outgoing circuits shall be terminated on the gland plate supplied for this purpose. (Refer to par. 1.4.9). Power cables up to and including 70 mm^2 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 70 mm^2 shall 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.

1.8.2. TERMINAL STRIPS

External wiring for low voltage, control, interlocking, alarm, measuring and D.C. circuits shall terminate on numbered wiring terminals complying the with Client's standard specification for "WIRING TERMINALS". The correct terminal size as recommended by the manufacturer for each conductor to be connected shall be used throughout. The terminal numbers shall appear on the wiring diagrams of the switchboard. Terminals for internal wiring shall not be interposed with terminals for external circuits. All connections to terminals shall be identified as described in par 1.8.3.5. Where switchboards consist of separate sections, the control wiring passing between sections shall be terminated on strips in each section so that control wiring can be readily re-instated when reassembling the board.

1.8.3. CURRENT RATINGS

The current rating of conductors for the internal wiring shall be sufficient for the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit-breaker or fuse protection for the circuit.

Table 3: Current Rating for International Wiring

Nominal cross-section mm^2	CONDUCTOR RATING (A)				
	Number of conductors in bunch				
	1	2 - 3	4 - 5	6 - 9	10 and more
2,5	28	25	22	19	16
4	37	33	30	26	22
6	47	42	38	33	28
10	64	54	51	44	38
16	85	76	68	59	51
25	112	101	89	78	67
35	138	124	110	96	88
50	172	154	137	120	103
70	213	191	170	149	127

The above table shall be applied for ambient temperatures up to 30°C. (Refer to table 3). For higher ambients the values shall be derated as prescribed by SABS 0142, Table 10.

1.8.3.1 INTERNAL WIRING

a) Standard 600/1 000 V grade PVS-insulated stranded annealed copper conductors to SABS 150 shall be employed for the internal power wiring of switchboards. The smallest conductor size to be used for power wiring in switchboards shall be 2,5 mm^2. Flexible cord of minimum size 1,0 mm^2 may be used for control wiring.

b) Where heat generating equipment is present and the internal temperature of the board is likely to exceed 50°C, silicon-rubber insulated stranded conductors shall be used.

c) Wiring shall be arranged in horizontal and vertical rows and shall be bound with suitable plastic straps or installed in PVC wiring channels. Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors

d) Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors. Conductors leaving the harnesses shall be so arranged that they are adjacent to the chassis.

e) 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.

f) 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 channel. Channels shall not be more than 40% full.

g) All wiring between different panels within the same switchboard shall be installed in wiring channels.

h) Grommets shall be installed in each hole in the metalwork through which conductors pass.

i) 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.

j) Conductors may be jointed at equipment terminals or numbered terminal strips only. No other connections are allowed.

k) Where conductors change direction, smooth bends shall be formed with a radius of at least 5 times the outside diameter of the conductor or harness.

l) Where screened cables are specified, the screening shall be earthed in the switchboard of control board only unless clearly specified to the contrary. Screened cables entering control boxes through pressed knock-outs, shall terminate in compression glands. Conductors shall as far as possible remain inside the screening at terminations. Where conductors have to separate from the screen, the braiding shall be separated, and the conductors drawn through the braid without damaging the braiding. The conductors shall then be connected to their respective terminals and the screening smoothed and connected to the earth terminal.

m) Where neutral connections are looped between the terminals of instruments, it is essential that the two conductor ends be inserted into a common lug or ferrule and are crimped or soldered together in order that the neutral connection is not broken when the conductors are removed from one of the instruments.

n) 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.

o) 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. Refer also to par. 1.8.6.

1.8.3.2LOAD END CONNECTIONS

The supply end connections to all equipment shall under all circumstances be at the top and the load end connections at the bottom.

1.8.3.2WIRING TO CIRCUIT-BREAKERS

Equipment with a rating exceeding the current rating of 70 mm^2 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 circuit, 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 MCB, 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.

1.8.3.3CONDUCTOR TERMINATIONS

Conductors connected to terminals complying with the Client's standard specification for "WIRING TERMINALS", need not be soldered or ferruled. Connections to circuit-breakers, isolators or contractors 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 soldered or 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.

1.8.3.4IDENTIFICATION

a) The colour of the conductors for all 220/250 V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black.
b) 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.
c) All conductors that terminate at wiring terminals and all conductors used for the internal wiring of the switchboard shall further be identified at both ends by means of durable cable marking ferrules. PVC or other tape is not acceptable.
d) The numbers on the markers shall be shown on the wiring diagrams.

1.8.3.5PAINT FINISH

Metal components of the framework, panels and chassis shall be painted in accordance with the Client's "STANDARD PAINT SPECIFICATION"

1.8.3.6LABELLING

Care shall be taken to ensure that all equipment is fully labelled, and that accurate descriptions and safety warning notices appear in both official languages.

1.8.3.7MATERIAL

Engraved plastic or ivory sandwiched strips shall be used throughout. The strips shall bear white lettering on a black background for normal labels and red letters on a white or yellow background for danger notices.

1.8.3.8MAIN SWITCHBOARD

Main switchboards and sub-main switchboards shall be supplied with the following bilingual labels:

a) Number and allocation of switchboard.
Example:

BEHEERBORD A4
CONRTROL BOARD A4

Lettering: at least 10 mm high. Label on the outside in a prominent position.

b) Designation of bus bar sections.
Example:

GELEISTAMSEKSIE 2
BUS BAR SECTION 2

Lettering: at least 10 mm high. Label on the outside in a prominent position.

c) Designation of all switchgear including circuit-breakers, isolators, contactors, etc. If the current rating of circuit-breakers is not clearly marked on the equipment, the value shall be indicated on the engraved label.
Example:

TOEVOER NA BORD C3
SUPPLY TO BOARD C3

POMPTOEVOER
PUMP SUPPLY

Letters at least 5 mm high. Label on the outside of the switchboard.

d) All other equipment including meters, instruments, indicator lights, switches, pushbuttons, circuit-breakers, fuses, contactors, control relays, protection relays, etc. shall be identified. The function of the equipment and circuits shall be clearly indicated. The main switch shall be labelled as such and designated:

"SWITCH OFF IN CASE OF EMERGENCY"
"SKAKEL AF IN NOODGEVAL"

Flush mounted equipment within doors or front panels shall be identified with labels fixed to the doors or front panels respectively. The labels for equipment installed behind panels shall be fixed to the chassis close together to accommodate descriptive engraved labels; the equipment may be identified by a code or number on an engraved label which shall be fixed close to the equipment. The code number shall be identified on a legend card which shall be installed on the switchboard behind a plastic or other protective cover.

1.8.3.9OTHER SWITCHBOARDS

All equipment on switchboards shall be identified with the necessary bilingual labels. The circuit number shall appear at grouped single-pole circuit-breakers. The circuit numbers shall correspond to the circuit numbers on the final installation drawings. The above-mentioned circuits shall be identified on a legend card, which shall be installed on the inside of the switchboard door, or in any other position where it can conveniently be observed. All fuses, including instrument fuses, shall have labels stating function, fuse rating and duty or type where applicable. All other equipment shall be identified separately, and their functions shall be clearly indicated.

1.8.3.10FIXING OF LABELS

a) Labels shall not be fixed to components or trunking but to doors, panels, chassis or other permanent structures of the switchboards.
b) Engraved strips shall be secured to facilitate a neat alteration of the designation of the labels. Sufficient fixing points shall be provided to prevent labels from warping. Labels in slotted holders shall be secured in position to prevent unauthorized removal. Labels may be secured by the use of brass bolts and nuts, self-tapping screws, slotted label holders or pop-rivets.

1.9. TESTS

The Client shall be notified when the mechanical construction of the switchboard, i.e. frame, panels and base frame, is complete in order that it may be inspected at the factory.

Function tests of all equipment, control and interlocking circuits shall be conducted to the satisfaction of the Client. Testing equipment and facilities including instruments, dummy loads and additional switchgear and cables shall be provided by the Contactor at no extra cost. The Client shall be notified in writing two weeks in advance of any test to be conducted, to allow its representative to be present at such tests. A complete report on the tests shall be handed to the Client.

1.10. DRAWINGS

1.10.1. DRAWINGS FOR APPROVAL

A set of three prints of the shop drawings for the switchboards shall be submitted to the Client for approval before the boards are manufactured. The following information shall be presented:

a) A complete wiring diagram of the equipment on the boards.
b) A complete layout of the arrangement of the switchboards indicating all equipment dimensions and the construction of the boards. The positions and method of fixing and sizes of busbars shall be shown.
c) All labelling information in both the official languages on a separate sheet.
d) The make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contractors, etc.

The approval of drawings shall not relieve the Contractor of his responsibility to the Client to supply the switchboards according to the requirements of this Specification.

1.10.2. FINAL DRAWINGS

A complete set of "as-built" transparent drawings of all switchboards shall be submitted to the Client within two weeks after delivery of the boards. The following information shall be presented:

a) Item (a) to (d) of the previous paragraph
b) Terminal strip numbers, numbers and colors of conductors connected to the terminal strips and numbers and colors of the conductors utilized for the internal wiring.
c) A separate schedule of all equipment.

1.10.3. MANUALS

Three sets of manuals for all specified main and sub-main switchboard shall be supplied to the Client at no extra cost. These manuals shall include the following information:

a) Complete information on the operation of the equipment.
b) Complete information for maintenance of the equipment
c) Brochures and ordering information
d) A complete equipment list indicating quantities and relevant catalogue numbers.

1.10.4. COMPLETION

The supply contract shall be regarded as incomplete until all tests have been conducted successfully and all drawings and manuals have been handed to the Client.

GSE44 – GENERAL SPECIFICATION ELECTRICAL

INSTALLATION OF HV CABLES

TABLE OF CONTENTS

1. INSTALLATION OF XLPE-INSULATED POWER CABLES FOR SYSTEMS WITH NOMINAL VOLTAGES OF 44 kV to 132 kV INSTALLATION OF CABLES

This section covers the installation of XLPE high voltage single core cables for system voltages of 44 kV to 132 kV, 50 Hz.

1.1 GENERAL

1.1.1 CABLE TYPES

a) All cables and jointing and termination accessories used for power distribution shall comply with the Quality Specifications contained herein.

b) Cables with copper and aluminium conductors shall be used throughout unless otherwise specified or approved.

1.1.2 COMPETENCE OF PERSONNEL

a) It is a definite requirement that the Contractor shall only employ personnel fully conversant with cable manufacturer's recommendations for joining and terminating cables.

1.2 IDENTIFICATION OF CABLES

Cables shall be identified at all terminations by means of punched metallic bands or marked with labels or tags.

The use of PVC tape with punched characters is not acceptable.

The identification numbers of cables shall be shown on "as built" drawings of the Installation.

2. TRENCHING

2.1.1 GENERAL

The Contractor shall be responsible for all trenching excavations unless specified to the contrary.

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.

The Contractor shall acquaint himself with the position 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's representative, the local municipal authority and any other authority which may be involved, in writing.

The Contractor will be held responsible for damage to any existing services brought to his attention by the Engineer and shall be responsible for the cost of repairs.

The Contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.

The Contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site constructions or other property.

2.1.2 MECHANICAL EXCAVATORS

Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to the 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.

2.1.3 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 Engineers and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

2.1.4 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. Refer also to section 2.1.1.

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.

2.1.5 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 Machinery and Occupational Safety Act.

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.

2.1.6 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 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 from site and disposed of at the cost of the Contractor.

Trenches across roads, access ways or footpaths shall not be left open. If cables cannot be laid immediately the Contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.

In the event of damage to other services or structures during trenching operations the Contractor shall immediately notify the Engineer and institute repairs.

Prior to cable laying the trench shall be inspected thoroughly 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 other damage or electrolytic action, the Engineer shall be notified before installing the cables.

2.1.7 DIMENSIONS OF TRENCHES

Cable trenches for three single core cables in trefoil or flat formation (single circuit) shall not be less than 500 mm wide and need not be more than 650 mm wide. The dimension shall be valid for the total trench depth.

The width shall be increased where more cables are installed to allow for the spacing stipulated in par 3.1.1 and 3.1.2.

Where trenches change direction or where cable slack is to be accommodated, the Contractor shall ensure that the minimum bending radii of cables according to table 1 are met when determining trench widths.

Table 1: Installation Minimum Bending Radii for HV Cables

<table>
<tr><td colspan="4">Installation minimum bending radii</td></tr>
<tr><td colspan="2">Cables placed into position adjacent to joints or termination</td><td rowspan="2">Laid direct or in air</td><td rowspan="2">Laid in ducts</td></tr>
<tr><td>Without former</td><td>With former</td></tr>
<tr><td>20D</td><td>15D</td><td>30D</td><td>35D</td></tr>
</table>

Trench depths shall be determined in accordance with cable laying depths and bedding thickness. Any variations in trench depths shall be approved by the Engineer.

Payment will be made on a volumetric excavation rate calculated on the basis of the given maximum dimensions or the actual dimension, whichever is the lesser.

2.1.8 JOINT BAYS AND JOINTS

Where cable joints are required to be made in the course of a cable run, a joint bay shall be excavated of sufficient size to enable the cable jointer to work efficiently and unimpeded.

The trenches on either side of the joint bay shall be properly backfilled prior to jointing for a distance of at least 10 m in both directions.

The joint bay shall at all times be covered with a clean waterproof tent. Prior to jointing it shall be ensured that adequate measures have been taken to stop the ingress of water into the joint bay and that an adequate seal has been placed around the joint bay tent to prevent rain or run-off water entering the joint bay.

A submersible pump shall be available at all times to pump away any water or seepage that may enter the joint bay.

The joint bay shall be adequately illuminated throughout the jointing operation and, shall be maintained free from dust, dirt and water.

Cable joints shall be installed according to the manufacturer’s installation instructions. Aluminium conductors shall be metal-inert gas (MIG) welded or CAD welded.

Joint bays shall be backfilled by placing rot-proof bags containing a weak sand-cement mix (30:1) under the cables and joints. The backfill materials shall then be installed and compacted by hand, in layers 150 mm thick. No mechanical compaction methods shall be used on the joint bays until after the concrete cover/slabs over the joint bay have been installed.

2.1.9 BEDDING

The bottom of the trench shall be filled across the full width with a 75 mm 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 1,5 BC m/W) may be used for this purpose. Sea or river sand, ash, chalk, peat, 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. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations.

After cable laying a further layer of bedding shall be provided to extend to 75 mm above the cables.

The bedding under joints shall be fully consolidated to prevent subsequent settling.

2.1.10 CABLE SLEEVES

Where cables cross under roads, railway tracks, other service areas, etc and where cables enter buildings, the cables shall be installed in PVC pipes.

Pipes shall be joined in accordance with the manufacturer's instructions.

Sleeves shall cross roads and railway tracks at right angles.

Sleeves shall have a minimum diameter of 160mm. They shall extend at least 2 m beyond the tracks of a railway line or of the outermost tracks where there is more than one line. In the case of roads, the sleeves shall extend at least 1 m beyond the road edge or kerb on both sides of the road.

All sleeves shall be graded 1:400 for water drainage.

Cable sleeves shall be installed to the spacing and depths stated in par 3.1.1 and 3.1.2 hereof.

The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

2.1.11 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 all electric cables a coloured plastic marking tape shall be installed 400 mm above the cable. The tape shall be yellow, with red skull and crossbones with the words "ELECTRIC CABLE/ELEKTRIESE KABEL". These markings shall not be more than 1 m apart from centre to centre.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material is 75 mm.

The Contractor shall have allowed in his tender for the importation of suitable backfill material if required.

The backfill shall be compacted in layers of 150 mm 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 case of roadways or paved areas the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated. The density required will be shown on the relevant detail drawings.

2.1.12 CABLE MARKERS (FOR HV CABLES ONLY, EXCEPT WHERE OTHERWISE SPECIFIED)

Cable markers shall be provided along all HV cable routes.
Cable markers shall consist of concrete blocks in the shape of truncated pyramids, approximately 300 mm high, 150 x 150 mm at the top and 250 x 250 mm at the bottom.

Brass plates shall be cast into the tops of the blocks in such a manner that they cannot be prised loose. The wording "ELECTRIC CABLE/ELEKTRIESE KABEL" shall be stamped on the brass plates as well as direction arrows and the cable voltage rating.

Cable markers shall be installed on the surface along all the underground routes and shall project 35 mm above normal ground level unless the projected markers could be a hazard to pedestrian or other traffic in which case they shall be installed flush with the surface.

Cable markers shall be installed at the beginning and end of a cable run (e g where a cable enters a substation or building) at all changes of direction, above all joints, above cable pipe entries and exits and at intervals not exceeding 150 m along the cable route.

The position of cable markers shall be indicated on the "as built" drawings.

3. INSTALLATION OF UNDERGROUND CABLES

3.1.1 INSTALLATION DEPTHS

Cables shall be installed at a minimum depth of 1,2 m

All cable depth measurements shall be made to the bottom of the cable when laid directly in ground or to the bottom of the duct or sleeve where these are provided.

The above depths shall apply to the bottom cables in the trefoil formation.

The Contractor may only deviate from the above depths provided prior authority in writing has been obtained from the Engineer. In this event the cables shall be protected with a suitable concrete covering.

The depth of cable pipes or ducts beneath railway lines or roads shall be not less than 1,3 m below the formation level.

3.1.2 CABLE SPACING

The cables shall be laid in either a trefoil formation or flat formation in the trench.

The spacing between two or more circuits in the same trench with a trefoil formation shall not be less than 300 mm and need not be more than 1 000 mm.

The spacing between two or more circuits in the same trench with a flat formation shall not be less than 600 mm and need not be more than 1 400 mm.

The Engineer shall specify the formation and the spacing between two or more circuits in the same trench.

All control or pilot cables shall be laid at least 300 mm from power cables.

3.1.3 CABLE LAYING

Except where ducts, tunnels or pipes are provided, cables shall be laid directly in the ground as specified.

The cable shall be removed from the drum in such a manner that the cable is not subjected to twisting from tension exceeding that stipulated by the cable manufacturer.

Cable rollers shall be used as far as possible to run out cables. Rollers shall be spaced so that the length of cable in the trench will be totally suspended during the laying operation and sufficiently close to prevent undue sagging and the cable from touching the ground. Rollers shall also be placed in the trench in such a manner that they will not readily capsize.

Cable rollers shall have no sharp projecting parts liable to damage the cables.

Where cables have to be drawn around corners, well-lubricated skid plates shall be used. The skid plates shall be securely fixed between rollers and shall constantly be examined during cable laying operations.

Where cables have to be drawn through pipes or ducts, a suitable cable pulling eye plumb shall be used and particular care shall be exercised to avoid abrasion, elongation or distortion of any kind.

The maximum allowable tension when pulling a cable is 30 N/mm^2 of conductor area.

Where cables are laid in trefoil they shall be tied together with “sisal” string at
2 m intervals to prevent any movement during backfilling.

It will be assumed that the price or rates contained in the tender includes for the installation of cables in pipes and ducts or below existing or newly installed services. The Engineer shall be informed timeously of the intention to carry out all cable laying operations to allow an inspection of the works by the Engineer if so required.

4. INSTALLATION OF CABLES IN CONCRETE TRENCHES

4.1.1 GENERAL

This paragraph covers the installation of cables in building trenches, service ducts, etc. The trenches, ducts, etc inside buildings will be constructed and installed by others.

4.1.2 INSTALLATION

Cables shall be installed in one of the following ways:

a) On horizontal cable trays.
b) On horizontal metal supports with suitable clamps.
c) On vertical cable trays or metal supports fixed to the side of the trench. The cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of the building trenches.

4.1.3 COVERS

The covering of concrete trenches shall as a rule fall inside the scope of the electrical installation. The Contractor shall be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other coverings as required.

Cables shall enter and exit the trench through sleeves protruding 300 mm beyond the covering. The sleeves shall be permanently secured in position and the open space between the cable and sleeves shall be sealed with a non-hardening, watertight compound.

4.1.4 FILLED TRENCHES

Where specified floor trenches shall be filled with sand.

If a sand filling is specified, the cables shall be fixed to non-corroding supports.

Sand-filled trenches other than in substations shall be covered in one of the following ways:

a) Reinforced concrete covers.
b) Sand and cement screed.
c) Removable chequer plates in steel edge frames.

Method a) above shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified allowance for a mass of 2 tons shall be made.

5. FIXING OF CABLES TO TRAYS OR STRUCTURES

5.1.1 INSTALLATION

Cables may be installed in one of the following ways:

a) On horizontal cable trays.
b) Against vertical cable trays with suitable clamps.
c) Against horizontal or vertical metal supports or brackets with suitable clamps.
d) On clamps which are fixed to the structure.

5.1.2 CLAMPS

Suitable clamps (cleats) which will secure cables without damage shall be used. Metal clamps or drilled hard wood blocks shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support or consist of two halves that are bolted together. The correct clamp size to fit the cable shall be used. Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

6. MEASUREMENTS

All measurements for payments shall be made jointly by the representatives of the Engineer 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 of the trench sides, other earth movements or for trenches excavated in excess of the stipulated dimensions.

The classification shall be as follows:

<u>Very hard rock</u>: shall mean rock that can only be excavated by means of explosives.

<u>Hard rock</u>: shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness, solid shale and boulders in general requiring the use of jack hammers and other mechanical means of excavations.

<u>Soft rock and earth</u>: shall mean rock and earth that can be loosened and removed by hand-pick and shovel.

Where very hard rock and 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.

All cable lengths indicated in the Detail Technical Specification and/or shown in the cable route drawings shall be regarded as estimates and are given for tendering purposes only. The successful tenderer shall measure actual cable lengths on site before ordering.

The final price for the supply and installation of all cables will be adjusted, on the basis of the actual lengths of installed cables, in accordance with the unit rates quoted at the time of tendering. Cable lengths shall be measured on site to the nearest 500 mm for this purpose and surplus cable will not be paid for.

7. COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. Such inspections will, however, not deem the portions inspected as being complete or accepted and the Contractor shall remain responsible for completing the installation fully in accordance with the Contract Documents.

The Contractor shall carry out a final "as built" survey of the cable routes and present to the Engineer "as built" route plans of the complete installation. The following information shall be reflected on the plans or submitted as separate schedules with the plans:

a) Overall length of each cable.
b) Locations of all joints (if any) in relation to permanent reference points. Dimensions shall be shown and the method of triangulation i.e. two dimensions to each joint, shall be used.
c) Identification of each cable. The works will be deemed to be incomplete until all tests have been conducted successfully and all "as built" drawings and schedules have been handed to the Engineer.

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GSE50 – GENERAL SPECIFICATION ELECTRICAL

MV CABLES

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1. GENERAL

The general requirements for Medium Voltage Cables are covered by NRS 013:2007 as amended.

The detailed project requirements shall be covered in the Project Specifications, Drawings and Bill of Quantities. Cables shall comply with the relevant SANS manufacturing standard and test voltages as prescribed by SANS10198-13 shall be applied during testing and commissioning.

Respective manufacturing standards:
SANS 97 (Paper insulated cables)
SANS 1339 (XLPE Cables)

The following documents contain provisions that and constitutes requirements of this specification. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below:

SANS 60055-1:	Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas pressure and oil filled cables) – Part 1: Tests on cables and their accessories.
SANS 61442:	Electric cables: Test methods for accessories for power cables with rated voltages from 6 kV (Um – 7,2 kV) up to 30 kV (Um = 36 kV).
CENELEC 629.1 S1:	Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36 (42) kV – Part 1: Cables with extruded insulation.
CENELEC 629.2 S1:	Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36 (42) kV – Part 2: Cables with impregnated paper insulation.
SANS 60502-4:	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV).
NRS 053:	Accessories for medium voltage power cables (3,8/6,6 kV to 19/33 kV).
SANS 876 / NRS 012:	Cable terminations and live conductors within air insulated enclosures (insulation co-ordination) for rated a.c. voltages of 7,2 and up to and including 36 kV.

GSE52 – GENERAL SPECIFICATION ELECTRICAL

BATTERY CHARGERS INDUSTRIAL TYPE

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1. GENERAL

The general requirements for Battery Chargers - Industrial Type is covered by SANS 1652:2013. The detail project requirements shall be covered in the Project Specification, Drawings and Bill of Quantities.

SE12 – GENERAL SPECIFICATION ELECTRICAL

INDOOR MEDIUM VOLTAGE SWITCHGEAR

HIGHBURY WATER TREATMENT WORKS MUNICIPAL 11kV SWITCHING STATION

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1. GENERAL REQUIREMENTS

1.1. The switchgear shall be of the single busbar type rated for operation at 11 kV in accordance with SANS 1885 and Eskom 34-1157.

1.2. This specification shall be read in conjunction with the SCADA and protection specification.

1.3. Provision to be made to for SCADA communication in the future. SCADA will not be installed at this stage.

1.4. The switchboard shall have a main label “HIGHBURY WTW MUNICIPAL 11kV SWITCHBOARD”.

1.5. The switchboard shall have a main label “HIGHBURY WTW 11kV SWITCHBOARD”.

2. SWITCHGEAR REQUIREMENTS

2.1. The switchboards shall be installed in a single straight line.

2.2. Switchgear shall be intended for normal indoor conditions as specified in SANS 1885. No special service conditions are required.

2.3. All doors shall have stops to prevent over swinging when opened.

2.4. The switchgear panels shall have withdrawable circuit breakers and rear cable entry.

2.5. The circuit breaker panel and the circuit breaker shall have clear OPEN/CLOSE indications.

2.6. Each circuit breaker panel shall have the following definite indication:

a) Circuit breaker open/close status and control;
b) Circuit breaker fail;
c) Stored energy device charged/discharged;
d) Earth switch applied status open/close;
e) Non-resettable mechanical operation counter.

2.7. All panel shall have CONSTANT trip circuit monitoring.

2.8. Earthing facilities shall be provided for all main circuits.

2.9. All spare inputs and outputs shall be wired to the terminal blocks on the front and rear of the panel and shall be clearly.

2.10. The earthing switches shall be the integral type that uses the circuit breaker.

2.11. The circuit breaker transporting device shall be integral.

2.12. No busbar earthing facility shall be provided. (non-Eskom standard)

2.13. No bus section earthing facility shall be provided. (non-Eskom standard)

2.14. OPEN/CLOSE (T/N/C) pistol grip control switches (push-to-turn & pad lockable handles) are required with spring return to the neutral position when operated.

2.15. Control compartment and circuit breaker compartments shall have single lever door opening handles.

2.16. All IED's for primary substations as well as switching stations shall be housed locally on the swing door of switchgear control compartment.

2.17. Each switchboard shall be supplied with a metal notice board by the OEM stipulating the step-by-step circuit breaker racking procedure.

2.18. The "Test", "Earth" or "Service" position of the circuit breaker shall be clearly visible on the outside of the circuit breaker compartment door.

2.19. **MIMIC PANEL**

If allowed for in the bill of quantities primary substations shall be provided with a remote mimic panel. There are various options for the mimic panel i.e.

- Custom floor standing panels.
- ~~48U floor standing panels.~~
- ~~Wall mounted panels~~
- ~~Tiled mimic~~
- Painted mimic (stick on mimic's shall not be accepted)
- Combination of tiled and painted mimic where semaphores are tiles used on a painted mimic.

No vinyl or stick on mimic shall be accepted.

FOR THIS PROJECT THE MIMIC SHALL BE FLOOR STANDING PANELS WITH A PAINTED MIMIC

Floor standing enclosures with segregated front entry access, bottom entry cable access from cable trench, painted mimic, tiled semaphores, lockable- press to turn- rotary T/N/C switches and fault indication. It is preferred that the mimic system runs via hardwired signals. Provision should be made on the mimic panel to display the status of the x2 11kV Generators, 3x Transformers, 3x Incomer Breakers and 2x Bus Sections of MCC 5A & 5B. However, the mentioned equipment will not be controlled from this Mimic Panel.

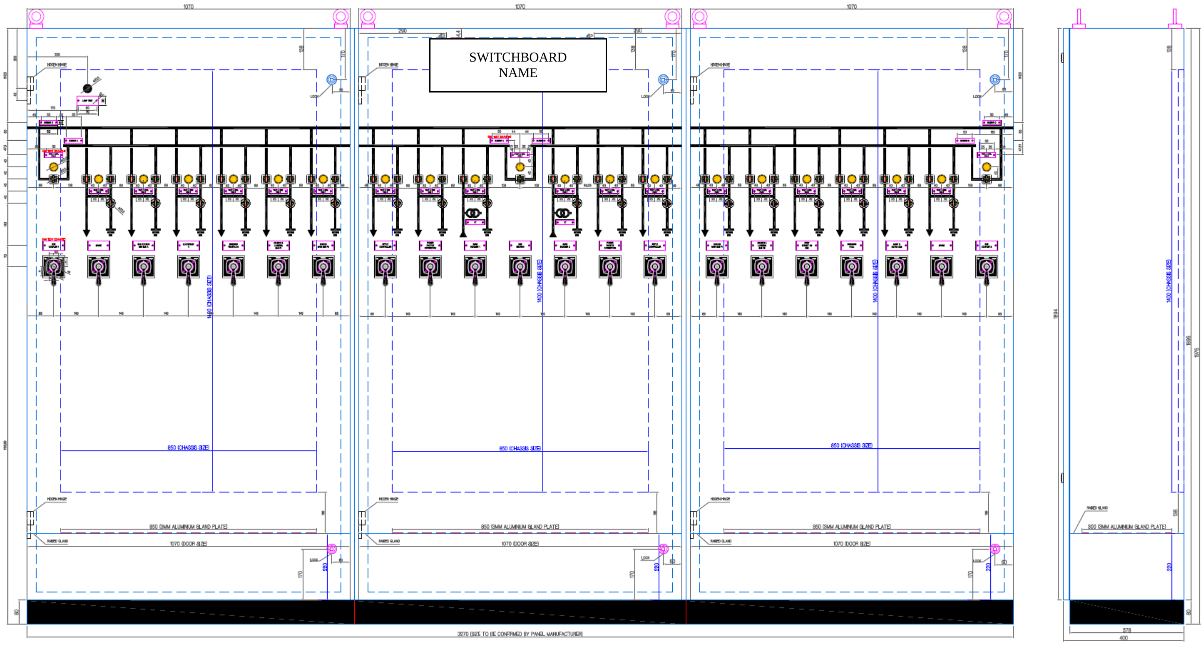

Figure 1: Typical primary substation MV switchboard mimic panel

2.20. The mimic panel shall include TRIP/NEUTRAL/CLOSE rotary switches for the entire switchboard. Switchgear panels shall also have a local mimic painted onto the switchgear panels with LED circuit breaker position indication (semaphores).

2.21. For satellite switching stations control gear shall be housed locally on the switchgear panel. Switchgear panels shall have a local mimic painted onto the switchgear panels with LED circuit breaker- and earth position- indication.

2.22. A panel connector for local OPEN/CLOSE control shall be provided as backup to the remote OPEN/CLOSE control. Such local connector shall be of the ITT Cannon (small) trip / close socket type and shall be supplied with one short cord for testing purposes and one extended cord for operational purposes (2x cords – per switchboard)

2.23. The closing mechanism shall be the spring charged coil type.

2.24. The tripping circuit shall consist of a DC shunt trip coil with an adequately rated “a” contact in series. (“a” contact – make contact)

2.25. Main trip coils and backup trip coils shall be provided.

2.26. All designs shall include a separate trip coil for each pole of the relay or protection device. Thus, a two overcurrent and one earth fault arrangement would require two trip coils on the phases associated with the overcurrent protective devices and a trip coil in the residual circuit.

2.27. Six (6) spare auxiliary contacts shall be offered:

- 3 x Normally open (N/O)

- 3 x Normally close (N/C)

2.28. Each individual switchgear panel shall have duplicated descriptive labels located at:

a) Front of switchgear panel above the circuit breaker compartment.
b) On the circuit breaker truck/trolley.
c) Back of the switchgear at the cable termination compartment.

2.29. OEM shall be responsible for the on-site installation and on-site operation testing of the switchboard.

2.30. The 2x Highbury 11 kV switchboards are a new installation, extension of an existing switchboard is not required.

2.31. Heaters shall be installed in the switchgear and the type of heater shall be stated in the switchgear technical schedule.

Suitably rated electric heaters shall be located inside the cable and circuit-breaker compartments to prevent moisture from condensing and being deposited inside each of the defined panel compartments. Depending on the switchgear design considerations (e.g. location of busbar compartment relative to other heated compartments, busbar support method, etc.), switchgear performance history and OEM recommendations.

The engineer reserves the right to request additional heaters in the busbar compartment(s).

Heaters shall maintain a dewpoint greater than the ambient temperature and shall circulate the air constantly to all parts of the enclosure. (NOTE The use of humidity transducers to control the dewpoint and prevent condensation within the switchgear compartments will be considered.)

Heaters shall be placed to avoid damage to temperature-sensitive components. Heater elements shall, where applicable, be protected and leads, which are heated by the conduction of heat from the element, shall be insulated by heat-resistant insulating material, e.g. ceramic beads or silicone rubber. The type of insulating material offered shall be stated in the tender offer.

The electrical supply for heaters shall be single-phase 230 V AC.

The heater control circuits shall comply with the requirements of Eskom 240-56063705 and D-DT-5408.

2.32. Each panel shall be equipped with a copper earth bar to facilitate cable sheath and armour earthing. The switchboard main earth bar shall be connected to the concrete floor steel reinforcement to serve as and equipotential earth grid during fault conditions. Under earth fault conditions the current density of the earth bar shall be less than 200A/mm^2. The switchboard earth-bar shall be internal to the switchboard panels, an additional earth-bar shall be installed on the vertical wall of the cable trench.

2.33. Where a switchboard is equipped with more than one incomer and bus-section or bus-coupler an interlocking circuit shall be provided to prevent continuous parallel operation of upstream power transformers. The interlocking scheme shall:

Have a 30 second delay before a strobe flasher light and sounder is activated.

The flasher and sounder shall be installed locally on the switchboard.

After a further 90 seconds (120 seconds cumulative) the respective bus-section or bus-coupler circuit breaker shall trip to break the parallel power transformer operation. The delay will allow transferring of load from one transformer to another.

Once parallel operation is terminated/tripped the sounder and strobe flasher shall stop.

The interlocking circuit shall be equipped with a bypass switch for testing and commissioning purposes, and emergency operations.

Electrical Interlocking required between the Generator Incomers and the Eskom Incomers.

Sync Check Relay to be installed on Generator Incomer Panels to allow for Synchronising of Generators.

3. RATING

3.1. The switchboard shall be air insulated with vacuum interruption mediums.

3.2. The rated voltage shall be 12kV.

3.3. The rated frequency shall be 50 Hz.

3.4. The rated nominal currents for incomers shall be 800A.

3.5. The rated nominal currents for feeders shall be 800A.

3.6. The rated nominal currents for bus-sections shall be 800A.

3.7. The rated nominal busbar current shall be 800A.

3.8. The rated peak lightning impulse withstand voltage shall be 95kV.

3.9. The rated short-duration power frequency withstand R.M.S. voltage shall be 28kV.

3.10. The standard 3s rated short-time withstand R.M.S. current shall be 25kA and 63kA rated peak withstand current.

3.11. The auxiliary circuit voltage shall be 110V DC.

4. POWER CABLE TERMINATION

4.1. Cable terminations shall be in accordance with SANS 1885 Annex C – type 2: lugs connected onto bushings or post insulators with a shrouded insulation termination.

SANS 1885:2004
Edition 1.1

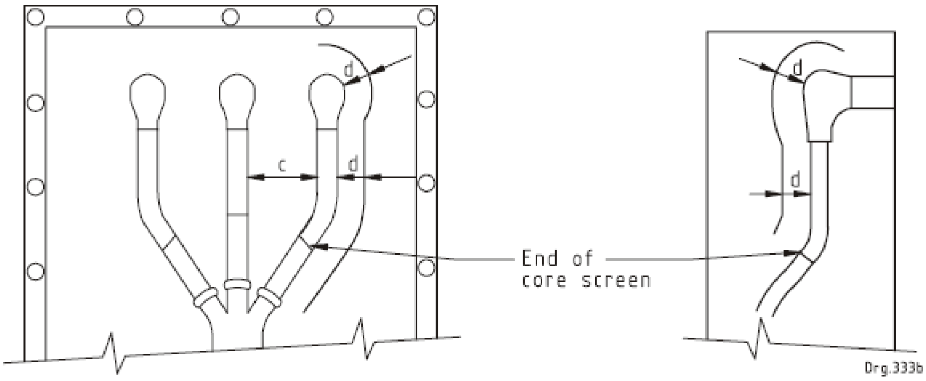

Figure 2: SANS 1885 Type 2 termination

4.2. Creepage distance shall be 31mm/kV.

4.3. All incomer panel cable termination compartments shall be fitted with aluminium gland plates. All panels shall be fitted with glands and cable clamps directly above the glands for air terminations.

5. BATTERY, CHARGERS, DC AND AUX. SUPPLIES

5.1. Highbury WTW Municipal 11kV Switchboard will have a single NiCad deep cycle battery bank and BTU.

The BTU system shall be located in the MV Switching room.

5.2. The Highbury WTW 11kV Switchboard will have a dual redundant NiCad deep cycle battery bank and BTU system with adequately rated blocking diodes for parallel operation or automatic change-over switch shall be included for the Switchboard.

The BTU system shall be located in the MV Mimic / Control room.

5.3. The battery charger shall comply with SANS 1652.

5.4. The peak and standby power requirements shall be determined in accordance with IEEE 1115.

5.5. The batteries and battery operating voltage shall be 110V DC and a maximum of 8 A shall be drawn.

5.6. Two "special" DC alarm outputs shall be provided:

DC Low – GSM output and alarm (if Eskom infeed to substation a signal shall be provided to Eskom as well)

DC Low Low – GSM output and alarm.

GSM module to be installed for sending Alarm SMS's. SMS to be sent for battery alarms. Municipality to supply sim card.

5.7. An Alstom Type Bitronics Battery Alarm 300 or an alternative shall be installed in the MV control room (primary substations) or on the bus-section panel (satellite switching station) irrespective of whether or not an alarm relay is equipped on the battery chargers.

5.8. The charger shall be supplied by a 230V supply from the main distribution board or chop over board with allowance for a main and backup low voltage supply.

6. CURRENT TRANSFORMERS

6.1. Current transformers shall comply with the requirements of SANS 60044-1.

6.2. Three current transformer cores shall be provided in accordance with Eskom specifications for:

a) Protection.
b) Metering.
c) Instrumentation.

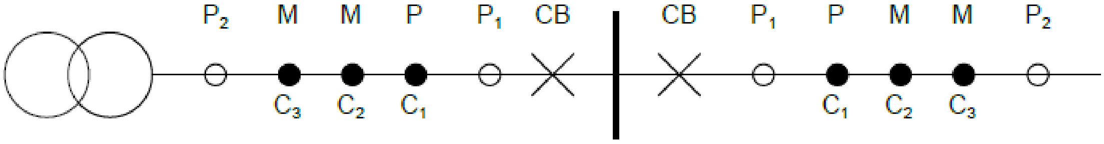

Figure 3: CT positioning (one set of protection CT cores in bus section)

6.3. CT cores, ratio's and wiring shall be in accordance with Eskom standard 34-1157 and D-DT5408

6.4. 800A Incomer and Feeder panel CT's shall comply with the following information: 2x Protection Multi-ratio Cores & 2x Measurement Multi-ratio Cores

SPECIFICATION OF MEASUREMENT CTs
NOTE 6

TAPPING	RATIO	CLASS	BURDEN
S1 - S2	200/1	0,5	5 VA
S2 - S3	400/1	0,2	5 VA
S1 - S3	600/1	0,2	5 VA
S1 - S4	800/1	0,2/10P10	5 VA

SPECIFICATION OF PROTECTIVE CTs
(TO BE TESTED ON 1/400 TURNS RATIO)

TAPPING	RATIO	CLASS	MIN V_k	MAX I_e	MAX R_s at 75 °C
S1 - S2	1/200T	PX	83,3 V	300 mA	1 Ohm
S2 - S3	1/400T	PX	167 V	150 mA	2 Ohms
S1 - S3	1/600T	PX	250 V	100 mA	3 Ohms
S1 - S4	1/800T	PX	333 V	75 mA	4 Ohms

Figure 4: 800A feeder panel CT's

6.5. All current transformer secondary connections shall be brought to a MMLG terminal block in the relay chamber.

7. VOLTAGE TRANSFORMERS

7.1. Voltage transformers shall be in accordance with the requirements of SANS 60044-2 and Eskom D-DT-5048 SH6.

7.2. Voltage transformers shall comply with the following minimum requirements:

a) One-phase or three-phase – three phase
b) Ratio - $\frac{(V_{nom})kV}{\sqrt{3}} \Big/ \frac{110V}{\sqrt{3}}$
c) Class – 3P/0.2
d) Burden – 50VA
e) Voltage factor – 1.2 continuous; 1.9 for 30s
f) Test block location – LV compartment on switchgear panel
g) 5 Limb – 5 Limb or 3 separate cores
h) Position – 2x Incomer cable VT's (Municipal)
1x Incomer cable VT (Highbury WTW)
2x Generator Feeder cable VT's (Highbury WTW)
2x Busbar VT's (Highbury WTW)
i) Rated Primary Voltage – 11 kV

8. PROTECTION RELAYS

8.1. Protection relays shall be installed on-board.

8.2. Programmable IED LED's shall be programmed and labelled as indicated on the Switchgear Schedule drawing.

8.3. Incomer Panels shall implement OC/EF protection.

8.4. Main, backup and auxiliary relays shall trip the circuit breaker directly and an indication shall be provided on the MV bay controller.

8.5. **Transformer Feeder** Panels shall implement REF, Transformer Differential protection and OC/EF protection. Relays to be applied as per switchgear schedule.

8.6. **Sync Check**

8.7. The bay controller shall receive all status and control signals – backup relays shall communicate and be remotely controlled through the bay controller.

8.8. **Feeder** panels shall denote radial supplies where only OC/EF protection will be implemented. Relays to be applied as per switchgear schedule.

8.9. All relays shall be programmed to latch if a trip occurs – circuit breakers must only be able to close once the trip is acknowledged.

8.10. Feeder breakers fail alarms and trip functionalities shall be wired to the respective incomer and bus section panel. For MV incomer “breaker fail” the respective upstream MV breaker shall trip. The same will apply to MV feeders where “breaker fail” shall trip the respective MV incomer, bus section (and bus-coupler if applicable). The breaker fail function shall apply to all protection schemes.

8.11. Arc protection relays shall be mounted locally on switchgear panels and shall be an independent standalone system. Local terminal and test blocks shall be included for the arc protection relay circuitry. Each local arc protection relay shall be panel mounted and have a LED (per sensor) with a label denoting all respective arc sensors. Arc relays shall reset on local switchgear i.e. it shall not be accepted to reset an arc trip on an adjacent panel. For single and double busbar system zoning shall be possible i.e. zone segregation between the main and backup busbar is compulsory. As required in the protection specification circuit breaker arc’s shall isolate the entire zone and prevent back feeding by means of interlocking with ring feeders. Each panel shall be equipped with interlocking capabilities which shall be easy to implement should the panel in future be configured as a ring feed panel. All zones shall be segregated by means of metal cladding as a minimum requirement for zone barriers. All Relays to be installed as per switchgear schedule.

8.12. All relays shall be IEC 61850 forward compatible for possible future implementation in accordance with Eskom specifications.

9. INSTRUMENTS, TRANSDUCERS AND METERING

9.1. Irrespective of local or remote control gear all switchgear panels shall have local Enerium E50 multifunction meters in accordance with IEC61557-12.

9.2. The Highbury WTW Municipal 11kV Switchboard shall be equipped with a tariff meter fitted to Highbury WTW feeder panel.

9.3. The Highbury WTW 11kV Switchboard shall be equipped with a tariff meter fitted to the incomer panel.

9.4. Where tariff / billing meters are required, the installation shall be within the control compartment of the panel. Due to the size of tariff meter, installation onto the control compartment door shall not be accepted.

9.5. MMLG test blocks shall be used for protection CT’s. PK2 test blocks are not preferred but will be accepted for metering and indication of CT’s. C&H test blocks shall not be accepted.

9.6. Voltmeter and ammeters shall be in accordance with the requirements specified in SANS 1885.

9.7. Energy meter shall be installed within all the panels. (Enerium E50)

9.8. All control compartment doors shall be fitted with an earth strap. If the earth strap is not installed through the wiring sleeve, braided earth straps shall be enforced.

9.9. All control compartment doors shall have permanently fixed durable rubber door seals installed.

10. LUMINOUS INDICATORS

10.1. All incomer and feeder panels shall have cable live indicators, and the bus-sections to have 2 x busbar live indicators. An "integrated" voltage detection system (VDS KRIES VOIS R+) with fixed voltage indicators and test points in accordance with SANS 61243-5 shall be provided for cable live indication on each incomer feeder and bus-section panel. The VDS systems shall be fitted on the LV compartment door. A spare status contact from each VDS shall be wired to terminals in the LV compartment as per Eskom D-DT-5408.

10.2. All trip indications shall be displayed on the switchgear panel locally.

11. ALARM CIRCUITS

Circuit breakers alarm circuits shall be provided and wired in accordance with Eskom DST34-1692 and D-DT-5408.

12. AUXILIARY CIRCUITRY

12.1. All insulated auxiliary wires shall be multi-stranded copper, of the following cross-sectional areas:

a) auxiliary wires: 1,5 mm^2; and
b) current transformers and voltage transformers: 2,5 mm^2.

13. ACCESSORIES

13.1. In accordance with SANS 1885.

14. RATING PLATES

14.1. In accordance with SANS 1885.

15. LABELS

15.1. In accordance with SANS 1885.

16. TESTS

16.1. Partial discharge test shall be performed

I. during the FAT,
II. following commissioning (SAT)
III. with lapse of the 12-month guarantee period

16.2. In accordance with SANS 1885.

16.3. Tests shall be carried out by an accredited laboratory and tenderers shall provide assurances thereof. Tendered rates shall include the costs of all services such as tests, delivery and spares.

16.4. Factory Acceptance Testing (FAT) and Site acceptance testing (SAT) shall be arranged by the OEM and shall be witnessed and approved by the Engineer. If either the FAT or SAT is rescheduled even once due to a delay in progress the OEM shall be liable for penalties.

16.5. All type test certificates shall be supplied when detail manufacturing drawings are issued by the OEM.

16.6. All routing tests shall be performed as part of the FAT at the manufacturer’s works.

16.7. Some routine test shall be redone on site at the Engineers discretion, commissioning shall include uploading and testing of the customers protection settings and “test after erection on site” as per SANS 1885.

16.8. In addition to the paragraphs to follow the following test shall be done during switchgear FAT and SAT:

a) CT magnetizing curves (to be provided prior to FAT)
b) All functionality tests i.e. instrumentation panels, breaker racking, breaker tripping, indications etc.
c) Protection function (10sec to trip) PS: 25% and TMS: 1
d) Protection function – grading and grading to incomers
e) Interlocking function – B/S alarm and trip for parallel operation with a delay for load transfer and a bypass switch for testing
f) Injection test to check ammeter and protection calibration
g) ARC protection functionality and zone tripping
h) Energy meter calibration
i) Mimic functionality test
j) Remote operation testing

16.9. TYPE TESTS

The type test certificates and reports shall be submitted for review during the tender or product evaluation stage.

The indoor switchgear panels (functional units) shall be type tested in accordance with SANS 62271-200 and shall include the following tests:

a) equipment insulation level (SANS 62271-200 6.2);
b) temperature rise and measurement of resistance of circuits (SANS 62271-200 6.5 & 6.4);
c) current withstand – main circuit (SANS 62271-200 6.6);
d) current withstand – earthing circuit (SANS 62271-200 6.6);
e) circuit breaker short-circuit making and breaking capacities (SANS 62271-200 6.101 and SANS 62271-100 6.102 to 6.106);
f) circuit-breaker critical current tests (where applicable) (SANS 62271-100 6.107);
g) circuit-breaker double earth fault tests (SANS 62271-100 6.108);
h) circuit-breaker out-of-phase making and breaking tests (applicable if an out-of-phase rating is assigned) (SANS 62271-100 6.110);
i) circuit-breaker capacitive current switching tests (SANS 62271-100 6.111.5);
j) circuit-breaker electrical endurance tests (SANS 62271-100 6.112);
k) earthing switch making capacity (SANS 62271-200 6.101 and SANS 62271-102 6.101) – where applicable;
l) circuit-breaker mechanical operation test (SANS 62271-200 6.102 and SANS 62271-100 6.101.2.1 - 6.101.2.3);
m) circuit-breaker extended mechanical endurance tests (for class M2 circuit-breakers) (SANS 62271-100 6.101.2.4);
n) mechanical operation for the withdrawable circuit-breaker intended to be used as a disconnector (SANS 62271-200 6.102.1 and SANS 62271-102 6.102);
o) earthing switch mechanical operation (SANS 62271-200 6.102) – where applicable;
p) test to verify the proper functioning of the position indicating device for the earthing switch (SANS 62271-102 6.105) – where applicable;
q) verification of the protection (IP coding and mechanical impact) (SANS 62271-200 6.7);
r) tightness test (SANS 62271-100 6.8);
s) x-radiation test procedures for vacuum interrupters (SANS 62271-200 6.11);
t) internal arc (SANS 62271-200 6.106);
u) partial discharge test (SANS 62271-200 6.2.9);
v) dielectric tests on cable testing circuits (SANS 62271-200 6.2.101); and (NOTE The relevant cable standard for cable testing is SANS 10198-13. Test voltages of up to 3 x U0 are applicable for on-site cable commissioning tests.)
w) additional tests on auxiliary and control circuits (SANS 62271-200 6.10).

16.10. ROUTINE TESTS

All tests are to be carried out at the factory where the switchgear is manufacture whether it’s local or overseas. The indoor switchgear shall be routine tested in accordance with SANS 62271-200 and shall include the following tests:

a) dielectric test on the main circuit (SANS 62271-200 7.1);
b) tests on auxiliary and control circuits (SANS 62271-200 7.2) (NOTE In the case of switchgear supplied from an overseas OEM where the wiring of auxiliary and control circuits is done locally, the tests on auxiliary and control circuits are to be done locally as part of the local factory acceptance testing)
c) measurement of the resistance of the main circuit (SANS 62271-200 7.3);
d) tightness test (SANS 62271-200 7.4);
e) design and visual checks (SANS 62271-200 7.5);
f) partial discharge measurement (SANS 62271-200 7.101);
g) mechanical operating tests on circuit-breaker (SANS 62271-200 7.102 and SANS 62271-100 7.101); and
h) tests of auxiliary electrical devices (SANS 62271-200 7.104).
i) The following quantities shall be measured and recorded during the mechanical operating tests (where applicable):

- closing and opening speeds;
- closing and opening times;
- time taken to recharge the mechanism following an O, C and OCO operation;
- synchronism across phases and between breaks of phases for an O, C and OCO operation;
- timing tests on each type of auxiliary switch contact in relation to the main contacts;
- time-current curves of the electrical tripping and closing circuits for normal operation. The resolution of the function times shall clearly be indicated on the test reports.

j) CTs shall be type and routine tested in accordance with SANS 60044-1.
k) VTs shall be type and routine tested in accordance with SANS 60044-2.
l) CPATs shall be type and routine tested in accordance with their relevant standard.
m) Any additional tests as instructed by the Engineer.

16.11. TESTS AFTER INSTALLATION ON SITE (PRE-COMMISSIONING TESTS)

Commissioning checks and a test programme (as determined by the manufacturer) shall be carried out in accordance with SANS 62271-200 7.105 and SANS 62271-100 10.2.101 – 10.2.102. This shall include checks after installation, circuit-breaker mechanical tests and measurements, checks of certain specific circuit-breaker operations and electrical tests and measurements.

Tests shall include, but are not limited to, the following:

a) 80 % power-frequency voltage tests of the main circuits in accordance with SANS 62271-200 7.105;
b) tightness tests for vacuum switchgear in accordance with SANS 62271-200 7.105 (dielectric test across the open contacts at a voltage stated by the manufacturer);
c) verification of remote control operation using the hand-held remote control unit for circuit-breaker switching and racking in and out of withdrawable parts.

Mechanical tests and measurements on the circuit-breakers may include, but are not limited to, the following:

a) verification of the rated operating sequence; and
b) measurement of time quantities.

Checks of certain specific operations for the circuit-breakers may include, but are not limited to, the following:

a) simulation of fault-making operation and check of anti-pumping device;
b) behaviour of the circuit-breaker on a closing command while an opening command is already present; and
c) application of an opening command on both releases simultaneously.

Electrical tests shall include, but are not limited to, the following:

a) measurement of resistance of the main circuits of the assembly in accordance with SANS 62271-200; and
b) dielectric tests on auxiliary and control circuits in accordance with SANS 62271-200.

For each measurement of the operating time, a recording shall be made of each individual operating coil current – namely close, trip I, trip II. The resolution of the function times shall be clearly indicated in the test reports.

For the measurement of the steady-state contact resistance of the main circuit, a d.c. current of at least 50 A shall be used. The results shall be given in μΩ and the resolution shall be at least 1 μΩ.

Reasons for differences between the results of the tests made on-site and the results of the tests as they were carried out at the OEM’s works (the circuit-breaker pass sheet) shall be clearly stated and corrections shall be made.

The results of pre-commissioning tests after installation on site shall be documented, signed off and a copy of the results included with the switchgear documentation for hand-over as part of the quality process. All tests shall be witnessed by the Engineer and a Client representative.

17. SPARES

17.1. Any spares ordered shall be delivered with the first delivery of switchgear, and shall be packed in sets in containers suitable for long periods of storage, and marked on the outside with the contract or order number, the supplier's name, the type and model of equipment and the date of packing.

18. DOCUMENTATION

18.1. DOCUMENTATION WITH ENQUIRY

18.2. The following documentation forms part of this enquiry:

Single line configuration diagram with the following information:

a) the type of panel required (circuit-breaker, switch disconnector or switch fuse);
b) current rating of each circuit;
c) busbar rating;
d) power cable for each circuit;
e) position of protection (on-board or remote); and
f) an indication of the front view of the switchgear panel.

Switch room layout drawing (i.e the proposed floor plan showing critical dimensions and positions of the door, the trench, auxiliary equipment, etc.);

Schedules A-B.

18.3. DOCUMENTATION WITH TENDER

Tenderers shall provide the following documentation with each tender:

a) schedule A-B.

b) a typical drawing of each type of switchgear panel; (NOTE This drawing should show all relevant dimensions including the height of the cable gland plate (if any) above floor level, the switchgear panel withdrawable dimensions, and a floor plan that gives the loads imposed on the foundations.)
c) a typical general arrangement of the switchboard; (NOTE This drawing should illustrate cable boxes or cable clamping (or both) and the cable termination arrangement.)
d) a schematic diagram of the primary connections;
e) a comprehensive spare or replacement parts lists for each type of switchgear panel supplied, including recommended quantities to cover a period of 10 years, including parts required for commissioning;
f) a full list of type test certificates or reports; and
g) the number of units of the switchgear offered that are currently in use in South Africa.

18.4. DOCUMENTATION WITH ORDER

The successful tenderer shall submit the following as agreed upon between the purchaser and the supplier:

a) a schematic diagram of the auxiliary circuits of each type of switchgear panel; and
b) one set of operating and maintenance manuals.

18.5. DOCUMENTATION ON HAND-OVER

Before hand-over, the supplier shall supply a full list of routine test certificates/reports in soft copy and hard copy format.

19. GENERAL SPECIFICATION

The general requirements for Medium Voltage Indoor Switchgear are covered by SANS1885:2004. The detail project requirements shall be covered in the Project Specification, Drawings and Bill of Quantities.

TECHNICAL ELECTRICAL SPECIFICATION

DRY TYPE (CAST RESIN) TRANSFORMER

11kV/415V

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Section - A

TECHNICAL SPECIFICATION OF 2,5 MVA, 11 KV/415V TRANSFORMER

1. Scope

The scope includes design/engineering, manufacture, testing and supply of resin cast dry type transformer of rating 2500 KVA, 11kV/415V, 50 Hz with required spares and accessories, as per the technical specification.

2. Codes and Standards

2.1. The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations, and safety codes.

2.2. Except where modified by these specifications, wherever applicable all material and equipment's shall conform to the requirements of latest Indian Electricity Rule (IER) and below given standards, including all amendments.

S. No.	Description		Standard
1.	Dry type transformer	:	IS 11171 & IS 2026
2.	Current transformer (PS class)	:	IS 2705
3.	Degree of Ingress Protection of control gear	:	IS 12063
4.	Bushing for Alternating voltage above 1000V	:	IS 2099
5.	Thermal Evaluation & Classification Of Electrical Insulation.	:	IS 1271
6.	Fittings and accessories	:	IS 3639
7.	Measurements of transformer and reactor sound levels	:	IEC 60076-10 or NEMA TR-1

2.3. The overriding effect of various applicable documents shall be as follows: 1. Tender technical specifications. 2. Applicable codes & standards. 3. Approved vendor drawings.

3. Bidder Eligibility Criteria:

The bidder shall comply with the following conditions:

3.1. The Bidder should be the Original Equipment Manufacturer (OEM)/ authorized dealer of the OEM. The OEM shall have experience of design/engineering, fabrication, testing and supply of cast resin dry type transformer of minimum 2000kVA rating in last 5 (five) years from the date of tender.

3.2. The Bidder shall submit balance sheet, profit & loss statement for last 03 (three) financial years. During this period the bidder shall not have incurred overall loss and average annual turn-over shall not be less than Rs. 02 (Two) crore.

Note: (a) In case bidder is not OEM, he should also submit the agreement with OEM, showing that he is authorized to quote on their behalf and the OEM shall support the bidder for all warranty etc.

(b) **Price not to be filled in Part-1 (Technical offer).**

4. Constructional Features:

4.1. General Requirements:

The dry type cast resin transformers shall be AN (Air Natural) cooled. All material used shall be new, best quality and of the most suitable class for working conditions as per the tender technical specifications. The material shall withstand the outdoor atmospheric conditions, overloads, over excitation and short circuits as per above standards without distortion, deterioration and the setting-up of undue stresses in any part.

4.1.1. For similar specifications, the supplied transformers shall be identical, and their parts shall be interchangeable.

4.1.2. Nuts, bolts, and pins shall be provided with lock washers or locknuts.

4.2. Core:

4.2.1. Transformer design shall be core type. The core shall be made out of high grade, non-ageing, low loss cold-rolled grain oriented (CRGO) silicon steel laminations. The core shall be painted and insulated with suitable resin to protect it against corrosion. The lamination shall be free from burrs and sharp projections.

4.2.2. The yoke laminations shall be interleaved and carefully assembled to avoid airgaps in the magnetic circuit. The core shall be earthed as per the relevant standards.

4.2.3. The insulation structure in between core to bolts and core to clamp plates shall withstand a minimum voltage of 2500 V for one minute.

4.2.4. All steel sections used for supporting the core shall be free from burrs.

4.2.5. The design of the magnetic circuit shall be as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure.

4.2.6. The assembled core with all the clamping structures shall be free from deformation and shall withstand the vibrations during operation.

4.2.7. The core clamping structure shall be designed to minimize eddy current losses.

4.3. Windings:

4.3.1. The Cu-ETP grade copper conductor shall be used for transformer HV and LV windings. The design and arrangement of the windings and their insulation shall be such as to ensure uniform distribution of the voltage surges among all the coils of the windings.

4.3.2. The windings shall be provided with Class-F epoxy resin cast insulation. The insulation shall have high tensile and dielectric strength. Enough measures shall be taken during casting to avoid the void formation, cracking and crazing etc. of the cast coils.

4.3.3. Both HV and LV windings of each phase shall be separately cast on rigid tubular coil co-axially arranged under vacuum into moulds. The epoxy resin insulation system shall be fiber glass strengthened.

4.3.4. The resin used for winding insulation shall be non-hygroscopic to prevent the penetration of moisture into windings. It should be possible to energize the transformer without pre-drying even after a long period of service interruption. The resin used shall be non-inflammable, self-extinguishing, void free and suitable for tropical climate with 100% relative humidity. In the case of windings provided with taps, the inter-turn insulation of tapped windings shall be reinforced to obtain stress distribution.

4.3.5. The transformer shall be able to withstand short circuits as well as switching and lighting/atmospheric impulse voltages as specified in the IS 11171 Standard. The leads and connections shall be mechanically strong and adequately brazed to withstand short circuit forces and transportation shocks.

4.4. Core and Coil Assembly:

The cast coils are inserted on to the core limbs. The resin cast spacer blocks, end blocks and separators shall be used as required.

4.5. Earthing:

Single point earthing shall be used for magnetic circuit. The framework and clamping arrangements of core and coil shall be securely earthed by copper strip connection to the main frame and enclosure. Two earthing terminals suitable for 75X10 mm GI strip shall be provided on the frame for enclosure earthing.

4.6. Tapping:

Off circuit tap changing link shall be provided with total tapping range of +10% to -10% in steps of 2.5 %. The tapings shall be on high voltage side. The transformer shall be capable of delivering its rate output at any tap position without damage.

4.7. Terminal box arrangement:

4.7.1. The HV side termination facility of the transformers shall be designed for connecting 11kV XLPE insulated armoured cable terminated in crimping type lugs and heat shrinkable sleeves or pre-moulded cast resin push on type terminations. Suitable undrilled gland plate shall be provided for terminating HV cables. HV terminals shall be extended up to the cable terminals and the bus bars shall be located at a convenient height. The cable entry shall be from the bottom. Preferably the busbars shall be supported by the supporting insulators from the top frame of the enclosure. The winding delta formation on HV side shall be in supplier's scope.

4.7.2. The LV side terminals and the LV termination box of transformers shall be suitable for sandwich bus duct connection with flexible conductors. The earthing stud shall be provided on LV termination box for clamping sandwich bus duct earthing conductor. The winding star formation on LV side shall be in supplier's scope.

4.7.3. The LV neutral terminal of the star connected winding shall be brought out at two separate insulated terminals. One neutral terminal shall be provided by side of the phase terminals for connecting neutral to busbar in the LV termination box. A second neutral terminal shall be provided to facilitate the earth conductor down to the ground level. The terminal shall be suitable for connecting two numbers of earth conductors (75mmX10mm GI) for neutral earth connection with two separate earthing pads.

4.8. Support Insulators:

a) Support Insulators shall be designed and tested to comply with the applicable standards.
b) HV terminals rated for minimum current 400A shall have nonferrous and non-magnetic flanges and hardware.
c) Air clearance and creepage distance shall be maintained as per the relevant standard.
d) Preferably the material for support insulators shall be Porcelain or epoxy resin cast.

4.9. Current Transformer (CT):

a) The REF (Restricted Earth Fault) CT shall be epoxy resin casted under vacuum and having ratio of 3200/ 1A, Class PS, 10 VA. The CT shall have minimum V_{knee} 400V, maximum 30mA 1_{mag} at $V_{knee}/2$ and R_{ct} less than 7 Ohm. This CT shall be provided in the common portion of the LV neutral (Before branching to LV neutral to earth connection). Class of insulation system of the CT shall be class F.
b) CT Secondary leads shall be brought to the marshalling box.
c) CT details shall be indicated on name plate of the transformer.

4.10 Temperature sensor & winding temperature indicators (WTI):

a) Temperature sensors: Two (2) numbers, reputed make simplex type (Platinum) PT100 shall be provided in each phase at suitable place for measuring hot spot temperature.

b) A multi-channel digital winding temperature indicator shall be provided to display the temperature of the windings.

c) The indicating instrument shall be provided with four adjustable electrically independent ungrounded contacts brought out to separate terminals for winding temperature alarm and trip. The WTI shall be compatible to 110V DC and 230V, 50Hz. AC auxiliary supplies.

d) WTI scanner shall have remote PC (personal Computer) communication facility.

4.11 Marshalling box:

a) The weatherproof marshalling box shall be mounted on the transformer housing. All doors, covers and plates shall be provided with neoprene gaskets. Bottom of the marshalling box shall be at least 600 mm above floor level and provided with removable bolted & undrilled gland plate etc. The required number of knock-our punches shall be provided for outgoing control cables.

b) All contacts for alarm, trip and indication circuits shall be electrically potential free, wired for auxiliary supply as specified and brought out to separate terminals at the terminal blocks in the marshalling box. If required, separate MCBs shall be provided for protection, isolation, and distribution of AC & DC control supplies in the marshalling box. Wiring shall be with PTFE insulated (Insulation for wire & cable shall be in consistence with the ambient temperature in the housing). The wiring conductor shall be stranded copper and of sizes not less than 4 sq. mm for CT circuit and 2.5 sq. mm for other control circuits. CT terminals shall be provided with standard shorting facility. The wires shall be drawn trough neatly clamped conduits. Engraved identifications ferrules, marked as per the approved wiring diagrams shall be provided on each wire. Ferrules shall be yellow colour with black lettering. Preferably the terminals shall be stud type and provided with crimping type cable sockets.

5. Enclosure for transformer:

5.1 The core and coil assembly shall have CRCA sheet steel MS enclosure. The purpose of having the enclosure is to provide safety from live parts, protect and make the equipment suitable for outdoor conditions, prevent ingress of foreign matters, vermin, and rodents etc. The minimum number of louvers shall be provided on the sides of enclosure and the louvers should be covered with SS or galvanized sheet fine (openings not more than 2.5 mm) mesh. The enclosure should have structural steel framework with lockable hinged door on HV and LV termination sides of the transformer. The gasketed doors shall facilitate the inspection of the transformer.

5.2 The enclosure frame shall be fabricated using suitable CRCA pressed and shaped sheet steel of thickness not less than 3.0 mm for structural members and 2.0 mm for all doors/covers etc.

5.3 All panel edges and door edges shall be reinforced against distortion/deformation by rolling, bending and addition of welded reinforcement members.

5.4 The complete structure shall be rigid, self-supporting and shall be suitable for connecting ventilation hood on the top. To remove heat from the transformer, its metallic enclosure shall have sufficient heat dissipation capability in outdoor conditions, throughout the year without any additional cooling arrangement. GI or SS wire mesh shall be provided in the gap in between enclosure and ventilation hood to prevent entry of birds etc. Powder/enamel paint coated 3mm thick perforated MS mesh shall be provided for enclosing the bottom side.

5.5 The enclosure shall not have a degree of ingress protection less than IP 33.

5.6 Door switch with 2 NO + 2 NC auxiliary contacts of required rating shall be provided. It will be used for providing interlock in the HV breaker circuit.

5.7 **Painting:** After thorough metal treatment enclosure surface shall be given two coats of enamel/powder paint. Double coat of corrosion resistant primer shall be applied before painting. The inside of the enclosure shall have a semi-glossy paint finish. All metal parts not accessible for painting shall be made of corrosion resistant material. All paints shall be carefully selected to withstand heat and tropical weather conditions.

6. Fittings and accessories:

Following fittings and accessories shall be provided:

6.1 HV/LV Terminals suitable for the purchaser’s external conductors.
6.2 Rating, terminal marking and danger plates.
6.3 Three earth terminals per transformer, each suitable for earth conductors of size 2 nos. 75X10 mm GI strip for earthing of the body of the transformers and its enclosure.
6.4 Lifting lugs for:
6.4.1 Complete transformer (with enclosure)
6.4.2 Core-Coil assembly.
6.5 The under base shall be provided with channels etc.
6.6 Four bi-directional rollers in base frame for movement of complete transformer assembly. The stopper arrangement to lock the transformer in the required position shall also be provided.
6.7 Enclosure with provision for dismantling.
6.8 Marshalling box.
6.9 Neutral earth terminal with lugs.

6.10 Six number PT100 RTDs with WTI display.
6.11 Off circuit tap links.

7 Performance requirement:

7.1 Transformers shall operate without abnormal heating at the rated KVA at any voltage within ± 10 percent of the rated voltage of that particular tap.
7.2 Transformer shall be designed for 110% continuous over fluxing withstand capability.
7.3 The continuous and short time overloading capacities shall be furnished in detail. Overloads shall be allowed within the condition defined in the applicable standard. Terminal, taps or any other auxiliary equipment shall not limit such overloading. **The transformer shall also be suitable for feeding power to the load as per the load features (refer clause number 17) of the specification.**
7.4 The neutral terminal of windings with star connection shall be designed for the highest over-current that can flow through this winding.
7.5 The bidder shall ensure that the design and manufacturing of the transformer shall be such as to reduce noise and vibration level. The sound level of the transformer with its enclosure in position shall not exceed 66dBA measured in accordance with NEMA TR-1 or IEC 60076-10 Standard.
7.6 The apparent charge limit shall be 20pC during partial discharge test as per IS 11171.
7.7 The transformer HV winding shall be suitable for vacuum circuit breakers switching.
7.8 All other performance requirement as per the relevant standards and codes shall be met with the conditions specified above.

8 Inspection and Test:

At all reasonable times, the purchaser’s representative shall have access to the manufacturer or sub-manufacturer works for the purpose of witnessing, test and ascertaining that the transformer being supplied conform to the requirements of this specification. The stage inspection shall be performed during the fabrication stage. The bidder shall provide the detailed activity schedule for stage inspection. The bidder shall inform the purchaser at least in 15 days advance of the testing due date and ask for their representative’s availability. The detailed test schedule shall also be submitted.

The visual checks including dimensions and clearances shall be performed during Pre-dispatch Inspection (PDI). In addition to the above checks, the following routine and special test shall be carried out on each assembled transformer.

8.1 Routine Test:

The test shall be as below:

a) Measurement of Resistance of windings.
b) Measurements of voltage ratio at all taps and check of voltage vector relationship.

c) Check test for polarity.
d) Measurement of impedance voltage (principal tap), short circuit impedance and load loss at rated current.
e) Measurement of No-Loads loss and current.
f) Separate source voltage withstand test.
g) Induced over voltage withstand test.
h) Measurement of insulation resistance.
i) HV test on auxiliary & control wiring.
j) Calculation of the regulation and efficiency at rated load on unity P.F and 0.8 P. F lag.

All routine tests shall be carried out as per the IS 11171/2026.

8.2 Special Test:

a) Partial Discharge test.
b) Measurements of acoustic sound level.
c) Measurements of zero sequence impedance.

8.3 Type Test:

These tests shall be performed on one of the transformers (as selected by the purchaser during PDI) from the lot.

a) The Temperature rise test as per IS 11171.
b) Lighting impulse test at 75kV full standard (1.2/50p.sec.) lightning impulse. This test shall be carried out as per IS 11171, at IEC/CPRI/ERDA/NABL/Govt. approved labs only.

If transformer fails in any of the tests specified, the purchaser shall have the option to reject complete lot. An additional test shall be performed to determine the reason of failure and after necessary modifications; all the tests shall be repeated to prove that the modified transformer meets with the requirements of the specification in all respects. The cost, if any, for the modification, testing including any additional test required for verification of the transformer performance shall be t the account of the bidder.

9. Tolerances:

Allowable tolerance for other parameters except losses shall be as per the IS-2026 Part-I. In respect of total losses maximum +10% shall only be permissible, subject to penalty as per clause 10 of the specification. The losses in the guaranteed technical particulars (GTP) submitted by the supplier shall be the reference for percentage loss and bid evaluation.

10. <u>Acceptance Criteria:</u>

Successful testing as per clause 8 of the specification.

11. <u>Guarantee Period:</u>

The transformers shall be guaranteed for a period of a minimum of 2 (Two) years from the date of Site Tests after delivery.

12. <u>Documentation:</u>

The bidder shall submit the documents at different stages as given below.

12.1 <u>With Bid (Technical/Part-1):</u>

a) Copies of orders, completion/performance certificate and contact details of the end users in support of OEM experience. Refer clause 3.1 of bidder eligibility criteria of the technical specification.

b) Copies of the balance sheet, profit & loss statement of the bidder for last 03 (three) financial years. Refer clause 3.2 of bidder eligibility criteria of the technical specification.

c) Detailed catalogues/datasheet and literature indicating technical specifications.

d) The following Type Test reports of the cast resin dry type transformer minimum 2500kVA rating.

   (i) Impulse voltage withstand test

   (ii) Short-circuit withstand test.

   (iii) Temperature rise test report for offered item rating.

e) Exhaustive Quality Assurance Plan (QAP) of the manufacturer.

f) Duly Filled GTP as per the format given in clause 16 (GTP).

g) Detailed activity schedule as per the format given in section-B clause 3.0.

Note: ***The offer(s) without copies of the above mentioned shall be liable for summary rejection.***

12.2 <u>After placement of purchase order:</u>

The following documents shall be submitted for approval, before taking up fabrication.

a) Detailed transformer drawings along with LV and HV termination box dimensions.

b) Earth terminals, marshalling panel details and bill of material etc.

c) Supporting calculations for additional losses caused by harmonic loading (refer clause17) and corresponding hot spot/average winding temperature rise.

d) Graph of core loss in watt/kg versus flux density (wb/m²) for the transformer core material.

e) Continuous and short time over loading details.

12.3 **On completion:**

Six (06) sets of bound manuals of final detailed drawings, control drawings (marshalling panel), test reports, technical catalogues, installation instructions, O&M instructions, guarantee certificate & compliance report etc. along with their soft copy.

13. Delivery period:

The bidder shall quote for minimum delivery period. In this regard, a detailed activity bar chart shall be submitted by the bidder for manufacturing, testing at works, transportation and delivery. Expected supply schedule for the total work is around 4-5 months from the date of order placement.

14. Brief technical specifications:

The technical details are as below.

TECHNICAL PARTICULARS

1.	Rating	: 2500 kVa
2.	Frequency	: 50 Hz ±3%
3.	No. of Phases	: 3 (Three)
4.	Rated Voltage	
	(i) HV	: 1100 Volts with +6% & -9% tolerances
	(ii) LV	: 415 Volts
5.	Winding connections	
	(i) HV	: Delta
	(ii) LV	: Star
6.	Vector Group	: Dyn 11
7.	Seismic Zone	: Zone-III
8.	Maximum ambient air temperature	: $50^{o}C$
9.	Max. daily average ambient temp.	: $40^{o}C$
10.	Service	: Outdoor
11.	Other service conditions	: As per IS:11171/2026

12. Class of Insulation : minimum class – F

13. Allowance Max. temp. rise of windings : 90ºC

14. Tapping : +10% to -10% in step of 2.5% on HV side through off circuit tap links

15. Percentage Impedance voltage at principal tap. : 6.25%

16. Type of cooling : AN

17. Terminal arrangement
    (i) HV : 3 core, 11KV XLPE cable up to 240 Sq.mm
    (ii) LV : Aluminium conductor Sandwich bus duct as per the specification

18. Sound level in transformer : 66 dBA (measured as per standard IEC 60076-10 or NEMA TR-1

19. System voltage
    (i) HV side
        a) Nominal system voltage : 11kV
        b) Highest system voltage : 12kV

    (ii) LV side
        a) Nominal system voltage : 415V
        b) Highest system voltage : 477V

20. System earthing : Solidly grounded system neutral

21. System fault level : 25KA for 1 sec. at 11kV

22. Insulation withstand voltages
    a) Impulse : 75KV (peak)
    b) Power frequency HV : 28KV (rms)
    c) Power frequency LV : 3 KV (rms)

C4 ENVIRONMENTAL MANAGEMENT PLAN

THE PROPOSED CONSTRUCTION OF THE ROSEDALE WATER TREATMENT WORKS AND ASSOCIATED RAW WATER SUPPLY INFRASTRUCTURE, KING SABATA DALINDYEBO LOCAL MUNICIPALITY, EASTERN CAPE

FINAL ENVIRONMENTAL MANAGEMENT PROGRAMME
MARCH 2016

DEDEAT REF: EC157/ORT/ORT/M/15-08

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DEFINITIONS

For the purpose of this document the following definitions will apply:

Alien vegetation means all undesirable vegetation, defined as but not limited to, all declared category 1 and category 2 plants in terms of the Conservation of Agricultural Resources Act (43 of 1983) (CARA) amended regulations 15 and 16 as promulgated in March 2001.

Construction activity refers to any action taken by the Contractor, his subcontractors, suppliers or personnel in undertaking the construction work.

Construction area(s) refers to all areas used by the Contractor in order 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.

Contractor is a person or company appointed by the Applicant to carry out construction activities.

Emergency is an undesired event that does result in a significant environmental impact and requires the notification of the relevant statutory body, such as a Local Authority.

Environment means 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 Control Officer is an individual appointed to monitor and audit the implementation and of the EMPr.

Environmental Impact is a change to the environment, whether adverse or beneficial, wholly or partially, resulting from an organisation’s activities, products or services.

Environmental Management Programme is a detailed plan of action prepared to ensure that recommendations for enhancing or ensuring positive impacts and limiting or preventing negative environmental impacts are implemented during the life cycle of a project. This EMPr focuses on the

Construction, Post Construction Rehabilitation and Operation / Maintenance Phases of the proposed project.

Environmental Impact refers to any change to the environment, whether desirable or undesirable, that would result directly or indirectly from any construction activity.

Department refer to the relevant Environmental (or non-environmental) department responsible for authorising activities conducted on site. All references to the 'Department' made in the Environmental Authorisation refer to Department of Economic Development Environmental Affairs and Tourism (DEDEAT).

Hazardous material/substances refer to any substance that contains an element of risk and could have a deleterious effect on the environment.

Incident is an undesired event which may result in a significant environmental impact but can be managed through internal response.

ABBREVIATIONS

AVCP	Alien Vegetation Clearing Programme
BA	Basic Assessment
BAR	Basic Assessment Report
CEMPr	Contractor's Environmental Management Programme – which in this case is this final EMPr
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ELO	Environmental Liaison Officer
EMPr	Environmental Management Programme
ER	Employers Representative
IAP	Interested and Affected Party
IDP	Integrated Development Plan
MS	Method Statement
NEMA	National Environmental Management Act

1. INTRODUCTION

1.1 Project Background

Terratest (Pty) Ltd was appointed by the Gibb Engineering and Architecture (GIBB) on behalf of the OR Tambo District Municipality, to undertake an application for Environmental Authorisation in terms of Section 24 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) for the construction of the Rosedale Water Treatment Works (WTW) and associated raw water supply infrastructure, near Mthatha, King Sabata Dalindyebo Local Municipality, Eastern Cape Province

The proposed Rosedale Project comprises the following elements:

- Upgrade of the existing abstraction point located at the wall of the Mthatha Dam to facilitate increased abstraction volumes;
- Construction of a raw water rising main and associated pump station, to link the abstraction point and the WTW;
- Construction of the new Rosedale WTW, which will be developed in phases and ultimately have a total treatment capacity of 100 Mℓ/day, to supply the areas located to the north and west of Mthatha town;
- Construction of new clear water rising mains to transfer the treated water from the WTW, to the command reservoirs and the greater reticulation network (both assessed under a separate application).

The Rosedale project is intended to be established in 3 phases. Phase 1 will supply 50 Mℓ / day of drinking water and is intended to come on line by 2017. The construction of Phase 2, which will result in a 25 Mℓ / day increase, will begin immediately following the commencement of operations in Phase 1. Construction will take 2 years to complete, therefore coming on line by the end of 2019. Phase 3 is intended to be operational by 2033.

The preferred layout is illustrated in Figure 1.

1.2 Aims of this Document

The purpose of this EMPr is to ensure that the impacts of the construction and operational phases of the project on the environment are kept to a minimum. This includes ensuring that the mitigation measures described in the Basic Assessment Report (BAR) are implemented, to ensure continued monitoring of the construction and operational phases and to ensure the involvement of interested and affected parties (IAPs) in a meaningful way.

In addition, the EMPr details the roles and responsibilities of all parties with respect to Environmental Management during construction and operation of the proposed development.

1.3 Status of this Document

The provisions of this EMPr are binding on the Contractor (and his subcontractors, where applicable) during the construction period and Defects Liability Period of the contract. This specification must therefore be read in conjunction with all the documents that comprise the contract documents for this contract. In the event that any conflict occurs between the terms of the EMPr and the Project Specification, the terms of the EMPr shall stand.

The provisions of this EMPr are binding on the Applicant and the subcontractors appointed to undertake maintenance work, for the operational lifetime of the development.

Responsibility for environmental management on the site, as stipulated in the EMPr will be handed over from the Contractor to the Applicant upon issuing of a completion certificate at site handover.

Figure 1: The preferred layout of the proposed Rosedale bulk water supply project.

2. PROJECT BACKGROUND

2.1 Environmental Authorisation Process

The proposed project triggers a Listed Activities contained within GN R544 and R546 of the Environmental Impact Assessment (EIA) Regulations (2010) promulgated under the NEMA, 1998 (Act No. 107 of 1998). The proposed development therefore requires an Environmental Authorisation (EA) from the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism (DEDEAT).

3. OTHER APPLICABLE LEGISLATION

3.1 South African Constitution (No 108 of 1996)

Chapter 2 of the Constitution comprises the Bill of Rights which makes provision for Environmental Rights. These include that everyone has the right:

- To an environment that is not harmful to their health or well-being; and
- To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that
    - Prevent pollution and ecological degradation;
    - Promote conservation; and
    - Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

3.2 National Environmental Management Act, 1998 (Act No. 107 of 1998)

The National Environmental Management Act, 1998 (NEMA) is a ‘principles-based Act’ and is an overarching statute regulating various aspects of natural resource use, integrated environmental management and pollution control. The Act provides for sustainable development, environmental protection, equitable distribution of natural resources and the formulation of environmental management frameworks. The definition of the environment includes the land and water of the earth, micro-organisms, plant and animal life or a combination of those things, and the inter relationships among them.

The Act aims to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance, and procedures for co-ordinating environmental functions exercised by organs of state. Section 24 provides for the prohibition, restriction and control of activities which are likely to have a detrimental effect on the environment.

NEMA contains a set of principles that govern environmental management, and against which all environmental management plans and actions are measured. Sustainable development requires the consideration of all relevant factors including the following:

- Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably.
- That the disturbance of ecosystems and loss of biological diversity are avoided, or where they cannot be altogether avoided, are minimized and remedied.
- That pollution and degradation of the environment are avoided, or, where unavoidable, are minimised and remedied.
- That waste is avoided, or where unavoidable is minimised and reused or recycled where possible and/or disposed of in a responsible manner.
- That a risk-adverse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions or actions.
- That negative impacts on the environment and on people’s environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimized and remedied.
- The right of workers to refuse work that is harmful to human health or the environment and to be informed of dangers must be respected and protected.
- The role of women and youth in environmental management and development must be recognised and their full participation therein must be promoted.
- Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.
- The participation of interested and affected parties in environmental governance must be promoted, and people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation.
- The participation by vulnerable and disadvantaged persons must be ensured.
- Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge.
- That the cost of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimizing further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.
- Community well-being and empowerment must be promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means.

- Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law.

3.3 National Water Act, 1998 (Act 36 of 1998)

The National Water Act, 1998 (NWA) makes provision for the protection of surface water and groundwater resources and their sustainable management for the prevention and remediation of the effects of pollution, and for the control of emergency occurrences.

The primary purpose of this Act is to manage and control South Africa's water resources by:

- Meeting the basic human needs of present and future generations.
- Promoting the efficient, sustainable and beneficial use of water in the public interest.
- Facilitating social and economic development.
- Providing for growing demands for water use.
- Protecting aquatic and associated ecosystems and their biological diversity.
- Reducing and preventing pollution and degradation of water resources; and meeting international obligations.
- Landowners and users have an obligation not to pollute water, and prescribe certain measures to prevent pollution.
- When a bed, bank, course or characteristics of a watercourse is altered, or when the flow of water in a watercourse is impeded or diverted, the Act required that an application for authorisation / license be made to the Department of Water and Sanitation (DWS).

4. GENERAL REQUIREMENTS OF THE EMPr

4.1 EMPr Administration

(i) Construction Phase

During the Construction Phase, copies of this EMPr shall be kept at the construction site office and must be distributed to all senior contract personnel. All senior personnel shall be required to familiarise themselves with the contents of this document and will further be required to sign a register confirming their understanding of the document. If necessary, the Environmental Control Officer (ECO) must conduct a training session with senior personnel regarding the implementation of the EMPr. During the construction phase, senior personnel will be required to educate their workers regarding the contents of this document and how to comply with its requirements. This register shall be continuously updated as changeover of senior personnel takes place.

(ii) Operational Phase

During the Operational Phase, a copy of this EMPr must be maintained by the OR Tambo District Municipality. All senior operational and maintenance staff (including those sub-contracted by the municipality) will be required to familiarise themselves with the contents of the document and will have to sign a register to the effect that they have read and understood the contents of the document. If necessary the ECO can conduct a training session with senior personnel regarding the implementation of the EMPr during the operational phase. Senior staff will be required to educate their operational staff as to the contents of this document and how to remain compliant.

4.2 Roles and Responsibilities

The implementation of this EMPr requires the involvement of several stakeholders, each fulfilling a different but vital role to ensure sound environmental management during the construction and operational phases. These stakeholders are discussed below.

4.2.1 Eastern Cape Department of Economic Development, Environmental Affairs and Tourism

The DEDEAT is the designated authority responsible for authorising the environmental application and the EMPr related to the project. The DEDEAT has overall responsibility for ensuring that the Applicant complies with the conditions of the Environmental Authorisation (EA) and this EMPr.

4.2.2 OR Tambo District Municipality

Under South African environmental legislation, the Applicant/Employer is accountable for the potential impacts of the activities that are undertaken and is responsible for managing these impacts. OR Tambo, as the Applicant/Employer therefore has overall environmental responsibility to ensure that the implementation of this EMPr complies with the relevant legislation and the conditions of the EA. The Employer will appoint a Contractor to undertake the construction and operation of the proposed development, but will still ultimately be responsible for any environmental impacts.

4.2.3 Employer's Representative

The appointed Civil and Consulting Engineers, as the Employer’s Representative (ER) would act as the Employer’s on-site implementing agent, together with the appointed Contractors during the construction and operational phases, and will have the responsibility to ensure that the Employer’s responsibilities are executed in compliance with the relevant legislation, the EA and the EMPr.

In addition to general project management, the ER, together with the Applicant has the responsibility to appoint the Environmental Control Officer (ECO). Any on-site decisions regarding environmental management, however, are ultimately the responsibility of the ECO.

The on-site ER shall assist the ECO where necessary and will have the following responsibilities in terms of the implementation of this EMPr:

- Ensuring that the necessary environmental authorisations and permits have been obtained;
- Reviewing and approving the Contractor's Method Statements with input from the ECO where necessary;
- Assisting the Contractor in finding environmentally responsible solutions to problems with input from the ECO where necessary;
- Ordering the removal of person(s) and/or equipment not complying with the EMPr specifications. Issuing fines for transgressions of site rules and penalties for contravention of the EMPr; and
- Providing input into the ECO's on-going internal review of the EMPr, which is submitted as a report to the Employer.

4.2.4 Environmental Control Officer

The independent Environmental Control Officer (ECO) appointed to the project will monitor and review the on-site environmental management and implementation of this EMPr by the Contractor during both the construction and operational phases (EA no. 4.24). This will be done by conducting site audits for the duration of the contract and supply monthly audit reports for submission to the Project Team. The ECO shall be appointed before the commencement of any land clearing or construction activities (EA no. 4.25).

The ECO's duties will include the following:

- Assisting the ER in ensuring that the necessary environmental authorisations and permits have been obtained prior to construction and operation commencing;
- Maintaining open and direct lines of communication between the ER, Employer and Contractor with regard to environmental matters;
- Reviewing the Contractor's construction Method Statements together with the ER;
- Site inspections of all construction areas with regard to compliance on a fortnightly basis;
- Verifying adherence to the EMPr, the EA and approved Method Statements;
- Monitoring and verifying that environmental impacts are kept to a minimum;
- Taking appropriate action if the specifications are not followed, this includes reporting the transgressions to the ER;
- Monitoring the undertaking by the Contractor of environmental awareness training for all staff and new personnel coming onto site;

- Advising on the removal of person(s) and/or equipment not complying with the specifications of the EMPr (via the ER);
- Recommendations regarding the issuing of fines for transgressions of site rules and penalties for contraventions of the EMPr (via the ER);
- Auditing the implementation of the EMPr and compliance with the EA on a monthly basis;
- Recording all activities on site, problems identified, transgressions noted and a task schedule of tasks undertaken by the ECO (EA no. 4.26);
- The ECO shall remain employed until all rehabilitation measures, as required for implementation due to construction damage, are completed and the site and route are ready for operation (EA no. 4.27);
- Sending records relating to monitoring and auditing to the Department when 50% of construction works are complete(EA no. 4.28);
- Compiling a final audit report regarding the EMPr and its implementation during the construction period after completion of the contract and submitting this report to the Employer and the authorising authority;
- The ECO will continue to conduct audits during the operational phase as required by the EA.
- The ECO must revisit the rehabilitated areas on a quarterly basis for at least one (1) year after rehabilitation to monitor recovery of the area and report findings and recommendations to this Department (EA no. 4.42)

4.2.5 Contractor's Environmental Liaison Officer

The Contractor referred to is appointed by the Employer to undertake the construction activities for the project.

The appointed Contractor will be required to appoint a competent individual as the Contractor’s on-site Environmental Liaison Officer (ELO). The selected ELO must be at least at Foreman level appointment and must fully familiarise him-/herself with the contents of this EMPr. He/she will be required to sign the register confirming his/her familiarity with the document. The ELO must furthermore possess the necessary skills to action environmental management to all personnel involved in the contract.

The ELO will be responsible for overseeing the Contractor’s (including any persons working on site as sub-contractors or service providers to the main Contractor) internal compliance with the EMPr requirements and ensuring that the environmental specifications are adhered to (EA no. 4.74(j)).

The ELO will be responsible for keeping detailed records of all site activities that may pertain to the environment and include all these aspects in an environmental register. This register must be presented at each EMC meeting and be made available to the ECO during his/her fortnightly audits. In addition to the environmental register the ELO must keep a register of complaints from any community members on environmental issues. Finally, the ELO will be required to keep a record of all on-site environmentally related incidents and how these incidents were dealt with.

4.2.6 Environmental Management Committee (EMC)

It is recommended that an EMC be established for the project. This shall be a multidisciplinary team tasked with monitoring the progress of the implementation of the EMPr and resolving any environmental problems that may arise during the course of the project. The EMC shall be accountable for ensuring that environmentally sound principles guide the project during the construction phase.

The EMC shall consist of all the relevant stakeholders in the construction phase, as well as representatives of interested and affected parties, for example:

- Applicant / Employers representative;
- ER's representative;
- Contractor's representative (the ELO);
- The ECO;
- Any affected landowners and/or communities;
- The local municipality; and
- DEDEAT (if they request it).

The EMC should meet on a monthly basis.

4.2.7 Organizational structure

Details of the proposed organizational structure are presented in Figure 2. The structure illustrates the reporting procedures for stakeholders in the implementation of this EMP.

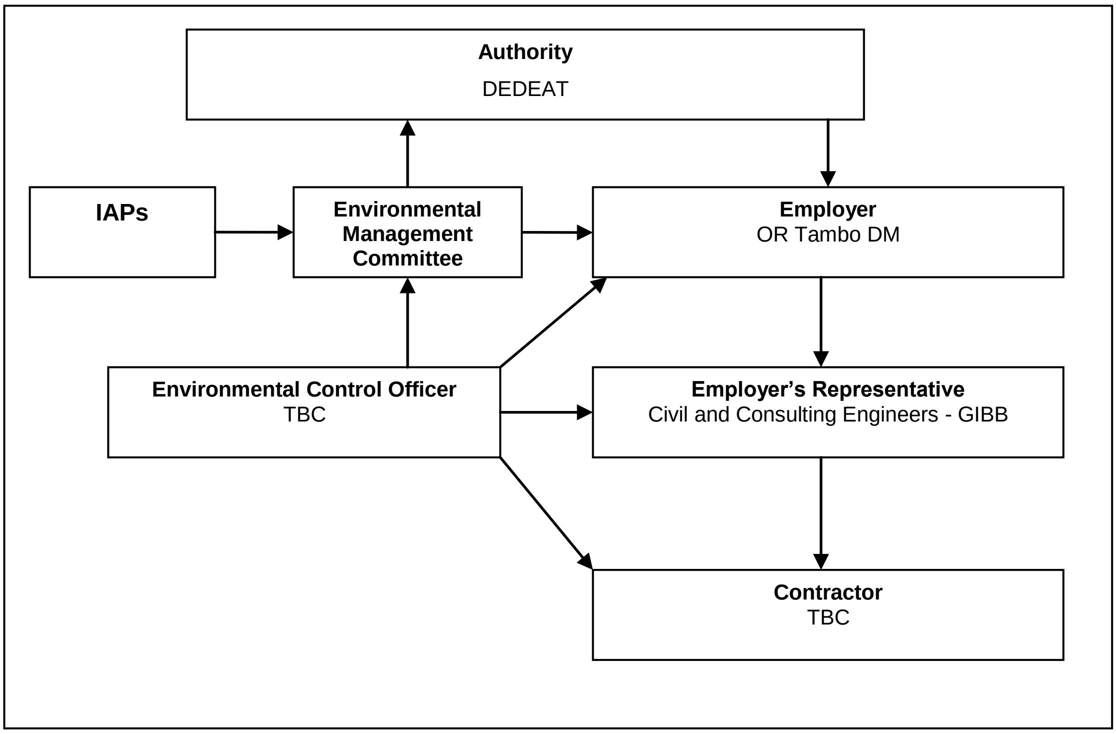

Figure 2: Proposed EMPr implementation organisational structure.

4.3 Environmental Awareness Training

The Contractor shall ensure that adequate environmental awareness training of senior site personnel takes place and that all construction and operational phase workers receive an induction presentation on the importance and implications of the EMPr.

The presentation shall be conducted, as far as possible, in the employees' language of choice.

As a minimum, training shall include:

- Explanation of the importance of complying with the EMPr;
- Discussion of the potential environmental impacts of construction / operational activities;
- The benefits of improvement 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 EMPr and its implementation; and
- Explanation of the management structure of individuals responsible for matters pertaining to the EMPr.

The contractor shall keep records of all environmental training sessions, including names, dates and the information presented. These records will be presented at the EMC meetings and to the ECO on request during his/her audits.

4.4 Method Statements

Method Statements (MS) are written submissions by the Contractor to the ER in response to the requirements of this EMPr or to a request by the ER. The Contractor shall be required to prepare Method Statements for several specific construction activities and/or environmental management aspects.

The Contractor shall not commence the activity for which a Method Statement is required until ER has approved the relevant Method Statement.

Method Statements must be submitted at least 20 working days prior to date on which approval is required to the ER. The ER must in turn accept or reject the Method Statement within 10 working days of receipt.

Failure to submit a Method Statement may result in suspension of the activity concerned until such time as a Method Statement has been submitted and approved.

An approved Method Statement 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 Method Statement shall be rehabilitated at the Contractor's expense.

The Method Statements shall cover relevant details with regard to:

- Construction procedures and location of the construction camp
- 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/incident which would occur during the procedure; and
- Compliance/non-compliance with the EMPr specifications and motivation if non-compliant.

Method statements (MS) required:

Based on the specifications in this EMPr, the following Method Statements (MS) are required as a minimum:

MS1: Site layout and establishment

MS2: Site clearing (terrestrial and aquatic environments)

MS3: Handling, storage and disposal of hazardous substances (if applicable)

MS4: Solid waste (general and hazardous) control system

MS5: Erosion remediation and stabilisation

MS6: Stormwater Control

MS7: Working in watercourses (Mthatha River and seepage wetland)

MS8: Alien vegetation clearing programme

MS9: Rehabilitation procedures (terrestrial and aquatic environments)

The ECO and RE may specify additional Method Statements to be submitted by the Contractor as required.

5. CONTROL OF CONSTRUCTION ACTIVITIES

Most environmental impacts of developments occur in the construction phase of the project. As a result the regulation of construction activities and the general conduct of the workforce is an essential component of this EMPr and must be carried out in conjunction with the ECO.

In the tables that follow, the following abbreviations have been used:

E = Engineer,

ECO = Environmental Control Officer,

C = Contractor,

PA = Project Agent;

OM = Operational Manager,

RE = Resident Engineer;

S = Staff.

PRE-CONSTRUCTION ACTIVITIES	RESPONSIBILITY	OCCURRENCE	METHOD	✓ / ×
♦ The authorised activity shall not commence within thirty (30) days from the date of notification to give allowance for possible appeals to be lodged (EA no. 4.31).	C	Before construction	Document review	
♦ Notice boards of the activity to get underway must be placed at conspicuous places to alert road users and affected communities, at least two (2) weeks prior construction works. The notification /s must include the date on which construction is anticipated to commence (EA no. 4.33).	C	Before construction	Document review	
♦ A notification letter that the activity will commence must be sent to the Department in twelve (12) days before commencement of construction. The letter must include the date upon which construction is anticipated to commence (EA 4.34).	C	Before construction	Document review	
♦ The facility illustrations attached as Appendix C in the BAR dated October 2015 is approved. Any changes must be submitted to this Department for approval prior to construction (EA 4.46).	C	Before construction	Document review	
♦ Where household(s) are to be relocated, agreement reached with family / house owners must be adhered to. This environmental authorisation does not give the holder permission to relocate people against their will (EA no. 4.68).	C	Before construction	Document review	
SITE LAYOUT	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
The Contractor is to adhere to the following with regards to the Materials Storage Area and Contractors Camp: ♦ All servitudes and existing services must be verified prior to establishment, in particular, contact must be made with Eskom's Customer Network Centre (CNC) to ensure that existing overhead electrical infrastructure is not impacted on during construction. ♦ The camp site must be fenced before construction commences. ♦ All unauthorised persons must be denied access to the construction area unless approved by the site foreman as the case may be (EA no. 4.35).	C	Before construction	Site inspection	

♦ Site establishment shall not take place on steep slopes, within 100 m of wetland areas and watercourses or sites declared as no-go areas. ♦ Establishment of a base camp on previously disturbed land is recommended against the use of a pristine environment.				
♦ Adequate parking must be provided for site staff and visitors.	C	For duration of construction	Site inspection	
♦ Existing roads must be used during construction. Where new access roads are required, new roads must not exceed 4 meters in width (EA no. 4.45).	C	For duration of construction	Site inspection	
MS1: Before construction can begin, the Contractor shall submit to the ER for approval a Method Statement detailing: ♦ A layout plan and the method of establishment of the construction camp, i.e. all offices, storage and stockpiling areas and all other areas/facilities required for the undertaking of activities required for completion of the project. ♦ The plan shall include the location and layout of waste storage facilities, ablution facilities, stockpiling and spoil areas (if applicable), no go areas and hazardous material storage areas (if applicable). The demolition and removal of these facilities on completion of construction works shall also be detailed. ♦ The Contractor shall restrict all his activities, materials, equipment and personnel to within the area specified. 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.	C	Before construction	Inspection of MS	
NO GO AREAS	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ Areas where construction activities (including temporary access tracks) are prohibited are referred to as no-go areas. These include watercourses, wetlands, steep slopes and areas which have been severely eroded. Entry into these areas by any person, vehicle or equipment without the ER's written permission will result in a penalty.	C	For duration of construction	Site inspection	

♦ All sensitive areas highlighted in the specialist reports must be avoided at all times (EA no. 4.48).	C	For duration of construction	Site inspection	
♦ Activity within, on, across or next to rivers, wetlands or any water course must be according to the approvals of the Department of Water and Sanitation (EA no. 4.49). ♦ No structures must obstruct Mthatha river or dam / stream flow (EA no. 4.51) ♦ No power-lines must be disturbed without the consent and or approval from ESKOM and DEA National EA no. 4.52). ♦ Pipe jacking underneath the access roads or within road reserves must be agreed with KSD Local Municipality / Department of Public Works (EA no. 4.56).	C	For duration of construction	Site inspection	
♦ All declared no-go areas will be demarcated by temporary fencing, the position of which shall be agreed to by the ER and the ELO, and appropriate signage.	C	For duration of construction	Site inspection	
♦ All private property outside of the construction areas as set out in the site layout plan shall be considered no-go areas.	C	For duration of construction	Site inspection	
♦ The identified wetland area shall be considered a no go area (excluding the small portion within which construction of the pipeline is to be undertaken).	C	For duration of construction	Site inspection	
♦ The riparian areas surrounding the Mthatha Dam shall be considered to be no go areas (excluding those areas where construction of the abstraction works is to occur).	C	For duration of construction	Site inspection	
♦ Where the pipeline runs parallel to river / streams, an appropriate buffer zone of 32 meters to 50 meters should be delineated / demarcated to prevent impacts on riparian vegetation and aquatic vegetation (EA no. 4.58)	C	For duration of construction	Site inspection	
♦ 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 the EMC.	C	For duration of construction	Site inspection	
♦ Demarcation materials (fencing, signage, etc.) shall not be moved or removed at any stage of the project without the written consent of	C	For duration of construction	Site inspection	

the ER.				
TEMPORARY FENCING	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ The Contractor shall erect temporary fencing along the perimeter of the contractor's site camp and designated no-go areas.	C	For duration of construction	Site inspection	
♦ Temporary fencing shall, as a minimum, consist of wooden or metal posts at 3m intervals, with two plain wire strands tensioned horizontally at heights of 300mm and 900mm above the ground, threaded with commercial type danger tape.	C	For duration of construction	Site inspection	
♦ The Contractor shall maintain in good order all demarcation fencing and barriers for the duration of construction activities, or as otherwise instructed.	C	For duration of construction	Site inspection	
ABLUTIONS	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ Portable chemical toilets must be provided for the construction workforce. These facilities must be regularly serviced by an appropriate service provider. Portable chemical toilets must be moved together with the construction work front to ensure that they are always available to construction workers as work along the powerline route progresses.	C	Ongoing	Site inspection	
♦ Toilets must be no closer than 50m from any natural water body watercourses (Section 1 (24 and 29) National Water Act (36 of 1998)).	C	Ongoing	Site inspection	
♦ The construction of long drop toilets is forbidden.	C	Ongoing	Site inspection	
♦ Under no circumstances may local drainage lines or streams be used as a toilet or cleaning facility by workers on site.	C	Ongoing	Site inspection	
♦ The Contractor shall be responsible for ensuring that all ablution facilities are maintained in a clean and sanitary condition to the satisfaction of the ER (EA no. 4.74 (g)..	C	Ongoing	Site inspection	
♦ Chemical toilets are to be emptied at a registered waste water treatment works (EA no. 4.74 (g).	C	Ongoing	Site inspection	
EATING AREAS	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ If none is available, the Contractor shall provide adequate temporary	C	Ongoing	Site inspection	

shade within the construction areas to ensure that site personnel do not move off site to eat.				
♦ The Contractor shall provide adequate refuse bins at all eating areas to the satisfaction of the ER, in order to minimise littering.	C	Ongoing	Site inspection	
♦ If deemed necessary by the ER, the Contractor shall demarcate designated eating areas.	C	Ongoing	Site inspection	
SITE CLEARING	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
MS2: The Contractor shall submit a site clearing method for all areas where the Contractor is required to, or intends to, clear vegetation. The Method Statement will include: ♦ A clear indication of land reference; ♦ Which areas will be cleared; ♦ How these areas will be cleared; and ♦ How the cleared materials will be stored or disposed of.	C	Before construction	Inspection of MS	
♦ No vegetation clearing shall take place without written approval of the Method Statement by the ER.	C	Ongoing	Site inspection	
Specific requirements from the specialists: ♦ Vegetation removal must be limited to the construction footprint only. ♦ If the wetland seepage area is to be cleared, healthy, moist sods must be maintained for use during rehabilitation. ♦ An application must be submitted to the Department of Economic Development, Environmental Affairs and Tourism for the removal of protected species prior to commencement of this activity ♦ A Horticultural Landscaper should be employed to assist with the seed collection and nursery propagation of protected species.	C	Ongoing	Site inspection	
♦ Vegetation clearing shall take place in a phased manner in order to retain vegetation cover for as long as possible.	C	Ongoing	Site inspection	
♦ For cutting down of trees / transverse and construction in state forests a licence to do so must be obtained from Department of Agriculture, Forestry and Fisheries (DAFF) prior commencement of	C	Ongoing	Site inspection	

the activity.				
TOP SOIL REMOVAL AND STOCKPILING	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ The Contractor shall remove topsoil from all areas where topsoil will be impacted on by construction activities, including temporary activities such as storage and stockpiling areas.	C	Ongoing	Site inspection	
♦ Stripped topsoil shall be stockpiled in areas agreed with by the ER for later use in rehabilitation and shall be adequately protected. Topsoil is considered to be the natural soil covering, including all the vegetation and organic matter. The depth of the soil may vary and due to this reason the top 300mm of soil must be removed and preserved as topsoil.	C	Ongoing	Site inspection	
♦ Topsoil stockpiles shall be convex in shape and no more than 2m high. Stockpiles shall be shaped so that no surface water ponding can take place.	C	Ongoing	Site inspection	
♦ Topsoil stockpiles shall be protected from erosion by wind and rain by providing suitable stormwater and cut-off drains (approved by the ER) and/or the establishment of temporary indigenous vegetation.	C	Ongoing	Site inspection	
♦ Topsoil stockpiles shall not be subject to compaction greater than 1 500 kg/m^2 and shall not be pushed by a bulldozer for more than 50m.	C	Ongoing	Site inspection	
♦ Topsoil stockpiles shall be monitored regularly to identify any alien plants. If any establish, these must be removed when they germinate to prevent contamination of the soil. Before topsoil is to be re-used the stockpiles should be fertilised.	C	Ongoing	Site inspection	
♦ Any topsoil contaminated by hazardous substances shall not be used but shall be disposed of at a registered H:h landfill site. Proof of appropriate disposal must be filed in the Environmental File in the Contractor’s Camp.	C	Ongoing	Site inspection	
♦ The Contractor shall be held responsible for the replacement, at his expense, of any unnecessary loss of topsoil due to his failure to	C	Ongoing	Site inspection	

work according to the approved Method Statement and the requirements of this EMPr.				
♦ Soil must be stockpiled in such a way as to minimize erosion.	C	Ongoing	Site inspection	
WORKSHOP, EQUIPMENT MAINTENANCE AND STORAGE	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ All vehicles and equipment shall be kept in good working order to maximise efficiency and minimise pollution. ♦ Vehicles must be checked for readiness prior commencement of activities for each day (EA no. 4.65).	C	Ongoing	Site inspection	
♦ All maintenance, including washing and refuelling of plant shall take place off site. If refuelling is necessary on site it shall take place at a designated location, away from any sensitive environments and over a drip tray.	C	Ongoing	Site inspection	
♦ Service of machinery and/or vehicles for construction must not take place on site, especially next to water courses. Service must instead take place on a suitable site identified by a qualified mechanic within the site camp on an impermeable surface (EA no. 4.65).				
♦ The Contractor shall ensure that no contamination of soil or vegetation occurs as a result of refuelling activities.	C	Ongoing	Site inspection	
♦ Drip trays shall be provided for all stationary plant.	C	Ongoing	Site inspection	
♦ No washing of equipment shall be permitted on the site.	C	Ongoing	Site inspection	
GENERAL AESTHETICS	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ The Contractor shall not deface, paint, damage or mark any natural feature (e.g. rocks, etc.) situated on or around the site for survey or any other purposes unless agreed beforehand with the ER. Any features, affected by the Contractor in contravention of this clause shall be restored/rehabilitation to the satisfaction of the ER.	C	Ongoing	Site inspection	
♦ All construction areas must be kept neat and tidy at all times. Different materials and equipment must be kept in designated areas and storing/stockpiling shall be kept orderly.	C	Ongoing	Site inspection	
♦ Pipes must be placed in trenches and must not be visible above				

ground (EA no. 4.71).				
♦ Lighting (if utilised) shall be of the downward facing spill off type.	C	Ongoing	Site inspection	
TRANSPORTATION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ The Contractor shall ensure that all suppliers and their delivery drivers are aware of procedures and restrictions (e.g. no-go areas) in terms of this EMPr.	C	Ongoing	Site inspection	
♦ Material shall be appropriately secured to ensure safe passage between destinations during transportation. Loads shall have appropriate cover to prevent them spilling from the vehicle during transit. The Contractor shall be responsible for any clean-up resulting from the failure by his employees or suppliers to properly secure transported materials.	C	Ongoing	Site inspection	
STOCKPILING	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ The Contractor shall plan his activities so that materials can be transported directly to and placed at the point where it is to be used.	C	Ongoing	Site inspection	
♦ No stockpiling within 50 meters of rivers, streams or wetlands (EA no. 4.51).	C	Ongoing	Site inspection	
♦ Should temporary stockpiling become necessary, the areas for the stockpiling of excavated / 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.	C	Ongoing	Site inspection	
♦ Stockpiles shall be positioned and sloped to create the least visual impact.	C	Ongoing	Site inspection	
♦ No foreign material generated/deposited during construction shall remain on site.	C	Ongoing	Site inspection	
HAZARDOUS SUBSTANCES	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**

MS3: If hazardous materials are to be stored on the site, the Contractor shall provide a Method Statement detailing the types of hazardous substances/materials that are to be used, as well as the storage, handling and disposal procedures for each substance/material and emergency procedures in the event of misuse or spillage that might negatively affect people or the environment.	C	Before construction	Inspection of MS	
♦ Should any hazardous material/substances (e.g. petrochemicals, oils, paints, etc.) need to be stored on the site, this shall be under controlled conditions. All hazardous materials/substances shall be stored in a secured, appointed area that is fenced and has restricted entry. All storage shall take place using suitable, sealable containers to the approval of the ER. These containers must be placed within a bunded area which has the capacity to contain 110% of the total volume it stores. The floor and wall of the bund area shall be impervious to prevent infiltration of any spilled/leaked materials into the soil. No spillages or accumulated stormwater within this bunded area will be allowed to be flushed from the bund into the surrounding area. All fluids accumulated within the bunded area shall be removed by a registered service provider and disposed of at an approved landfill site which is registered to deal with waste of this nature. Proof of appropriate disposal must be kept in the Environmental File at the Contractor's Camp. Hazard signs indicating the nature of the stored materials shall be displayed on the storage facility or containment structure.	C	Ongoing	Site inspection	
♦ Should there be a need to store fuel on the site, it shall be stored in a steel tank supplied and maintained by the fuel supplier. The tanks shall be located in a secure, demarcated area and an adequate bund wall (110% of the total volume of the tank) shall be provided. The floor and wall of the bund area shall be impervious to prevent infiltration of any spilled/leaked fuel into the soil. No possible spillages or accumulated stormwater within this bunded area will be allowed to be flushed from the bund into the surrounding area. All fluids accumulated within the bunded area shall be removed by a	C	Ongoing	Site inspection	

registered service provider and disposed of at a DWA approved landfill site which is registered to deal with waste of this nature. Proof of appropriate disposal must be kept in the Environmental File at the Contractor's Camp.				
♦ Material Safety Data Sheets (MSDS's) must be readily available for all chemicals / hazardous substances to be used on site. Where possible and available, MSDS's should include additional information on ecological impacts and measures to minimise and mitigate against any negative environmental impacts in the result of an accidental spill.	C/E	Before construction commences	Review of MSDSs	
♦ Handling and/or use of hazardous material, including but not limited to chemicals, must be performed by qualified personnel (EA no. 4.63).	C	Ongoing	Site inspection	
♦ Storage of hazardous materials must be in sealed containers that are leak free and comply with the requirements of the SANS code of practice. These shall be open only when required and not left open thereafter (EA of no. 4.64).	C	Ongoing	Site inspection	
♦ Weigh bills shall be sourced from the service provider for any hazardous waste disposal and be kept on site for inspection by the ECO during his/her audits.	C	Ongoing	Site inspection	
♦ Should any significant spills of hazardous substances occur, these must be reported to the Department of Water Affairs.	C	Ongoing	Site inspection	
♦ Ensure that any hydrocarbon/chemical/hazardous substance spills are cleaned up as soon as possible.	C	Ongoing	Site inspection	
♦ Provide drip-trays for vehicles that leak hydrocarbons and fix these leaks off site immediately.	C	Ongoing	Site inspection	
♦ Ensure that a proper spill-kit is available at all times where hydro-carbon handling will be undertaken.	C	Ongoing	Site inspection	
CEMENT AND CONCRETE MIXING	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ If concrete or cement mixing is to be undertaken on the site, this must be undertaken on an impermeable surface. Any contaminated water generated by these activities must be contained and	C	Ongoing	Site inspection	

appropriately treated / disposed of. No contaminated water may be discharged to the environment.				
♦ At the end of each day, any leftover / unused cement is to be removed from the site for appropriate disposal by the concrete supplier.	C	Ongoing	Site inspection	
♦ Washing of the excess concrete into the ground is not allowed.	C	Ongoing	Site inspection	
♦ Mixing, batching or compaction of cement and stone and or concrete must not take place within 32 meters of a watercourse. In this regard, it is proposed that the ready material should be brought to the spot where it is required for installation (EA no. 4.54).				
WASTE MANAGEMENT	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
MS4: The Contractor shall submit a Method Statement detailing a solid waste control system (minimisation procedures, separation, storage, provision of bins, site clean-up schedule, bin clean-out schedule, recycling options and points of disposal for the various waste types (general and hazardous, as a minimum) to the ER for approval.	C	Before construction	Inspection of MS	
An integrated waste management approach is to be implemented that is based on waste minimization and must incorporate reduction, recycling, re-use and disposal of waste where appropriate. Any solid waste shall be disposed of at a landfill licenced in terms of section 20 (b) of the National Environmental Management Waste Act, 2008 (Act No. 59 of 2008) (EA no 4.19).	C	Ongoing	Site inspection	
Waste management on site shall be strictly controlled and monitored. Only approved waste disposal methods shall be allowed, these include: ♦ Topsoil: Topsoil will be utilised on site for rehabilitation purposes. ♦ Material: landfilled (if approved by the relevant municipality), spoiled in closed borrow pit (with permission from borrow pit operator and/or landowner). ♦ General construction waste: must be removed from bins at sufficient intervals to prevent overflow. This waste must be stored in skips within a designated waste storage area in the Contractor's Camp. General waste must be transported to the local municipal	C	Ongoing	Site inspection	

general waste landfill site by either the municipality, the Contractor or a private waste disposal contractor. Service agreements in this regard must be obtained by the Applicant / Contractor prior to the commencement of construction activities. It is recommended that general wastes be separated on the site and delivered to appropriate depots for recycling. This would be facilitated by the provision of separate and labelled bins / skips. ♦ Hazardous construction wastes: Must be stored in a designated, access controlled, sign posted and bunded storage area. This waste must be collected as and when necessary by an appropriately trained service provider and must be transported to a Hazardous Waste Landfill Site for disposal.				
♦ The Contractor shall ensure that all site personnel are instructed in the proper disposal of all waste.	C	Ongoing	Site inspection	
♦ Demarcated and fenced areas where waste can be safely contained and stored on a temporary basis within the Contractors Camp must be established. General waste storage areas must be separate from hazardous waste storage areas. When adequate volumes (not more than 1 month) have accumulated, waste is to be removed from site and disposed of at a licensed facility.	C	Ongoing	Site inspection	
♦ Waste is not to be buried or burned on site.	C	Ongoing	Site inspection	
♦ Waste shall not be discharged to any watercourse, river, and stream. Refuse waste must not be stockpiled within 32 meters from any watercourse (EA no. 4.55).	C	Ongoing	Site inspection	
General Solid Waste ♦ 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 with regard to the disposal of all refuse. At all places of work the Contractor shall provide litter bins, containers and refuse collection facilities for later disposal at a registered landfill site; ♦ Solid waste may be temporarily stored on site in a designated area	C	Ongoing	Site inspection	

approved by the ER prior to collection and disposal at a registered landfill site. Waste storage containers shall be covered, tip-proof, weatherproof and scavenger proof. The waste storage area shall be fenced off to prevent wind-blown litter; ♦ No burning, on-site burying or dumping of waste shall be allowed; and ♦ All solid waste shall be disposed of at a registered landfill site. The Contractor shall supply the ER with the Weighbills for these disposals who will keep them on record for the duration of the project.				
Hazardous Waste ♦ All hazardous waste (including bitumen, paint and all petrochemicals, etc.) shall be disposed of at a registered hazardous landfill site. The Contractor shall provide the ER with the appropriate Weighbills for record keeping; ♦ All hazardous wastes must be stored under controlled conditions in a secured, appointed area that is fenced and has restricted entry. All storage shall take place using suitable, sealable containers to the approval of the ER. These containers must be placed within a bunded area which has the capacity to contain 110% of the volume it stores. The floor and wall of the bund area shall be impervious to prevent infiltration of any spilled/leaked materials into the soil. No spillages or accumulated stormwater within this bunded area will be allowed to be flushed from the bund into the surrounding area. All fluids accumulated within the bunded area shall be removed by a registered service provider and disposed of at an approved landfill site which is registered to deal with waste of this nature. Weighbills must be maintained in the Environmental File at the Contractor's Camp as proof of appropriate disposal. Hazard signs indicating the nature of the stored wastes shall be displayed on the storage facility or containment structure.	C	Ongoing	Site inspection	
NOISE CONTROL	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**

♦ It must be ensured that noise levels are kept to a minimum during the construction phase. All machinery and equipment to be utilised on the site should be fitted with mufflers and must be maintained in good working order to minimise noise levels. It is recommended further that the Contractor encourage construction workers to minimise shouting and hooting on the site. Construction work should be completed in as short a time frame as possible in order to limit the longevity of these impacts.	C	Ongoing	Site inspection	
♦ The Contractor shall endeavour to keep noise generating activities to a minimum.	C	Ongoing	Site inspection	
♦ The Contractor shall restrict all operations that result in undue noise disturbance to local communities and/or dwellings to daylight hours on workdays (Monday to Saturday) or as otherwise agreed with the ER.	C	Ongoing	Site inspection	
♦ The Contractor shall warn any local communities and/or residents that could be disturbed by noise generating activities well in advance and shall keep such activities to a minimum.	C	Ongoing	Site inspection	
♦ The Contractor shall be responsible for compliance with the relevant legislation with the respect to noise.	C	Ongoing	Site inspection	
♦ Equipment must be operated within its specifications and capacity and must not be overloaded.	C	Ongoing	Site inspection	
♦ All machinery/plant must be serviced and lubricated regularly to ensure a good working order.	C	Ongoing	Site inspection	
♦ Ensure that the potential noise source will conform to the South African Bureau of Standards recommended code of practice, SANS Code 0103:1983, so that it will not produce excessive or undesirable noise when it is released.	C	Ongoing	Site inspection	
♦ All the Contractors' equipment shall be fitted with effective exhaust silencers and shall comply with the South African Bureau of Standards recommended code of practice and the South African National Standard (SANS) Code 0103:1983, for construction plant noise generation.	C	Ongoing	Site inspection	

DUST CONTROL	RESPONSIBILITY	OCCURRENCE	METHOD	✓ / ✗
♦ The Contractor shall ensure that the generation of dust is minimised and shall implement a dust control programme, as necessary, to maintain a safe working environment and minimise nuisance for surrounding residential areas/dwellings.	C	Ongoing	Site inspection	
♦ Construction vehicles shall comply with speed limits and haul distances shall be minimised. Material loads shall be suitably covered and secured during transportation.	C	Ongoing	Site inspection	
♦ Exposed soils and material stockpiles shall be protected against wind erosion. The location of stockpiles shall take into consideration the prevailing wind directions and locations of sensitive receptors.	C	Ongoing	Site inspection	
♦ The Contractor shall implement dust suppression measures (e.g. Water spray vehicles, covering material stockpiles, etc.) if and when required.	C	Ongoing	Site inspection	
♦ Environmentally-friendly soil stabilisers may be used as additional measures to control dust on gravel roads and construction areas if complaints are received regarding dust generation.	C	Ongoing	Site inspection	
SOIL EROSION AND SEDIMENTATION CONTROL	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
MS5: The Contractor shall submit a Method Statement to the ER for approval detailing the methods of stabilisation and erosion prevention and remediation in specific areas, as and when the need arises.	C	Before construction	Inspection of MS	
MS7: The Contractor shall submit a Method Statement to the ER for approval detailing the method of working within watercourses (Mthatha River and seepage wetland).	C	Before construction	Inspection of MS	
♦ The Contractor shall, as and when necessary, implement erosion control measures to the satisfaction of the ER.	C	Ongoing	Site inspection	
♦ During construction, the Contractor shall protect all areas susceptible to erosion by installing necessary temporary and permanent drainage works as soon as possible and by taking any other measures necessary to prevent stormwater from	C	Ongoing	Site inspection	

concentrating in streams and scouring slopes and steep banks. ♦ Construction must include appropriate design measures that allow surface and sub-surface movement of water along drainage lines so as not to impede natural surface and sub-surface flows (EA no. 4.18). ♦ Drainage measures must promote the dissipation of storm water run-off (EA no. 4.20).				
♦ Any runnels or erosion channels developed during the construction or maintenance period shall be backfilled and compacted and the areas restored to a proper condition similar to the condition before the erosion occurrence. ♦ Cleared areas, trenches, disturbed areas must be rehabilitated thoroughly to avoid severe soil erosion (EA no. 4.72).	C	Ongoing	Site inspection	
♦ Stabilisation of cleared areas to prevent and control erosion and/or sedimentation shall be actively managed. The method of stabilisation shall be determined in consultation with the ER. Consideration and provision shall be made for the following methods (or combination thereof): ➢ Brushcut packing; ➢ Mulch or chip cover; ➢ Straw stabilising; ➢ Watering, planting or sodding; ➢ Soil binders; ➢ Anti-erosion compounds; ➢ Mechanical cover; and ➢ Packing structures (including the use of geo-fabric and log/pole fencing) ♦ The head-cut / gully erosion site could be used as a donga filling site, if excess soil is created post construction.	C	Ongoing	Site inspection	
♦ Traffic and movement over stabilised areas shall be restricted and controlled and damage to stabilised areas shall be repaired and maintained to the satisfaction of the ER.	C	Ongoing	Site inspection	
♦ In areas where construction activities have been completed and	C	Ongoing	Site inspection	

where no further disturbance would take place, rehabilitation and re-vegetation (comprising the replacement of top soil and grass planting) must commence as soon as possible.				
STORMWATER MANAGEMENT	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
MS6: The Contractor shall submit a Method Statement to the ER for approval detailing the method of stormwater control measures for the entire project area.	C	Before construction	Inspection of MS	
♦ To prevent stormwater damage, the increase in stormwater runoff resulting from the construction activities must be estimated and the drainage patterns accessed accordingly. A drainage plan must be submitted to the Engineer for approval.	C	Ongoing	Site inspection	
♦ Temporary cut off drains and berms may be required to capture stormwater and promote infiltration.	C	Ongoing	Site inspection	
PROTECTION OF FLORA	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
MS8: The Contractor shall submit a Method Statement to the ER for approval detailing the method of alien vegetation control measures for the entire project area.	C	Before construction	Inspection of MS	
♦ No Alien Vegetation must be permitted to establish on the site as a result of disturbances during the construction phase.	C	Ongoing	Site inspection	
♦ A permit from DEDEAT must be obtained prior removal/ keeping/ gathering/ transportation/ relocating any plants listed in terms of the Nature and Environmental ordinance or Transkei Environmental Conservation Decree. Threatened or Protected Species (TOPS) must not be disturbed without a permit from DEDEAT (EA no. 4.62).	C	Ongoing	Site inspection	
PROTECTION OF FAUNA	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ The Contractor shall ensure his employees do not undertake any hunting, poaching, trapping, shooting, poisoning, killing or other disturbance of any fauna on-site or in the areas surrounding the site (EA no. 4.61).	C	Ongoing	Site inspection	
♦ The feeding of any wild animals is prohibited.	C	Ongoing	Site inspection	

♦ The use of pesticides is prohibited unless approved by the ER.	C	Ongoing	Site inspection	
♦ Pipelines must not be let open and unattended to avoid dangers to road users and livestock (EA no. 4.71).	C	Ongoing	Site inspection	
FIRE CONTROL	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ The Contractor shall take all reasonable steps to avoid increasing the risk of fire through activities on site.	C	Ongoing	Site inspection	
♦ The Contractor shall ensure that basic fire-fighting equipment is available at all construction activities on site.	C	Ongoing	Site inspection	
♦ The Contractor shall appoint a fire officer who shall be responsible for ensuring immediate and appropriate action in the event of a fire.	C	Ongoing	Site inspection	
♦ The Contractor shall ensure that all site personnel are aware of the procedure to be followed in the event of a fire.	C	Ongoing	Site inspection	
♦ Burning and lighting of fires is strictly prohibited (EA no. 4.61)	C	Ongoing	Site inspection	
WATER PROVISION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ The Contractor shall make available safe drinking water fit for human consumption at the site offices and all other working areas.	C	Ongoing	Site inspection	
♦ All drinking water must be from a legal source and comply with recognised standards for potable use. The Contractor shall comply with the provisions of the National Water Act, 1998 (Act 36 of 1998) and its Regulations pertaining to the abstraction of waters from rivers and streams and the use thereof.	C	Ongoing	Site inspection	
♦ If water is stored on site, drinking water and multi-purposed water storage facilities shall be clearly distinguished and demarcated.	C	Ongoing	Site inspection	
♦ No water for either drinking or construction purposes may be abstracted from local streams, rivers or drainage lines.	C	Ongoing	Site inspection	
PROTECTION OF HERITAGE AND CULTURAL FEATURES	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ If any archaeological or paleontological artefacts, structures older than 60 years or remains/graves are uncovered during earthmoving activities, work in the vicinity of the find shall cease immediately.	C	Ongoing	Site inspection	

The Contractor shall immediately notify the ER, who shall contact the relevant Competent Authority who will take appropriate steps. Heritage remains must not be destroyed, disturbed or removed from site until approval is obtained by SAHRA or delegated provincial authorities.				
♦ The Contractor will be required to abide by the specifications as set out by the Competent Authority or the heritage specialist appointed to investigate the find.	C	Ongoing	Site inspection	
♦ The Contractor may not, without a permit issued by the relevant heritage resources authority, destroy, damage, excavate, alter, deface or otherwise disturb archaeological material.	C	Ongoing	Site inspection	
MATERIALS MANAGEMENT	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ Contractors shall prepare a source statement indicating the sources of all materials and submit these to the ECO for approval prior to the commencement of any work.	C/ECO	Before construction commences	Review of source statement	
♦ A signed document from the supplier of natural materials (e.g. material to be utilised in backfilling around structures or in foundations for the substation) must be obtained confirming that they have been obtained in a sustainable manner and in compliance with relevant legislation (if applicable).	ECO	On receipt of natural materials	Review of signed document	
♦ 600mm steel pipelines must be used, 12 ml raw water balancing tanks, rising mains must be constructed (EA no. 4.44)	C	Ongoing	Site inspection	

ENVIRONMENTAL EDUCATION AND AWARENESS	RESPONSIBILITY	OCCURRENCE	METHOD	✓ / ✗
♦ It must be ensured that all site personnel have a basic level of environmental awareness training. The contractor must ensure that all construction staff are aware of the following: ➢ What is meant by "environment"; ➢ Why the environment needs to be protected and conserved; ➢ How construction activities can impact on the environment; ➢ What can be done to mitigate against such impacts; ➢ Awareness of emergency spills response provisions; and ➢ Social responsibility during construction (being considerate to residents etc.). ➢ Sensitive and no-go areas	C/ECO	During staff induction / Ongoing	Site inspection and staff interviews	
♦ It is the Contractors' responsibility to provide the site foreman with no less than 1 hour's environmental training and to ensure that the foreman has sufficient understanding to pass this information onto the construction staff.	C	Prior to moving onto site	Site inspection. liaison with Contractor, Foreman	
♦ Translators are to be used if necessary, to ensure that all staff understand what is required of them in terms of the EMP.	ECO	Ongoing	Liaison with labour	
♦ The Contractor / ECO must be on hand to explain any technical issues and to answer questions.	C/ECO	Ongoing	-	
♦ The need for a 'clean site' policy needs to be explained to everyone working on site.	ECO	During staff induction, followed by ongoing monitoring	Liaison with labour	
ADMIN	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ A Complaints Register must be maintained on the site for the duration of the construction phase. This should be kept in the Environmental File. An example of the format of the complaints register is attached in Appendix A.	C	Ongoing	Document review	
♦ An Environmental Incidents Register must be maintained on the site for the duration of the construction phase. This should be kept in the	C	Ongoing	Document review	

Environmental File. An example of the format of the environmental incidents register is attached in Appendix B.				
♦ A copy of the Environmental Authorisation (attached in Appendix C to this final EMPr) must be kept at the site camp during the construction phase and made available to any authorised official of the Department, employee or agent of the holder of the Authorisation who works or undertakes work at the property (EA no. 4.1 and 4.2).	C	Ongoing	Document review	
♦ Where any of the applicants contact details change, including the name of the responsible person, the physical address or postal address and / or telephonic details, the holder must notify the Department as soon as the new details become known to them (EA no. 4.3).	C	Ongoing	Document review	
♦ The holder of the Authorisation must notify the Department, in writing and within forty eight (48) hours, if any conditions of this Authorisation cannot be or is not adhered to. Any notification in terms of this condition must be accompanied by reasons of non-compliance. Non-compliance with a condition of this Authorisation may result in a criminal prosecution or other actions provided by National Environmental Management Act, 1998 and EIA Regulations (EA no. 4.4).	C	Ongoing	Document review	
♦ The holder of the EA shall be responsible for ensuring compliance with the conditions contained in this EA. This includes any person acting on the holder's behalf, including but not limited to an agent, servant, contractor, sub-contractor, employee, consultant or any person rendering a service to the holder of the authorisation (EA no. 4.10).	C	Ongoing	Document review	
♦ Any changes or deviations from the project description set out in this authorisation must be approved in writing by the Department before such changes or deviations may be effected. In assessing whether to grant such approval or not, the Department may request such information as it deems necessary to evaluate the significance and impacts of such changes or deviations and it may be necessary for the holder of the authorisation to apply for further authorisation in terms	C	Ongoing	Document review	

of the regulations, 2014 (EA no. 4.12).				
♦ Activities must commence within twenty four (24) months from the date of issue. If commencement of the activities does not occur within that period, the authorisation lapses and a new application for environmental authorisation must be made in order for the activity to be undertaken (EA no. 4.13).	C	Ongoing	Document review	
♦ After commencement of the activities, construction works must be completed within thirty-six (36) months from the commencement date (EA no. 4.14).	C	Ongoing	Document review	
♦ All correspondence with regard to these activities must be forwarded to the attention of the Regional Manager: Environmental Affairs within the Department (EA no. 4.22).	C	Ongoing	Document review	
♦ The holder of an environmental authorisation has the responsibility to notify the competent authority of any alienation, transfer and change of ownership rights in the property on which the activity is to take place (EA no. 4.23).	C	Ongoing	Document review	
♦ Records relating to monitoring and auditing must be sent to this Department as of and when 50% of the construction work is completed and at the completion of the entire construction works. A copy must remain on site (EA no. 4.28).	C	Ongoing	Document review	

6. CONTROL OF POST-CONSTRUCTION AND REHABILITATION ACTIVITIES

Site rehabilitation is an essential component of this EMPr and must be carried out in conjunction with the ECO. The guideline is to be used as the basic structure for the site rehabilitation; the specific details must be decided by the E and / or OM in conjunction with the ECO.

The requirements for the control of soil, water, dust and noise pollution stipulated in Section 5 of this EMPr still apply during the site rehabilitation phase of the project. Similarly, the requirements for soil management, erosion control, alien vegetation removal and vegetation and fauna protection also apply.

POLLUTION CONTROL STRUCTURES	RESPONSIBILITY	OCCURRENCE	METHOD	✓ / ✗
♦ Excavate all areas of contaminated substrate (e.g. from sumps utilised to capture contaminated runoff from concrete / cement mixing areas), transfer the contaminated substrate to an appropriate disposal site and treat the affected areas with appropriate ameliorants.	C	On completion of construction	Site inspection	
♦ Remove all plastic linings used for pollution control and transfer to an appropriate disposal site.	C	On completion of construction	Site inspection	
♦ Break up all concrete structures that have been created (e.g. working and parking surfaces) and remove concrete waste to an appropriate disposal site.	E	On completion of the project	Site inspection	
WASTE	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ Remove all leftover construction materials from the storage area and construction site and either sell, auction, donate to the local community or transfer to the Contractor's base. If leftover materials are donated to the local community, it is the Contractor's responsibility to ensure that the materials are used appropriately, and do not cause harm to the environment.	C	On completion of construction	Site inspection	
ALIEN VEGETATION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ Existing and newly established alien vegetation must be removed from the entire construction footprint and replaced, where necessary, with suitable indigenous / endemic grass species.	C/ECO	Ongoing	Site inspection	
RE-VEGETATION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**

MS9: The Contractor shall submit a Method Statement to the ER for approval detailing the method for rehabilitation in construction areas. The ECO shall guide the contractor as to the layout, content, programme and timeframe for this Method Statement.	C	Before construction	Inspection of MS	
♦ Disturbed areas must be rehabilitated / re-vegetated immediately and m mitigation measures must be done to rehabilitate dongas so as to avoid severe soil erosion (EA no. 4.57).	C	On completion of construction	Site inspection	
♦ Where compaction of soil has occurred due to heavy vehicular activity, ensure that the soil surface is loosened (scarified and ripped) prior to replacing the topsoil.	C	On completion of construction	Site inspection	
♦ All areas of bare soil must be re-vegetated and rehabilitated utilising top soil and grass seeds / plugs.	C/ECO	On completion of construction	Site inspection	
♦ It is important that the re-vegetation activities be planned in advance to ensure that seed and grass stockists are able to supply the required volume when required.	E	On completion of construction	Site inspection	
♦ Re-vegetated areas may need to be watered to ensure plant growth and development.	C/ECO	Ongoing.	Site inspection	
♦ The site should be contoured to ensure free flow of runoff and to prevent ponding of water.	C/ECO	Ongoing.	Site inspection	
SPECIALISTS REQUIREMENTS FOR POST-CONSTRUCTION REHABILITATION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ✗**
♦ A Horticultural Landscaper should be employed to assist with the rehabilitation process, in particular where subsequent planting of protected species is required and in steep and eroded areas (EA no. 4.60).	E	On completion of construction	Review of appointment	
♦ Rehabilitate the construction footprint. For terrestrial systems this should be achieved by hydroseeding. Recommended grass species for use are:	C	On completion of construction	Site inspection	

GRASS SPECIES	APPLICATION RATE (kg/ha)
Aristida junciformis	1
Chloris gayana	1
Cymbopogon plurinoides	1
Cynodon dactylon	4
Digitaria eriantha/sanguinalis	3
Eragrostis curvula	3
Eragrostis capensis	1
Heteropogon contortis	1
Hyparrhenia hirta	2
Melinis repens	2
Panicum deustum	3
Sporobolus africanus	3
Setaria sphacelata	1
Themeda triandra	2

♦ If the wetland seepage area is disturbed, in-situ sods should be used to rehabilitate the area immediately after construction, utilising the healthy, moist sods which were maintained during construction. ♦ The dam or berm should be removed (smoothed to the natural contours) on approval from community members, if possible, to re-instate a more natural condition.	C	On completion of construction	Site inspection	
♦ Rehabilitate the construction footprint with protected species as follows: For every 500 m of pipeline plant 2 of each species (therefore 6 plants per 500 m). For example: 4 500 m of pipeline will require 54 plants to be planted (18 X *Gladioulus ecklonii*, 18 X *Gladioulus woodii*, 18 X *Xysmalobium* (possibly *orbiclare*)).	C	On completion of construction	Site inspection	
♦ Watering will be required to ensure establishment of plants, unless sufficient rainfall is experienced during the rehabilitation period. ♦ The maintenance period shall not be less than 6 months to 1 year duration from the time a specific stretch of corridor is rehabilitated. ♦ Acceptable Cover: 80 % indigenous plant cover and 80 % survival rate of protected species planted out should be ensured, and if such cover (or survival	C	On completion of construction	Site inspection	

rate) is not secured the maintenance period shall be extended.				
♦ If boulders cannot be avoided (recorded at the upper contours at reservoir and water treatment work sites of Option 2 and 3), and where these boulders are removed, place the boulders as close to the original arrangement in the surrounding landscape, to provide habitat for rehabilitation purposes and natural restoration processes. ♦ Protected species could be planted in and around the boulders.	C	On completion of construction	Site inspection	

7. CONTROL OF OPERATIONAL PHASE ACTIVITIES

The holder of the authorisation must compile an operational EMP for the operational phase of the activity (EA no. 4.37). The Rosedale/High burry Water Treatment Plant should never be allowed to deteriorate and conditions relating to the operational phase of the activity are valid for as long as the water supply scheme operates (EA no. 4.38 & 4.39).

The following EMPr stipulations should be adhered to at all times during the operational phase.

SITE SAFETY	RESPONSIBILITY	OCCURRENCE	METHOD	✓ / ×
♦ All OSH requirements and traffic safety requirements must be fulfilled during maintenance activities ♦ If excavations are required for repair works, barricading of excavations and appropriate safety signs must be erected.	OM	Ongoing	Site inspection	
WATER QUALITY MANAGEMENT	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ To prevent the contamination of natural water resources, the following must be adhered to: ➢ Hazardous materials (such as flocculants) utilised at the site must be handled, stored and disposed of appropriately as per the applicable SDS ➢ Any hazardous waste such as oily rags or chemical containers must be disposed at an appropriate hazardous waste facility ➢ Any spills of hazardous materials must be rectified in an appropriate manner so as to minimise environmental impacts ➢ Waste manifest must be kept by the applicant to prove safe disposal of all waste generated through maintenance activities ➢ Leaking vehicles are not permitted on site. If a vehicle leak is detected during maintenance it must be removed from site immediately. No vehicle repair work is permitted on site. ➢ Only chemical toilets or other ablution facilities may be used by personnel	OM	Ongoing	Site inspection	

➢ No littering is permitted during maintenance activities				
♦ If any form of contamination (including water or soil) arises as a result of the operational substation, the DWS and DEDEAT must be informed. These Departments will provide input on the appropriate clean-up measures. It may be necessary to appoint an appropriately trained specialist to undertake the clean-up required. ♦ If any leaks in the pipeline are detected or reported to OR Tambo Municipality, OM must investigate the leaks and repair the pipeline immediately.	OM	Following contamination event	Site inspection	
ALIEN VEGETATION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ Alien vegetation establishment on the site must be controlled for the duration of the project. ♦ Use of herbicides is not permitted unless approved by the ECO. The ECO must recommend the method for invasive vegetation management that will cause the least environmental harm with due consideration of the surrounding environment in particular water courses and sensitive habitats.	OM/ECO	Ongoing	Site inspection	
SOIL EROSION	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ Any erosion which may arise as a result of the development must be remediated and rehabilitated. If deemed necessary, stabilisation measures must be implemented to prevent future erosion from occurring. ♦ Maintenance vehicles must stay on designated and existing access tracks	OM	Ongoing	Site inspection	
STOCKPILING OF MATERIALS	**RESPONSIBILITY**	**OCCURRENCE**	**METHOD**	**✓ / ×**
♦ Materials and excavated soil must be stockpiled within designated areas and not within drainage lines to any watercourse. ♦ The contractor must prevent sediment from stockpiles entering any watercourse.	OM	Ongoing	Site inspection	

8. SITE CLOSURE AND DECOMISSIONING

Upon completion of the construction works and start of the operational phase of the activity, temporary structures must be removed immediately. Such structures must not be allowed to remain on the location for more than one (1) month after completion of the construction works (EA no. 4.40). The area used for base camp must be rehabilitated to resemble the state it was prior to construction. This includes, but not limited to, re-planting of indigenous vegetation that had been disturbed for the establishment of the base camp (EA no. 4.41). The ECO must revisit the rehabilitated areas on a quarterly basis for at least one (1) year after rehabilitation to monitor recovery of the area and report findings and recommendations to this Department (EA no. 4.42).

9. NON-COMPLIANCE

8.1 Procedures

- The Contractor shall comply with the environmental specifications and requirements on an on-going 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 can be followed:
    - The ER shall issue a notice of non-compliance to the Contractor, stating the nature and magnitude of the contravention. A copy shall be provided to the ECO during his/her site audit;
    - The Contractor shall act to correct the non-conformance within 24 hours of receipt of the notice, or within a period that may be specified within the notice;
    - The Contractor shall provide the ER with a written statement describing the actions to the taken to discontinue the non-conformance, the actions taken to mitigate its effects and the expected results of the actions. A copy shall be provided to the ECO;
    - In the case of the Contractor failing to remedy the situation within the predetermined time frame, the ER shall impose a monetary penalty based on the conditions of contract;
    - 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; and
    - In the event of a dispute or difference of opinion between any parties arising out of the interpretation of the conditions of the EMP, or a 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 arbitration.
- The ER 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.

8.2 Offences and Penalties

- Any avoidable non-compliance with the conditions of the EMPr shall be considered sufficient ground for the imposition of a penalty;
- Possible offences, which must result in the issuing of a contractual penalty, include, but are not limited to:
    - Unauthorised damage to natural vegetation;
    - Unauthorised camp establishment (including stockpiling, storage etc.);
    - Hydrocarbons/hazardous material: negligent spills/leaks and insufficient storage;

- Ablution facilities: non-use, insufficient facilities and insufficient maintenance;
- Late Method Statements or failure to submit Method Statements;
- Insufficient solid waste management (including clean-up of litter, unauthorised dumping and absence of weighbills as proof of disposal at a DWA registered landfill site);
- Erosion due to negligence/non-performance;
- Excessive cement/concrete spillage/contamination;
- Insufficient fire control and unauthorised fires;
- Preventable damage to water courses or pollution of water bodies; and
- Non-induction of staff.

TYPICAL INCIDENTS INCURRING PENALTIES	VALUE
Any contravention with Method Statement	At digression of the RE
Any contravention of the environmental or health and safety specification.	At digression of the RE
Untidiness and litter at camp.	R 500.00
Construction vehicles not adhering to speed limits	R 500.00
Not making use of the site ablution facilities.	R 500.00
Failure to submit Method Statements timely (per Method Statement).	R 1,000.00
Failure to stockpile topsoil correctly.	R 1,000.00
Inappropriate use of bins and poor waste management on site	R 1,000.00
Failure to maintain basic safety measures on site	R 1,000.00
Failure to stockpile materials in designated areas.	R 1,000.00
Insufficient education of staff regarding environmental matters and site housekeeping practices	R 1,000.00
Failure to provide drip trays and/or empty them frequently.	R 1000.00
Repeated incidences of dust or excess noise on or emanating from the site.	R 1000.00
Any person, vehicle, item of plant, or anything related to the Contractor's operations causing a public nuisance.	R 1000.00
Improper use of plant or equipment.	R 1000.00
Failure to demarcate working servitudes and/or maintain demarcation tape.	R 1,000.00
Failure to provide adequate sanitation, waste disposal facilities or services.	R 1,000.00
Failure to demarcate 'No-go' Areas before commencing construction clearance and other activities	R 1,000.00
Failure to secure construction site from public access.	R 1,000.00
Entrance into no-go areas	R 1,000.00
Stockpile of soils and materials outside demarcated areas	R 1,000.00
Inappropriate mixing of cement/concrete and poor management of slurry	R 1,000.00
Failure to erect temporary fences as and when required.	R 1,000.00
Failure to maintain a register of incidents on site	R 1,000.00
Failure to eradicate alien vegetation when requested within the specified	R 2,000.00

TYPICAL INCIDENTS INCURRING PENALTIES	VALUE
timeframe (per area).	
Failure to reinstate disturbed areas or begin with required rehabilitation actions within the specified timeframe (per area).	R 2,000.00
Persistent and un-repaired oil leaks from machinery. The use of inappropriate methods of refuelling.	R 2,000.00
Failure to carry out required community liaison, damage to property etc, without prior negotiation and/or compensation and other social infringements.	R 3,000.00
Inappropriate offsite disposal of waste from site (per incident).	R 5,000.00
Failure to provide equipment for emergency situations	R 5,000.00
Pollution of natural water bodies – including increased suspended solid loads.	R 5,000.00
Causing fire through negligence.	R 5,000.00
Failure to remove all temporary features and leftovers from the construction site and works areas upon completion of the works.	R 30,000.00

C5 OH&S SPECIFICATIONS & BASELINE ASSESSMENT

O.R. TAMBO
DISTRICT MUNICIPALITY

KING SABATA DALINDYEBO PRESIDENTIAL INTERVENTION

BULK WATER SUPPLY

CONSTRUCTION HEALTH AND SAFETY SPECIFICATION FOR THE CONSTRUCTION OF 50ML/D HIGHBURY WATER TREATMENT WORKS & RAW AND CLEAR WATER PUMPSTATIONS: MECHANICAL & ELECTRICAL

CONTENTS

1. DEFINITIONS

To this Construction Health and Safety Specification, all definitions in the Occupational Health and Safety Act & Regulations, the abbreviations and the definitions given hereunder shall apply:

1. **“Agent”** refers to **EQPROJECT MANAGERS AND SAFETY SOLUTIONS (Pty) Ltd** represented by a Professional Construction Health and Safety Agent appointed to act on behalf of the Client, and who is appointed in writing.

2. **“Client”** refers to **OR TAMBO DISTRICT MUNICIPALITY**.

3. **“COIDA”** means Compensation for Occupational Injuries and Diseases Act 130 of 1993

4. **“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;

5. **“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 including overseeing occupational health and safety;

6. **“construction site”** means the approved construction footprint and grounds where construction work is being performed as part of this contract.

7. **“construction supervisor”** means a competent person responsible for supervising construction activities on a construction site;

8. **“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; and, includes a bakkie or LDV used by the principal contractor or any contractor

9. **“Contractor”** refers to a Contractor of the Principal Contractor or a sub-contractor to such a contractor

10. **“CHSS”** refers to this document, the Construction Health & Safety Specification

11. **“CR**” refers to the Construction Regulations, 2014

12. **“COC”** refers to Certificate of Compliance.

13. **“DSTI”** refers to a documented daily safe task instruction compiled and issued by a contractor and trained to all relevant employees

14. **“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;

15. **“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;

16. **“fall protection plan”** means a documented plan, which includes and provides for-

    a. All risks relating to working from a fall risk position and work where there is a risk of dropping materials.
    b. The procedures and methods to be applied in order to eliminate the risk of falling and dropping of materials on persons; and

    c. A rescue plan and procedures;

17. **“fall risk”** means any potential exposure to falling either from, off or into;

18. **“H&S”** refers to Health and Safety

19. **“Health and Safety Plan”** refers to a documented plan which addresses hazards identified and includes safe work procedures to mitigate, reduce or control the hazards identified.

20. **“Health and Safety Specification”** refers to a documented specification of all health and safety requirements pertaining to the associated works on a construction site, so as to ensure the health and safety of persons.

21. “**Hot Work**” means any work where there is a fire or explosion risk, including but not limited to all welding, plasma cutting, LPG-or acetylene gas applications, grinding, work with flammable or explosive substances and work with chemicals with the potential of exothermic reactions.

22. **“Medical certificate of fitness”** means a valid medical certificate of fitness; such medical testing shall be relevant to the risks of the construction work performed on site and shall conform to the Occupational Health and Safety Act and Regulations and to the requirements in this H&S specification.

23. “**Method statement**” refers to a document detailing the key step by step activities to be performed to reduce as reasonably as practicable the hazards identified in the risk assessment.

24. **“OHSA”** refers to the Occupational Health & Safety Act of 1993

25. **“Principal Contractor”** means an employer who performs construction work for the client and who is appointed by the client.

26. **“Regulations”** refers to the Regulations issued under the Occupational Health & Safety Act.

27. **“S”** refers to a Section in the Occupational Health & Safety Act of 1993.

28. “**Sub-Contractor**” means an employer appointed by a contractor of the Principal Contractor to perform construction work on the Site; also means an employer appointed by a sub-contractor to perform work on the Site.

29. **“Pr. CHSA”** mean a professional registered construction health and safety agent with the SACPCMP.

30. **“SACPCMP”** means the South African Council for the Project and Construction Management

Profession 31. **Clearance Zone**

Means an area declared safe and cleared from any employees, members of the public, vehicles or any other sort of structure that could either be harmed or damaged when construction works at performed at heights or lifting and lowering operations are performed.

32. Electrical Clearance Zone:

Electrical clearance zone means the consideration of safe clearance zone between electrical equipment, supply and any other equipment or material that could conduct electricity.

33. **Vertical lines**

Means a safe method utilized to support the fall arrest and fall restraint systems when working at heights. The vertical lifelines consist of a certified safe for use cable attached to two or more anchor points on a structure.

34. Safety Harnesses

Means a safety harness used as fall protection equipment that has a double lanyard, the lanyard attaches two hooks on points and lanyard legs to a shock absorber which allows employees to move around whilst being continuously attached.

35. Emergency Rescue Plan

Means a plan to establish the contractor approach and procedure for the responds to a mayor emergency. this plan should outline in the unlikely event of employees falling and being arrest in the fall how will the emergency rescue be implemented to ensure those employees is placed to safety.

2. PROJECT SCOPE OF WORKS

1. This project entail the supply, delivery and installation of electrical and mechanical components in the 50ML/D Highbury Water Treatment Works as per the project specifications.

2.A client baseline risk assessment has been conducted identifying all potential risks to be encountered, the contractor is therefore responsible to ensure a detailed contractor baselines risk assessment is undertaken and submitted for approval prior to the construction works starting on site.

3. INTRODUCTION TO THIS CONSTRUCTION HEALTH AND SAFETY SPECIFICATION

1. This Construction Health & Safety Specification is published in terms of the Occupational Health & Safety Act of 1993 (OHS Act), Construction Regulations 2014, Regulation 5(1)(b).

2. The CHSS does not replace the Construction Regulations, 2014, but is a supplementary specification as required in terms of the Regulations.

3. Partial references to or quotes from the Regulations do not imply that the sections not referred to or quoted from are of lesser importance or are not applicable.

4. The Principal Contractor with all other sub-contractors is, at all times required to and will remain responsible to fully address all requirements and standards of the Occupational Health and Safety Act, Regulations and the full Construction Regulations in the Health and Safety Plan and the implementation thereof.

5. The client is committed to ensuring that the highest standards of health and safety prevail and this CHSS may contain standards which are more onerous that the statutory standards.

4. LIMITATION OF LIABILITY

1. The client or its Agent shall not be responsible for any acts or omissions of any Contractor which may directly or indirectly result from the application of the CHSS or any project specific version thereof.

2. All contractors must ensure that articles, work, equipment, machinery, plant and work practices are, always, compliant to the legal requirements as these apply.

3. The client shall limit its responsibility to the application of the Construction Regulations' Client Requirements only.

4. This CHSS is developed to ensure that the Client and any bodies that enter into formal agreements with the Client such as Consultants, Principal Contractors, and Principal Contractors achieve an acceptable level of OHS performance. No advice, approval of any document required by the CHSS or the Pr. CHSA, such as hazard identification and risk assessment action plan or any other form of communication from the client or the Pr. CHSA shall be construed as an acceptance of any obligation that absolves the Principal Contractor from achieving the required level of performance and compliance with legal requirements. Further, there is no acceptance of liability by the client or the Pr. CHSA which may result from the Principal Contractor failing to comply with the CHSS.

5. The Principal Contractor shall enter into a Mandatary Agreement with the client, as defined in Section 37(2) of the
   Occupational Health and Safety Act. The Principal Contractor shall ensure that each contractor appointed by the Principal Contractor and each and sub-contractor appointed by a contractor also enter into a Mandatary Agreement with the client, as defined in Section 37(2) of the Occupational Health and Safety Act.

6. The Principal Contractor shall be appointed by the client in terms of the Construction Regulations of 2014.

7. These agreements and appointments shall be included in the Principal Contractor's H&S file on site and be valid for the duration of the contractor's work on the construction site.

5. PURPOSE OF THE CONSTRUCTION H&S SPECIFICATION

1. The purpose of the CHSS is to be used as the standard of H&S on this project on which Principal Contractors', Designers and other project representatives plan their project implementation thus ensuring safe work execution and legal compliance.

2. This CHSS will be applicable to all construction work performed on site.

3. All employees working on this site shall conform to the standard in the CHSS. All the duties of a Principal Contractor in this CHSS equally apply, in full, to contractors of such Principal Contractor and to sub-contractors of such contractors.

6. IMPLEMENTATION OF THE CONSTRUCTION H&S SPECIFICATION

1. This CHSS forms an integral part of the Contract, and Principal Contractors are required to make it an integral part of their contracts with subcontractors and suppliers.

2. Any Principal Contractor submitting a tender for the Construction for this project shall ensure that the tender contains sufficient evidence of:

    a. Adequate provision for the cost of health and safety measures.
    b. The principal contractor's access to and intention to appoint persons with the necessary competencies to carry out the construction work safely.
    c. The principal contractor's access to the necessary resources to carry out the construction work safely;

7. PROVISION FOR THE COST OF H&S

1. The appointed Principal Contractor shall allow in their tenders for the cost of complying with the requirements of this CHSS and the legislative requirements based on the project scope of WORKS.

8. NOTIFICATION OF CONSTRUCTION WORK

Based on the estimated Contract Value, duration of the project as well as estimated Man-hours of this project, it will require a Notification of Construction work from Department of employment and Labour. The proof of the notification must be always on the file.

9. CONSTRUCTION MANAGER

1. The principal contractor shall appoint a full-time competent person as the construction manager with the duty of managing all the construction work on the Site.

2. The construction manager must be exclusively dedicated to this project/site.

3. Proof of competency of the construction manager shall be incorporated in the H&S file; evidence of H&S competence and, as a minimum this shall include:

    a. Proof of professional training

    b. Proof of experience in the construction scope of work relevant to this project nature

    c. Proof of experience in general H&S management for work as defined in the scope

4. The construction manager shall be responsible to ensure that the following duties are executed and shall actively communicate with the client-agent to:

    a. Confirm and provide proof of compliance; and

b. Discuss any compliant constraints which may be experienced.

5. The construction manager may be assisted by the safety officer and, where such an arrangement is planned, the H&S plan of the Principal Contractor shall clearly define the respective duties of the construction manager and of the safety officer.

6. The construction manager shall be appointed in writing and each of the tasks below shall be included in the signed letter of appointment.

7. The construction manager and safety officer shall present the site-specific health and safety plan, based on this health and safety specifications to the client agent and shall discuss and amend the H&S plan until finally approved by the Pr. CHSA

8. The construction manager shall ensure that the H&S plan is applied from the commencement of and for the duration of the construction work.

9. The construction manager shall ensure that the H&S plan is reviewed and updated as work progresses.

10. The construction manager shall open and keep the Site health and safety file and ensure that, always, this file is on site and available to an inspector, the client, the client's agent or a contractor.

11. The construction manager shall provide contractors and sub-contractors with this CHSS.

12. The construction manager with support of the safety officer only approves a H&S plan of a contractor and a subcontractor if there is sufficient evidence that the contractor:

    a. Has made sufficient provision for health and safety measures during the construction process

    b. Has the necessary competencies to perform the construction work safely; and

    c. Has made the necessary resources available to perform the construction work safely.

13. The construction manager shall ensure that all contractors appointed by the Principal Contractor have an approved H&S plan, prior to appointing the contractor and prior to allowing the contractor to start working on site.
14. The construction manager shall ensure that contractors have evidence of both registration and good standing in terms of COIDA and shall not permit any contractor to start work or to continue with work on site unless a valid Certificate of Good Standing is on site.

15. Additional to the requirements of the Construction Regulations, the Principal Contractors' construction manager shall ensure that all sub-contractors appointed by any of the contractors of the Principal Contractor comply with the construction regulations and the construction manager shall:

    a. Ensure that employees of these contractors are also inducted in the H&S induction program of the Principal Contractor.
    b. Inform the Client Agent in writing (via e-mail) whenever a contractor or sub-contractor's H&S plan is approved.

16. The construction manager shall ensure all construction supervisors adhered shall adhere to the H&S requirements on site.

17. The construction manager and supervisor shall stop all construction work which is not in accordance with this CHSS or with the principal contractor's health and safety plan or which poses a threat to the health and safety of persons.

18. The construction manager shall ensure that, where changes are brought about to the design and construction on the site, sufficient health and safety information and appropriate resources are made available to any contractor.

10. CONSTRUCTION HEALTH AND SAFETY OFFICER

1. The Principal Contractor shall appoint a competent Construction safety officer for the construction work.

2. The Construction Health and Safety Officer shall be **Part-Time**, however must be on site when the High-risk construction activities take place , at least 2 years working experience as a construction Health and safety officer working on electrical installation project within the construction industry. The Construction Health and Safety Officer must be registered with SACPCMP as a Candidate Construction Health and Safety officer

3. The Principal Contractor shall define the duties of the appointed safety officer in the H&S file.

4. The safety officer shall have a valid registration with the South African Council for the Projects and Construction Management Professions.

5. Proof of competence and registration/proof of application & confirmation of the appointed construction safety officer must be included in the H&S file and file.

6. The authority and relationship of the safety officer with the construction manager must be documented in the H&S file.

7. The safety officer should have access to resources such as mobile phone, laptop and printing machine to ensure all administrative requirements are implemented and adhered too.

11. HAZARD IDENTIFICATION AND RISK ASSESSMENT

1. The Principal Contractor shall appoint a competent person to perform a site-specific baseline- and, thereafter, ongoing issue-based hazard identification and risk assessment. There may be more than one risk assessor appointed if this is required.

2. The competent risk assessor shall form part of the construction team working on the construction site.
3. The risk assessment must be based on the scope of work, the site-specific materials required, and the site-specific machinery, equipment and structures applied during the construction on this project.

4. The client requires that an additional risk assessment is conducted and submitted to the Pr. CHSA for verification when:

    a. A new machine is introduced onto site

    b. A system for work is changed or operations altered

c. After an incident or near miss has occurred

d. New knowledge comes to light and information is received which may influence the level of risk to employees on site.

5. All risk assessments shall be conducted in terms of an acceptable and documented methodology and control measure must comply to the hierarchy of controls prior to commencement of work and in accordance with the provisions of the CR.

    a. The baseline risk assessment shall document.

    b. Issue-based risk assessment, risk monitoring and risk review shall be done at the hand of pre-task risk assessment communicated to all employers; a system of daily safe task instructions may be used. The risk assessment must include:

        i. A daily tasks/activity list, step by step ii.

        A daily documented listing of hazardous

        events iii. A daily documented listing of

        H&S risk controls

        iv. Proof of communication of the above to all employees: the client requires that the Principal Contractor shall ensure that all employees on site are conversant with the content of all relevant risk assessments, the appropriate measures to either eliminate or reduce the identified risks. The Principal Contractor shall outline to employees what role they are expected to play in the Risk Assessment and control measure process.

6. The principal contractor shall include a method for risk review ensuring that the all risks on site are adequately managed

7. All risk assessments must document all H&S controls. Should the Principal Contractor commence any work without a compliant risk assessment or should the risk assessment not reflect the activities being undertaken, the responsible contractor may be instructed to be immediately stop that specific activity, and the Principal Contractor will have no claim against the client in such a case for lost time or costs, irrespective of whether it can be demonstrated that the work was being safely undertaken.

8. The principal contractor should ensure issue-based project specific risk assessments and method statements for all high-risk tasks identified on site:

12. HEALTH & SAFETY FILE AND PLAN

1. The Principal Contractor shall provide and maintain an H&S File, containing all relevant documents as prescribed in the OHSS, the Construction Regulations of 2014 and all forms or records referred to that has relevance to specific legislation.
2. The H&S File shall be kept on site and available for inspection by the client Agent or the Department of Labour’s Inspectors.

3. The content of the file is included in this specification, but additional items may be added.

4. The H&S plan should include and project background/introduction section taking into consideration the following:

   I. Project name
   II. Client details, name of responsible person and the business address
   III. Client/Designer details, name of responsible person and the business address if applicable
   IV. H&S CHSA details, name of responsible person and the business address
   V. Principal Contractor, name of responsible person (16.2 appointee) and business address
   VI. Completion project scope

5. The H&S plan should include a detailed site-specific overview of the
   - Scope of works and activities of the project; this overview must include all work controlled by the Principal Contractor, whether directly or through the services of a contractors or sub-contractors.
   - An overview of the machinery and plant used in the project; this overview must include all machinery and plant directly or indirectly (through the services of a contractor or sub-contractor) controlled by the Principal Contractor.
   - Specific on-site working hours should be stipulated in the H&S plan.

H&S Plan Content & Numbering

1. Index of the H&S Plan
2. Project scope of works
3. Scope & activities, machinery, plant, equipment, hazardous articles to be used
4. Health and Safety Resources and Budget
5. Construction manager: duty, responsibility, authority, document control
6. Safety officer: duty, responsibility, authority, document control
7. Principal Contractor H&S management processes
8. Management of the issue-based risk-, risk review- and risk monitoring
9. H&S Induction training and H&S competency management
10. General record keeping management
11. Contractor and Sub-contractor management
12. Site communication management
13. Fall protection plan and method statements for heights work
14. First aid, accident & incident and emergency management
15. Fire prevention and equipment management
16. Safety signage management
17. Access & on-site traffic and public H&S management
18. Excavation management
19. Electrical management
20. Hazardous chemical substances management
21. Construction plant and machinery management
22. Lifting Operations and Management
23. Occupational hygiene, occupational health and fitness for work management
24. PPE management
25. Safety Inspections and Inspection Register management

26. Internal Audit management
27. Waste management

H&S File Content & Numbering

1. Index of the H&S File
2. Electrical installation certificate from DoEL
3. Principal Contractor's Policies applicable to the construction site: Occupational Health and Safety Policy
4. Project and OHS organogram with contact numbers
5. Principal Contractor Appointment
6. Mandatary Agreement between client and the principal contractor
7. Proof of Construction Work Permit
8. Letter of Good Standing
9. Contractors Baselines Risk Assessment
10. H&S Plan
11. Induction Plan
12. Emergency Plan
13. Fall Protection Plan
14. Issue Based Risk Assessments
15. Construction Manager, Supervisor and Safety Officer letters of the appointed competent persons and evidence of competency (registrations, qualifications and other proof of competency)
16. Updated Employee List
17. Medical Certificates of Fitness
18. Legal appointment letters
19. Training and Competency Matrix
20. Training records
    a. Employees H&S Induction records
    b. Visitors Induction records
    c. Records of training and competency for method statements
21. Incident Register & Investigation reports & COIDA Accident and incident management procedure
22. H&S Inspection Registers, list should be provided in the H&S Plan
23. PPE Issue Register
24. Internal Audits
25. Letters of approval of contractors and sub-contractors H&S Plans
26. Letters appointment of contractors and sub-contractors
27. Principal contractor's contractor- and sub-contractor audits
28. DSTI's
29. Audits by Client Agent
30. Corrective / Preventive Action plans for client audits
31. All supporting evidence deriving from the H&S Plan

13. CLOSE-OUT AND CONSOLIDATED H&S FILE

1. The Principal contractor shall compile a consolidated H&S file and hand this to the Agent at the end of the construction work.
2. The consolidated H&S file shall be in hard copy and in USB format.
3. The consolidated file shall include:
    a. A copy of the approved H&S plan of the principal contractor
    b. The H&S file of the Principal Contractor, which, amongst the other, shall have dedicated chapters dealing with:
        i. Project H&S plan Approvals Record
        ii. Project H&S management plans, H&S plan, Fall Protection, Emergency plan, Storm water management, Traffic management iii. Project Baseline Risk Assessments.
        iii. Designer inspections/assessments and confirmation of conformance.
        iv. Monthly Risk & Incident Reports.
        v. Incidents registers & IOD investigation record.
        vi. COIDA Claim incidents and supporting medical treatment record.
        vii. The completed final register required in the 'Staffing on Site' chapter of this CHSS.
        viii. Monthly H&S performance report.
        ix. Monthly H&S audit reports from the Agent and the enjoining corrective action reports.
        x. Endorsed minutes of H&S Committee meetings.
        xi. Employee lists as required in this CHSS.
        xii. Records of exit medicals records.
    c. A reference record of all drawings, designs and materials used
    d. A reference record of H&S statutory certificates required by the owner; this reference record shall indicate the designated person at the principal contractor, who is responsible for the document and the client-designate to whom the document has been handed.
    e. The comprehensive list of all the contractors on site accountable to the principal contractor, including a list of the agreements between the parties and the type of work being done
    f. An index of all inspections and reference to the inspection registers for the site
    g. A list of all responsible persons appointed in statutory positions for the duration of the project
    h. A list of all occupational injuries and diseases including the name of the injured, the reference number of the Annexure I document and the reference number of the COIDA notification of the injury (if any).
    i. All documents relating to any reportable injury or disease during the construction work, as defined in Section 24 and 25, of the Occupational Health and Safety Act.

14. INDUCTION AND H&S AWARENESS

The Principal Contractor should ensure a project specific induction plan is available and that all employees, subcontractor or stakeholders undergo induction before entering on site.
The Principal Contractor shall develop a documented project-specific induction training plan that must be submitted for approval by the Agent, to ensure that all employees on site are conversant with:

- The risks of the construction project
- The controls documented in the H&S plan relating to working at a sub-station.
- The role of employees in ensuring health and safety on the construction site

- The emergency arrangements that are put in place by the Principal Contractor
- The general health and safety rules applicable to the site, inclusive of an introduction to whom the Construction Manager, Supervisors and Safety Officer is on site.

The contents of the induction programme and method of ensuring that all employees are inducted will be documented in the H&S file and the Principal Contractor is advised that a generic induction or a human-resource induction shall not be sufficient.

When working on the site, each employee of any contractor and sub-contractor accessing the site, including management, shall complete the principal contractors' induction; the principal contractor shall ensure that none of his or his contractors' employees accesses the site unless having been inducted by the principal contractor. Each visitor to the site shall be inducted in the risks and risk controls which the visitor may be exposed to; the visitor's induction and method to ensure compliance shall be documented in the H&S file. H&S awareness

The Principal Contractor shall conduct, on site, periodic toolbox talks, preferably weekly or before any hazardous work takes place. The talks shall cover the relevant activity and an attendance register must be kept and signed by all attendees. A record of who attended and the content of the topic will be kept on the site health and safety file as evidence of training. Awareness training of management responsibility on site must be conducted with all management representatives including contractors and sub-contractors.

15. HEALTH AND SAFETY COMPETENCY

1. The principal Contractor shall ensure that the H&S plan includes evidence of such competence for every competent person designated to this construction site.
2. Work may only allow to be commenced if there is sufficient evidence of H&S competence for each person designated in the H&S plan; unless otherwise specified in this CHSS and as a minimum, this shall include:
    a. Proof of training in the OHSA, CR and evidence that a training provider certifies the designated person to be familiar with the OHSA and with the applicable regulations made under the OHSA.
    b. Proof of competency in the specific skill of the designation; amongst other this may include supervisory training, risk assessment training, equipment (such as ladders, lifting equipment, fire extinguishers, portable electrical machinery etc.) or high risk construction (such as working at electrical substation, installation of overhead electrical lines etc)

16. STAFFING ON SITE

1. The Principal Contractor shall compile a list of all employees on site indicating:
    a. Name and ID number
    b. Designation (job title)
    c. Date of OHS Induction for the site
    d. Date of expiry of medical
    e. Where applicable, competency in the safe work instructions included in the H&S plan
2. This employee list shall be included in the start-up H&S file and maintained thereafter.

3. The H&S plan shall include a method statement on communication on site; this shall address:
    a. Language and translation controls
    b. Communication methods within and between teams (radio controls and permits)
    c. Emergency communication methods
    d. Regular planned meeting and communication sessions planned by the Principal Contractor.

17.PUBLIC HEALTH & SAFETY

1. The works areas should be rendered safe before works commence and continuous supervised and monitored on site to prevent public risk exposures.

2. Construction work in progress, warning signage and barricading should be in place at all works areas.

3. All members entering site must indicate in what capacity they are visiting site, and a site register should be completed and on record by the principal contractor.

4. The Principal Contractor shall ensure that each person visiting the site shall be inducted to the site and such induction shall outline the hazards likely to arise from on-site activities and the precautions to be observed to avoid or minimise those risks.

5. The Principal Contractor should ensure the public risks associated with mobile plant operations is controlled and managed on site, flag persons should be assigned to mobile plant operations that is in reverse motion on site where member of the public is exposed.

6. Where members of the public and community is at risks to hazardous exposures, the principal contractor should ensure the works area and condition is rendered safe.

18. ACCESS, TRAFFIC MANAGEMENT AND CAMP SITE

1. All employees of all contractors working at the construction site shall access the site camp before works commence.
2. No employee shall be transported together with goods or tools.

3. All construction vehicles operating on site must comply with the requirements of the National Road Traffic Act, 1996.
4. The Principal Contractor shall ensure the traffic accommodation requirements as per this specification and the tender document requirements are adhered too at all times.
5. Where applicable the required approvals for the traffic manager for the George Municipality should be obtained and all the requirements of South African Road Traffic Signs Manual (SARTSM) and the CSRA/CUTA Road Signs Note 13, Roadworks are complied with on site for the duration of the construction works.
6. All activities planned to occur in the campsite shall be risk assessed and planned; this includes risk controls for the parking of staff- and visitor’s vehicles, parking of mobile plant and machinery, dedicated storage areas, planned and compliant stacking practices, traffic controls, including the safe separation of pedestrian (employee) transport from risk areas.

7. Every construction vehicle shall:
    a. Be in serviceable condition and safe.
    b. Be inspected by a competent person daily and the result of the inspection logged in a register kept in the vehicle.
    c. Where non-conformities are identified, these shall be subject to immediate and documented appropriate corrective action.
    d. Have a serviced portable fire extinguisher installed at all times.
    e. Be operated by a competent driver appointed in writing; the driver shall:
        i. Be in possession of a conforming driver's license; ii. Be in certified medically fit as a driver.

19.NIGHT-, WEEK-END WORK AND FATIGUE

1. Where week-end work is planned, the principal contractor shall ensure that its construction supervisor is on site; this applies even if only contractors or sub-contractors are working on the site.
2. Where week-end work is planned, each contractor or sub-contractor shall ensure that its construction supervisor is on site; this applies even if the principal contractors' manager or supervisor is on the site.
3. All working after hours and on weekends should be approved by the Client, before the contractor commence with such work.

20.INSPECTION, MONITORING AND REPORTING

1. The Principal Contractor shall carry out daily safety planned task observations and planned H&S inspections on the site (or more frequent, where so required in the Regulations), and shall take steps to rectify any unsafe condition of which he is aware.
2. The appointed Construction Manager (or a person designated by the Construction Manager) and the Health & Safety Officer shall perform regular inspections and document these in the H&S File.
3. The relevant inspection templates and the frequency of inspections shall be included in the H&S Plan.
4. The H&S Plan shall contain a list and template of all the inspection registers which shall be kept on site:
    a. The templates must correlate with the machinery and equipment listed on site;
    b. The inspector responsible for the inspection and maintenance of the register must be appointed in writing. Proof of training and competency in the performance of the inspections must be documented.

21.CONTRACTORS AND SUB-CONTRACTORS

1. Contractors and sub-contractors must be given a copy of this H&S Specification and any additional specification issued by the client and shall comply with these specifications integrally. All employers working on this site shall conform to the standard in the CHSS. All the duties of a

Principal Contractor in this CHSS equally apply, in full, to contractors of such Principal Contractor and to sub-contractors of such contractors.

2. The Principal Contractor shall ensure that all contractors and sub-contractors under his control, plan the construction work in a H&S Plan, approved by the Principal Contractor; such H&S plan and H&S file shall be in accordance with guidelines provided in the specifications.
3. Whenever a contractor or sub-contractor's H&S plan is approved, the Principal Contractor shall communicate with the Agent (at eric@ericqampiprojects.co.za) for verification of the approved H&S plan prior to the contractor being allowed to start work. Unless the Principal Contractor has been notified of the approval of the H&S plan in writing by the Agent, no contractor shall commence work on site.
4. Principal Contractors shall ensure that all contractors and sub-contractors comply with their H&S Plans, based on all applicable H&S Specifications, the requirements of the OHSA and all other relevant legislation.
5. Regular planned task observations planned H&S inspections and monthly audits of all contractors and sub-contractors must be recorded and filed in the principal contractor 's H&S File, for inspection by the client Agent.
6. The Principal Contractor shall ensure that the comprehensive and updated list of all the contractors and subcontractors on site, placed in the H&S file, includes:
    a. A reference to the agreements between the parties, including all contractor's Section 37(2) agreements with the Principal Contractor and the Section 37(2) agreements with the client.
    b. The type of work being done.
    c. The date of the approval of the H&S plan.
    d. The date of expiry of the COIDA certificate of good standing.
    e. The date of the last monthly audit.
7. Principal Contractors shall ensure that each contractor and each sub-contractor enters into a Section 37(2) Mandatary Agreement with the client and that these agreements are signed and in place prior to approval of the contractor's or sub-contractors' H&S plan. The original agreement must be filed in the H&S file of the principal contractor.
8. The Principal Contractors' H&S Plan must include the Principal Contractor's procedures to ensure that all contractors and all sub-contractors fully comply with all H&S requirements; this must include, but is not limited to, defining the submission, assessment and final approval method (including the nominated responsible person) of H&S Plans of subcontractors and the signing of a mandatary agreement with the client.

22.PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING

1. The Principal Contractor shall ensure that every employee is issued with, and wears SABS-approved PPE, consisting of all PPE identified in the risk assessment.
2. All the contractors' employees shall wear full length overalls and shall wear identification with respect to the employer.
3. All employees performing construction work shall wear steel-capped safety boots and a hard hat.
4. Employees working in the vicinity of mobile plant or construction vehicles shall wear a reflective vest; reflective stripes on overall do not meet the required visibility and shall not suffice.
5. The use of respiratory protective equipment shall be defined in the site risk assessment and validated at the hand of hygiene measurements of airborne pollutants for the specific risk.
6. The H&S Plan shall contain an outline of the PPE to be used and the management of such PPE on site, including the issuing of PPE, storage, any sanitising of PPE and all disposal of PPE.

7. Failure to use protective equipment as per the site risk assessment shall require disciplinary intervention and this process shall be documented in the site induction.
8. Disposal of PPE must conform to the Environmental legislation.

23.OCCUPATIONAL HEALTH AND SAFETY SIGNAGE

1. The Principal Contractor shall erect and maintain quality safety signage.
2. The signage shall include, but is not limited to:
   a. The work permit number displayed at the entrance
   b. A sign indicating that all visitors must report to the site office and must be accompanied by the principal contractor when accessing the site
   c. The name and telephone number of the responsible person(s)
   d. Emergency telephone number(s)
   e. PPE to be worn at the site
   f. Traffic controls

24.FIRST AID MANAGEMENT

1. The Principal Contractor shall ensure that adequately trained first aiders are on site at all times when construction employees are on site; this is applying even if less than 10 employees are on site.
2. The Principal Contractor, any contractor or sub-contractor shall ensure that it appoints a trained First Aider on site regardless of number of labours on site.
3. First aiders shall be identified and shall have immediate access to a comprehensively stocked first aid box.
4. Such first aid box shall be stocked to include all first aid equipment as per the minimum requirements listed under General Safety Regulation 3, and any additional items identified in the risk assessment.
5. Where shift work is performed, each shift shall comply with the above first aid requirements.
6. All the above controls shall be documented in the H&S Plan.

25.INCIDENTS, ACCIDENTS AND EMERGENCIES

1. All near misses, incidents and accidents must be recorded, investigated and managed in accordance with the statutory provisions.
2. Each H&S incident and accident must be recorded in a register kept in the H&S file; a template of the register shall be included in the H&S File.
3. Every accident shall be reported to the Agent immediately; that is as soon as the construction manager or the supervisor or the principal contractor becomes aware of it.
   a. Such reporting must occur via direct contact (person-to-person or via telephone) and via e mail to eric@ericqampiprojects.co.za.
   b. Incident Investigation process must be followed by competent role players and a preliminary investigation report must be submitted to the Agent within 24 hours for review and comment.
   c. Final investigation must be finalized by the Principal Contractor and submitted to the Agent within 7 working days, unless requested otherwise.

4. A record of all incident investigations shall be kept in the health and safety file and all records shall be made available to the client without exception; this includes records relating to Section 24 of the OHSA.
5. Where a fatality or permanent disabling injury or any incident referred to in Section 24 occurs on the construction site, the Principal Contractor must ensure that the provincial director is provided with a report contemplated in section 24 of the Act, in accordance with regulations 8 and 9 of the General Administrative Regulations, 2013, and that the report includes the measures that the Principal Contractor intends to implement to ensure a safe construction site as far as is reasonably practicable.
6. The Principal Contractor shall ensure that contractors and sub-contractors apply the same measure and shall require that this process is documented in these contractor's H&S plan. The Principal Contractor's H&S plan shall include a specific procedure in this regard, which shall include that all documents and instructions in respect of any incident referred to in Section 24 shall immediately and unconditionally be forwarded to agent.
7. The contractor shall organise and document detailed emergency and accident arrangements on site and outline these, in detail, in the H&S Plan. These arrangements shall be specific for the site H&S risks and shall make specific provisions for:
    a. A specified ambulance service
    b. A method to ensure that the appropriate COIDA documents are available on site, so that prompt medical aid, as defined in the COIDA, may be available to any injured employee.
8. The emergency arrangements shall be displayed on site and shall include:
    a. A comprehensive emergency and evacuation plan
    b. An emergency flow chart
    c. An updated list of emergency telephone numbers
9. A site emergency and evacuation plan shall be included in the H&S plan.

26.FACILITIES FOR EMPLOYEES

1. The Principal Contractor shall document the construction site's method to ensure the statutory application of employee's rights in terms of employee facilities as defined in the OHSA, the General Safety Regulations and the Construction Regulation, including:
    a. The provision of facilities for safekeeping and changing
    b. The method of ensuring that employees requiring to change on site can do so in privacy
    c. The provision of an eating area
    d. The provision and maintenance of sufficient toilets on site.
2. Contractor's toilets must be:
    a. Fixed so as to avoid becoming wind-blown
    b. Sign-written: 'Male' and 'Female' use
    c. Sanitised daily; an inspection and sanitising record must be kept in the H&S file
    d. Inspected daily and, where bucket collections are in place, emptied at least twice a week and one of these occasions must be on Fridays.
3. Consider the scope of works, the principal contractor should consider having temporary toilet at strategic points on site where works will be performed.

27.AUDITS AND INSPECTIONS

1. The client Agent shall conduct regular health & safety audits to ensure legal compliance and compliance with the Principal Contractors' H&S Plan.

2. Records of findings and audits shall be kept in the Principal Contractor's H&S File together with a record of any nonconformance report, investigation and corrective & preventative action.
3. The Principal Contractor shall document corrective action planning and forward this to the Client Agent within 48 hours of receiving a finding.
4. The Principal Contractor's H&S Plan shall document the corrective and preventative action procedure applicable to the project, including the planned method to ensure that non-conformities are managed immediately.
5. The client Agent shall stop all or any work which does not conform to the H&S Plan, which is contradictory to statutory requirements, or which poses a threat to the health and safety of persons.
6. The Principal Contractor shall conduct and document monthly health & safety audits of all contractors and subcontractors to ensure compliance with the OHSA, its Regulations and the Principal Contractors' H&S Plan and of these contractor's H&S plan.
7. Records of Principal Contractor audits of all contractors and sub-contractors on site shall be kept in the Principal Contractor's H&S File together with a record of any non-conformance report, investigation and corrective & preventative action by sub-contractors and shall be made available to the Agent during monthly H&S audits.

28.HOT WORK, FIRE RISKS, FIRE EXTINGUISHERS AND FIRE FIGHTING EQUIPMENT

1. No open fires are allowed on site.
2. All flammable products must be stored in an adequate storage facility; this process shall be documented in a method statement in the H&S Plan.
3. The Principal Contractor shall provide suitable fire extinguishers and firefighting equipment, which shall be serviced regularly, in accordance with the manufacturer's recommendations.
4. Safety signage shall be prominently displayed in all areas where fire extinguishers are located. The Principal Contractor shall arrange for the training of the relevant personnel, in the use of fire extinguishers.
5. The fire extinguisher inspection registers and the letter of appointment of the competent inspector shall be included in the H&S Plan.
6. Hot work permit is required on site, appropriate screens, fire prevention, fire extinguishing and a documented safe work permit system are all in place.
7. The principal contractor shall include a hot work and lock out/tag out method statement in the H&S file for approval. Each person perform hot work or lockout shall be trained in the method statement and shall be documented in the H&S file.

29. EXISTING SERVICES

1. The Principal Contractor should ensure an on-site assessment is to determine the existing services before commencement of construction work.
2. Upon identification of the existing services, mitigation measure should be implemented on site to ensure minimal disruption or risk exposures to employees. Safe clearance distances should be implemented for all known services on site and the movement and operations of mobile plant should be adequately planned and managed on site.

3. The contractor should therefore ensure the required wayleaves are obtained from the relevant authorities.

4. The principal contactor should ensure safe working method are implemented on site with regards to working in proximity of existing services.

30. LIVE ENERGY WORK AND ELECTRICAL RETICULATIONS AND MACHINERY

1. The Principal Contractor shall appoint a competent electrician who shall ensure zero potential of all electrical reticulations worked on and who shall ensure that dedicated power sources are safely installed for the use during the construction.
2. The Principal Contractor shall identify and inspect all exposed underground cables, overhead cables or any other electrical installations to ensure that these are not a hazard to any person.
3. The competent person shall certify and inspect all temporary electrical installations and machinery; the frequency shall be determined in the H&S plan.
4. The letters of appointment, proof of competency and registers applicable to these inspections shall be included in the H&S Plan.
5. All electrical cables shall be assumed “alive” and, where applicable, the Principal Contractor shall take adequate steps to ensure that all persons are prevented from accessing any electrical installations.
6. All existing electrical services must be always assumed live.
7. Contractors will ensure that all energy is brought to zero potential, that residual energy is purged, that energy sources are switched off and locked out by all employees working in the danger zone and are tagged, prior to any work being performed on the energy source or reticulation. The contractor shall include a zero Potential, Lock Out and Tag Out method statement and safe work instruction(s) in the H&S Plan.
8. No electrical machinery shall be allowed to have any joined leads.
9. The principal Contractor shall ensure that all electrical testing equipment to be used on site has a valid calibration and that the calibration sticker is affixed to the equipment, clearly indicating the calibration date and the next due date.
10. Any unsafe condition shall be reported immediately to the client and the Principal Contractor shall take immediate steps to prevent employees or members of the public from gaining access to the dangerous installation and the area surrounding it.
11. The Principal Contractor shall appoint a competent person to inspect all portable electrical tools, including leads. The letter of appointment and template of this inspection register shall be included in the H&S Plan.
12. The Principal Contractor shall include a method statement for the safe use of portable electrical tools, including the management of the hazards of extension leads.
13. Where temporary installations are installed a COC for these installations shall be included in the H&S File.
14. Where applicable, the contractor shall include any ‘electrical dangerous work procedure’ in the H&S Plan.

31.LADDERS

1. Ladders shall be compliant to the statutory requirements.
2. Ladders shall only be used for the purpose for which they are designed.
3. Ladders shall be identified, inspected regularly and the record of the inspection shall be kept in the H&S file.
4. A-frame ladders shall have a patent spreader bar system.
5. Ladders shall extend at least 90 cm above any level or opening accessed with the ladder.

6. No vertical ladders shall be accessed by any person unless firmly attached at the bottom and top or held in place by a fixed installation or a buddy.

32.CRANES AND LIFTING OPERATIONS

The following shall apply to any crane used on site, including truck mounted cranes on delivery vehicles:

1. Each crane shall have (in the cab or operating area), the following legal documents on site always:
    a. The latest and up-to-date load certificate of the crane.
    b. A record of the 6-monthly inspection of the crane by a registered inspector;
    c. The crane operator(s) current crane license;
    d. The crane operator(s) medical certificate of fitness, issued by an occupational medical practitioner;
    e. The inspection register or certification of 3-monthly inspection of all lifting equipment used with the crane;
2. Where applicable, the H&S Plan shall include the method statement for the erection, maintenance, inspections and dismantling of the crane.
3. The H&S Plan shall include the method statement for safe use of the crane, including the method of communication, the protection of fall zones and the method of determining whether the weather permits safe crane work.
4. Any fixed crane's load test certificates shall be included in the H&S file.
5. All lifting equipment and gear used on site shall be identified, SWL-indicated and listed in a register contained in the H&S file.
6. A template inspection register of the lifting gear shall be included in the H&S Plan.
7. Where TLB, front-end loaders or excavators are used for lifting or rigging, the principal contractor shall ensure that:
    a. The lug or attachment point is certified and that a SWL is identified;
    b. The operator is trained as a lifting machine operator and has a license as defined in Driven machinery regulation of the OHS Act.
8. The requirements for cranes and lifting operations apply equally to delivery trucks and the principal contractor shall ensure that all deliveries requiring lifting or rigging comply with the legal requirements.
9. The H&S plan shall include a specific method statement listing the planned lifts and the planned methods of attachment and rigging.
10. The principal Contractor shall ensure that deliveries using cranes comply with the above requirements and that all legal documents are kept in the cab of the delivery truck whilst on the Client's site.

33.STORAGE AND USE OF FLAMMABLE LIQUIDS

1. No flammable substance must be stored on site unless these are stored in a flammable store or cage; no other materials shall be stored in the flammable store.
2. Where required, the H&S Plan shall include a method statement detailing the safe use, storage, decanting and spill controls for all flammable liquids used or stored on site.
3. Storage management must comply with Environmental legislation.

34.HAZARDS

CHEMICAL SUBSTANCES

1. With respect to hazardous chemical substances used, the contractor shall ensure that:
    a. All MSDS are included in the H&S file
    b. A HCS risk assessment is included in the H&S plan
    c. The safe use, storage, emergency procedures and safe disposal of hazardous substances are addressed in a method statement/s, included in the H&S Plan.
    d. Proof of competency and signed letters of appointment of the person responsible for chemical handling, is included in the H&S file.
2. Any hazardous chemical substance intended to be applied on site during the project (i.e. after approval of the H&S Plan) shall be subject to an issue-based risk assessment and method statement, which must be presented to the client Agent prior to the substance being introduced on site.
3.

OPARATING ON ELECTRICAL EQUIPMENT

There are Five (5) types of Hazards associated with electrical Equipment:

- **Electrical shock**: There is no way to tell if an electrical conductor or terminal is live just by looking at it, it should be tested using appropriate approved tester. Thereafter if should be made safe in such a manner that it cannot be energised by someone else whilst it is being worked on.

- **Electrical Burns**: With Medium Voltage it is not necessary to touch the conductor or the terminal to burned. When a person gets too close to an electrical wire that is not properly insulated, the air can break down and form a conducting path between them to earth. Coils and capacitors store electrical energy and release it after power has been turned off and should, be discharge before work commence.

- **Fire explosion:** There is great danger of fire and explosion when working with medium voltage equipment, due to the large fault currents that can flow in the system. Oil Circuit Breakers (OCBs) and Mini Sub Station (MSS)and Ring main Panels (RMPs) pose threat. Operator error can also cause faults, livening up a cable, whilst the other end is earthed for instance.

- **Heat up:** Heat can build up in wires. A lightweight extension lead gets hot when used for heavy duty service. Avoid using extension leads at all, if possible or ensure they ca carry the current without overheating.do not string them overhead, across aisles and under the mats, where can build and fully extend them.

- **Mechanical Hazard**: Moving parts always a source of danger, always ensure that guard are in place. make sure the machine you are working on cannot be turned on the knowledge of supervisor.

35.ELECTRICITY

Because there is serious threat of flashover, shock, arcing etc. When working in a medium voltage environment, lower voltage tends to be treated with less respect.it must be remembered that a voltage as low as 50Volts, with a current of +-30 milliamps cause asphyxia and /or heart muscle fibrillation.

The biggest danger of electricity is that live and dead apparatus are indistinguishable from each other. Therefore, apparatus must never be assumed dead. Always presume it is live. This can only be ascertained by safety testing with the appropriate approved tester. Or by the present of visual earth connections.

Electricity can jump gaps, which means that it is not even necessary to touch a medium voltage conductor to get hurt. Merely approaching too close can have fatal results, therefore is necessary to maintain proximity distance.

<u>CLOSE PROXIMITY</u>

Close proximality is the minimum distance any part of a person body or work tool may encroach to any unearthed, bare LV conductors or any unearthed and unscreened MV/HV conductor.

RATED VOLTAGE	CLEARANCE
Up to 11kV	0,2m
Exceeding 11 KV, but exceeding 33KV	0,43m
Exceeding 33KV, but not exceeding 132KV	1.45m
Exceeding 132KV but not exceeding 275KV	2,35m

36.HOUSEKEEPING, STACKING, STORAGE AND DROP ZONES

1. The Principal Contractor shall appoint a person responsible for general housekeeping and stacking and storage of materials and equipment on the entire site.
2. A method statement for the safe management of the drop zone shall be included in the H&S plan.
3. A method statement for the safe lowering of materials shall be included in the H&S Plan.
4. All deliveries of building materials shall be controlled by the appointed person for stacked areas agreed with the client.

37.WASTE

1. The Principal Contractor shall appoint a person responsible for site-wide control & removal of scrap, waste and debris;
2. No hazardous waste, combustible materials and containers shall accumulate on the construction site;
3. The Principal Contractor shall document a waste management method statement in the H&S Plan. Such method statement shall include all liquid and solid waste produced during the construction process.
4. Designated waste areas should be identified on site.
5. Waste management must comply with the Environmental legislation.
6. All waste skips removed from site must be recorded and a proof of final deposit at a registered waste site (waste disposal certificate) must be on record in the H&S file.
7. Waste bins for domestic waste must:
    a. Be placed at all eating areas
    b. Have a functional lid, which prevents windblown dust and entry by monkeys
    c. Be emptied daily.

38.CLIENT OH&S RISK ASSESSMENT

A client baseline risk assessment is included at Annexure B. The assessment takes into consideration the high-level risks associated with the construction work that was identified by the client representative.
The contractor is required to develop their own baseline risk assessment for the construction works.

39.OCCUPATIONAL HEALTH

1. The H&S file shall include:
    a. All medical certificates of fitness for all employees working on the site, a list of all employees on site must be generated by the principal contractor and updated monthly. This list should include all sub-contractor as well.
2. The Principal Contractor and every contractor shall ensure that a person-job specification (PJS)is issued for each job title on the construction site. The PJS specification should be sent with each employee to the occupational medical practitioner in order for the medical testing and assessment to be relevant to the statutory requirements and the risk exposures.

3. All contractors shall use that occupational health examinations, medical surveillance and certificate of fitness are conducted for all employees working on the project.

ANNEXURE A

Acknowledgement of the H&S Specification by Principal Contractor

Construction Health & Safety Specification

Issued in terms of the Occupational Health and Safety Act, 1993

Construction Regulations, 2014

I,____representing

____ Principal Contractor have satisfied myself with the content of this
Construction Occupational Health and Safety Specification and shall ensure that the Principal Contractor, all contractors and sub-contractors and all employees on site comply with it.

__________________________________ ________________________

Signature of Principal Contractor Date

__________________________________ __________________________

Signature of Agent Date

This document must be signed and returned to the Pr. Construction Health and Safety Agent.

ANNEXURE B

Client Baseline Risk Assessment (find attached)

BASELINE RISK ASSESSMENT FOR CONSTRUCTION OF 50ML/D HIGHBURY WATER TREATMENT WORKS & RAW AND CLEAR WATER PUMPSTATIONS: MECHANICAL AND ELECTRICAL

TYPE OF REPORT	BASELINE RISK ASSESSMENT	HAZARD IDENTIFICATION AND RISK ASSESSMENT
COMPILED BY	ERIC NQAMPI	
DATE OF ASSESSMENT	20 JUNE 2024	
DATE OF REVIEW	22 JULY 2024	
SCOPE OF WORK	Mechanical and Electrical installations	
REVIEW DATE	EVERYONE (1) year or after reportable incident or change in scope of work.	

Probability Index			Severity index injury /disease			Severity index (Production)			Severity index due to Environment			Severity index (Financial impact)			Frequency index		
	5	Almost certain to inevitable		5	Fatal		5	No production for at least 12 months		5	Permanent effects		5	Greater than R500 000.00		5	Hazards permanently present
	4	Probable		4	Permanently disabling injury		4	Loss of 1 month or more		4	Long term > 2 years		4	R100 000. 00 – R499 999,00		4	Hazards arises every week
	3	Improbable		3	Likely to be absent for more than 14 days		3	Loss of 1 week in production		3	Medium – 6 months to 12 months		3	R10 000.00 – R99 999.00		3	Hazards arises every month
	2	Less than even a chance		2	Medical recovery within 14 days		2	Loss of 1 day in production		2	Short term 1 day to six (6) months		2	R1 000.00 – R9 999.00		2	Hazards arises every year
	1	Highly improbable		1	First aid only		1	Loss of half day in production		1	Insignifican t effect		1	R0 – R999.00		1	Hazards arises every five (5) years
	0	Not probable		0	Near misses		0	No loss of time but production affected by shock of employees		0	No aspect or impact		0	No cost involved		0	No hazards exists

	PRIORITY OF ACTION				ACTION TO BE TAKEN
	RISK	A	75 – 100%	Immediate	Training, Safe Work Practice, Method Statements & detailed action plans

		B	60 – 74%	Within 1 week	Training, Safe Work Practice, Method Statements & detailed action plans
		C	45 – 59%	Within 1 month	Training, Safe Work Practice, Method Statements & detailed action plans and registers
		D	30 – 44%	Within 6 months	Training and Safe Operating Procedures
		E	15 – 29%	Within 12 months	Training
		F	0 – 14%	As reasonable	Training

Ref No.	**Sequence of Activity in Action**	**Hazards (Safety, Health, and Environment)**	**Risk rating E (L + C)**				**Control Measure**	**Control Effectiveness Rating**	
			Exposure (E)	**Likelihood (L)**	**Consequence (C)**	**Risk Rating**		**Control Type**	**Control effectiveness rating**
1.	Site Establishment	• Damage to Construction equipment, Vehicles, heavy lifting equipment etc. • Damage to existing electrical or Telecommunication lines. • Damage to property of client or private properties. •	2	3	4	14	• The principal contractor will be required to develop and submit prior to commencement of work a risk assessment, health and safety plan, the method statements, and all relevant supporting documentation to ensure that all overall activities are properly planned. • When using lifting equipment and cranes to assist with site establishment or construction work, ensure that all relevant risk assessments and method statements are conducted & employees are briefed on the risks involved. • Use competent employees to fulfil functions during the activities. • Ensure that sites are suitably and sufficiently fenced off and provided with controlled access points to prevent the entry of unauthorized persons. • The principal contractor must provide a detailed site establishment methodology prior commencement of activities.	Administrative	Satisfactory
2.	Location, exposure, and	• Possible damage to existing	3	3	4	21	• The principal contractor must obtain the relevant details and drawings depicting existing services of all kinds from	Administrative	Satisfactory

	protection of known and unknown existing underground services	property e.g electrical supply or water line which could lead to disruption of municipal services. • Electrocution of contractor personnel through the direct contact with underground/over head powerlines which may lead to injury or, in the worst case, fatality.					the Competent Authorities, prior to commencement of activities. • Relevant risk assessments and safe working procedures or must be developed and implemented accordingly. • Existing services are to be located, identified, and subsequently safeguarded. • Competent supervision and adequate pre-task training and induction required prior to activities. • Excavations opened overnight to be barricaded or fenced with a fence that is at least 1m in height. • No excavations must be left open over weekends and public holidays.		
3.	Site access and drivers on site.	• Possible collision of construction vehicles and/or mobile plants with site personnel, property, or members of the public while operating at work areas. • Unroadworthy vehicles/plants, drunk drivers, poor road, and weather	2	3	4	14	• A clear demarcation, and separation of working spaces or areas between the Principal Contractor and members of the public or residents must be established. • Traffic accommodation and signage to be installed before any construction work may commence. • Traffic movement to be observed and manually controlled where necessary. All visitors must be warned of the current heavy construction traffic at the entrance/exit point of the site. • All vehicles and mobile plants are to be checked for roadworthiness and safety before they are allowed onsite. • All construction vehicle drivers and operators are to be tested for alcohol on a regular basis.	Engineering, Administrative & PPE	Satisfactory

		conditions causing collisions leading to personnel injuries and fatality.					• All site personnel must be issued and always wear reflective vests while on site for visibility		
4.	Hazardous Chemical Substances	Exposure to hazardous chemical substances such as lead, mercury and other metals, flame retardants and certain phthalates.	4	2	3	20	• Before any employee is allowed to use HCS, they must be trained and made aware of possible hazards as per MSDS. Correct and relevant PPE should be issued and worn to mitigate any possible risk of exposure.	Administrative and the use of PPE	Good
5.	Electricity	Electrical shock due to contact with live electrical wire	3	5	3	24	• Develop detailed method statement and ensure that it is implemented. • Exclusion zones to be created with rigid barriers and warning signs. • No machine to be operated in an area where any part of machine or equipment can contact electrical wire. • All persons to be provided with training in the hazards associated with live electrical wire. • Provide employees with relevant PPE	Combination of Administrative process and PPE	Satisfactory
	Electricity	Electrical shock or electrocution due to the use of unsafe electrical equipment (including generators)	3	5	3	24	• Electrical equipment to be inspected by an authorised operator or inspector daily prior to use. • Details of these inspections to be recorded in a register which will be always kept on site.	Administrative	Satisfactory
	Electricity	Electrical shock or electrocution due to contact with live overheard power lines	3	5	3	24	• Electrical artisans need to be mindful of existing electrical wires. Before any equipment is used on a work site, an assessment should be carried out and reports of such assessments kept in the Contractor’s SHE file.	Administrative	Satisfactory

6.	Unauthorised person to switch room	Switch on/off the switches that can result to the following: • Burns • Shock • Fire • And or Explosion and arc flashes	3	5	3	24	• Switch boards room must be lock if there is no authorised person working in the room • Notice board that indicated that "**No Unauthorised person are allowed"**	Administrative	Good
7.	Ladder: to gain access to excavations, trenches, and elevated positions.	Falling from the ladder leading to injuries	3	3	3	18	• Must be inspected by a competent person. • Principal contractor to appoint such a competent person in writing and must ensure that no worker uses a scaffolding that is not approved for use by a competent person. • Provide personal protective equipment	Administrative	Good
8.	Erecting working platforms	Poor manual handling leading to sprains, strains, and fractures.	4	3	5	32	• The principal contractor must appoint in writing a temporary works designer who will design, inspect and approve the erected temporary works on site before use. Temporary works must be carried out under the supervision of a competent person appointed in writing as a temporary works supervisor. • Train employees on good lifting techniques. • Providing suitable working platforms for working conditions.	Administrative	Good
9.	Personal protective equipment (PPE)	Electrical Shock due to not wearing the correct PPE	3	5	3	24	• Wear electrical safety Shoes with non-conductive soles and insulating mats to protect against electrical Shock and insulation for the feet.		

							• Hard hat with electrical insulation protect against electrical Shock and against falling objects .etc.		
10.	Drilling and grinding	Flying particles that can cause asthma	4	3	5	32	Machine guard to be fitted and ensure that the machine is working properly. Inspection and pre checks to be conducted before using any driven machine. Employees to be issued with relevant PPE.	Engineering and administrative	Satisfactory
11.	Excavation work	Excavated trenches left open resulting in employees and members of the public tripping and falling causing injuries.	4	3	5	32	• All excavation work must be supervised by a competent person who is appointed in writing as an excavation's supervisor. • All excavations must be inspected, and a register must be kept in the contractor's OHS file. • All open excavations must be barricaded off with a high visibility orange and yellow net that is not shorter than 1 meter in height. • Signs warning of open excavations must be installed. • No excavations or trenches may be left open over weekends and public holidays.	Administrative Engineering solution	Good
12.	Improper stacking and storage	Material falls due to improper stacking causing injuries to persons.	3	4	4	24	• Stacking should be supervised by competent person. Best stacking practices should be applied. Training for those responsible for discharging this duty should be provided. • No stormwater pipes or any other construction material may be stacked blocking the residents' gates or against residents' fences.	Administrative	Good
13.	Loading, offloading and installing of electrical/ mechanical equipment	Loading and offloading of heavy electrical equipment e.g telemetry equipment, 11kV switchgear and associated 440 V	3	3	6	27	• Train employees on safe lifting techniques, reduce the weight of items to be lifted and use the appropriate mechanical equipment to lift heavy items.	Administrative	satisfactory

		cables, MCC and DB boards and attributed components crushing limbs etc.							
14.	Portable Electrical Equipment	Noise will be generated by portable electrical equipment which will lead to noise induced hearing loss	2	2	3	10	• Principal Contractor to provide PPE (Ear Protection). Workers should be rotated to reduce exposure. Noise must be measured and if found to be more than 85 decibels, the contractor must provide means to mitigate the impact.	Administrative	Satisfactory
15.	Removal of old services	Unsafe removal of underground services leading to electrocution, waterline bursts/disruption in supply of services.	4	5	4	36	• The Principal Contractor must ensure that the removal of old services is included in the health and safety plan. A detailed method statement must be submitted for review and approval before any work can be carried out. Such plans must be shared with the employees once approved. • Employees must be provided with the relevant PPE such as gloves and goggles.	Administrative	Good
16.	Mistakes in operation by employees and operators	Lack of training leads to mistakes, use of equipment incorrectly	4	5	4	36	• All employees on site to be properly inducted. • Competent supervision to be provided on site.	Administrative	Good
17.	Mixing of concrete	Hand mixing of concrete done on the ground resulting in environmental pollution and back pains and hand injuries	4	5	4	36	• No mixing of concrete is to be done on the ground. The principal contractor must provide damkos and mixing of concrete must be done on top it to protect the environment. • Employees must be trained on safe working procedures for working with concrete. • Relevant PPE such as gloves and goggles must be provided for employees.	Engineering and administrative controls	Good

18.	Housekeeping	Housekeeping not being maintained daily. Generated waste, scrap and debris not removed from site at reasonably appropriate intervals. Construction areas near occupied offices not sufficiently hoarded.	4	3	4	28	• Housekeeping to be maintained daily. • Hoarding must be maintained daily and must be kept up to standard.	Administrative	Good
19.	Working at elevated position / heights	Falling objects Employees working at heights not having necessary competency to work at heights.	4	5	5	40	• Tools to be secured while working at heights to prevent falling from heights. • Adequate training and awareness to be provided to employees on working in elevated/fall position.	Engineering and administration	Good
20.	Fall protection	Employees not working according to approved fall protection plan. Employees not trained on fall protection plan. Lack of supervision to ensure that workers are implementing the approved fall protection plan.	4	5	5	40	• Fall Protection plan to be communicated among all employees by means of induction training and toolbox talks. • Employees to have the necessary competency to qualify to work at heights. • Fall protection plan to be updated throughout the project life span. • Fall protection plan to address all site-specific conditions.	Engineering and administration	Good

21.	Oil and attributed tools and equipment.	Oil, diesel, petrol, and grease spillage Oil/ grease being flushed down drains	3	4	3	21	• All cleaning and servicing of plant and equipment to be conducted in a controlled manner and working area. • No oil or grease to be disposed of down drains or into the stormwater systems. • Empty oil/ grease containers to be removed from site and disposed of as per regulations on disposal of hazardous chemical waste.	Administrative	Good
22.	Traffic Accommodation	Poor traffic accommodation resulting in car accidents, employees being hit by cars or members of the public/ properties being hit by cars	4	5	5	40	• The principal contractor must submit a detailed site-specific traffic management plan for approval prior to commencement of construction activities. • Sufficient signage alerting motorists of construction activities, maximum speeds and delineators must be installed. Flag people must be placed in strategic areas to wave down speeding vehicles. • Equipment working outside the demarcated work area must be assigned flag people to work with it. • All employees must wear high visibility vests	Administrative	Good
23.	Poorly installation of electrical/mechanical equipment	Burns, explosion, fire and Smoke inhalation	4	5	5	40	• The principal Contractor must appoint a competent person for the installation. •	Administrative	Good

1. A risk level is attributed to each circumstance in the following manner

- Low Risk = 1 – 15
- Medium Risk = 16 – 30
- High Risk = 31 – 50

2. Risk Ranking calculation

2.1 Consequence

- Medical Treatment only or less (minor injury) = 2
- Average Lost Time Injury = 4
- Major Injury = 6
- Fatality or Permanent disabling injury = 8

2.2 Probability

- Not likely to occur in our lifetime = A
- Could occur = B
- Has happened = C
- Common Occurrence = D

2.3 Calculation of Risk

- Consequence = probability x frequency

3. Evaluation of results

Activities listed in the high-risk zones must be seen as tasks requiring immediate attention. Administration will in most instances solve some of the problems satisfactory, administration would involve training and awareness programmes to educate employees about the hazards and risks associated with their tasks.

An implementation plan must be devised to address the outstanding issues which may need engineering solution or PPE if all attempts fail. The action plan must be cognisance of the specific hazards that need to be eliminated.

4. Assessment Team

The following professionals were involved in the design of this baseline risk assessment for the installation of mechanical and electrical components for 50ML/D Highbury Water Treatment Works:

Eric Nqampi – Pr. CHSA
Dunyiswa Nosana: Pr. CHSO
Siwapiwe Bekebu: Pr. CHSO

5. Task Specific Risk Assessment

Should the baseline risk assessment indicate tasks in high-risk zone, a specific task risk assessment must be conducted. The assessment will then target the specific tasks and hazards attached to the identified activity.

6. Required and Existing Control Measures

- Safe Work Procedures
- Training
- Medical Examination
- Supervision
- Risk assessment
- Mitigation measures
- Consequence management

C6 TENDER DRAWINGS

DRAWING NO **DRAWING TITLE**

Figure 1 Contract Nameboard

GENERAL LAYOUT (LAY)	
J31067/LAY/100 ME	General Site Layout Plan
J31067/LAY/150 ME	Water reticulation layout
J31067/LAY/320-01	Interlinking Pipelines Layout Sheet 1 of 4
J31067/LAY/320-02	Interlinking Pipelines Layout Sheet 2 of 4
J31067/LAY/320-03	Interlinking Pipelines Layout Sheet 3 of 4
J31067/LAY/320-04	Interlinking Pipelines Layout Sheet 4 of 4
DETAIL DRAWINGS (DET)	
J31067/MECH/210-01	Clariflocculator Tank Sheet 1 of 5
J31067/MECH/210-02	Clariflocculator Tank Sheet 2 of 5
J31067/MECH/210-03	Clariflocculator Tank Sheet 3 of 5
J31067/MECH/210-04	Clariflocculator Tank Sheet 4 of 5
J31067/MECH/210-05	Clariflocculator Tank Sheet 5 of 5
J31067/MECH/216-01	Filter Backwash delivery and suction pipework fitting details (Sheet 1 of 4)
J31067/MECH/216-02	Filter Backwash delivery and suction pipework fitting details (Sheet 2 of 4)
J31067/MECH/216-03	Filter Backwash delivery and suction pipework fitting details (Sheet 3 of 4)
J31067/MECH/216-04	Filter Backwash delivery and suction pipework fitting details (Sheet 4 of 4)
J31067/MECH_220-01	Rapid Gravity Sand Filter1 - Sheet 1 of 10
J31067/MECH_220-02	Rapid Gravity Sand Filter1 - Sheet 2 of 10
J31067/MECH_220-03	Rapid Gravity Sand Filter1 - Sheet 3 of 10
J31067/MECH_220-04	Rapid Gravity Sand Filter1 - Sheet 4 of 10
J31067/MECH_220-05	Rapid Gravity Sand Filter1 - Sheet 5 of 10
J31067/MECH_220-06	Rapid Gravity Sand Filter1 - Sheet 6 of 10
J31067/MECH_220-07	Rapid Gravity Sand Filter1 - Sheet 7 of 10
J31067/MECH_220-08	Rapid Gravity Sand Filter1 - Sheet 8 of 10
J31067/MECH_220-09	Rapid Gravity Sand Filter1 - Sheet 9 of 10
J31067/MECH_220-10	Rapid Gravity Sand Filter1 - Sheet 10 of 10
J31067/MECH/221	Air Blower Delivery Pipework (Indicative)
J31067/MECH/222	Chlorine dosing delivery pipework (indicative)
J31067-MECH_240-01	Filter Pump Building (sheet 1 of 2)
J31067-MECH_240-02	Filter Pump Building (sheet 2 of 2)
J31067/MECH/250-01	2 No. 5Ml Reservoirs: Floor, roof plan and sections
	-
J31067_MECH_260-01	600kL Sludge Storage Reservoir (Sheet 1 of 2)
J31067_MECH_260-02	600kL Sludge Storage Reservoir (Sheet 2 of 2)
	-
J31067/MECH/270-01	Sludge Dehydrator Sludge Stockpile Slab
J31067/MECH/270-02	Sludge Dehydrator Building & Platform
J31067/MECH/280-01	Meter and Flow control chamber: Concrete Work
J31067/MECH/280-02	Meter and Flow control chamber: Pipework
J31067/MECH/290	Division box to clariflocculators
J31067/MECH/300	Sludge pond inlet/outlet box detail
J31067/MECH/310-02	Interlinking Pipework Chambers & Details Sheet 1 of 2
J31067/MECH/310-04	Interlinking Pipework Chambers & Details Sheet 2 of 2
J31067/MECH/320-01	Clear Water Pumpstation and Electrical building (Sheet 1 of 7)
J31067/MECH/320-02	Clear Water Pumpstation and Electrical building (Sheet 2 of 7)
J31067/MECH/320-03	Clear Water Pumpstation and Electrical building (Sheet 3 of 7)

J31067/MECH/320-04	Clear Water Pumpstation and Electrical building (Sheet 4 of 7)
J31067/MECH/320-05	Clear Water Pumpstation and Electrical building (Sheet 5 of 7)
J31067/MECH/320-06	Clear Water Pumpstation and Electrical building (Sheet 6 of 7)
J31067/MECH/320-07	Clear Water Pumpstation and Electrical building (Sheet 7 of 7)
J31067/MECH/321-01	Diesel Tank bund wall and canopy Structural Details Sheet 1 of 3
J31067/MECH/321-02	Diesel Tank bund wall and canopy Structural Details Sheet 2 of 3
J31067/MECH/321-03	Diesel Tank bund wall and canopy Structural Details Sheet 3 of 3
J31067-MECH_330-01	Backwash Recycle Pumpstation (Sheet 1 of 3)
J31067-MECH_330-02	Backwash Recycle Pumpstation (Sheet 2 of 3)
J31067-MECH_330-03	Backwash Recycle Pumpstation (Sheet 3 of 3)
J31067/MECH/340-01	Sludge Supernatant Recycle Pumpstation
J31067-DET_401-01 ME	Chlorination Building (Sheet 1 of 2)
J31067-DET_401-02 ME	Chlorination Building (Sheet 2 of 2)
J31067/MECH/430	Dosing Building
J31067/MECH/500-01	Rosedale Isolation and Scour Chamber Pipework Details Sheet 5 of 7
J31067/MECH/500-02	Rosedale Isolation and Scour Chamber Pipework Details Sheet 7 of 7
J31067/MECH/600	Nqadu Isolation, Meter and Scour Chamber Concrete Work
J31067/MECH/650-01	Temporary Raw Water Abstraction Pumps: Locality Plan
J31067/MECH/650-02	Temporary Raw Water Abstraction Pumps: Suction Pipe: Plan & Longsection
J31067/MECH/650-03	Temporary Raw Water Abstraction Pumps: Intake Steelwork Detail
J31067/MECH/650-04	Temporary Raw Water Abstraction Pumps: Pumpstation Plan
J31067/MECH/650-05	Temporary Raw Water Abstraction Pumps: Pumpstation Sections
J31067/MECH/651	Raw Water Rising Main: Flow Meter Chamber
CIVIL DRAWINGS (CIV)	
J31067/CIV/650-02	Temporary Raw Water Abstraction Pumps: Pumpstation Layout Detail
J31067/CIV/650-03	Temporary Raw Water Abstraction Pumps Electrical & Guard Room Building
J31067/CIV/650-04	Temporary Raw Water Abstraction Pumps: Elec & Guard Room: Finishes Sch
J31067/CIV/650-05	Temporary Raw Water Rising Main: PI0 to AV Tie In Point Plan & Longsection
J31067/CIV/651	Raw Water Rising Main: Flow Meter Chamber
J31067/CIV/700	KSDLM Electrical Building
ELECTRICAL DRAWINGS (ELE)	
J31067/ELE/101	Electrical Site plan Layout
J31067/ELE/110	Electrical Sleeve Layout for Instrumentation and Fibre optic cables
J31067/ELE/120	High Mast Layout
J31067/ELE/220	Rapid Gravity Sand Filter: Lighting and Power Layout
J31067/ELE/240	Filter Plant Room: Lighting and Power Layout
J31067/ELE/320	Clear water Pumpstation & Electrical Building: Lighting and Power Layout
J31067/ELE/330	Backwash Recycle Pumpstation Building: Lighting and Power Layout
J31067/ELE/340	Sludge Supernatant Recycle Pumpstation Building: Lighting & Power Layout
J31067/ELE/350	Workshop: Lighting and Power Layout
J31067/ELE/400	Chlorination Building: Lighting and Power Layout
J31067/ELE/410	Administration Building: Lighting and Power Layout
J31067/ELE/420	Guard House: Lighting and Power Layout
J31067/ELE/430	Dosing Building: Lighting and Power Layout
J31067/ELE/440	Staff Member Type A: Lighting and Power Layout
J31067/ELE/441	Staff Member Type B: Lighting and Power Layout
J31067/ELE/150	Instrumentation and PLC Diagram Page 1
J31067/ELE/151	Instrumentation and PLC Diagram Page 2
J31067/ELE/160	Single Line Diagram Sheet 1
J31067/ELE/161	Single Line Diagram Sheet 2
J31067/ELE/161A	Single Line Diagram Sheet 3
J31067/ELE/162	Switchgear Panel
J31067/ELE/163	PLC Network Architecture
J31067/ELE/164	GA of Typical Out-station

J31067/ELE/165	GA of Power Kiosk
J31067/ELE/166	Typical MCC Panel
J31067/ELE/167	Typical Schematic Diagram
J31067/ELE/100	Raw Water Pumpstation: Lighting and Power Layout
P&ID DRAWINGS	
J31067-PID_001	P&ID Symbols
J31067-PID_101	P&ID Temporary Raw Water Pumps
J31067-PID_300	P&ID Overall Layout
J31067-PID_301	P&ID Raw Water Reservoir & Inlet Works
J31067-PID_302	P&ID Poly Dosing System
J31067-PID_303	P&ID Clariflocculators
J31067-PID_304	P&ID Filter Building No1
J31067-PID_305	P&ID Filter Building No2
J31067-PID_306	P&ID Filter Plant Room & Clear Water Reservoirs
J31067-PID_307	P&ID Clear Water Pumpstation and Isolation Chamber
J31067-PID_308	P&ID Backwash Recycling Tank and Pumps
J31067-PID_309	P&ID Sludge Holding Tank and Sludge Return Pumpstation
J31067-PID_310	P&ID Chlorine Dosing and Scrubber System
J31067-PID_311	P&ID Standby Generator & Fuel System
STANDARD DRAWINGS (STD)	
J31067/STD/001	Nameboard
J31067/STD/002	Miscellaneous Pipe &Chamber Details
J31067/STD/019	Insulating Flange Detail

*** DRAWINGS ISSUED via DOWNLOAD LINK ***

C7 RINGFENCED BoQ FOR LOCAL SMMEs

The attached BoQ is provided for information only.

SECTION: 1 PRELIMINARY AND GENERAL

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
1.1	**SANS 1200A 8.3**	**SCHEDULED FIXED CHARGE AND VALUE RELATED ITEMS**				
1.1.1	8.3.1	Contractual Requirements	Sum	1		
	8.3.2 PSAB 8.2.1 to 8.2.9	Establishment of Facilities on Site				
	8.3.2.2	2) Facilities for SubContractors				
1.1.2		a) Office and storage sheds	Sum	1		
1.1.3		b) Workshops	Sum	1		
1.1.4		e) Ablution and latrine facilities	Sum	1		
1.1.5		f) Tools and equipment	Sum	1		
1.1.6		g) Water supply, electric power and communications.	Sum	1		
1.1.7		h) Dealing with water (Sub-clause 5.5)	Sum	1		
1.1.8		i) Access (Sub-clause 5.8)	Sum	1		
1.1.9		j) Plant	Sum	1		
1.1.10		k) Security and fencing and hoarding	Sum	1		
1.1.11	8.3.3 PSA 8.2.1	General Responsibilities and other fixed charge obligations (including making allowance for effects and payments taking up to 60 days from date of invoice)	Sum	1		
		OH&S - Fixed Charges				
1.1.12		1a) OH&S documentation	Sum	1		
1.1.13		1b) Entry medicals for all workers	Sum	1		
1.1.14		1c) Provision of PPE and all other protective clothing incl all COVID prevention measures	Sum	1		
1.1.15		1d) Signage (warning, hazard etc)	Sum	1		
1.1.16		1e) Staff Training	Sum	1		
1.1.17		1f) First Aid	Sum	1		
1.1.18		1g) All other items	Sum	1		
1.1.19		2) Completing and checking the Project H&S File and handing over the Client on completion of the works and exit medicals for all workers	Sum	1		
		CARRIED FORWARD				

SECTION: 1 PRELIMINARY AND GENERAL

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
1.1.20		3) Provision of HIV/Aids Awareness plan and all necessary fixed charge items to achieve compliance with SANS 1921 Part 6 HIV/Aids Awareness	Sum	1		
		Environmental- Fixed Charges				
1.1.21	PSA 8.11	Fixed charges associated with complying with the Environmental Management Plan	Sum	1		
		Dis-establishment				
1.1.22	8.3.4	Removal of SubContractor's site establishment on completion of works	Sum	1		
1.2	**8.4 PSA 8.2.1**	**TIME-RELATED ITEMS**				
1.2.1	8.4.1	Contractual Requirements	Sum	1		
	8.4.2	Operate and maintain Facilities on Site for the duration of on-Site activities up to commencement of Trial Operating Period				
	8.4.2.2	2) Facilities for Contractor				
1.2.2		a) Office and storage sheds	Sum	1		
1.2.3		b) Workshops	Sum	1		
1.2.4		e) Ablution and latrine facilities	Sum	1		
1.2.5		f) Tools and equipment	Sum	1		
1.2.6		g) Water supply, electric power and communications.	Sum	1		
1.2.7		h) Dealing with water (Sub-clause 5.5)	Sum	1		
1.2.8		i) Access (Sub-clause 5.8)	Sum	1		
1.2.9		j) Plant	Sum	1		
1.2.10		k) Security and maintaining fencing & hoarding	Sum	1		
1.2.11	8.4.3	Supervision for duration of on-Site activities	Sum	1		
	PSA 8.9 PS - OHS	Time-related charges associated with complying with Health and Safety Requirements:				
1.2.12		1) Cost of Construction Safety Officer on Site	Sum	1		
		CARRIED FORWARD				

SECTION: **1 PRELIMINARY AND GENERAL**

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
1.2.13		2) Updating and amending the risk assessments, safe work procedures, the project H&S File, the H&S Plan, medicals for all workers, the provision of PPE and protective clothing and facilities and all other H&S matters that fulfill OHS Act 85 of 1993 and construction regulation 2014	Sum	1		
1.2.14		3) Full compliance with all H&S matters during the construction	Sum	1		
1.2.15		4) Compliance with SANS 1921 Part 6 HIV/Aids Awareness plan during the contract	Sum	1		
		<u>Environmental</u>				
1.2.16	PSA 8.11	Time-related charges associated with complying with the Environmental Management Plan	Sum	1		
TOTAL FOR SECTION 1 CARRIED FORWARD TO SUMMARY						

SECTION: 2 DAYWORKS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		Drilling holes in existing brick and concrete structures for electrical cables and small-bore pipes etc and making good afterwards				
	8.7	LABOUR				
2.1		a) Team leader / charge hand	hr	40		
2.2		f) Skilled	hr	80		
2.3		g Semi-skilled	hr	250		
2.4		h) Unskilled	hr	500		
	8.7	PLANT				
2.5		For plant used in execution of Dayworks at rate agreed with Engineer	PC Sum	1	100 000.00	100 000.00
	8.7	MATERIALS				
2.6		For materials used in execution of Dayworks as agreed with the Engineer	PC Sum	1	150 000.00	150 000.00
2.7		Overheads, Charges and Profit on item 2.6 above	%	150 000.00		
TOTAL FOR SECTION 2 CARRIED FORWARD TO SUMMARY						

SECTION: 3 TEMPORARY RAW WATER PUMPSTATION: SITE WORKS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
3.1	**SANS 1200C**	**SITE CLEARANCE**				
	8.2.1	Clear and grub areas to:				
3.1.1		Access Road to Pumpststion & site	m²	5000		
3.2	**SANS 1200 D**	**EARTHWORKS**				
	PSD 8.3.3	RESTRICTED EXCAVATION				
		Excavation for pumpstation plinth				
3.2.1		Excavate in all materials to spoil for pumpstation (spoil within 1km)	m³	1000		
3.2.2		Extra-over item 3.2.1] for excavation in hard mudstone / siltstone using 30t excavator fitted with Heavy Duty Hydraulic Breaker	m³	600		
3.3	**SANS 1200DM**	**EARTHWORKS (ROADS, SUBGRADE)**				
		<u>Access Road</u>				
3.3.1	8.3.7	Box-cut at least 4m wide x 150mm in soft and intermediate material to line and level for access road and spoil within 1km	m³	400		
3.4	**SANS 1200ME**	**SUBBASE**				
		<u>Access Road</u>				
3.4.1	8.3.3	Construct 150mm thick gravel wearing course 4m wide with approved G7 material from commercial sources	m³	300		
3.5	**SANS 1200DK**	**GABIONS & PITCHING**				
		<u>Wave Barrier and Retaining Wall</u>				
3.5.1	8.2.2	Supply and installation of 1m x 1m x 2m Gabion Baskets constructed of 2,7 mm galvanized wire, mesh size 80 x 100 mm, diaphragm spacing 1 m, selvedge 3,4 mm, including rock fill as directed by the Engineer.	m³	50		
3.5.2	8.2.4	Geofabric (Bidim A4 or Similar approved)	m²	100		
3.6	**SANS 1200 G**	**CONCRETE**				
3.6.1	8.2	FORMWORK				
	8.2.1	Rough:				
		CARRIED FORWARD				

SECTION: 3 TEMPORARY RAW WATER PUMPSTATION: SITE WORKS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
	8.2.5	Rough vertical plane narrow widths:				
3.6.1.1		hidden faces Floor slab	m	35		
		vertical plane to elements:				
3.6.1.2		Anchor blocks	m²	15		
	8.2.2	Smooth:				
		vertical plane to elements:				
3.6.1.3		Pump Plinths etc	m²	6.3		
3.6.2	8.3	REINFORCEMENT				
3.6.2.1	8.3.1	Mild steel bars up to 12mm	t	0.5		
3.6.2.2	8.3.1	High tensile steel bars 25mm dia (basic price)	t	2		
	8.3.1	High-tensile steel bars:				
3.6.2.3		10 to 12 mm dia	t	3.5		
3.6.3	8.4	CONCRETE				
		15 MPa/19mm concrete				
3.6.3.1	8.4.2	50mm blinding under strip footings, retaining wall footings, bases, cable and drainage trench floors	m³	4.5		
3.6.3.2		Surfacing to access ramps to Engineer's direction on site	m³	10		
	8.4.3	Strength concrete				
		Grade 15 MPa/19 mm:				
3.6.3.3		Pipe supports and pipe encasement	m³	1		
3.6.3.4		Mass concrete for thrust block encasement on pipes	m³	2		
		Grade 30 MPa/19mm for:				
3.6.3.5		Floor	m³	10		
3.6.3.6		Pump Plinth	m³	12		
3.6.3.7		Walls	m³	10		
3.6.4	PSG 8.4.4	UNFORMED SURFACE FINISHES				
		Wood Float finish				
3.6.4.1		Concreted floor	m²	14		
		CARRIED FORWARD				

SECTION: 3 TEMPORARY RAW WATER PUMPSTATION: SITE WORKS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		Steel-float finish to horizontal surfaces:				
3.6.4.2		Top of plinths etc	m²	6		
		Access road conc surfacing at ramps				
3.6.4.3		Roughened finish for skid resistance	m²	100		
3.7		**FENCING**				
		2.1m High 25mmx50mm Weld Mesh Perimeter Fence				
3.7.1		Construct fencing complete as per Drawing STD -561 including Excavations, concrete ground beam, standards, straining and corner posts, straining wires, concertina razor coils, labour, materials etc	m	100		
3.8		**BUILDING WORK (SPEC QB)**				
3.8.1	QB 6.2.4	BRICKWORK				
		Brickwork of NFX bricks (14 MPa nominal compressive strength) in class II mortar				
3.8.1.1		230mm low retaining walls	m²	10		
TOTAL FOR SECTION 3 CARRIED FORWARD TO SUMMARY						

SECTION: 4 TEMPORARY RAW WATER RISING MAIN

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		DN500 pipeline from Temporary Raw Water Pumpstation at Mthatha Dam to tie-in point at existing Raw Water Rising Main to Highbury WTW				
4.1	**SANS 1200 DB**	**EARTHWORKS (TRENCHES)**				
4.1.1	PSDB 8.3.1	SITE CLEARANCE				
		Clear and Grub				
4.1.1.1		Strips, 3m wide	m	642		
4.1.1.2		Remove topsoil to a nominal depth of 150 mm, 3m wide strip	m²	2100		
4.1.2	PSDB 8.3.2	TRENCH EXCAVATION				
		From Flow Meter Chamber at Pumpstation to where RM joins existing DN1200 steel Raw Water Rising Main				
	8.3.2(a)	Excavate in all materials for trenches, backfill, compact and dispose of surplus unsuitable material, for DN500 GRP pipes for depths				
		Over but not exceeding				
4.1.2.1		1,0 m 2,0 m	m	342		
4.1.2.2		Extra Over Item 4.1.2.1 for hard rock excavation using controlled blasting	m³	250		
4.1.2.3		Extra Over Item 4.1.2.1 for hard rock excavation using expanding grout rock splitting	m³	25		
		Last 300m on top of existing 1200mm Rising Main (excavated backfill to be conserved for backfilling of temporary RM)				
4.1.2.4		Hand excavation at 20m intervals to confirm depth to crown of existing DN1200 steel Rising Main	m³	100		
	8.3.2(a)	Excavate in soft material for trench over existing pipe, backfill and compact and dispose of any surplus material for DN500 GRP pipes for depths				
		Over but not exceeding				
4.1.2.5		1,0 m 2,0 m	m	300		
4.2	**SANS 1200 L**	**MEDIUM PRESSURE PIPELINES**				
		CARRIED FORWARD				

SECTION: 4 TEMPORARY RAW WATER RISING MAIN

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		GRP PIPES				
	PSL 8.2.1 a)	Supply, handle, lay, joint, bed and test pressure pipe complete with standard couplings:				
4.2.1		DN500 PN10 SN5000 GRP pipes	m	642		
		BENDS & ADAPTORS				
	PSL 8.2.2	Extra over items 4.2.1 for supply, lay and bed GRP pipe specials, complete with GRP sleeve couplings				
4.2.2		DN500 PN10: 5 to 60 degree bend	No	3		
4.2.3		DN500 PN10: 61 to 90 degree bend	No	1		
4.2.4		DN500 PN10 GRP flange adaptor	No	2		
		FITTINGS AT TIE-IN TO EXISTING RISING MAIN				
		Refer to drg CIV/650-03				
4.2.5		Item 2: DN600 x DN500 flanged mild steel epoxy coated and lined gusseted tee	No	1		
4.2.6		Item 3: DN500 PN10 flanged nozzle-type Non-Return Valve ("Vent-O-Mat NCV-BK" or similar approved)	No	1		
4.2.7		Item 4: DN500 x DN50 PN10 flanged mild steel epoxy coated and lined tee	No	1		
4.2.8		Item 5: DN50 PN10 flanged RSV valve with handwheel	No.	1		
4.2.9		Item 6: DN50 Flanged Double-Acting Air Valve with "Anti-shock" function; "Variant 50LX" or similar approved	No.	1		
		PIPELINE MARKERS				
4.2.10	PSL 8.2.16	Supply and install concrete pipe markers as detailed on standard Drawing No J31067STD/102 at 50m intervals along pipe route or at changes in direction	No	6		
4.3	**SANS 1200LB**	**BEDDING (PIPES)**				
	PSLB8.2.1	Provision of imported bedding and selected fill from commercial sources ('Sibunga'):				
4.3.1	a)	Selected granular material	m³	500		
		CARRIED FORWARD				

SECTION: 4 TEMPORARY RAW WATER RISING MAIN

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
4.3.2	b)	Selected fill material	m³	170		
		Extra over 4.3.1 to 4.3.1 pipe bedding as stated below				
4.3.3		For 6% cement stablised bedding material around pipe (to 300mm above crown) for pipes crossing under roads or where directed by the Engineer	m³	30		
4.4	**PSA 8.13**	**TIE-IN TO EXISTING HIGHBURY RAW WATER RSING MAIN**				
		Tie into existing Air Valve chamber on existing DN1200 steel rising main. Refer to CIV/650-03 for details of modifications and fittings required				
4.4.1		Excavate by hand in soft material on one side of existing Air Valve Chamber to expose tie-in point and backfill and compact on completion of tie-in	m³	10		
4.4.2	PSA 8.13	Remove 2m dia x 150mm thick precast concrete cover slab and unbolt DN600 blank flange over pipeline access tee (item 1 on drg) and cut out 800 x 800 opening in 2m dia precast concrete 100mm thick chamber wall for connecting-in temporary rising main and, on completion of tie-in pipework, re-instate DN600 blank flange onto new tee and reinstate chamber cover slab (Employer's Agent to arrange draining of existing Rising Main)	Sum	1		
4.5	**PSA8-13**	**BRICK CHAMBERS**				
		1): Construct flow meter chamber around pipework next to Raw Water Pumpstation Electrical Room (pipework supplied and installed by others). See Drg CIV 651.				
		2): Construct air valve chamber around existing Rising Main Air Vlave Chamber at tie-in point See Drg CIV 650-03.				
		Brickwork				
4.5.1		Supply and lay 230mm walls using approved hard-burnt clay facebrick for chamber walls (unplastered)	m²	16		
		Stepirons				
4.5.2		Supply and install polypropylene-coated steel stepirons including drilling into brick and concrete	No.	12		
		CARRIED FORWARD				

SECTION: 4 TEMPORARY RAW WATER RISING MAIN

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		Air Vents				
4.5.3		Per Chamber: Supply and build-in 12 No. 50mm uPVC air vent pipes 230mm long immediately below roof slab (6No. one side, 6No. opposite side)	No.	24		
		Access Cover Slab & Frames				
4.5.4		Cast RC cover slab with box-out for access (incl shuttering & Y12 @200 at bottom each way)	No	2		
4.5.5		Supply and cast-in 650x650mm GMS access MH frame with hinged cover as per DRG /STD/104 (padlocks to be supplied under Dayworks materials)	No.	2		
TOTAL FOR SECTION 4 CARRIED FORWARD TO SUMMARY						

SECTION: 5 TEMPORARY RAW WATER PUMPSTATION: GUARDROOM & ELEC BUILDING

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
5.1	**SANS 1200D**	**EARTHWORKS**				
5.1.1	8.3.3	RESTRICTED EXCAVATION				
		Excavation in all materials not exceeding 2m deep and dispose of to spoil or stockpile or backfill				
5.1.1.1		Strip footings for walls	m³	15		
5.1.1.2		Cable Trenches	m³	7.2		
5.1.1.3		Flow Meter floor	m³	9		
5.1.1.4		Remove and spoil unsuitable material under floor slabs to depth as directed by the Engineer	m³	12		
		Floor slab foundation layers				
5.1.1.5		Import selected G5 material from commercial sources, place in layers not exceeding 150mm, compact to 98% ModAASHTO, including trimming of surface ready to receive floor slab	m³	10		
5.1.1.6		Selected infill materiaL ripped and recompacted, place in layers not exceeding 150mm, compact to 93% ModAASHTO	m²	5		
5.2	**SANS 1200G**	**CONCRETE (STRUCTURAL)**				
5.2.1	8.1.1	FORMWORK				
	8.2.1	Rough vertical plane to elements				
5.2.1.1		Strip footings over bases	m²	11		
5.2.1.2		To sides of stooling under strip footings	m²	8		
5.2.1.3		Sides of column bases	m²	7.2		
	8.2.2	Smooth Vertical Plane to elements:				
5.2.1.4		Columns	m²	24		
5.2.1.5		Cable trench walls and sump walls	m²	32		
5.2.1.6		Plinths	m²	1.3		
	8.2.2	Smooth Horizontal Plane to Elements:				
5.2.1.7		Beams	m²	22		
5.2.1.8		Suspended slabs	m²	36.2		
	8.2.5	Smooth Narrow widths up to 400mm high for:				
		CARRIED FORWARD				

SECTION: 5 TEMPORARY RAW WATER PUMPSTATION: GUARDROOM & ELEC BUILDING

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
5.2.1.9		Suspended slabs (roofs)	m	25		
5.2.1.10		Suspended beams	m	49		
5.2.1.11		Edges of Ramps	m	7		
5.2.1.12		V-channel sides	m	24		
	8.2.5	<u>Boxing in to formwork to form rebates,etc</u>				
5.2.1.13		Formwork to edge of trench wall to form 50 x 50mm rebate along top edge to suit 45 x 45 x 5mm GMS angle (measured aswhere) framing section cast into concrete	m	23		
5.2.1.14		Rainwater drip	m	26		
5.2.1.15		Formwork in V-Channel to form rounded edge finish at top of contraction joint	m	36		
		Chafers exceeeding 20x20mm				
		<u>25x25mm chamfers to edges of :</u>				
5.2.1.16		Suspended slabs	m	52		
5.2.1.17		Plinths	m	10		
		BOXOUTS				
	8.2.6	Box out holes/Formwork/form voids/cast in pipes and fittings/ sleeves and conduits				
5.2.1.18	8.2.6.a.1	Small Circular of diameter up to and including 0.35m	No.	1		
5.2.2	8.1.2	<u>REINFORCEMENT</u>				
5.2.2.1	8.3.1	Mild steel reinforcement: (all sizes)	t	0.07		
5.2.2.2	8.3.2	High tensile steel reinforcement (all sizes)	t	5		
		<u>High-tensile welded mesh:</u>				
5.2.2.3		Type 395 mesh reinforcement (double layer) in concrete surface bed	m²	200		
5.2.3	8.1.3	<u>CONCRETE</u>				
		<u>Mass Concrete</u>				
		<u>15MPa/19mm concrete</u>				
5.2.3.1		Strip footings	m³	10		
		CARRIED FORWARD				

SECTION: 5 TEMPORARY RAW WATER PUMPSTATION: GUARDROOM & ELEC BUILDING

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
	8.4.3	Strength Concrete				
		25MPa/19mm concrete				
5.2.3.2		Floor slab	m³	9.3		
5.2.3.3		Suspended beams and roof slab	m³	4		
5.2.3.4		Surface bed cast in panels on waterproofing	m³	5.5		
5.2.4	8.4.4	UNFORMED SURFACE FINISHES				
		Smooth top surface of concrete with steel-float finish to horizontal surfaces:				
5.2.4.1		Top of suspended roof slab	m²	47		
5.2.4.2		Top of cable trench foundation and sumps	m²	5		
5.2.4.3		Top of cable trench wall	m²	4.1		
		Steel-floated finish to horizontal surfaces:				
5.2.4.4		Surface bed and chamber floor slab and ramp	m²	26		
5.3		**BUILDING WORK (SPEC QB)**				
5.3.1		BRICKWORK				
		SUPPLEMENTARY PREAMBLES				
		"one brick" is a double-skin wall and "half brick" is a single-skin wall				
		Foundations:				
		Brickwork of NFX bricks (14 MPa nominal compressive strength) in class II mortar				
5.3.1.1		230mm brick wall	m²	14		
		Superstructure				
		Brickwork of NFX bricks (14 MPa nominal compressive strength) in class II mortar				
5.3.1.2		230mm brick wall	m²	25		
	QB 6.2.4	FACE BRICKWORK				
		Extra over items 5.3.1.1 and 5.3.1.2 brickwork for single sided face brickwork				
		CARRIED FORWARD				

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		"Corobrick Montana Travertine FBS" or similar approved face bricks to Internal and External Face of walls (unless otherwise specified) pointed with recessed horizontal and vertical joints				
5.3.1.3		Superstructure brickwork	m²	77		
	QB 6.2.12	Setting/casting the following pipes into or through brickwork, including concrete/grouting work, making good, fixing, securing for accuracy for the listed fittings below:				
5.3.1.4		DN100 steel pipe through 220mm brickwork	No.	1		
	QB 6.2.4	<u>BRICKWORK SUNDRIES</u>				
		<u>Brickwork reinforcement</u>				
5.3.1.5		150mm Wide reinforcement built in horizontally	m	250		
		<u>Prestressed fabricated lintels</u>				
5.3.1.6		150 x 70mm Lintels in lengths not exceeding 4m	m	1		
		<u>Galvanised hoop iron cramps, ties, etc.</u>				
5.3.1.7		30 x 1,6mm Wall tie 450mm long with one end shot pinned to concrete and other end built into brickwork	No	120		
5.3.2		<u>WATERPROOFING</u>				
		One layer of 375 micron "Consol Plastics Brikgrip DPC" embossed damp proof course				
5.3.2.1		In walls	m²	5.5		
		One layer of 500 micron "Consol Plastics Gunplas USB Green" waterproof sheeting sealed at laps with "Gunplas Pressure Sensitive Tape"				
5.3.2.2		Under surface bed and ramp	m²	26		
5.3.2.3		Under cable trench floor	m²	9.7		
		One layer derbigum SP4 waterproofing membrane, with 75mm side and 100mm end laps, sealed to bitumen primed surface to falls and crossfalls by means of ' Torchfusion'. Finish with reflective aluminium-Bitumen paint. Waterproofing to be carried out by an approved derbigum contractor.				
		CARRIED FORWARD				

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
5.3.2.4		Derbigum waterproofing	m²	47		
5.3.3		CARPENTRY AND JOINERY				
		Doors				
		Design Supply, manufacture, deliver, install doors, including all ironmongery, frames, joinery, hinges, locks,as per finishing schedules (DRG CIV 650-05)				
5.3.3.1		D01 Aluminium external single door	No	1		
5.3.3.2		D02 Semi-solid core internal single door	No.	1		
5.3.3.3		D03 GMS double door with removable panel above 1800W x 2800H	No	1		
		Windows				
5.3.3.4		W01 Aluminium sliding + fixed window 1646W x 1225H as per Finishing Schedule	No	3		
5.3.3.5		W02 Aluminium top-hung window 600W x 600H as per Finishing Schedule	No	1		
5.3.4		METALWORK				
	SANS 1200H 8.3.9	Open Grid Flooing				
		Galvanised "Rectagrid" type RS40 grating flooring panels with 40 x 4,5mm bearer bars, welded to bearers				
5.3.4.1		Floor of banded panels	t	0.26		
5.3.4.2		45 x 45 x 5mm Galvanized mild steel angle framing section cast into concrete edge with fishtail lugs at 600mm centres	t	0.085		
5.3.5		INTERNAL PLASTER				
		Cement plaster on brickwork				
5.3.5.1		On walls	m²	77		
5.3.5.2		On narrow widths	m²	15		
5.3.6		PAINTWORK				
		CARRIED FORWARD				

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		One coat alkali resistant primer, one coat masonry filler rubbed and sanded smooth to an approved finish, one undercoat and two coats Acrylic PVA paint				
5.3.6.1		On internal walls	m²	78		
TOTAL FOR SECTION 5 CARRIED FORWARD TO SUMMARY						

SECTION: 6 SCREED TO CLARIFLOCCULATOR FLOORS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		Screeding of sloping foors to be done once rotating bridges have been installed. Main Contractor will operate bridge as screeding guide.				
6.1		Supply and deliver concrete screed to Site (as directed by Emplyer's Agent)	PC Sum	1	600 000.00	600 000.00
6.2		Mark-up on above	%	600 000.00	10.00%	60 000.00
6.3		Screed to suit rotaing bridge scrapers and complete steel trowelling of surface	m²	1930		
TOTAL FOR SECTION 6 CARRIED FORWARD TO SUMMARY						

SECTION: 7 CLEAR WATER PUMPSTATION EXCAVATION AND BACKFILL FOR PIPES

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		Refer to drawing J31067-MECH/320/01-07.				
		BURIED SUCTION & DELIVERY PIPELINES				
		Pipes supplied and laid by Mech Contractor				
7.1	**SABS 1200D**	**EARTHWORKS**				
	8.3.3	RESTRICTED EXCAVATION				
7.1.1	a)	Restricted excavation for pipes in all materials, haul to on-site spoil embankment, place and compact	m³	75		
7.1.2	b)	Extra over Item 7.1.1 for hard rock excavation	m³	10		
7.2	**SANS 1200LB PSL 8.2.5**	**BEDDING**				
	8.2.2	Provision of bedding material importated from commercial sources (to full depth of trench to underside basecourse layer				
7.2.1		Selected granular material (Sibunga)	m³	70		
7.3	**SABS 1200 G**	**CONCRETE**				
	8.2	FORMWORK				
	8.2.2	Smooth vertical plain				
7.3.1		Pipe supports	m²	5		
	PSG 8.4.7	Setting/casting pipes in concrete box-outs:				
7.3.2		DN 800 steel through walls up to 500mm thick	No	1		
	8.3	REINFORCEMENT				
7.3.3	8.3.1	Mild steel bars up to 12mm	t	0.2		
7.3.4	8.3.1	High tensile steel bars up to 16mm	t	1		
	8.4	CONCRETE				
	8.4.3	Strength concrete				
		Grade 15 MPa/19 mm:				
7.3.5		Mass filling where ordered (Provisional)	m³	2		
		Grade 25 MPa/19mm for:				
7.3.6		Pipe supports	m³	2		
		CARRIED FORWARD				

SECTION: 7 CLEAR WATER PUMPSTATION EXCAVATION AND BACKFILL FOR PIPES

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
7.4	**SANS 1200MF**	**BASE**				
	8.3.3 b	Construct base course over completed and backfilled pipeline with material from commercial sources				
7.4.1		G2 crusher run compacted to 100% Mod AASHTO	m³	25		
7.5	**SANS 1200MJ**	**SEGMENTED PAVING**				
	8.2.2	Pave over pipeline to complete the area platform previously-paved by others				
7.5.1		Construction of paving complete using 80mm concrete pavers to match existing and 20mm bedding sand	m²	80		
7.5.2	8.2.3	Cutting of pavers	m	40		
7.6		**BUILDING WORK (SPEC QB)**				
	QB 6.2.12	Make good openings in facebrick walls after pipes installed by others (using free-issue face bricks)				
7.6.1		DN500 steel pipe through 270mm cavity brickwork	No.	3		
7.6.2		DN200 steel pipe through 270mm cavity brickwork	No.	1		
7.6.3		DN250 steel pipe through 270mm cavity brickwork	No.	1		
TOTAL FOR SECTION 7 CARRIED FORWARD TO SUMMARY						

SECTION: 8 ELECTRICAL ROOM FOR KSDLM INCOMER

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
8.1	**SANS 1200D**	**EARTHWORKS**				
8.1.1	8.3.3	RESTRICTED EXCAVATION				
		Excavation in all materials not exceeding 2m deep and dispose of to spoil or stockpile or backfill				
8.1.1.1		Strip footings for walls	m³	15		
8.1.1.2		Cable Trenches	m³	7.2		
8.1.1.3		Flow Meter floor	m³	9		
8.1.1.4		Remove and spoil unsuitable material under floor slabs to depth as directed by the Engineer	m³	12		
		Floor slab foundation layers				
8.1.1.5		Import selected G5 material from commercial sources, place in layers not exceeding 150mm, compact to 98% ModAASHTO, including trimming of surface ready to receive floor slab	m³	10		
8.1.1.6		Selected infill materiaL ripped and recompacted, place in layers not exceeding 150mm, compact to 93% ModAASHTO	m²	5		
8.2	**SANS 1200G**	**CONCRETE (STRUCTURAL)**				
8.2.1	8.1.1	FORMWORK				
	8.2.1	Rough vertical plane to elements				
8.2.1.1		Strip footings over bases	m²	11		
8.2.1.2		To sides of stooling under strip footings	m²	8		
8.2.1.3		Sides of column bases	m²	7.2		
	8.2.2	Smooth Vertical Plane to elements:				
8.2.1.4		Columns	m²	24		
8.2.1.5		Cable trench walls and sump walls	m²	32		
8.2.1.6		Plinths	m²	1.3		
	8.2.2	Smooth Horizontal Plane to Elements:				
8.2.1.7		Beams	m²	22		
8.2.1.8		Suspended slabs	m²	36.2		
	8.2.5	Smooth Narrow widths up to 400mm high for:				
8.2.1.9		Suspended slabs (roofs)	m	25		
		CARRIED FORWARD				

SECTION: 8 ELECTRICAL ROOM FOR KSDLM INCOMER

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
8.2.1.10		Suspended beams	m	49		
8.2.1.11		Edges of Ramps	m	7		
8.2.1.12		V-channel sides	m	24		
	8.2.5	Boxing in to formwork to form rebates,etc				
8.2.1.13		Formwork to edge of trench wall to form 50 x 50mm rebate along top edge to suit 45 x 45 x 5mm GMS angle (measured aswhere) framing section cast into concrete	m	23		
8.2.1.14		Rainwater drip	m	26		
8.2.1.15		Formwork in V-Channel to form rounded edge finish at top of contraction joint	m	36		
		Chafers exceeeding 20x20mm				
		25x25mm chamfers to edges of :				
8.2.1.16		Suspended slabs	m	52		
8.2.1.17		Plinths	m	10		
8.2.2	8.1.2	REINFORCEMENT				
8.2.2.1	8.3.1	Mild steel reinforcement: (all sizes)	t	0.07		
8.2.2.2	8.3.2	High tensile steel reinforcement (all sizes)	t	5		
		High-tensile welded mesh:				
8.2.2.3		Type 395 mesh reinforcement (double layer) in concrete surface bed and ramp	m²	200		
8.2.2.4		Type 245 mesh reinforcement (single layer) in concrete V-channel	m²	40		
8.2.3	8.1.3	CONCRETE				
		Mass Concrete				
		15MPa/19mm concrete				
8.2.3.1		Strip footings	m³	10		
	8.4.3	Strength Concrete				
		25MPa/19mm concrete				
8.2.3.2		Floor slab	m³	9.3		
8.2.3.3		Suspended beams and roof slab	m³	4		
		CARRIED FORWARD				

SECTION: 8 ELECTRICAL ROOM FOR KSDLM INCOMER

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
8.2.3.4		Surface bed cast in panels on waterproofing and plinths	m³	5.5		
8.2.3.5		Cable trench footings and sump footings	m³	2.5		
8.2.3.6		Cable trench walls	m³	2.5		
8.2.3.7		Suspended roof slab	m³	12		
8.2.4	8.4.4	UNFORMED SURFACE FINISHES				
		Smooth top surface of concrete with steel-float finish to horizontal surfaces:				
8.2.4.1		Top of suspended roof slab	m²	47		
8.2.4.2		Top of cable trench foundation and sumps	m²	5		
8.2.4.3		Top of cable trench wall	m²	4.1		
		Steel-floated finish to horizontal surfaces:				
8.2.4.4		Surface bed and chamber floor slab and ramp	m²	26		
8.3		**BUILDING WORK (SPEC QB)**				
8.3.1		BRICKWORK				
		SUPPLEMENTARY PREAMBLES				
		"one brick" is a double-skin wall and "half brick" is a single-skin wall				
		Foundations:				
		Brickwork of NFX bricks (14 MPa nominal compressive strength) in class II mortar				
8.3.1.1		230mm brick wall	m²	14		
		Superstructure				
		Brickwork of NFX bricks (14 MPa nominal compressive strength) in class II mortar				
8.3.1.2		230mm brick wall	m²	25		
	QB 6.2.4	FACE BRICKWORK				
		Extra over items 5.3.1.1 and 5.3.1.2 brickwork for single sided face brickwork				
		"Corobrick Montana Travertine FBS" or similar approved face bricks to Internal and External Face of walls (unless otherwise specified) pointed with recessed horizontal and vertical joints				
		CARRIED FORWARD				

SECTION: 8 ELECTRICAL ROOM FOR KSDLM INCOMER

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
8.3.1.3		Superstructure brickwork	m²	77		
	QB 6.2.12	Setting/casting the following pipes into or through brickwork, including concrete/grouting work, making good, fixing, securing for accuracy for the listed fittings below:				
8.3.1.4		DN100 steel pipe through 220mm brickwork	No.	1		
	QB 6.2.4	<u>BRICKWORK SUNDRIES</u>				
		<u>Brickwork reinforcement</u>				
8.3.1.5		150mm Wide reinforcement built in horizontally	m	250		
		<u>Prestressed fabricated lintels</u>				
8.3.1.6		150 x 70mm Lintels in lengths not exceeding 4m	m	1		
		<u>Galvanised hoop iron cramps, ties, etc.</u>				
8.3.1.7		30 x 1,6mm Wall tie 450mm long with one end shot pinned to concrete and other end built into brickwork	No	120		
8.3.2		<u>WATERPROOFING</u>				
		One layer of 375 micron "Consol Plastics Brikgrip DPC" embossed damp proof course				
8.3.2.1		In walls	m²	5.5		
		One layer of 500 micron "Consol Plastics Gunplas USB Green" waterproof sheeting sealed at laps with "Gunplas Pressure Sensitive Tape"				
8.3.2.2		Under surface bed and ramp	m²	26		
8.3.2.3		Under cable trench floor	m²	9.7		
		One layer derbigum SP4 waterproofing membrane, with 75mm side and 100mm end laps, sealed to bitumen primed surface to falls and crossfalls by means of ' Torchfusion'. Finish with reflective aluminium-Bitumen paint. Waterproofing to be carried out by an approved derbigum contractor.				
8.3.2.4		Derbigum waterproofing	m²	47		
8.3.3		<u>CARPENTRY AND JOINERY</u>				
		Doors				
		CARRIED FORWARD				

SECTION: 8 ELECTRICAL ROOM FOR KSDLM INCOMER

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		Design Supply, manufacture, deliver, install doors, including all ironmongery, frames, joinery, hinges, locks, corrosion protection, as per finishing schedules (DRG CV 650-03)				
8.3.3.1		D03 GMS double door with removable panel above 1800W x 2800H	No	1		
8.3.4		<u>INTERNAL PLASTER</u>				
		<u>Cement plaster on brickwork</u>				
8.3.4.1		On walls	m²	77		
8.3.4.2		On narrow widths	m²	15		
8.3.5		<u>PAINTWORK</u>				
		One coat alkali resistant primer, one coat masonry filler rubbed and sanded smooth to an approved finish, one undercoat and two coats Acrylic PVA paint				
8.3.5.1		On internal walls	m²	78		
TOTAL FOR SECTION 8 CARRIED FORWARD TO SUMMARY						

SECTION: 9 BUILDING ELECTRICAL INSTALLATIONS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
9.1		**ELECTRICAL INSTALLATION FOR BUILDING WORK**				
		Supply, installation and commissioning of the complete electrical installation, inclusive of DB's, galvanized conduit, light switches, 15 A plug points , 63 A welding outlets, light fittings, signs and fire extinguisher of the following according to SABS 10142 and as specified in PSE 19				
		Electrical installations				
		Dosing Building				
9.1.1		Supply	Sum	1		
9.1.2		Install	Sum	1		
		Filter Plant Room Building				
9.1.3		Supply	Sum	1		
9.1.4		Install	Sum	1		
		Filter Building 1				
9.1.5		Supply	Sum	1		
9.1.6		Install	Sum	1		
		Filter Building 2				
9.1.7		Supply	Sum	1		
9.1.8		Install	Sum	1		
		Chlorine Building				
9.1.9		Supply	Sum	1		
9.1.10		Install	Sum	1		
		Backwash Recycling Building				
9.1.11		Supply	Sum	1		
9.1.12		Install	Sum	1		
		Clear Water Pump Station Building				
9.1.13		Supply	Sum	1		
9.1.14		Install	Sum	1		
		Sludge Dewatering Building				
9.1.15		Supply	Sum	1		
9.1.16		Install	Sum	1		
		CARRIED FORWARD				

SECTION: 9 BUILDING ELECTRICAL INSTALLATIONS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
		Supernatant Pump Station Building				
9.1.17		Supply	Sum	1		
9.1.18		Install	Sum	1		
		Temporary Raw Water Pump Station				
9.1.19		Supply	Sum	1		
9.1.20		Install	Sum	1		
		Workshop Shop				
9.1.21		Supply	Sum	1		
9.1.22		Install	Sum	1		
		Admin Building				
9.1.23		Supply	Sum	1		
9.1.24		Install	Sum	1		
		Guard House				
9.1.25		Supply	Sum	1		
9.1.26		Install	Sum	1		
		Staff Accomodation Type A				
9.1.27		Supply	Sum	1		
9.1.28		Install	Sum	1		
		Staff Accomodation Type B1-5				
9.1.29		Supply	Sum	5		
9.1.30		Install	Sum	5		
		Municipal MV metering Room				
9.1.31		Supply	Sum	1		
9.1.32		Install	Sum	1		
9.2		**CABLE ENTRIES**				
		Sealing of cable entries at buildings and cable ducts with Pratley Pearl for the following buildings:				
		Dosing Building				
9.2.1		Supply	Sum	1		
		CARRIED FORWARD				

SECTION: 9 BUILDING ELECTRICAL INSTALLATIONS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
9.2.2		Install	Sum	1		
		Filter Plant Room Building				
9.2.3		Supply	Sum	1		
9.2.4		Install	Sum	1		
		Filter Building 1				
9.2.5		Supply	Sum	1		
9.2.6		Install	Sum	1		
		Filter Building 2				
9.2.7		Supply	Sum	1		
9.2.8		Install	Sum	1		
		Chlorine Building				
9.2.9		Supply	Sum	1		
9.2.10		Install	Sum	1		
		Backwash Recycling Building				
9.2.11		Supply	Sum	1		
9.2.12		Install	Sum	1		
		Clear Water Pump Station Building				
9.2.13		Supply	Sum	1		
9.2.14		Install	Sum	1		
		Sludge Dewatering Building				
9.2.15		Supply	Sum	1		
9.2.16		Install	Sum	1		
		Supernatant Pump Station Building				
9.2.17		Supply	Sum	1		
9.2.18		Install	Sum	1		
		Temporary Raw Water Pump Station				
9.2.19		Supply	Sum	1		
9.2.20		Install	Sum	1		
		Municipal MV metering Room				
		CARRIED FORWARD				

SECTION: 9 BUILDING ELECTRICAL INSTALLATIONS

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
9.2.21		Supply	Sum	1		
9.2.22		Install	Sum	1		
TOTAL FOR SECTION 9 CARRIED FORWARD TO SUMMARY						

SECTION: 10 ELECTRICAL EXCAVATION, BACKFILL AND SLEEVES

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
10.1		**EXCAVATIONS AND BACKFILLING**				
		Excavating to a depth of 1 m and 1m wide, backfilling and compacting to initial soil conditions. as specified in PSE 15				
		Earth and soft rock				
10.1.1		Supply	m	1500		
10.1.2		Install	m	1500		
		Hard rock (compressor work)				
10.1.3		Supply	m	1500		
10.1.4		Install	m	1500		
10.2		**BEDDING**				
		Supply and installation of a 200 mm thick bedding layer per running meter of soft sieved soil in existing trench for cable protection as specified in PSE 15				
10.2.1		Supply	m	3000		
10.2.2		Install	m	3000		
10.3		**DANGER TAPE**				
		Supply and installation of danger tape to a depth of 300 mm.				
10.3.1		Supply	m	3000		
10.3.2		Install	m	3000		
10.4		**SLEEVES**				
		Supply and installation of 12 m x 160mm dia PVC sleeves at road crossings				
10.4.1		Supply	No	10		
10.4.2		Install	No	10		
		Supply and installation of 50mm dia PVC sleeves at road crossings				
10.4.3		Supply	m	30		
10.4.4		Install	m	30		
TOTAL FOR SECTION 10 CARRIED FORWARD TO SUMMARY						

SECTION: 11 SLUDGE DEWATERING BUILDING

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		NOTE: Details of building to be confirmed with M&E Contracator				
11.1	**SANS 1200D**	**EARTHWORKS**				
	8.3.3	RESTRICTED EXCAVATION				
		Excavation in all materials not exceeding 2m deep and dispose of to spoil or stockpile or backfill				
11.1.1		For reinforced concrete floor slab, column bases and drainage channel	m³	20		
		Extra-over item 5.1.1 for				
11.1.2		Intermediate mudstone / siltstone using 30t excavator fitted with Heavy Duty Hydraulic Breaker	m³	10		
		Floor slab foundation layers				
11.1.3		Import selected G7 material from commercial sources, place in layers not exceeding 150mm, compact to 95% ModAASHTO, including trimming of surface ready to receive floor slab	m²	50		
11.2	**SANS 1200G**	**CONCRETE**				
11.2.1	8.2	FORMWORK				
	8.2.2	Smooth, vertical, plane to :				
11.2.1.1		Floor ducts, floor channels, sumps, etc.	m²	95		
		Smooth, vertical, plain, narrow widths to:				
11.2.1.2		sides (max 300mm) of apron slab and structure floor slab etc	m	20		
		Smooth, vertical, curved, narrow widths to:				
11.2.1.3		sides (max 300mm) of apron slab	m	100		
11.2.2	8.3	REINFORCEMENT				
11.2.2.1		Mild steel bars:	t	1		
11.2.2.2		High tensile steel bars (all sizes):	t	10		
	8.3.3	High-tensile welded mesh:				
11.2.2.3		Type reference 193 in concrete surface beds, slabs, etc	m²	200		
11.2.3	8.4	CONCRETE ITEMS				
		CARRIED FORWARD				

SECTION: 11 SLUDGE DEWATERING BUILDING

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
	8.4.1	Prescribed Mix Concrete				
		15MPa/19mm concrete				
11.2.3.1	8.4.2	50mm Surface blinding under suface bed	m²	100		
		25MPa/20mm concrete				
11.2.3.2		Bottoms and sides of floor ducts	m³	7		
11.2.3.3		Strip footings, bases and upstands	m³	11		
11.2.3.4		surface beds	m³	132		
11.2.3.5		Columns	m³	2		
11.2.3.6		Column bases	m³	6		
		Concrete encasing Pipes				
11.2.3.7		15MPa/19 mm bedding material 100mm below pipe, 200mm around pipe up to 300mm above crown for pipes crossing under slabs or where directed by the Engineer	m³	5		
	8.4.4	Unformed surface finishes				
		Wood-float finish to:				
11.2.3.8		Floor slab	m²	70		
		Steel-float finish to:				
11.2.3.9		tops of walls, etc	m²	8		
		Power-floated finish in:				
11.2.3.10		Apron slab	m²	70		
11.2.4	8.5	JOINTS				
		Saw cut joints				
11.2.4.1		3 x 35mm Saw cut joints in top of concrete	m	91		
11.3	**PSQB**	**BUILDING WORKS**				
11.3.1	PSQB	Brickwork				
		"Montana Travertine FBS" face bricks pointed with recessed horizontal and vertical joints				
		Facebrick both sides				
11.3.1.1		230mm brick wall	m²	90		
11.3.1.2		Extra over brickwork for face brickwork	m²	90		
		CARRIED FORWARD				

SECTION: 11 SLUDGE DEWATERING BUILDING

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		BROUGHT FORWARD				
11.3.1.3		Extra over brickwork for header course	m	10		
11.3.2		Brickwork reinforcement:				
11.3.2.1		Brickforce	m	180		
		Floor coatings by Specialist SubContractor:				
		Grind floor to sound concrete then clean-off all dust and loose material ready to apply coating, then prime and apply Sika Purcem 20N polyurethane screed, or similar approved product, to a nominal thickness of 6mm, in strict accordance to the manufacturer's specification.				
11.3.2.2		Dewatering facility floors	m²	50		
11.4	**SANS 1200 HA**	**STRUCTURAL STEELWORK (SUNDRY ITEMS)**				
11.4.1	8.3.1 PSHA 8.3.1 & 8.3.6	Structural steel				
		Supply and install hot-rolled sections				
11.4.1.1		IPE 120	kg	165		
11.4.1.2		50x50x5 angle braces	kg	38		
11.4.1.3		30x30x3 angle	kg	20		
11.4.1.4		Miscellanious small items (cleats etc)	kg	27		
		Supply and install cold-rolled sections				
11.4.1.5		100x75x20x2,5	kg	480		
		Supply and install sheetmetal cladding				
		0,5mm "Klip-Lok" Z275 spelter galvanised high yield steel ribbed sheeting with "Chromadek" finish on outside side and white on inside, in single lengths fixed to steel purlins or rails and 0,6mm galvanised steel accessories with "Chromadek" finish on one side				
11.4.1.6		Roof, sides and ends	m²	90		
11.4.1.7		Ridge capping	m	8		
11.4.1.8		Vertical closures	m	18		
TOTAL FOR SECTION 11 CARRIED FORWARD TO SUMMARY						

SECTION: 12 DISMANTLE ABANDONED & OBSOLETE CRANE

ITEM	PAYMENT REFERS	DESCRIPTION	UNIT	QUANTITY	RATE R	AMOUNT R
		There is a 40 ton abandoned tracked crane on the Highbury WTW Site. This is to be dismantled and disposed of. Quotes are to be invited from local SMME Contractors to break it up and cart away to scrap metal dealer / waste disposal site. The proceeds from the sale of iron and steel delivered to scrap metal dealers is to be used to fund local community training programs or similar as directed by the Employer.				
12.1		Preliminary & General items (fixed and time related); including H&S Plan and OH&S compliance and establishment of equipment and vehicles and staff amenities	Sum	1		
12.2		Step 1 - Remove all lubricants / hydraulic fluids etc from engine and power transmission system and dispose of at registered waste diposal site.	Sum	1		
12.3		Step 2 - Strip all non-metalic components from the crane and dispose of at registered waste disposal site.	Sum	1		
12.4		Step 3 - Remove / cut-up all steel haulage cables (use Oxy-Acetylene torch) and dismantle crane boom and jib and cut into transportable pieces and deliver to approved scrap metal dealer	Sum	1		
12.5		Step 4 - Remove all steel panelling and covers and engine, radiator and gearboxes and differentials and deliver to scrap metal dealer	Sum	1		
12.6		Step 5 - Cut-up all heavy cast-iron components (counter-weights, track plates, chassis / frame / axils)	Sum	1		
12.7		Clean-up Site on completion and remove and dispose of all contaminated soil	Sum	1		
12.8		Disestablish facilities	Sum	1		
TOTAL FOR SECTION 12 CARRIED FORWARD TO SUMMARY						