CONTRACT NO: RLM/RWST/OMM/0101/2024/25

RE-ADVERT: APPOINTMENT OF A CONTRACTOR FOR CONSTRUCTION OF BOSPOORT NORTH RESERVOIR AND ACCESS ROAD

JULY 2025

VOLUME 2: PARTICULAR SPECIFICATIONS, HEALTH AND SAFETY SPECIFICATIONS, ENVIRONMENTAL MANAGEMENT PLAN

NAME OF BIDDER: ……..

Prepared by:

RUSTENBURG WATER SERVICES TRUST
1A KOCK STREET
RUSTENBURG
0300

BID CLOSES: 29 July 2025 at 10:00

CONTENTS LIST

RLM/RWST/OMM/0101/2024/25 - RE-ADVERT: APPOINTMENT OF A CONTRACTOR FOR CONSTRUCTION OF BOSPOORT NORTH RESERVOIR AND ACCESS ROAD

Contents			
Number	**Heading**	**Volume**	**Colour**
The Tender			
Part T1: Tendering procedures		**Volume 1**	
T1.1	Tender Notice and Invitation to Tender		White
T1.2	Tender Data		Pink
T1.3	Standard Conditions of Tender		Pink
Part T2: Returnable documents		**Volume 1**	
T2.1	List of Returnable Documents		Yellow
T2.2	Returnable Schedules		Yellow
T2.3	Technical Schedules	**Volume 1**	Yellow
The Contract			
Part C1: Agreement and Contract Data		**Volume 1**	
C1.1	Form of Offer and Acceptance		Yellow
C1.2	Contract Data		Yellow
C1.3	Form of Guarantee		Yellow
C1.4	Occupational Health and Safety Agreement		Yellow
Part C2: Pricing data		**Volume 1**	
C2.1	Pricing Instructions		Yellow
C2.2	Bills of Quantities		Yellow
C2.2	Summary of Schedules		Yellow
Part C3: Scope of Work		**Volume 1**	
C3	Scope of Work		Blue
C3.1	Description of Works		Blue
C3.2	Engineering		Blue
C3.3	Procurement		Blue
C3.4	Construction (Specifications)		Blue

C3.4.1	General Clauses and Requirements		Blue
C3.4.2	Standard Specifications		Blue
C3.4.3	Particular Specifications	**Volume 2**	Blue
C3.4.4	Variations and Additions to Standard and Particular Specifications	**Volume 1**	Blue
C3.5	Management		Blue
C3.5.1	Management of the Works		Blue
C3.5.2	Reference to the Scope of Works in Terms of the Occupational Health and Safety Act and Regulations: Health and Safety Specification	**Volume 2**	Blue
C3.5.3	Environmental Management Plan	**Volume 2**	Blue
Part C4: Site information		**Volume 2**	
C4.1	Geotechnical information		Green
Book of Drawings		**Volume 3**	

C3.4.3.1 PARTICULAR SPECIFICATIONS FOR CIVIL WORKS

INDEX

PLK: MANUFACTURE AND SUPPLY OF VALVES

INDEX

PLK 1 SCOPE

This section of the Specification includes the manufacture, testing and supply of valves for the conveyance of raw or potable water at ambient temperatures in pipes under pressure.

PLK 2 STANDARDS

The most recent issues of the following standard specifications will apply for the purposes of this Specification.

SANS 144	:	Cast-iron single door non-return valves
SANS 191	:	Cast steel gate valves
SANS 192	:	Cast steel single door non-return valves
SANS 664	:	Cast iron gate valves for waterworks
SANS 665	:	Cast iron gate valves for general purposes
BS 5155	:	Cast iron and carbon steel Butterfly valves
ISO 2441	:	Pipeline flanges for general use - shapes and dimensions of pressure tight surfaces
SANS 1123	:	Steel pipe flanges
SIS 05 5900	:	Pictorial surface preparation standard for painting steel surfaces

PLK 3 MATERIALS

PLK 3.1 Sluice Valves

PLK 3.1.1 The valve body, bonnet, thrust dome, gate and glands shall be of cast iron or cast steel as specified and depending on the required test pressures.

PLK 3.1.2 The stuffing box shall be of ample depth to afford sufficient space for long period packing and the design shall be such as to allow the gland to be easily and conveniently repacked under pressure.

PLK 3.1.3 Body and gate sealing rings shall be of bronze, gunmetal or stainless steel. RSV gate shall be nitrile rubber covered and fully encapsulated. The rubber shall not be removed from the guides of the gate.

PLK 3.1.3 Spindles shall be of high grade stainless steel.

PLK 3.1.4 An isolating valve must be able to check the specified water pressure from both sides.

PLK 3.2 Butterfly Valves

PLK 3.2.1 Valve bodies and discs shall be of high-grade cast-iron or cast steel as specified and depending on the required test pressures.

PLK 3.2.2 The disc shaft or stub-shafts shall be of stainless steel located in self-lubricating bearings.

PLK 3.2.3 Sealing rings, seal retaining rings, body seatrings and associated screws shall be of stainless steel.

PLK 3.2.4 A butterfly valve must be able to check the specified water pressure from both sides.

PLK 3.3 Reflux Valves

PLK 3.3.1 Valve bodies shall be of cast iron or cast steel depending on the specification or test pressures.

PLK 3.3.2 Valve doors shall be of cast iron or cast steel.

PLK 3.3.3 The valve body and doors or disc shall be fitted with replaceable stainless steel body and door seat rings.

PLK 3.4 Air Valves

PLK 3.4.1 Function

Air valves are required to perform any combination of the following functions:

- Uninterrupted high volume air discharge through a large orifice during pipe filling.
- Uninterrupted high volume air intake through a large orifice during pipe emptying.
- Discharge of pressurised air through a small orifice during normal operation.
- Surge alleviation mechanism during rapid air discharge or rejoining of separated water columns.

PLK 3.4.2 Closing mechanism, construction and design

PLK 3.4.2.1 The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. Floats of spherical design shall not be accepted. Any hollow float design will not be acceptable due to implosion and distortion making sealing difficult or impossible.

PLK 3.4.2.2 The ends of the cylinder shall be of fusion bonded epoxy powder coated mild steel, secured by means of stainless steel tie rods.

PLK 3.4.2.3 Floats shall be housed in a tubular stainless steel or corrosion protected body, secured by means of stainless steel fasteners.

PLK 3.4.2.4 The seats, spindles, guides, etc shall be of a suitable non-corroding metal with sufficient clearance and shall be designed to prevent abrasion of the ball or float when subjected to frequent operation.

PLK 3.4.2.5 The seats of the orifices shall not have sharp edges and shall be designed so as not to damage the ball or float when subjected to pressure.

PLK 3.4.2.6 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.

The performance capability of an integral surge alleviation mechanism shall be substantiated through third party testing, conducted by a recognized authority.

PLK 3.4.2.7 Large orifice sealing shall be effected by the flat force of the control float seating against a nitrile rubber ‘O’ Ring housed in a dovetail groove circumferentially surrounding the large orifice.

Sealing in any other form shall not be accepted due to the vulcanizing of the float or the wedging of the float in the large orifice.

PLK 3.4.2.8 Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

Valves with slotted air release apertures shall not be considered.

PLK 3.4.2.9 The intake/discharge orifice area shall be equal to the nominal size of the valve i.e. a 200 mm valve shall have a 200 mm intake/discharge orifice.

Valves up to and including 200mm NB shall incorporate an over pressure safety feature that will fail without an explosive effect, such as is normally the case when highly compressed air is released suddenly. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

PLK 3.4.2.10 The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to 2 times the designed working pressure.

PLK 3.4.3 Testing

PLK 3.4.3.1 Manufacturers' published performance data must be substantiated by third party testing from a recognized test authority.

PLK 3.4.3.2 A high pressure strength and leak test whereby the valve is filled with water and pressurized to 2 times the rated working pressure which shall be held for a period of 2 minutes. Any leaking, weeping and sweating shall be a reason for rejection. These tests must be on total, completed units including floats.

PLK 3.4.3.3 Any imported valves shall be retested locally in all areas of specification.

PLK 3.4.4 Isolating valves for air valves

PLK 3.4.4.1 Each air valve shall be provided with a suitable double flanged resilient seal gate valve to isolate the air valve from the main.

PLK 3.4.4.2 The isolating valves shall be capable of operating in a horizontal position and shall be provided with a handwheel for operation and gearing is not required.

PLK 3.4.4.3 Each isolating valve shall be provided with a handwheel fitted to the spindle in an approved manner and shall have directional indication so cast into a recess on the upper surface of the rim that the top of the letter, arrows and rim are at the same level.

PLK 3.4.5 Drains

PLK 3.4.5.1 All air valves be provided with drain cocks so that the body of the valve can be drained when isolated from the pipeline. Cast steel gate valves shall be provided for this purpose.

PLK 3.4.6 Pressure gauge fitting

PLK 3.4.6.1 A 12-mm cast steel full bore gate valve shall be fitted to the spool piece between the isolating valve and the air valve flanges for attaching a pressure gauge.

PLK 3.5 Ring needle valves

PLK 3.5.1 The valve body shall be of spheroidal graphite iron or cast-steel with supporting feet. The body seat shall be of stainless steel and shall be replaceable or may be deposit welded on a removable body section.

PLK 3.5.2 For ring needle valves the piston (plunger) shall be of cast stainless steel with replaceable resilient seal to obtain drop tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws.

PLK 3.5.3 For spherical ball valves, the eccentrically supported ball plug shall be of cast stainless steel or spheroidal graphite iron with replaceable resilient seal to obtain drop-tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws. The valve body shall include an access door to permit adjustment or replacement of the valve seal without dismantling the valve.

PLK 3.6 Manufacture

PLK 3.6.1 General

PLK 3.6.1.1 The design pressure of the valves shall not be less than the pressure specified subject to a minimum of 1 000 kPa.

PLK 3.6.1.2 All valves shall be double-flanged with bolt holes drilled off-centre all in accordance with the requirements of SANS 1123 or as otherwise specified.

PLK 3.6.1.3 The Tenderer shall give as a function of the downstream pressure the maximum acceptable discharge of water through the valves without risks of vibration and cavitation. The Tenderer shall also submit the head-loss characteristics of the valves.

PLK 3.6.1.4 The design pressure will be hand stamped on the top edge of the flanges of valves in kPa.

PLK 3.6.1.5 If specified, valves shall be supplied with by-passes to be bolted on to the body of the valve and not to the adjoining pipework.

PLK 3.6.1.6 Valves shall be fitted with position indicators if specified. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators.

PLK 3.6.1.7 Arrows shall be cast on all handwheels together with the wording "OPEN" or "CLOSE". The closing direction shall be clockwise unless otherwise specified.

In the case of cap top valves, an aluminium disc of at least 100 mm diameter and with the same wording and arrows shall be slipped over the spindle and retained by the cap.

PLK 3.6.1.8 All valves shall be supplied complete including bolts, nuts, washers and gaskets in accordance with the class of valve. Bolts shall be of sufficient length to allow not more than three screw threads to protrude outside units after complete tightening of the assembly. Gaskets for flanged joints shall be of compressed asbestos fibre to BS 2815 Grade A and full faced with a minimum thickness of 3 mm for pressures up to and including 1 600 kPa cloth-inserted rubber may be used.

PLK 3.6.1.9 Where isolating valves are required to be equipped with extended off-set spindles, the spindles shall be equipped with sufficient universal joints to ensure satisfactory valve operation. All spindle extensions shall be secured to permanent structures with galvanised clamps to the Engineer's approval. The rate for such valve items shall include for any required clamps, extensions joint, etc.

Handwheels on such extended spindles shall be mounted on plain-ended spindle or handwheel pedestal as specified or indicated on the construction drawings.

Isolating valve operation:

Cap top	CT
Handwheel	HW
Electric actuator	EA
Pneumatic actuator	PA
Handwheel spindle extension	HSE
Plain ended spindle extension	PESE
Platform-mounted handwheel pedestal	PMP
Handwheel pedestal on wall support bracket	HPWB
Stub handwheel pedestal on wall support bracket	SHWB
Grid-mounted handwheel pedestal	GMP

PLK 3.6.1.10 The following information shall accompany the tender:

- Description
- Flange Drilling
- Maximum working pressure
- Maximum unbalanced pressure
- Test pressure
- Manufacturers number
- Material of components
- Gearing

- Accessories

PLK 3.6.2 Sluice Valves

PLK 3.6.2.1 Double-flanged, wedge-gate, internal (non-rising) spindle sluice valves of the waterworks pattern are required to comply fully with SANS 191 or SANS 664 where applicable.

PLK 3.6.2.2 Only full-way valves will be accepted (i.e. the gate must be clear of the waterway in the fully open position).

PLK 3.6.2.3 The maximum force required to turn the handwheel at the maximum torque shall not be greater than 100 N per hand at the handwheel run (Total effort = 200 N) when operating at an unbalanced pressure equal to the rated working pressure of the valve. This may be achieved with the aid of gearing of a suitable ratio.

Where gears are used replaceable shear pins shall be provided to prevent damage to the valve if excessive pressure is used.

PLK 3.6.3 Butterfly Valves

PLK 3.6.3.1 Horizontal spindle type butterfly valves complete with gearing, handwheels and flanged at both ends with separate bolting for joining to the adjacent pipework is required.

PLK 3.6.3.2 All butterfly valves shall be double eccentric / offset type.

PLK 3.6.3.3 Wafer valves or valves fitted with studs for attachment to the adjacent flanges are not permitted.

PLK 3.6.3.4 Valves shall be drop-tight when closed and metal to metal sealing is not acceptable.

PLK 3.6.3.5 All resilient seals shall be removable and readily replaceable on Site with the valve in position.

PLK 3.6.3.6 Resilient seals shall be retained by corrosion resistant securing elements to prevent corroding in position (e.g. bolts, set screws, etc.)

PLK 3.6.3.7 The valve-water seal shall be of the following types:

- a resilient seal fixed to the edge of the disc by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the body.
- a resilient seal fixed to the body of the valve by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the edge of the discs.

PLK 3.6.4 Reflux Valves

PLK 3.6.4.1 Reflux valves shall be double-flanged, SANS 1551.

PLK 3.6.4.2 Valve bodies and seals shall be free of pockets that will allow dirt accumulation and prevent the doors from closing fully.

PLK 3.6.4.3 Stops or an approved resilient material shall be fitted into the body to prevent the doors from fluttering under full flow conditions.

PLK 3.6.4.4 Valves shall be designed to allow for rapid but non-slamming closing characteristics.

PLK 3.6.5 Air Valves

PLK 3.6.5.1 Air valves shall be supplied with double-flanged, wedgegate internal (non-rising) spindle sluice valves for isolation, which unless otherwise specified shall conform in all respects to this specification.

PLK 3.6.6 Ring needle valves

PLK 3.6.6.1 Ring needle valves used as auto closing valves shall fulfil the following functions:

- Electrical operation (isolating and control) suitable for opening and closing against the specified pressure and for continuous operation in any intermediate position.
- Automatic as well as manual mode control.
- Automatic reflux action for quick closure by means of drop-weight and hydraulic dash pot in case of power failure or motor protective tripping.
- Adjustable closing time and adjustable closing characteristic.

PLK 3.6.6.2 The totally enclosed flanged-on gearbox shall include the following:

- Either an electo-mechanical unit comprising:
  - a totally enclosed brushless electromagnetic gear clutch for quick closing;
  - a totally enclosed directly mounted electric valve actuator with integral electric controls and auxiliary handwheel for manual operation;
- or an electro-hydraulic unit comprising:
  - an oil hydraulic lift cylinder for opening the valve;
  - a totally enclosed directly mounted electronic driven oil pump and oil reservoir. The oil pump and reservoir may be individually mounted on each valve or a

centralised system may be employed to feed more than one valve and/or pumpline;

- a solenoid operated hydraulic control valve which shall be de-energised to initiate closure of the valve.

PLK 3.6.6.3 Either of the above actuators shall also be provided with:

- limit switches for signalling the “open”, “closed” and intermediate “10%” positions and further control functions as required;
- a directly mounted oil hydraulic dashpot with the necessary control valves for adjusting closing time and operating characteristic;
- means to operate the valve manually;
- valve shaft (stub shafts) of high tensile stainless steel located in bushes of zinc-free bronze;
- a drop weight lever arm of steel with adjustable cast iron drop weight. The lever arm shall be keyed or splined to the shaft.

PLK 3.6.6.4 The overhang shaft carrying the drop weight lever arm shall be supported at its bearing housing from the foundation block.

PLK 3.6.6.5 Travel of the drop weight shall be restrained for reasons of safety at either end of the lever arm.

PLK 3.6.6.6 The control valves shall be arranged for selection of either manual-electric or automatic-electric operation controlled from the pump control console. Push buttons “open”, “close” and “stop” for piloting ghese valves, when throttling is required, shall be incorporated in each pump control console, as well as indicator lamps showing “closed” (green) “intermediate” (amber) “open” (red) positions. In addition, a selector switch “manual/automatic” shall be incorporated, the automatic position being in conjunction with pump starting. A further “test” selector switch shall bew mounted inside the panel to permit manual-electric testing of the equipment without running the pumpset.

PLK 3.6.6.7 In the “automatic” mode the valve shall open automatically from the fully closed to fully open position when the pumpset is started, likewise closing automatically, when the pumpset is to be shut down. In die “manual” mode the valve shall open automatically to at least the “10% open” intermediate position, whereafter manual selection of the valve position shall be enabled.

- Each valve shall be interlocked with the pump starter. When the pump is to be stopped, the valve shall close slowly to prevent water hammer either by means of the electric actuator or by releasing hydraulic pressure in the lift cylinder by means of control valves before the pumpset ios tripped and stopped by interlocked relays.

- Similarly, the valve shall be arranged so that the pump can be started only when the valve is fully closed. The valve shall open only when the starting operation is completed and the motor is up to speed.

PLK 3.6.6.8 The control valves shall have automatic reflux action features to close by drop-weight, controlled by an oil hydraulic dashpot, in the event of power failure or motor protective tripping. The drop-weight shall be released by a solenoid operated clutch or a valve which is constantly energised during pumping operations. Closing time and characteristics shall be adjustable to minimise water hammer.

PLK 3.6.6.9 It shall be possible to energise the “manual” mode only when:

- the associated pump is running.
- the valve is at least 10% open as indicated by the “intermediate” lamp.
- the valve is in the “test” mode

Selection of the “manual” mode shall not affect the automatic reflux action.

When the opening of the valve has been set manually, the valve shall maintain this position in the absence of any further action.

PLK 3.6.6.10 “Test” mode: With both isolating valves closed and electrically interlocked, a test facility shall be provided to enable the maintenance personnel to manually operate the valve without the pumpset running by selection from inside the pump control console.

PLK 3.6.6.11 Valves shall be designed to operate free of cavitation in intermediate positions.

PLK 3.6.7 Electric Actuators

PLK 3.6.7.1 When specified, in the Project Specification the valves shall be fitted with electric, motor-driven flood-proof IP 68 actuators of robust design, capable of closing the valves under all unbalanced pressures.

PLK 3.6.7.2 The Tenderer shall state the maximum torque required to operate the valve in his Tender. In determining this maximum torque an allowance shall be made for any deterioration that could be expected to occur in the bearings during the life of the valve. The actuator shall be capable of transmitting twice this maximum torque without any of its components suffering permanent damage. This shall be proven to the Engineer's satisfaction by workshop tests.

PLK 3.6.7.3 The actuators shall be capable of restraining the valve in any position under all possible conditions of operation, and shall not, in any circumstances, be capable of becoming self-motorised as a result of the dynamic torque loading on the disc or plunger.

PLK 3.6.7.4 All gearing shall be manufactured in accordance with BS 436 Class C and shall be machine cut. All components requiring lubrication shall be adequately lubricated and totally enclosed flood-proof casing fabricated in cast iron and/or die cast aluminium to suit the service weather proof casing whether the valve is to be installed in the open or under cover. Actuators shall also be fitted with mechanical stops to prevent excessive turning and shall be provided with replaceable shear pins.

PLK 3.6.7.5 Handwheels shall be fitted to all actuators. The direction of rotation to close the valve shall be clockwise when viewed from above the end of the input shaft and from the position of operation. In addition, they shall be clearly and indelibly marked with an arrow showing the direction of closing and the words "Close" and "Toe".

PLK 3.6.7.6 Whether the valve is actuator driven or manually operated, the maximum force required to turn the handwheel at the maximum torque defined above shall not be greater than 100 N per hand at the handwheel rim. (Total effort = 200 N.) For large valves the minimum of complete revolutions of the handwheel to move the valve gate from fully open to fully closed shall not be less than 100.

PLK 3.6.7.7 All electric actuators shall be provided with reversing contactors: local and remote control shall be provided; a device making the local control non-operative shall also be provided on the relevant remote control panel.

PLK 3.6.7.8 After factory tests, the actuators shall be removed from the valve and delivered to Site in separate boxes to safeguard against damage.

PLK 3.6.8 Protection

All materials and workmanship to comply with relevant SANS Specifications.

PLK 3.6.8.1 Internal Protection

Internal surfaces of valve bodies and discs shall be grit blasted to a Sa 2½ of SIS 05 50 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP 2300 or similar) shall then be applied to give a final dry film thickness of 250 µm. Drying times between successive layers shall be strictly in accordance with the requirements of the paint manufacturer.

As an alternative to the protection as specified above, the Contractor may be required to use either a solventless epoxy paint system or a fusion bonded epoxy powder coating as specified in the Project Specification.

PLK 3.6.8.2 External Protection

External surfaces of valve bodies shall be wire brushed to a A 3 of SIS 05 59 00 standard and painted with one layer zinc chromate primer (dried film thickness 50 µm). This will be followed by two alkyd-based undercoats (each coat 25 µm thick) and one alkyd-based enamel finishing coat (dried film thickness 25 µm). Final colour will be as specified by the Engineer.

Machined flanges will be painted with a protective coating of shellac or similar.

PLK 3.7 Tolerances

Tolerances as specified in the appropriate SANS or BS standards shall apply to this Contract.

PLK 4 TESTING AND INSPECTION

PLK 4.1 Testing by Manufacturer

The Manufacturer shall carry out all tests to ensure that valve materials conform to the requirements of the relevant SABS or BS Specification. These tests will not necessarily be attended by the Engineer but records must be kept and all test results shall be made available to the Engineer.

PLK 4.2 Testing by Independent Body

The Engineer may appoint an independent recognised body to conduct control tests. Samples required for such tests will be provided by the Manufacturer free of charge and sampling will be done by this body in accordance with the relevant SANS or BS Specification.

The cost of such control tests will be borne by the Employer.

PLK 4.3 Inspection

PLK 4.3.1 Visual, operational and dimensional inspection of valves as well as inspection of protective coatings will be carried out by the Engineer and/or the Manufacturer in the Manufacturers workshops prior to the despatch of valves to site.

PLK 4.3.2 Inspection by the Engineer shall in no way relieve the Manufacturer of any of his obligations to design, manufacture and supply valves strictly in accordance with the Specification.

PLK 4.4 Hydrostatic Testing

PLK 4.4.1 All hydrostatic tests will be witnessed by the Engineer and the Manufacturer will give at least one week prior notification to the Engineer of the proposed dates for such tests.

PLK 4.4.2 Valve bodies will be close end tested to at least 1,5 times the working pressure. Test pressures will be maintained for at least 5 minutes and valve bodies will be water tight in all respects at the test pressure.

PLK 4.4.3 Assembled valves will be open-end tested to 1,5 x working pressure for materials strength and soundness. Valves will be drop tight from both directions over the complete range of pressures from 0 to 1,5 x working pressure.

PLK 4.4.4 Each valve will be supplied with a test certificate certifying that it complies in all respects with the requirements of this Specification.

PLK 5 MEASUREMENT AND PAYMENT

PLK 5.1 General

Tendered prices shall include for the following unless otherwise specified in the Project Specification.

- Protective coatings as specified.
- Couplings and/or jointing material for each type of valve.
- Packing and temporary protection against damage during transport and delivery.
- Temporary storage and maintenance if required.
- Delivery and storage of material on site or in a store as specified.
- Testing and inspections at Manufacturer's works.

PLK 5.2 Valves will be measured per unit of each type

PLN: MANUFACTURE, SUPPLY AND TESTING OF STEEL PIPES

INDEX

PLN 1 SCOPE

This specification covers the manufacture and supply of bare, electric welded low carbon steel pipes and steel pipe special items for the conveyance of water at ambient temperatures and at medium pressures.

PLN 2 STANDARDS

Pipes and specials shall be manufactured, tested and inspected in accordance with the latest issues of the following standard specifications unless amended in subsequent clauses in this specification.

a) Welded pipes larger than 150mm:

SANS 719: Steel Grades A, B and C
SABS 1431: Steel Grades 300 WA, 350 WA
API 5L: Steel Grades, X42, X46, X52, X56 and X60
EN 10025-2: Steel Grade S355JR + AR (where specified for specials)

b) Welded specials and fittings smaller than or equal to 150mm:

SANS 62 (Heavy Class) up to 50 bar design pressure

c) Seamless Pipes:

ASTM A106 – Schedule 40(40 bar) or 80(80 bar) as determined by the design pressure.

d) Seamless specials and fittings:

ANSI B16.5 & B16.9 – Schedule as determined by the design pressure

e) Qualifications of Welders

All manual or semi-automatic welds and repair welds shall only be undertaken by welders qualified under the tests laid down in accordance with API 1104.

f) Non-destructive Tests and Adjudication

- Radiographic inspection: API 1104
- Ultrasonic inspection: API 5L

g) In this Specification reference is made to the latest issues of the following specifications:

SANS	719
API	5L
API	1104
ASME	Section V
BS	2971
BS	2633

PLN 3 PROCESS OF MANUFACTURE FOR PIPES

PLN 3.1 Welding process

Pipes shall be manufactured by an approved semi-automatic submerged-arc welding process or shall be electric resistance welded. Where semi-automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. The number of longitudinal weld seams shall not exceed:

a) one seam for pipes up to 1 000mm nominal diameter
b) two seams for pipes larger than 1 000mm and up to 2 000mm nominal diameter

Circumferential welds by semi-automatic submerged-arch welding method for factory double jointed pipes shall have at least one pass on the inside and at least one pass on the outside.

PLN 3.2 Welds

SANS 719, BS 2971 and BS 2633 shall generally apply.

For fusion welded pipes and specials, the internal weld bead shall not protrude more than 1,0 mm into the bore of the pipe or special.

For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 2,0mm.

For pipes to be joined by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200mm from ends to be jointed.

For pipes to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 200mm from the end to be coupled.

PLN 4 DIMENSIONAL REQUIREMENTS

PLN 4.1 Pipes

All dimensions shall be in accordance with SANS 719 clause 5.1 (or other relevant clause numbers in later versions) except for the following amendment to clause 5.1.3:

The wall thickness of pipe shall, subject to a tolerance of +10% or -0%, be one of the relevant values given in columns 3 to 6 of table 2, unless otherwise specified by the purchaser.

PLN 4.2 Specials

The tolerances on specials will be in accordance with BS 534, Section 4.

Unless shown otherwise, branch and manifold sections of Tees to have a common centre line and of scour tees to have a common invert line.

All dimensions on layout drawings or item details are outer face to outer face, i.e. overall.

Position dimensions for puddle flanges and restraining flange refers to centre of flanges.

PLN 5 TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND AT SITE

PLN 5.1 General

Factory and site testing and inspections (quality assurance), supervision of tests and reviewing of test records shall be carried out by the Contractor.

Unless otherwise specified in the contract documents, the Contractor shall appoint an independent inspectorate (“Inspectorate”) and shall be responsible for the Inspectorate’s and all associated costs. The name of the Inspectorate to be submitted for the Employer /Engineer’s approval. The Inspectorate will be responsible for the monitoring, witnessing and reviewing of the quality assurance plans, testing, inspections and records on behalf of the Employer / Engineer. The service provided by the Inspectorate shall not replace the duties and responsibilities of the Contractor in terms of the Contract.

All tests and inspections at the factory and on site shall be at the expense of the Contractor who shall provide all necessary testing facilities, labour, instruments, equipment and samples that will be required by the Contractor and the Inspectorate, to verify that the material complies with the Specifications. The testing facilities, instruments and equipment shall comply with the requirements of the Inspectorate.

The Inspectorate shall be afforded every facility and opportunity during the manufacturing and testing to enable the inspection to be carried out effectively.

All test samples shall be selected by the appointed Inspectorate and all instruments used for testing purposes shall be approved by the Inspectorate and if in the opinion of the Inspectorate any instrument should require calibration, such instruments shall be calibrated at the expense of the Contractor by the SABS or such other body as may be approved by the Inspectorate.

No mechanical working or straining of pipes and specials shall be allowed after testing and inspection.

PLN 5.2 Visual Inspection

All finished pipes and specials shall be visually examined and shall be free of injurious defects as defined in API 5L Section 10.2.7. In addition, welds on specials shall be inspected by the application of a penetrant-dye on the inside of the welds and no trace of the dye should appear on the outside of the pipe after completion of the test.

PLN 5.3 Non-destructive Inspection

PLN 5.3.1 Ultrasonic Inspection

The Engineers approval of a detailed method statement is required for the use of this test method prior to the start of production. When this method is used 100% of all longitudinal or spiral welds on straight pipes shall be checked with an approved ultrasonic method capable of continuous and uninterrupted inspection of the weld seam in accordance with API 5L, Annexure E5. The equipment shall be checked with an applicable reference standard at least twice every production shift.

PLN 5.3.2 Radiographic Inspection to API 1104

Radiographic testing of welds are regarded as industry norm and shall be used unless approved otherwise by the Engineer. Test records are required to be saved in digital format. It is a requirement that 100% of longitudinal, circumferential, spiral welds and scalp welds shall be subject to radiographic inspection in accordance with API 1104, Section 9.3.

Radiographic inspection of pipes shall be as follows:

a) Longitudinal Welded Pipe

Submerged-arc fusion welded pipe, if inspected full length by ultrasonic methods, shall also be inspected by radiographic methods for a distance of 200 mm from each end of

each length of pipe. Electric resistance welded pipes shall, however, only be inspected full length by ultra-sonic methods.

b) Spiral Welded Pipe

Submerged-arc fusion welded pipe, if also inspected full length by ultrasonic methods, shall also be inspected by radiographic methods for a distance of 100 mm from each end of each length of pipe and of the complete "H" at all skelp end welds including 150 mm of the spiral welds in both directions away from the intersection points with the skelp end welds.

c) Circumferential Butt Welds

100 percent of the length of circumferential butt welds shall be examined radiographic methods unless consistently acceptable results are obtained. Then the number of welds to be tested may be reduced by the Engineer.

d) Specials

100 percent of the length of all manual or semi-automatic welds in specials shall be examined radiographically (where possible) and all other welds by liquid penetrant testing unless consistently acceptable results are obtained. Then the number of welds to be tested may be reduced by the Engineer.

Where specials cannot be hydrostatically tested, all welds shall be liquid penetrate tested as per ASME Section V.

e) Repairs

For straight pipes 100 percent of the total length of all repairs shall be examined radiographically unless repairs are done prior to ultrasonic inspection and such repairs pass ultrasonic inspection. Then no radiographic inspection of same is required.

For pipe specials, 100% of all repairs shall be examined radiographically (where possible) and all other weld by liquid penetrant testing.

f) Pipes for rail, road and river crossings shall be examined radiographically 100 percent of the total length of all welds.

PLN 5.3.3 Liquid Penetrant Testing

All fillet welds and other welds where requested by the Engineer, shall be liquid penetrant tested in accordance with sub-clause 7.2.1 of SANS 1200 L, clause 9.5 API 1104, ISO 10893-4 and ASTM E165.

PLN 5.3.4 Magnetic Particle Testing

Where requested by the Engineer, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

PLN 5.4 Hydrostatic Testing

Each individual straight pipe shall be subjected to a hydrostatic test in accordance with the methods described in API 5L. Test pressures shall be such as to produce tensile fibre stresses in the pipe wall of 90% of the minimum specified yield strength of the steel or shall be 9 MPa whichever is the lesser. Leaks or sweats shall be considered injurious defects.

Should it not be possible to hydrostatically test straight piping and/or specials, the liquid penetrant test as per ASME Section V shall be done on all welds over and above the non-destructive tests specified above. This shall only be applicable with the prior written approval of the Engineer.

PLN 5.5 Repair of Injurious Defects

Injurious defects found by non-destructive testing of welds, visual examination, hydrostatic testing or determined by any other means to exceed the limitations in API 5L Section 10, shall be repaired in accordance with API 5L Annexure D but subject always to the requirements of this specification.

PLN 5.6 Destructive Testing

PLN 5.6.1 Type of tests

The following destructive tests shall be performed in accordance with SANS 719 clause 6.2 on the first pipe and thereafter on one pipe of every 500 subsequent pipes.

a) Transverse Tensile Test
b) Root Bent Test (Electric Fusion Welds)

c) Flattening Test (Electric Resistance Welds)

PLN 5.6.2 Sampling for Destructive Tests

The following samples shall be selected for destructive testing:

a) **First Sample**

A section long enough to provide all the test specimens and material shall be cut from the selected pipe.

b) **Second Sample**

If the test specimens and material from the first selected pipe fail to pass any of the tests, a section long enough to provide the appropriate specimens for the tests failed by the first sample shall be cut from two further pipes.

c) **Third Sample**

If the test specimen from the second sample fails to pass the test(s) a similar section shall be cut from each of a further ten pipes.

d) **Compliance**

The piping shall be considered as complying with the specification if after testing of the first or the second or the third sample no defect is found.

PLN 6 FLANGES

a) Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the drawings. Flanges not covered by BS EN 1092 shall be manufactured according to NWS 1676 Revision 0 dated May 1981. Unless otherwise indicated on the drawings or specified in the Bill of Quantities, flanges shall be of forged Grade 300WA steel or ASTM A105.

b) Sealing faces shall be machined flat to a tool-mark of 0.8 mm to 1.25 mm pitch spiral or concentric serrations and back of flanges to be either machined or spot-faced around holes with sufficient clearance to ensure proper seating of bolt heads and nuts. All bolt holes shall be drilled perpendicular to the flange face. Bolt holes shall be positioned off-centre and symmetrically off-set from the vertical centre lines of the flange and flanges shall be installed truly square to the axis of the pipe. The Contractor shall check the compatibility of drilling of all flanges to be connected together.

c) Flange thicknesses and bolt sizes shall conform to the appropriate table of BS EN 1092 or NWS 1676 Revision 0 dated May 1981 for flanges not covered by BS EN 1092. The

Contractor shall satisfy himself that the flanges in his supply shall match the flanges supplied by others or at interfaces between Subcontractors, if any.

d) The Contractor shall ensure that the drilling patterns of pipe specials to be installed on both sides of valves and flow meters will match that of the appropriate supplied valve and flow meter.

e) All flanges designed for pressure ratings up to and including 1600 kPa, shall be flat faced with full face gaskets. Flanges designed for pressure rating exceeding 1600 kPa shall be raised face flanges supplied with ring gaskets. Flanges with pressure ratings of 6400 kPa and higher and flange sizes of 2500 mm diameter and larger, irrespective of pressure rating, shall incorporate an “O” ring groove. Details of the “O” ring groove shall be furnished by the Contractor for consideration by the Engineer.

f) All gaskets supplied under this Contract shall be of tanged graphite full face for flat joint faces and aramid and glass fibre with nitrile rubber binder to BS 7531 ring face for raised faces. Gaskets shall be suitable for the specified pressures with a minimum thickness of 3 mm and purpose made to the dimensions of the matching flanges. Joints in gaskets shall be kept to the minimum. Where not avoidable, joints shall be a tight fitting dovetail design.

g) Corrosion protection for the area not clamped shall be similar in all respects to that applied externally to the pipework/valve/pump.

h) All mill scale on flanges shall be removed by abrasive blasting before flanges are fitted and welded to pipes and fittings.

i) All flanges shall be supplied complete with bolts, nuts, washers and gaskets. Rubber joint rings shall comply with SANS 4633.

j) Puddle flanges shall not be drilled.

k) Some flexible couplings to be restrained by means of a restraining flange. Unless specified on the Drawings, the diameter, number and length of the long restraining bolts as well as any possible pipe wall thickening shall be designed by the Contractor with the assistance with the manufacturer. The effect of cyclic loading and fatigue must also be taken into consideration. The seal retaining flange on the flexible coupling may be factory machine scalloped to accommodate the long bolts. All the necessary nuts, washers, etc. for the restraining bolts must be provided by the Contractor.

Restraining flanges need not have all the bolt holes specified in the applicable flange drilling table. Only those required for the long restraining bolts need to be provided. These holes must comply with the applicable flange drilling table and be spaced equally on the flange PCD and symmetrically around the flange centre lines.

Restraining bolts to be positioned so as to not interfere with any stubs specified for an item.

l) Blank (Blind) flanges for pipes equal to or greater than 400 dia to be provided with two suitable lifting handles with coating similar to the blank flange.

PLN 7 FLEXIBLE COUPLINGS AND FLANGE ADAPTORS

Flexible couplings and flange adaptors shall be the Viking Johnson or Klamflex type or similar approved by the Engineer. Straub, Arpol or similar clamp on couplings are not acceptable.

Manufacturer of straight and stepped couplings (SR-C & ST-C) as well as flange adaptors (FA) to be approved by the Engineer. Couplings must be able to withstand hydrostatic test pressures of 1.5 times the specified design pressures and coupling flanges must be designed to withstand all stresses due to tightening of the bolts.

Rubber rings shall generally comply with SABS 974 Class F.

Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

Coupling installation gaps to comply with supplier's specification.

Applicable to all flange adaptors:

- Studs may not be welded onto flange.
- Flange to be drilled and tapped for threaded studs where applicable.
- Drilling to suit connecting flange.

PLN 8 BOLTS, THREADED RODS, STUDS, NUTS AND WASHERS

The following specification is applicable:

(a) The threads of all bolts, nuts and studs shall be in accordance with SANS 1700-7-3, 1700-7-5, 1700-14-3, 1700-14-4 (in part);
(b) No brass bolt or stud shall have a diameter of less than 6mm;
(c) Two washers shall be installed underneath each bolt and nut;
(d) Each bolt shall protrude by at least three threads but not more than five threads through the nut with all washers in position and all bolts at a flange must be of equal length;
(e) The Contractor shall supply to the Employer any special tool required for any nut, bolt, screw or other fastener used in a position which is not accessible using conventional tools. This also applies where the size or shape of the fastener is not conventional.
(f) Bots, threaded rods, studs, nuts and washers shall be hot dipped galvanised to SANS 763 or ISO 1461 and shall be coated with molybdenum disulphide lubricant after installation.
(g) Bolts, shall comply with SANS 1700 Grade 8.8.
(h) Stainless steel threads shall be treated with nickel base anti-seize corrosion protection compound.

PLN 9 THERMIT WELDING PADS

Where pipes and specials are to be jointed by means of flexible couplings and will be subjected to cathodic protection, the manufacturer shall weld steel plates not less than 50 x 75 x 10 mm thick 250 mm from each end of all pipes during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for thermit welding pad bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

PLN 10 MARKING OF PIPES

All pipes and specials shall be clearly hand stamped alongside a longitudinal or spiral weld on one end of the pipe with the following.

a) Grade and thickness of steel
b) Serial number of the pipe or specials
c) Outside diameter
d) Factory hydraulic test pressure in kPa

PLN 11 UV PROTECTION OF COATINGS

All pipes with MDPE, 3LPE or Bituguard coatings shall be painted with a white polypropylene overcoat [to be approved by the Engineer] for protection against UV. The overcoat to be maintained by applying additional layers until the pipe is backfilled.

PLN 12 HANDLING, DELIVERY AND STORING OF PIPES AND SPECIALS

The contractor shall ensure that pipes and specials including coating and lining are not damaged.

Coated pipes and fittings shall be handled 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 and any other equipment with a possibility to damage the coating shall not be used. Slings shall be suitably rated for the loads to be handled and in good condition. Deteriorated slings shall not be used.

All pipes are to be handled with the aid of a “spreader” lifting beam. The dragging or skidding of pipes and specials in contact with the ground shall not be permitted.

Pipes shall be stacked with a minimum clearance of 100 mm between adjacent pipe walls and a minimum of 200mm clear of the ground. Pipes shall be stored on sand bags with sufficient supports to prevent permanent longitudinal deflections. Sandbags are required at least at one

third of a single pipe length from each pipe end. The sand bags shall be at least 500 mm wide for pipes with Bituguard coating.

Pipes shall also be stacked in a manner that limits loading on lower layers of pipes. Any pipe showing permanent ovality as a result of surcharge loading will be rejected.

All pipe deliveries shall be accompanied by delivery notes which will be checked by the Engineer on-site. The Engineer reserves the right to not accept and reject pipe deliveries where there are discrepancies.

PLQ: CORROSION PROTECTION OF STEEL PIPES AND FITTINGS

INDEX

PLQ 1 SCOPE

This specification covers various corrosion protection systems for cast iron, steel and stainless steel pipes and fittings for the conveyance of water at ambient temperatures.

PLQ 2 CORROSION PROTECTION SYSTEMS

PLQ 2.1 Standards and codes

The following standards and codes form part of this specification. Unless otherwise specified herein, the latest edition shall apply.

ASTM–American Society for Testing and Materials

ASTM D2240	Standard test method for rubber property (Durometer Hardness)
ASTM D4541	Standard test method for pull-off strength of coatings using portable adhesion testers
ASTM G14	Standard test method for impact resistance of pipeline coatings (falling weight test)
ASTM D4285	Standard test method for indicating oil or water in compressed air
ASTM G62	Standard test methods for holiday detection in pipeline coatings

BS EN–British Standard European Norm

BS EN 10289	Steel tubes and fittings for onshore and offshore pipelines. External liquid applied epoxy and epoxy-modified coatings
BS EN 10290	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings
BS EN 12068	Cathodic protection - External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection - Tapes and shrinkable materials
BS EN 13000	Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating

ISO–International Organization for Standardization

ISO 1514	Paints and varnishes – Standard panels for testing
ISO 2808	Paints and varnishes – Determination of film thickness
ISO 4624	Paints and varnishes – Pull off test for adhesion

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 uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 8502	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness
ISO 8503	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-Cleaned steel substrates Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces. Part 2: Method of grading of surface profile of abrasive blast-cleaned steel-comparator procedure. Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - stylus instrument procedure. Part 5: Replica tape method for the determination of surface profile.
ISO 8504-2	Preparation of steel substrates before application of paints and related products - Surface preparation methods - part 2: Abrasive blast cleaning
ISO 11124-1	Preparation of steel substrates before application of paints and related products - Specifications for metallic blast cleaning abrasives - Part 1: General introduction and classification Part 2: Chilled iron grit Part 3: High-carbon cast-steel shot and grit Part 4: Low-carbon cast-steel shot
ISO 12944-4: 2017	Paints and varnishes — Corrosion protection of steel structures by protective paint systems - part 4: Types of surface and surface preparation
ISO 12944-5: 2018	Paints and varnishes — Corrosion protection of steel structures by protective paint systems - part 5: Protective paint systems

NACE - National Association of Corrosion Engineers

NACE RP0274	High-Voltage electrical inspection of pipeline coatings prior to installation
NACE RP0287	Field measurement of surface profile of abrasive blast cleaned steel surfaces using a replica tape
NACE SP0394	Application, performance, and quality control of. plant-applied, fusion-bonded epoxy external pipe

SSPC–Steel Structures Painting Council

SSPC PA 2	Measurement of dry coating thickness with magnetic gauges (Steel Structures Painting Manual, Ch 5 - Paint Application Specs.)
SSPC SP1	Solvent cleaning
SSPC SP11	Power tool cleaning to bare metal
SSPC SP 15	Commercial Power Tool Cleaning.
SSPC SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

South African Bureau of Standards

SANS 241	Specifications for drinking water
SANS 1160:2011	Drinking water system components - Health effects
SANS 1217	Internal and external organic coating protection for buried steel pipelines

PLQ 2.2 Standard corrosion protection systems

The following corrosion protection systems shall apply unless otherwise specified in the project specific specifications/employer's requirements or in the bill of quantities or on the drawings.

PLQ 2.2.1 Buried steel pipework

All specials, fittings and couplings shall be lined and coated with epoxy paint. After installation the specials, fittings and couplings shall be protected with a tape wrapping system in accordance with ISO 21809-3:2016/A1:2020. The following alternative systems are applicable:

- Type 10 – hot applied bituminous tapes, minimum 5mm thickness (e.g. Densotherm HD).
- Type 11A – Petrolatum tapes, with mastic filler and external bondbreaker (e.g. Denso Petrolatum).
- Type 12A – Polymeric tapes, with pressure sensitive adhesive, minimum thickness 300µm (e.g. Denso MDP 032).
- Type 12A – Polymeric tapes, with polymer modified bitumen mastic adhesive, minimum thickness 1000µm (e.g. Denso Ultraflex or CPT).
- Type 13A – Reinforced viscoelastic tape with integral or applied polymeric outerwrap, minimum thickness 1300µm (e.g. Stopaq Wrappingband CZH)

The type, combination and application of the tape wrapping system shall be as detailed in the project specific specifications/employer's requirements or in the bill of quantities or on the drawings.

Standard pipe lengths shall be lined with epoxy paint and coated with fusion bonded medium density polyethylene (FBMDPE), Polymer Modified Bitumen, 3LPE or Rigid Polyurethane as specified below in this specification, unless otherwise specified in the project specific specifications/employer's requirements or in the bill of quantities or on the drawings.

Where the application of epoxy lining and the testing thereof is not feasible for a specific pipe or special or fitting of small diameter, the Contractor shall notify the Engineer and request the approval of the Engineer for hot-dipped galvanized lining and coating of the particular pipe or special or fitting as specified below in this specification.

PLQ 2.2.2 Pipework inside chambers

a) New pipework:

Fittings, specials and couplings shall be coated and lined with epoxy paint.

Where the application of epoxy lining and the testing thereof is not feasible for a specific pipe or special or fitting of small diameter, the Contractor shall notify the Engineer and request the approval of the Engineer for hot-dipped galvanized lining and coating of the particular pipe or special or fitting as specified below in this specification.

The outside end of the fitting cast into the wall as well as flanges and couplings outside the chamber shall be protected with a Denso Clingwrap protection system.

After installation and where specified in project specific specifications/employer's requirements or in the bill of quantities or on the drawings, the pipe shall be painted with re-coatable polyurethane to the Employer's colour coding specification. All systems to comply with ISO 12944-4 and 12944-5 (Table C.4 System C4.07).

b) Deteriorated aged external coatings shall be repaired as follows:

i) General

The area to be repaired shall be demarcated to the extremity of sound coating which shall retain a firm edge during surface preparation. If the apparently sound coating does not display a firm edge during surface preparation, the repair shall be extended until a firm edge is obtained.

The sound coating adjacent to the repair area shall be feathered and roughened using abrasive paper only for a distance of 50mm from the edge of the exposed steel.

Surface preparation shall be undertaken by means of one of the following techniques:

- Abrasive blast cleaning of steel surface to Sa 2 ½ of ISO 8501-1 using portable vacuum recovery blasting equipment.
- Mechanical cleaning of steel surface using Bristle Blaster™, abrasive flapper disc or power sander to SSPC SP15. Grinding discs may not be used.

The prepared steel surface shall be free of moisture, dust & debris prior to application of the repair coating.

Dust and debris shall not exceed 0,2% when tested in accordance with SANS 8502-3:2008.

Total soluble salts shall be in accordance with the requirements of the specific coating supplier when tested in accordance with SANS 8502-6 (Bresle Patch).

The feathered edge of the sound epoxy shall be activated using MEK or the solvent compatible with the repair coating.

ii) Aged epoxy coated pipework

The repair material shall be aluminium flake pigmented surface tolerant epoxy mastic (e.g. Carbomastic 15) or similar approved by the Engineer plus re-coatable polyurethane to the Employer's colour coding specification.

The repair coating shall be applied in multiple coats to match the dry film thickness of the original coating. (minimum 300 micron).

The painted area shall be tested for pinholes and thickness.

iii) Aged bitumen coated pipework

The repair material shall be Polymer Modified Bitumen heat applied wrapping (Densotherm HD) or similar approved by the Engineer.

PLQ 2.2.3 Pipework exposed to sunlight

a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for coating application as per ISO 12944-4.

Atmospheric exposure (Inland) ISO 12944-5: 2018 Table D.1 System G3.02:
Galvanised pipes shall be coated in the factory with epoxy primer (80 micron).
Erection damage must be repaired with “single pack zinc rich epoxy primer” followed by a full coat of silver polyurethane acrylic (50 micron)

Atmospheric Exposure (Coastal) ISO 12944-5:2018 Table D.1 System G5.05:
Galvanised pipes shall be coated in the factory with epoxy primer (80 micron) plus epoxy intermediate (125 micron per coat).

Erection damage must be repaired with “single pack zinc rich epoxy primer” and epoxy intermediate, followed by a full coat of silver polyurethane acrylic (50 micron)

After installation the pipe shall be painted with re-coatable silver polyurethane acrylic (50 micron) as per ISO 12944-5

b) Pipe diameter larger than 150mm

Pipework shall be lined with epoxy paint.

Atmospheric exposure (Inland) ISO 12944-5: 2018 Table C.3 System C3.06:
Pipes shall be coated in the factory with two component inorganic zinc silicate primer (75 micron) plus one coat of silver polyurethane acrylic (50 micron).

A second coat of silver polyurethane acrylic (50 micron) must be applied on site. The inorganic zinc silicate must be repaired with “single pack zinc rich epoxy primer”.

Atmospheric Exposure (Coastal) ISO 12944-5:2018 Table C.5 System C5.08:
Pipes shall be coated in the factory with two component inorganic zinc silicate primer (75 micron) plus two coats of epoxy intermediate (125 micron per coat).

Erection damage must be repaired with “single pack zinc rich epoxy primer” and epoxy intermediate, followed by a full coat of silver polyurethane acrylic (50 micron)

PLQ 2.2.4 Exposed pipework inside buildings

a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for re-coatable polyurethane site application.

After installation the pipe shall be painted with re-coatable polyurethane to the Employers colour coding specification. All systems to comply with ISO 12944-4 and 12944-5:2018 (Table D.1 System G2.01)

b) Pipe with diameter larger than 150mm

Pipes, fittings and couplings shall be lined and coated with epoxy paints.
After installation the pipework external shall be painted with re-coatable polyurethane to the Employers colour coding specification. All systems to comply with ISO 12944-4 and 12944-5:2018 (Table C.2 System C2.05).

PLQ 2.2.5 Pipework inside water retaining structures

All pipework (including stainless steel) inside water retaining structures and cast into the walls or floor of water retaining structures shall be lined and coated with epoxy paint.

All stainless steel shall be grade 316L.

PLQ 3 SURFACE PREPARATION

Contractors must submit information on the cleaning methods to be used to comply with the specified requirements.

PLQ 3.1 Surface preparation of steel surfaces

All projections, sharp edges, layers that have formed and tool marks must be removed from the surface so that the surface is smooth, and it must be abrasive blast cleaned in accordance with section 5.3 of SANS 10064:2011 so that it meets the following requirements:

(a) A grade of cleanliness of Sa 3 of ISO 8501-1 for immersion/buried conditions or Sa 2 ½ of ISO 8501-1 for atmospheric exposure.
(b) A surface profile between 60 micron and 85 micron when tested in accordance with SANS 5772.
(c) Dust and debris shall not exceed 0,2% when tested in accordance with SANS 8502-3:2008.
(d) The profile produced shall be angular and shall be in accordance with the requirements of the material product data sheet when tested in accordance with SANS 5772 (profile gauge) or SANS 8503-5 (replica tape)
(e) Water soluble salts shall not exceed 100mg/m^2 when tested in accordance with the Weber Reilly Method or conductivity measurement. Lower values may be required for immersion applications.

(f) Any laminations revealed by blast cleaning shall be ground out and re-blast cleaned to meet the requirements above.

PLQ 3.2 Surface preparation of galvanized surfaces

Surfaces to be coated shall not be passivated.

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SANS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Engineer.

Large areas shall be prepared by sweep-blasting with non-metallic abrasive in accordance with SSPC SP16. Cracking, flaking or any form of de-lamination of the zinc coating due to excessive blast-cleaning shall not be permitted. Removal of zinc by blast-cleaning shall not exceed 10 µm.

Surfaces that cannot be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or by using non-metallic abrasive pads.

Finally, all dust and debris shall be removed by vacuum-cleaning.

Epoxy primer for galvanised surfaces shall be applied immediately after surface preparation to a minimum dry thickness of 50 µm.

PLQ 3.3 Surface preparation of stainless steel surfaces

Oil and grease contamination shall be removed by:

- Steam-cleaning
- An emulsifiable or aqueous detergent, or
- An alkaline cleaning solution.

Stainless steel surfaces shall be blast-cleaned with stainless steel grit or non-metallic abrasive. The use of steel shot and steel or cast iron grit is strictly prohibited.

The grade of cleanliness shall be in accordance with SSPC SP16.

Surface profile shall be in the range of 30 to 50 µm.

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.

Dust and debris shall be removed by vacuum-cleaning.

PLQ 4 HOT-DIP GALVANIZING

The following specification is applicable:

(a) Where galvanising is specified or a requirement of the design, such galvanising shall be performed by the hot-dip process to SANS EN 10240 in part and SANS ISO 1461;
(b) For all parts, other than wires, the equivalent zinc coating thickness shall not be less than 455 g of zinc per square metre of surface;
(c) The galvanising must be clean, smooth, of uniform thickness, unblemished and free from defects;
(d) All drilling, welding, cutting, sawing, punching, filing and bending shall be complete and the metal shall be cleaned of any machining blemishes, millscale, rust and lubricants, before galvanising;
(e) Galvanised areas must be kept free of lubricants. Surfaces which are in contact with oil shall not be galvanised or cadmium plated;
(f) Electrolytic deposition of zinc is not acceptable.
(g) Unless otherwise specified, steel pipes up to 150 mm dia shall be hot-dipped galvanized. Hot-dip galvanizing to be in accordance with SANS 121 ISO 1461 except that minimum thickness shall be 55 micron. Cut ends and small damaged areas shall be repaired by the application of a zinc-rich epoxy (single pack) to SANS 121 ISO 1461 (ZINC GALV 1 – Dulux or POLY GALV – Plascon).
(h) Only heavy duty galvanising shall be accepted and all items to be provided with a SANS approval certificate.

PLQ 5 EPOXY PAINTS

PLQ 5.1 General

Epoxy paint shall comply with SANS 1217 or ISO 12944-4 and ISO 12944-5. Surface preparation shall be abrasive blast cleaning to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals for internal linings/immersion conditions, or Sa 2½ . of ISO 8501-1 or SSPC SP16 for non-ferrous metals for atmospheric exposure.

The following will be applicable where epoxy paint is specified:

- Lining of pipes with nominal diameter equal or larger than 600 mm and standard pipe lengths of 9,144 m, 12,192 m, 18,3 m and 19.2 m:

Solvent free epoxy SANS 241 certified (Pipecoat SFX or similar product approved by Engineer), with a minimum dry film thickness of 500 micron and a maximum dry film thickness of 800 micron. (Equivalent to ISO 12944-5:2018, Table C.6 System I.06)

- Lining and coating of all other pipes, specials and fittings, except where multi-purpose epoxy coating is specified:

  Solvent borne epoxy (Carboguard 891 or similar product approved by Engineer) with a minimum dry film thickness of 500 micron and a maximum dry film thickness of 800 micron. (Equivalent to ISO 12944-5:2018, Table C.6 System I.06)

Epoxy paint and the repair kit for the repair of epoxy shall be from the same manufacturer.

Edges with epoxy paint shall have a radius of 3 mm or 50 % of the pipe wall thickness (smaller of two).

Where another type of coating is specified, epoxy paint lining shall continue around pipe edge for each of the following:

- *Flanged end*

  Onto both flange faces, extending for 50 mm (min) onto pipe outer wall beyond flange.

- *Ends suitable for straight or stepped couplings or flange adapters*

  Onto pipe outer wall for 250 mm (min) from pipe end.

- *Ends suitable for flange adapters, incorporating a restraining flange*

  Onto pipe outer wall from pipe end, up to and including both faces of the restraining flange as well as 50 mm (min) beyond the restraining flange.

The following specification shall be applicable to pipes, specials and fittings to be welded on site:

- In the factory:

  Abrasive blast cleaning of complete steel surface to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals. Apply epoxy paint to 100mm from pipe end.

- On site:

  Abrasive blast cleaning of steel surface to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals and 50 mm of painted surface to a surface profile of 60 – 85 microns.

  Apply epoxy repair kit from the same manufacturer as the factory applied epoxy to a minimum dry film thickness of 500 micron. The type of epoxy repair kit shall be subject to the approval of the Engineer.

At completion of the laying of pipes, after the epoxy lining of welded joints, repair of lining defects and cleaning of pipes and before filling of the pipe with water, the Contractor shall be responsible for the holiday (pinhole) testing of the epoxy lining of the complete pipeline. The Contractor shall implement measures to prevent entrance by persons, animals, water or any other foreign matter into the sections where holiday testing was successfully completed.
Holiday testing shall be undertaken in accordance with ASTM D5162 Test method B: High Voltage Spark Testing.

PLQ 5.2 Repair/rehabilitation of aged internal epoxy linings on site

The following deviations from paragraph PLQ 5.1 shall be applicable to the repair/rehabilitation of aged internal epoxy linings of steel pipes, specials and fittings on site:

The repair material shall be a surface tolerant reinforced epoxy with minimum 90% volume solids. A certain level of solvent is preferred in order to enhance the wettability, flow and adhesion characteristics of the material. The following materials are approved for this application:

- Carboguard 891GF Glass Flake System from Stoncor
- Ceramic Epoxy from Spec Coats
- Zip E from Corrocoat

Glass flake pigmented epoxy coatings from other manufacturers may be considered subject to approval by the Engineer.

Alternative products (e.g. Pipecoat SFX or Carboguard 550) may be considered for special cases of large scale repair work under controlled climatic conditions and with special measures for quality assurance in place and subject to approval by the Engineer. These alternative products shall be subjected to site application trials.

The area to be repaired shall be demarcated to the extremity of the sound epoxy coating which shall retain a firm edge during surface preparation. If the apparently sound epoxy does not

display a firm edge during surface preparation, the repair shall be extended until a firm edge is obtained.

The sound epoxy adjacent to the repair area shall be feathered and roughened using abrasive paper only for a distance of 50mm from the edge of the exposed steel.

Surface preparation shall be undertaken by means of one of the following techniques:

- Abrasive blast cleaning of steel surface to Sa 2½ of ISO 8501-1 using portable vacuum recovery blasting equipment.
- Mechanical cleaning of steel surface using Bristle Blaster™, abrasive flapper disc or power sander to SSPC SP15. Grinding discs shall **not** be used.

The prepared steel surface shall be free of moisture, dust & debris prior to application of the repair coating.

Dust and debris shall not exceed 0,2% when tested in accordance with SANS 8502-3:2008.

Total soluble salts shall be in accordance with the requirements of the specific coating supplier when tested in accordance with SANS 8502-6 (Bresle Patch).

The feathered edge of the sound epoxy shall be activated using MEK (Carboline Surface Prep 1 or similar approved by the Engineer) or the solvent compatible with the repair coating.

The epoxy repair coating shall be applied by brush ensuring the paint is worked into the surface of both the exposed steel and the feathered edge of the sound epoxy, overlapping 50mm onto the sound coating.

The repair coating shall be applied in a single coat to a minimum dry film thickness of 600 micron.

The painted area shall be tested for pinholes and thickness.

PLQ 6 UV-RESISTANT MULTI-PURPOSE EPOXY PAINT

Multi-purpose Epoxy shall be surface tolerant, self-priming aluminium pigmented epoxy mastic.

PLQ 7 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.

Over-coat with a 40 µm minimum layer of re-coatable polyurethane in accordance with the Employer's colour code.

PLQ 8 FUSION BONDED, MEDIUM DENSITY, POLYETHYLENE COATINGS (FBMDPE)

A uniform FBMDPE coating must be obtained by dipping the already prepared and heated pipe into a fluidified bed of FBMDPE powder which then fuses directly on to the heated surface.

The pipe coating shall be Sintakote II complying with all aspects of AS 1193, AS 4131 and AS 4321 of the latest revisions.

All coating materials shall be supplied complete with an original ISO 17050-1 Certificates of Conformity (COC) for the materials, clearly indicating compliance with all mechanical, physical and chemical properties of the coating, as defined in AS 4321, AS 1193 and AS 4131.

The supplier shall ensure that testing takes place as per AS 4321 Appendix A, as defined in Table A1 for the pipeline coating at the mill. In addition to this, a detailed third party report indicating compliance as per the 5 Yearly Type Testing and the annual testing as per Table A1 shall be submitted to the Engineer before production commences.

The minimum Dry Film Thickness (DFT) shall be 2.3mm minimum or as per Table 1 of AS 4321 for the different pipeline diameters as agreed by the Engineer.

The pipeline frequency of testing during production shall be as per AS 4321 Table 2.

The surface profile shall be angular and at least 60µ-75µ and the dust and debris level shall never exceed Class 2 ISO 8502-3 during production, the latter shall be confirmed during production on every 5th pipe and records shall form part of the hand-over pack issued to the Engineer. The cutback distance of the coating shall be 75mm from the pipe end.

PLQ 9 POLYMER MODIFIED BITUMEN (BITUGUARD)

This specification relates to factory applied pipe coating operations based on hot applied polymer modified bitumen. It is also applicable to modification, refurbishment and repairs on pipes coated with standard (oxidised or blown) bitumen fiberglass coatings.

PLQ 9.1 Applicable Standards

This part of the Specification makes reference to the standards listed below. Unless otherwise specified the latest editions of these documents, including all addenda and revisions, shall apply.

British Standards

BS 410	Specification for test sieves.
BS 1796	Methods using test sieves of woven wire cloth and perforated metal plate.
BS 2000	Methods of test for petroleum and its products.
BS 3900	Methods of test for paints: Part A 6 (replaced by EN 535) – Determination of flow time of paints. Part B 2 (replaced by ISO/DR 1515) – Determination of volatile matter and non-volatile matter.
BS 4147	Bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.
BS 7079	(Replaced by ISO 8501-8504) – Preparation of steel substrates before application of paints and related products.
BS EN 10300	Steel tubes and fittings for onshore and offshore pipelines – Bituminous hot applied materials for external coating.

Swedish Standard

SIS OS 5900	Pictorial surface preparation standards for painting steel surfaces.

American Standard

ASTM D 113-86	Ductility of bituminous materials.
ANSII AWWA C203-91	Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.

PLQ 9.2 Materials

PLQ 9.2.1 Primer

The primer shall be of synthetic composition, designed to be used with a specific polymer modified bitumen. The drying rate of the primer shall be suited to the application conditions. The primer shall be supplied in new sealed steel drums.

The primer shall have the characteristics shown in the table below. In addition, when stored in original sealed containers at ambient temperature, the primer shall retain the properties as set out in the table for not less than 6 months from the date of delivery.

CHARACTERISTICS OF PRIMER

CHARACTERISTIC	REQUIREMENTS	METHOD OF TEST
Viscosity at 23°C	35-60 seconds	Flow cup No 4 BS3900: Part A6 = EN 535
Volatile matter (max. % loss by mass)	75	BS3900: Part B2 = ISO/DR 1515 (105^0C for 3 hours)

PLQ 9.2.2 Polymer Modified Bitumen

a) Composition

The polymer modified bitumen shall consist of a uniform mixture of the following:

- A formulated blend of polymer modified bitumen, as specified in (c) and (d) below.
- A proportion of approved filler (limestone or asbestos shall not be used).
- Characteristics of the filler shall be as specified in (b) below.

b) Filler Grading

Method of test to BS 1796 modified to use the metric sieves specified in BS 410.
Passing 90 microns – not less than 93%.
Passing 250 microns – not less than 99%.

c) Characteristics of the Polymer Modified Bitumen

The material shall conform to the requirements given in the table below when tested in accordance with the methods specified.

d) Performance Tests of the Polymer Modified Bitumen System

The polymer modified bitumen shall be of thermoplastic rubber/bitumen modification.

The polymer modified bitumen containing mineral filler shall pass the performance test specified in the following table:

CHARACTERISTICS AND PERFORMANCE TEST: PMB

PROPERTIES	METHOD	UNIT	REQUIREMENTS
Softening Point	ASTM D36	°C	115-130
Penetration @ 25°C	ASTM D5	1/10 mm	15-30
Density @ 25°C	BS 4147	g/cm^3	1.1-1.4
Viscosity @ 170°C	Brookfield	Cp	7000-12000
Viscosity @ 190°C	Brookfield	Cp	3000-6000
Filler Content	BS 4147	%	20-30
Impact @ -10°C	BS 4147	mm^2	Max. 6500
Peel Initial / Delayed	BS 4147	mm	Max:

PROPERTIES	METHOD	UNIT	REQUIREMENTS
Sag @ 25°C	BS 4147	mm	3,0/3,0
Sag @ 40°C	BS 4147	mm	3,0/3,0
Sag @ 50°C	BS 4147	mm	3,0/3,0
Sag @ 60°C	BS 4147	mm	3,0/3,0
Sag @ 80°C	BS 4147	mm	Max. 1.5
Aging Test @ 190°C	Phoenix	hours	Min. 72
Bend	BS 4147	mm	Min. 15

Notes:

The test plates shall be cleaned by abrasive blasting to grade Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals and with a profile of 50 – 75 microns (SANS Method 772). They shall be coated with primer at a rate of 100g per m^2.

- For the impact test a plate 12.7 mm thick shall be used and a single impact made in each quarter of the plate. The average of the four areas disbanded shall not exceed the permitted value shown in the table.
- The peel test at 25°C is equivalent to / replaces the preliminary adhesion test in the original Specification.

PLQ 9.2.3 Outerwrap

a) The outerwrap consists of a combination of polyester and glass fibres to ensure the required strength and elasticity. This is combined with a glass fabric of uniform quality and amount to control the best application and the required amount of bleed through, in order for the outerwrap to provide maximum protection.

b) The outerwrap shall be impregnated with the polymer modified bitumen compatible material to fulfil the characteristics shown in the table below.

c) The characteristics of the outerwrap shall comply with the requirements of the table below and shall be determined in accordance with the test procedure.

CHARACTERISTICS OF OUTERWRAP SATURANT

CHARACTERISTIC	REQUIREMENT	METHOD OF TEST
Softening Point	Min 100°C	BS 2000
Penetration @ 25°C	60-85 1/10 mm	BS 2000
Saturant	Polymer Modified Bitumen	

PHYSICAL CHARACTERISTICS OF OUTERWRAP

CHARACTERISTIC	TYPE A	TYPE B	METHOD OF TEST
Minimum Thickness (mm)	0.6	0.6	AWWA C203-91
Weight (g) per m^2	500 – 700	500 – 700	AWWA C203-91
Tensile strength (N/50 mm)			
Longitudinal	> 800	> 400	AWWA C203-91
Transverse	> 800	> 200	AWWA C203-91

PLQ 9.3 Application

PLQ 9.3.1 Care of Wrapping Materials

All wrapping materials consigned to the coating yard or factory shall be properly stored to prevent damage or deterioration.

PLQ 9.3.2 Care of Pipe

Throughout the wrapping process pipe and coating materials shall be kept clean and away from all foreign matter.

PLQ 9.3.3 Marking

Any pipe manufacturer's identifying marks shall be removed before the start of the wrapping process and shall be permanently marked on the side of each pipe at both ends with a weatherproof paint. Metallic dye stamping shall only be permitted using approved stamps and only on the pipe bevel.

PLQ 9.3.4 Blast Cleaning

In preparation for the application of primer all grease or heavy soil shall be removed without spreading over the surface with a volatile solvent, e.g. xylene (or approved equivalent) and thereafter the external surface of the pipes shall be cleaned by abrasive blasting to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals and surface profile amplitude 75 µm. Refer to 37.15 for detailed description of surface preparation process.

PLQ 9.3.5 Priming

a) Following blast cleaning and within 2 hours, the pipe exterior shall be coated with the primer applied at a controlled rate to the manufacturer's recommendations. Pipes shall be coated within 24 hours of being primed.
b) The primer shall be applied to a dry, clean and dust free pipe and thereafter the primed

pipe shall be kept free from moisture, dust or any other contaminant. The primed pipe shall be uniform and free from runs, drips, flooded or bare areas. Particular care shall be taken to ensure complete coverage of weld areas.

c) The primer should be applied at a pipe temperature of 10°C (or above) or 3°C above the dew point. If the pipe temperature is lower than this level or if moisture is present on the pipe, heating of the pipe may be required.

d) Deteriorated or contaminated primer shall not be applied to the pipe. Primer that has deteriorated or become contaminated after its application shall be removed to the satisfaction of the Employer or his representative, at the Contractor's expense. The cleaned area shall then be re-primed.

PLQ 9.3.6 External Coating and Wrapping Application

a) The pipe, after priming and when the primer is no longer tacky, shall be passed through coating facilities of a type approved by the Engineer. The machine shall coat the pipe weld (longitudinal or spiral) with a 50 mm wide strip of extruded polymer modified bitumen and thereafter the entire pipe with an extruded coating of polymer modified bitumen and shall simultaneously apply the outerwrap.

b) All primed surfaces shall be clean and dust free immediately prior to coating.

c) The coating (including the outerwrap) shall have a minimum average thickness as specified in SANS ISO 2808 (5.5 mm minimum average and 5 mm minimum at any point) The coating shall be reinforced by a spirally-wound layer of outerwrap pulled into the polymer modified bitumen with an overlap of 20 mm, such that the outerwrap is wetted by the polymer modified bitumen. Particular attention shall be paid to the location of the reinforcement and thickness of the wrapping over the weld. The average thickness shall be determined in the following manner: At least four thickness measurements at approximately the pipe quarter points per lineal metre of pipe length shall be taken. At least 25% of the measurements shall be taken at the weld bead. The average thickness shall be the arithmetic average of all measurements.

d) The completed coating shall be well bonded to the pipe metal; uniform, smooth and free from Holidays, laminations, voids or other defects.

e) The wrapping shall be carefully trimmed off 100 mm from the ends of each pipe and bevelled throughout its thickness over a minimum length of ±5 mm, unless otherwise specified by the Employer or his representative.

f) Solar protection paint shall be applied to the coated pipe while the coating is still warm. It shall be white in colour, water resistant, continuous and shall cover the wrapping sufficiently to form an effective barrier to solar radiation. The solar protection shall be terminated approximately 100 mm from each end of the wrapping (i.e. 200 mm from each end of the pipe).

PLQ 9.4 Inspection and Testing

The Contractor shall be responsible for, and shall bear the cost of a system of inspection and

repair of the wrapped pipe approved by the Engineer. The system shall meet all relevant requirements in this Section and in addition the following requirements:

g) Monitoring of grit size and the finish of blast cleaned pipe.

h) Viscosity measurement and control of film thickness of external primer at least once for every batch of primer, in addition to visual checks of the applied prime coating.

i) Adequate temperature control of the polymer modified bitumen at the application head. In order to ensure that the polymer modified bitumen applied to the pipe has the characteristics specified, samples of the polymer modified bitumen shall then be taken from the application head and subjected to the following test and frequency of testing shown in the table below.

j) Visual checks on the outer wrap and the appearance of the final wrap.

k) Holiday detection of 100% of the surface area of every wrapped pipe with approved equipment operating at a minimum 15 kV, maximum 25 kV with regular calibration of the equipment to the satisfaction of Quality Assurance.

l) Test of bond strength and thickness of the wrapping including removal of samples of the wrapping for inspection.

m) Adequate and proper repair of any defects to ensure compliance with this Section. A need to repair more than 1 defect per m^2 of pipe coating shall be sufficient grounds to reject the pipe and cause the Contractor to adjust his process to reduce the number of defects to an acceptable level.

Any necessary repairs of tested pipes shall be carried out by the Contractor at no additional cost to the Employer.

One pipe from every day's production shall be held back for examination on the following day. This examination shall include bond testing, thickness testing and examination for laminations, voids or any other defects.

If, in the opinion of the Engineer, there are a signification number of defects on the test pipe, then a back check procedure will be invoked. This will involve checking the ten pipes immediately preceding and the ten pipes immediately following the faulty test pipe (the pipe numbers shall be available from the final inspection). These twenty pipes shall be subjected to an examination similar to that carried out on the test pipe. Should the number of defects detected be, in the opinion of the Engineer, significant, then the entire production for that week shall be quarantined and jointly investigated by the Contractor and the Engineer.

Should tests in any production batch show a defect rate of more than 10%, the Engineer may reject the whole batch. In such cases the Contractor shall conduct an investigation to establish the cause of the defects.

'IN PLANT TESTING'

TEST	FREQUENCY OF TESTING
1. Softening Point	Twice per working shift
2. Penetration at 25°C	Twice per working shift
3. Bond test for coated pipes	One pipe per working shift

These tests should be conducted at the coating Plant by the Contractor and monitored by the Authority (AIA), who would be trained in the procedures by the coating material supplier.

At least once during the Contract or when the method of surface preparation is changed, a sample wrapped pipe shall be tested for resistance to cathodic disbonding.
When tested, the wrapping shall not be disbonded from the pre-damaged area by more than a 5 mm radius after exposure for 28 days at the specified potential, i.e. -1500 mV (BS 3900:F1 1).

The inspection activities shall be coordinated with the Contractor's operations so as to delay or interfere with the operations as little as possible. The Contractor's methods shall, nevertheless, always permit inspection to be made and allow adequate repair of imperfections.

Prior to dispatch from his Plant, the Contractor shall ensure that the wrapped pipe is correctly marked on the internal painted surface of the pipe at each end with approved paint, with sufficient information to enable subsequent identification of the pipe to be made. Documentation shall be supplied to the Engineer to enable the history of the processing of each pipe to be traced.

PLQ 9.5 Methods of Testing

PLQ 9.5.1 Testing of Wrap Characteristics

a) General

The procedures given below are reference methods of test, which shall be used to establish conformity to the Specification in cases of dispute. Other similar methods, however, may be used by manufacturers for routine quality control purposes with the approval of the Engineer.

b) Thickness

The thickness shall be determined by means of a suitable instrument fitted with a micrometre dial gauge, a cylindrical brass block 57 mm in diameter and giving a nominal loading of 3.45kN/m^2 and a surface plate.

The thickness shall be measured by interposing the outer wrap between the cylinder and the surface plate. Measurements shall be made by marking 75 mm square across the

effective width of the mat and making a measurement within each square. No single reading across the width of the mat shall be less than the specified minimum thickness.

c) Weight per m^2

The weight per square metre shall be determined by cutting representative samples from the effective width of the outer wrap. The samples shall be of such a size, that the weight per square metre may be determined to an accuracy of ±2%.

d) Tensile Strength

The tensile strength shall be measured with approved equipment. The size of the samples cut from the roll shall be 520 mm long and shall have the required width.

When mounted in the equipment, the distance between the jaws shall be 320 mm. The constant rate of separation of the jaws shall be in the range of 100 mm to 610 mm/minute and the tensile strength at breaking point shall be determined. For reference purposes the rate of separation of the jaws shall be 200 mm/minute. At least four samples shall be tested and an average figure obtained. The test may be carried out on narrower samples if required, provided that at least two of the reinforcing strands are included in the specimen. Sealing of the ends is recommended.

The value for tensile strength obtained from a narrower sample shall be extrapolated to 150 mm width.

PLQ 9.5.2 Bond Test for Coated Pipes

a) Measure the temperature of the coating with a surface thermometer.
b) If the temperature of the coating is not between 10°C and 25°C, cool or warm the pipe in the test area to bring the temperature within this range.
c) Using a knife, heated if necessary, make two parallel cuts, through the coating down to the pipe surface. The cuts shall be 100 mm long and 30 mm apart.
d) With a stiff flat blade, loosen the coating the full width between the two cuts and lift the wrap upward in a direction at right angles to the pipe surface.
e) The bond shall be considered satisfactory if the coating does not peel cleanly from the primer or the pipe surface but is removed with difficulty.
f) This bond test should be carried out at the start of each shift or change in production and thereafter at a frequency approved by the Engineer.

PLQ 9.6 Handling

At all times the pipe, unwrapped as well as wrapped, shall be handled with the aid of slings, lifting yokes and protected hooks to the approval of the Engineer.

At all times the coated pipe shall be handled and stacked in such a manner as to prevent damage to the coating. Particular care shall be taken immediately after coating to avoid damage while the enamel is above ambient temperature. No stacking or loading shall be undertaken until the coating has cooled sufficiently to avoid marking.

The coated pipe shall be stored at all times clear of the ground and in such a way that either water or mud cannot accumulate on the inside or outside of the pipe. Storage shall be effected by the use of wooden bearers, suitably covered, or mounds of gravel-free sand, covered with polyethylene sheets.

The pipe shall only be stacked to a height such that no flattening of the wrapping occurs.

The pipes shall be separated from each other with approved polyethylene covered pads.

PLQ 9.7 Repairs

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation or laying of the coated pipe may occur. This shall be quickly repaired using torch-on membrane.

Damage shall be repaired by removing the existing coating to at least 10 mm beyond the area of damage. The repair area shall then be cleaned of all deleterious matter to 100 mm beyond the proposed repair area. Exposed metal shall be re-primed in accordance with this Section. The repair patch, which shall lap at least 50 mm onto sound coating, shall be applied by gently heating with a gas torch and applying it to the pipe in a manner, which prevents the entrapment of air bubbles. All air bubbles shall be removed using a wooden roller or by other means and the perimeter of the repair patch shall be neatly finished off. The patched area shall then be Holiday tested in accordance with the Specification.

PLQ 10 THREE LAYER POLYETHYLENE COATING (3LPE)

The 3LPE coating shall comply with ISO 21809-1. The Canadian Specification CSA Z245.20/Z245.21 is not applicable.
The materials supplied as part of the 3LPE coating, including the Fusion Bonded Epoxy (FBE), Copolymer adhesive and Polyethylene (PE) outer coating shall be supplied with ISO 10474 or EN 10204 Inspection Certificates 2.1 and 2.2, giving the results of the testing of coated pipes, as supplied on the contract/purchase order and signed by an authorised representative of the Engineer.

An Inspection and Testing Plan (ITP) providing an overview of the sequence of inspections and tests, including appropriate resources and procedures and a Quality Control Procedure (QCP)

shall be submitted for the approval of the Engineer's representative prior to coating production commencing.

Subsequent to the approval of the documentation detailed above, a Procedure Qualification Trial (PQT) shall take place and shall be witnessed by the Engineer's representative as well as subsequent inspection/testing of its properties, to confirm that the Application Procedure Specification (APS) is adequate to produce a coating with the specified properties. All to be carried out prior to the start of production.

The 3LPE shall be Type B coating, as per ISO 21809-1 Table 1.

The minimum thickness of the 3LPE coating shall be as follows:

FBE	0.30 mm
Adhesive	0.20 mm
HDPE	2.00 mm for nominal pipe diameter up to and including 250 mm
	2.50 mm for nominal pipe diameter larger than 250 mm but less than 600 mm
	3.0 mm for nominal pipe diameter 600 mm and larger

The 3LPE shall have minimum total thickness as above, and on heavier wall pipes it shall comply with class B3, as per ISO 21809-1 Table 2.

Polyethylene layer cut back shall be provided at pipe ends as follows:

Pipe ends shall be supplied as bare steel, free of all coating, for a distance of 100 mm (+25mm/-0mm tolerance) from the pipe end. In addition, each pipe end shall be left without polyethylene / adhesive coating so that a 20 mm (+10mm/-0mm tolerance) FBE toe protrudes on the steel beyond the cutback polyethylene coating layer.

The ends of the coating shall be bevelled at 30º to 45º.

The applicator shall use epoxy material that is in accordance with Table 3, Class B, as per ISO 21809-1 and shall test the materials/ensure compliance as detailed above in accordance with ISO 10474 or EN 10204.

The applicator shall use adhesive material that is in accordance with Table 4, Class B, as per ISO 21809-1 and shall test the materials/ensure compliance as detailed above in accordance with ISO 10474 or EN 10204.

The applicator shall use PE/PP material that is in accordance with Table 5, Class B, as per ISO 21809-1 and shall test the materials/ensure compliance as detailed above in accordance with ISO 10474 or EN 10204.

The applicator shall provide batch certificates supplied by the manufacturer of each material and shall contain the information given in Table 6 ISO 21809-1. The batch certificate shall state test methods and acceptance criteria. The applicator shall identify the materials and shall confirm that the certificates comply and relate to the specified materials, as well as the requirements stipulated in Clauses 8.3.2 and 8.3.3 ISO 21809-1.

Prior to the start of coating production and any specified PQT, the applicator shall prepare an APS as per Clause 9.2 ISO 21809-1.

The APS, including any Engineer approved written revisions, shall be approved by the Engineer prior to the start of production and any specified PQT and there shall comply with the requirements of Table 7, Class B coating system.

The APS shall be verified by a PQT in accordance with ISO 21809-1 Annexure L. The applicator shall prepare an ITP and a daily log to record quality control data in accordance with Annexure L of ISO 21809-1.

Prior to the commencement of the surface preparation for the coating operations, a visual inspection shall be performed on the bare steel pipes in order to verify that there are no steel or weld defects (welding slag, spatter or raised/sharp edges) or contamination with oil, grease, soil, dirt and similar contaminants.

In the event that steel defects are detected they shall be rectified using a file, light grinding or any other suitable tool as stipulated in API 1104 Clause 13.10. This intervention shall not reduce the pipe wall thickness below the tolerances specified in the relevant Specifications. In case the steel defect is of the nature that simple correction of this defect cannot be performed, the pipe affected by this defect shall be quarantined until the appropriate measures are taken.

In case oil, grease, or any other residues (e.g. adhesive materials or similar contaminants) are present, then they shall be removed using a high pressure water based detergent cleaner, and/or a suitable “solvent” as per the requirements of SSPC-SP-1 Specification. In the event of other “adherent” contaminant being present, then power tool brushes or any other appropriate method may be utilised in order to remove the contaminant from the pipe surface prior to grit blasting.

The blast cleaning abrasives shall be, at all times, kept dry, clean and free from contamination. The blast cleaning shall be performed when the following conditions are satisfied:

- The steel surface temperature is at least 3ºC above the ambient dew point, which shall be checked using a calibrated hygrometer or other method approved by the Engineer.
- The steel surface shall have no traces of moisture;

- The steel surface is protected from bad weather conditions such as rain or strong winds which can bring contaminants such as soil, sand, dirt, salt or any other such similar contaminant.

In the case that the steel surface temperature is less than 3ºC above the ambient dew point or traces of moisture are detected on the steel surface, the steel surface shall be heated using induction heating until the steel surface temperature is within the range of 50ºC to 60ºC. This temperature shall be maintained until all of the moisture has been removed from the steel surface.

Abrasive blast cleaning shall be in strict compliance with ISO 21809-1 Clause 10.1.2 with the exception that the profile shall be measured using ISO 8503-4 (Stylus method), replica tape is not permitted.

As per ISO 8502-3, the cleanliness of the steel surface shall be measured using the ISO Form: “Preparation of Steel Substrates before Application of Paint and Related Products – Test for the Assessment of Surface Cleanliness – Part 3: Pressure Sensitive Tape Method.” As prescribed, a strip of clear tension tape shall be placed, tacky side down, onto the blasted steel surface of the pipe after cleaning. The tape shall then be removed from the surface and placed on a piece of white glossy paper where it will be compared to the cleanliness levels provided in the ISO 8502-3 specification procedure. This shall not exceed a “Debris” and “Dust” level of Class/Level 2 at any given time and shall be recorded during pipe production on at least every 5th pipe to confirm compliance and records shall be kept for the client, which may be inspected at any given time.

The salt level on the bare steel pipe surface shall be measured according to ISO 8502-2 and shall be a maximum of 20 mg NaCl/m². The basic procedure of the test shall be to dampen circular piece of test paper of known area with a specified volume of laboratory water containing less than 0.1µg/cm² of salt. The test paper shall then be applied to the pipe for a period of 2 minutes, after which the test paper will be removed from the pipe and its resistivity measured. The salt content on the pipe will then be determined through the calibrated Salt Contamination Meter which uses the negative correlation between resistivity and salt content, along with empirically measured historical data to provide a reading.

If excessive salt contamination is established (≥20 mg NaCl/m²) during production testing, then the applicator shall ensure that a “Pre-Wash” system shall be employed prior to coating in order to remove the salt without causing “flash rusting” or any other “surface contamination”. The “pre-wash” shall be performed and shall form an integral part of the production Pre-Qualification Testing (PQT) before acceptance of the “Pre-Wash” procedure.

The maximum time elapsed after completion of the abrasive blasting operation, pre-wash (if applicable) and the application of the P primer shall be 120 minutes if RH < 85% and 60

minutes if RH > 85%. At no time shall the steel surface temperature be allowed to drop below the dew point before application of the P Primer. Should either of these conditions apply, the surface preparation shall be re-inspected and/or the surface preparation repeated as required.

The application of the 3LPE coating shall be in accordance with the approved APS in accordance with Clauses 10.2.2.3 and 4 of ISO 21809-1.

Inspection and testing shall be carried out in accordance with the approved APS and ITP and shall meet the minimum requirements as stipulated in ISO 21809-1 Tables 8 and 9.

Coating repairs shall be addressed in accordance with an Engineer's approved APS and PQT as per Clause 12 ISO 21809-1.

Pipeline marking shall be as per the Employer's requirements, but shall as a minimum include all aspects detailed in Clause 13 of ISO 21809-1.

PLQ 11 RIGID POLYURETHANE COATING (RPU)

PLQ 11.1 Introduction

This part of the Specification defines the minimum technical requirements for liquid applied coating for factory coated pipe and specials. The coating system shall comprise a homogenic layer of 100% solids rigid polyurethane mechanically bonded to the metal substrate.

Where specified it shall be used for the external coating of pipes. The pipeline will be buried and will be protected against external corrosion by the external coating and cathodic protection systems. The external coating (primary corrosion protection system) shall be suitable for the operating conditions applying to the specific pipeline.

PLQ 11.2 Standards

Unless otherwise specified herein, the latest edition of the following Standards should be read in conjunction with this Specification:

American Society for Testing and Materials

ASTM D16	Standard Test Method for Paint, related coatings, materials and applications.
ASTM D 543	Standard Test Method for Evaluating the resistance of plastics to chemical reagents.
ASTM D 570	Standard Test Method for Water absorption of plastics.
ASTM D 2240	Standard Test Method for Rubber Property (Durometer Hardness)
ASTM D 4060	Standard Test Method for Abrasion resistance of organic coatings by the Taber abraser.

ASTM D 4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM G14	Standard test method for impact resistance of pipeline coatings (Falling Weight Test)
ASTM D 4285	Method for indicating Oil or Water in Compressed Air

British Standard and European Norm

BS EN 10290	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings.

ISO – International Organisation for Standardization

ISO 1514	Paints and varnishes - Standard panels for testing
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 4624	Paints and varnishes - Pull off test for adhesion
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 Uncoated Steel Substrates and of Steel Substrates after Overall Removal of Previous Coatings
ISO 8502	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness
ISO 8503	Preparation of Steel Substrates Before Application of Paints and Related Products - Surface Roughness Characteristics of Blast-Cleaned Steel Substrates Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces. Part 2: Method of grading of surface profile of abrasive blast-cleaned steel comparator procedure. Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Stylus instrument procedure. Part 5: Replica tape method for the determination of surface profile.
ISO 8504-2	Preparation of Steel Substrates Before Application of Paints and Related Products - Surface Preparation Methods - Part 2: Abrasive Blast Cleaning
ISO 11124-1	Preparation of Steel Substrates Before Application of Paints and Related Products - Specifications for Metallic Blast Cleaning Abrasives - Part 1: General introduction and classification Part 2: Chilled iron grit Part 3: High-carbon cast-steel shot and grit Part 4: Low-carbon cast-steel shot

NACE – International

NACE RP0274	High-Voltage Electrical Inspection of Pipeline Coatings Prior to Installation
NACE RP0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape
NACE RP0394	Application, Performance, and Quality Control of Plant-applied, Fusion- Bonded Epoxy External Pipe Coating

SSPC – Society for Protective Coatings

SSPC SP11	Power Tool Cleaning to Bare Metal
SSPC PA 2	Measurement of Dry Coating Thickness with Magnetic Gauges (Steel Structures Painting Manual, Ch 5 - Paint Application Specs.)
SSPC SP 10	Near-White Metal Blast Cleaning NACE No.2-2000 (Steel Structures Painting Manual, Ch 2 - Surface Preparation Specs.)

PLQ 11.3 Materials

The required coating shall be a two-component liquid applied rigid polyurethane subject to the approval of the Engineer.

The two components shall have different colours allowing the verification of the correct mixing, and checking of the uniformity of the colour of the mixed product.

The coating is considered cured when it has attained the hardness recommended by the product manufacturer.

PLQ 11.3.1 Handling of Materials

Materials shall be handled and stored in accordance with the material manufacturer's recommendations, which shall be available for review by the Engineer at the Contractor's premises. Materials shall be stored in an air-conditioned, temperature controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected, unless otherwise agreed with the Engineers representative in the factory or on Site.

Materials shall be used in the order in which they are delivered and before their expiry date for use.

PLQ 11.3.2 Documentation from the Materials Manufacturer

The commercial rigid polyurethane coating system offered shall be qualified by the Contractor and will be subject to the Engineer's approval prior to application. Testing should be conducted on each applicable coating and shall meet the acceptance criteria of the table below. The qualification shall be based on tests carried out by an independent recognized certifying body and the relevant documents shall be submitted to the Engineer.

Full traceability of each batch of coating material shall be maintained. As a minimum, the following data shall be compiled and shall be available for immediate review by all parties:

- Name of manufacturer;
- Complete material identification: Trade name, chemical name and type of product details;
- Batch number;
- Date of manufacture;
- Place of manufacture;
- Shelf life / expiry date (if appropriate);
- Health and safety, and environmental instructions;
- Hazard warnings;
- Storage instructions;
- Quantity; and
- Manufacturing standard.

Any material not labelled with the above information shall not be used.

PLQ 11.3.3 Rigid Polyurethane Properties

The coating material properties and characteristics with respect to the 100% solids rigid polyurethane coating shall comply with the requirements of a Type V coating type in terms of the ASTM D16 Standard. The coating material shall be a homogenic solvent free layer with a chemical three-dimensional covalent cross-linked structure. The layer shall be made up from a liquid two pack coating system with Part A being poly-isocyanate rich and Part B consisting of polyols or amines that ensures relatively short curing times. Aliphatic polyurethanes shall be used above ground and aromatic polyurethanes shall be used below ground.

The performance properties of the coating shall comply with the requirements stated in the following table. The Contractor shall submit a full and comprehensive product datasheet to confirm material compliance with the Specification.

COATING MATERIAL PERFORMANCE PROPERTIES

PROPERTIES	TEST REFERENCE	ACCEPTANCE CRITERIA
Minimum application	BS EN 10290 (Annexure A)	1800 µm (Dry Film Thickness)

PROPERTIES	TEST REFERENCE	ACCEPTANCE CRITERIA
thickness		
Adhesion to steel	ASTM D 4541 Method E	> 15 MPa
Adhesion to factory coating	ASTM D 4541 Method	> 10 MPa
Hardness	ASTM D 2240 (Shore D)	As specified by coating manufacturer
Flexibility	BS EN 10290 (Annexure K)	Pass
Tensile strength	ASTM D 638	>15 MPa at 3mm thickness
Resistance to cathodic disbondment	BS EN 10290 (Annexure E)	r < 8mm (28 days)
Dielectric strength	ASTM D 149	Minimum 15 V/µm
Specific Electrical Insulation Resistance	BS EN 10290 (Annexure F)	10^6 ohm.m^2
Impact resistance	BS EN 10290	> 5J/mm at 23°C >3J/mm at 5°C
Indentation resistance	BS EN 10290 (Annexure H)	<0.2mm at 23ºC

PLQ 11.4 Application

PLQ 11.4.1 Surface Preparation

Refer to Clause PLQ 3 for the general steel surface preparation requirements. The steel surface shall be grit blasted to Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals with an anchor profile of minimum 75 µm. The hardness of the abrasive material must be Rockwell C 54 or greater. The abrasive material shall be dry, clean, and free from contamination. Salt contamination tests shall be regularly performed on abrasive to verify that total salt level in the soluble contaminants is less than 25ppm. Extensive grinding shall not be performed without Engineer approval. The anchor pattern shall be restored on all ground surfaces.

The quality control plan (QCP) hold point at the completion of the surface preparation shall be subject to the signing off by the Approved Inspection Authority (AIA) prior to the application of the coating material for all pipes, specials and joint repairs.

PLQ 11.4.2 Coating Application

The application of the coating shall only proceed once the cleanliness of the steel substrate has been approved and the substrate temperature is more than 3ºC above the dew point temperature. The work area shall be kept dry as the material reacts with humidity and moisture.

When required the surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this Specification. The temperature shall not exceed 85°C and the use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating. The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.

The individual liquid components of the rigid polyurethane coating shall be agitated thoroughly before use to disperse pigments and assure homogeneity. No thinning shall be done and the components shall not be mixed together.

The material shall be applied using a plural component, adjusted to the specified mix ratio on a heated airless spray unit with metering pumps. The width of the spray jet, the set up distance from the substrate surface and the overlap, the pipe rotation speed and the rate of application shall be predetermined for the final required dry film thickness applied in the workshop.

The wet film thickness shall be measured in accordance with ISO 2808. Particular attention shall be paid to the recommended dry film thickness which shall be measured in accordance with SSPC PA 2. No spot measurement may be less than 85% of the specified average thickness. Tools and equipment shall be cleaned using only such solvents as are recommended by the product manufacturer. Particular care shall be taken in the handling of the coated items before the coating has reached the minimum value of hardness recommended by the manufacturer. All pipes and other components shall be high spark holiday tested in accordance with NACE RP0274 at the test voltage recommended by the coating manufacturer.

For factory-coated pipe, bends and specials the cut back shall be 150 ± 20 mm. The edge of the cut-back shall be feathered at 30 – 45°.

PLQ 11.5 Inspection and Testing

The Contractor shall demonstrate that the proposed coating material and procedures will meet the requirements of this Specification when applied to pipes and pipe specials. The Contractor shall provide the documentation proof that the final selected coating material complies with the requirements listed in Table 37/15.

The Contractor shall test the finished coating during production to demonstrate continued compliance with this Specification. Details of all inspections and testing shall be fully documented in accordance with the approved quality control plan mentioned in Clause 37.4.2.

All stages of the surface preparation, coating and testing shall be subject to 100% inspection by

the Contractor. The Engineer shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection personnel in the factory as well as on Site.

PLQ 11.6 Testing of Production Pipes

The Contractor shall execute the following tests and provide written documentation proof of the test results within the agreed time frames:

PLQ 11.6.1 Visual Inspection (every pipe)

The coating shall be smooth, glossy, and free from pin holes, excessive orange peel effect, bubbling or excessive runs or sags.

PLQ 11.6.2 Dry Film Thickness (every pipe)

DFT shall be inspected in accordance with SANS ISO 2808, with a minimum average thickness of 1.8mm and a minimum of 1.6mm at any point.

PLQ 11.6.3 Electrical Insulation Defects (Holiday) Inspection (every pipe)

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 15 kV.

PLQ 11.6.4 Hardness Shore 'D' (every pipe)

The Shore 'D' hardness shall comply with the minimum set by the manufacturer in pre-qualification.

PLQ 11.6.5 Adhesion (1 test per shift)

The pull-off adhesion at 23ºC shall be greater than 15 MPa.

PLQ 11.6.6 Cathodic Disbondment (1 test per 50 pipes and commencement of new batch or new production run))

The disbondment shall be less than 8mm radius. BS EN 10290 Annexure E 48hr.

PLQ 11.6.7 Composition (1 test per 50 pipes or new batch or new production run)

The Thermo Gravimetric Analysis (TGA) scan shall be checked against the manufacturer's qualification scan.

PLQ 11.7 Coating Repairs

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond.

PLQ 11.7.1 Repairs before Full Cure in the Factory [Within Sixteen (16) Hours at 23°C of Application of Last Coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

Brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

PLQ 11.7.2 Repairs after Full Cure [After Sixteen (16) Hours at 23°C of Application of Last Coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.
The coating manufacturer's adhesive primer or activating solvent shall be applied only to the abraded surface.

After the designated curing time, brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

Repairs shall be carried out with repair grade materials from the supplier of the factory applied coating, unless otherwise approved by the Engineer.

The repair material shall be as recommended by the supplier of the factory applied coating. The supplier shall confirm material compatibility and surface preparation requirements. Prior to any repair work, the supplier shall demonstrate the use of the material to the Contractor and Engineer on site.

The repaired area shall comply with the quality control requirements as set out in paragraph PLQ 11.6.

Based on the above the Contractor shall prepare a detailed method statement on the repair of the coating for the approval of the Engineer.

PLQ 12 PETROLATUM TAPE WRAPPING SYSTEM

PLQ 12.1 General

An EN 12068 Class A Petrolatum System shall be used for the wrapping of buried flange and flexible joints and where specified in the Specifications, Bill of Quantities or Drawings. The Denso Clingwrap protection system or similar products approved by the Engineer will also be acceptable.

PLQ 12.2 Surface preparation

Bare pipes and fitting to be prepared to a recommended standard of St2 as specified by the Swedish Standard SIS 05590:

St2: Hand Tool Cleaning
Removal of all rust scale, mill scale, loose rust and loose paint to the degree specified by hand wire brushing, hand sanding, hand scraping, hand chipping or other hand impact tools or by a combination of these methods. The substrate should have a faint metallic sheen and also be free of oil, grease, dust, soil, salts and other contaminants.

Chamfer any raised edges or steps in the existing coating.

PLQ 12.3 Primer application

Surface to be primed with Priming Solution (e.g. S105 Paste)

Primer is applied to the steel surface with a brush or paint roller. The primer to be thoroughly mixed prior to application.

The primer to cover the entire steel surface, including the nuts and bolts and overlap onto the mill applied primary coating system by a minimum of 200mm.

The primer must not be diluted. Primer cans should remain covered when not in use to avoid solvent evaporation and contamination.

PLQ 12.4 Profiling mastic application

Apply Profiling Mastic to both sides of the fitting to form a generous fillet from the coupling onto the pipe barrel. The Profiling Mastic is also used to cover the bolt heads and nuts to form a regular profile onto which the Petrolatum Tape can be applied.

PLQ 12.5 Petrolatum tape application

Apply one layer of the Petrolatum Tape to the body of the pipe or fitting, ensuring that there is no air entrapped beneath the tape. The Petrolatum must be applied spirally, with a 55% overlap and at least 100 mm onto the factory coating and the barrel of the pipe.

PLQ 12.6 Clingwrap outerwrap tape application

Spirally apply Clingwrap Outerwrap Tape to cover the entire Petrolatum Tape system. Start at one end, wrapping with a 55% overlap, proceed to the other end and ensure the Clingwrap Outerwrap extends 100mm beyond each end of the repair.

PLQ 13 JOINT COATING SYSTEMS

PLQ 13.1 FBMDPE, three layer polyethylene (3LPE) and Rigid Polyurethane coating

The unprotected area at welded joints shall be protected against corrosion as follows:

- The cutback of the coating shall be 100mm from the pipe ends.
- Chamfer any raised edges or steps in the existing coating.
- The factory applied polyethylene pipe surface to which the cold tape wrapping is to be applied shall be abraded with 40 grit abrasive paper or sweep blasted for a minimum of 50 mm onto the mainline coating to obtain a surface profile with an R_z value between 40 and 70 µm
- Abrasive blast clean the steel surface Sa 3 of ISO 8501-1 or SSPC SP16 for non-ferrous metals. The surface profile shall be checked in accordance with ISO 8503-1, ISO 8503-4 and ISO 8503-5 with an average R_z larger than 75 µm. All types of abrasive that are used in the preparation of the field joints and small repairs shall comply with ISO 11124-2 to 4.
- The surface to be coated shall at the time of application be dry and free of dust and any contamination detrimental to the adhesion of the coating to the steel substrate. The Contractor shall prepare a detailed method statement on how the field joint area will be kept dry and clean during the application operation. It shall also include the trench space requirements for the application equipment.
- All dust, detritus and salts shall be removed from the metal substrate. The level of salts shall be measured in accordance with the requirements of ISO 8502-9 and shall be ≤ 30 mg/m^2

- The application of the coating shall only proceed once the cleanliness of the steel substrate has been approved and the substrate temperature is more than 3ºC above the dew point temperature.
- The temperature of the substrate shall be within the application temperature range specified by the coating manufacturer. When required the surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this Specification. The temperature shall not exceed 85°C and the use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating. The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.
- Applicable to 3 LPE only: Apply Denso Protal 7200 liquid epoxy to the blast cleaned surface and adjacent prepared factory FBE coating to a minimum dry film thickness of 400 micron.
- The entire joint surface to be wrapped shall be primed with Denso Butyl Primer P16HT.

  Allow approximately 30 minutes drying time or until the primer is tacky to the touch.

- Apply 100mm or 150mm wide 3 ply PE/Butyl rubber self-amalgamating inner-wrap compliant with DVGW EN12068 Class C 50°C (DENSO S43HT on similar product approved by the Engineer).

  The tape shall be applied to ensure that a minimum 55% overlap.

- Apply 100mm or 150mm wide 2 ply PE/Butyl rubber outer-wrap compliant with DVGW EN 12068 Class C 50°C (DENSO R23 on similar product approved by the Engineer).

  The tape shall be applied to ensure that a minimum 55% overlap shall be achieved.

  The tape shall be applied to a minimum width of 50mm beyond the applied inner tape-wrapped area onto the primed shop applied coating.

  Ensure that the tape is in full contact with the underlying surface with no wrinkles, fish-mouths or bubbles.

- Holiday detection shall be carried out in accordance with NACE RP0188.

The quality control plan (QCP) hold point at the completion of the surface preparation shall be subject to the signing off by the Approved Inspection Authority (AIA) prior to the application of the coating material for joint repairs

Damaged areas on coatings shall be repaired in accordance with the specifications and guidelines of the coating manufacturer. Hand or power cleaning can be used for small repair areas such as pinholes and areas inaccessible for blast cleaning. 80 Grit or coarser sandpaper can be used to suitably roughen and abrade the area to be prepared. The area shall be sanded to the substrate taking care not to polish the substrate.

Only Engineer approved DVGW Certified and or other Engineer approved certification materials may be used. All materials shall comply with the requirements of EN 12068 Class C HT50°C UV for either tapes and heat shrinkable sleeves (HSS), unless otherwise approved by the Engineer.

An ISO 17050-1 Certificate of Conformity from the supplier (point of origin) stipulating compliance with all chemical, physical and mechanical properties of the applied product, as per ISO 10474 or EN 10204 Inspection Certificates 3.1.B and 3.1 shall be submitted to the Engineer i.e. the DVGW Type Test Report and in-house batch testing for the batch(s) to be supplied.

Pipeline field joint repairs (FJR) may not commence without an Engineer approved Inspection and Testing Plan (ITP) document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures and Quality Control Procedure (QCP).

Subsequent to the approval of the documentation detailed above, a Procedure Qualification Trial (PQT) shall be carried out, to be witnessed by the Engineer's representative. The PQT shall include the application of the FJR and subsequent inspection/testing of its properties, to confirm that the Application Procedure Specification (APS) is adequate to produce a FJR system with the specified properties and shall be carried out prior to the start of production.

Alternatively for RPU mainline coatings, the same RPU material can be applied, once the Engineer has approved the APS, QCP and ITP. An ISO 17050-1 Certificate of Conformity from the RPU supplier (point of origin) stipulating compliance with all chemical, physical and mechanical properties of the applied product, as per ISO 10474 or EN 10204 Inspection Certificates 2.1 and 2.2 shall be submitted to the Engineer i.e. the EN 10290 Type Test Report and in-house batch testing for the batch(s) to be supplied as per EN 10290.

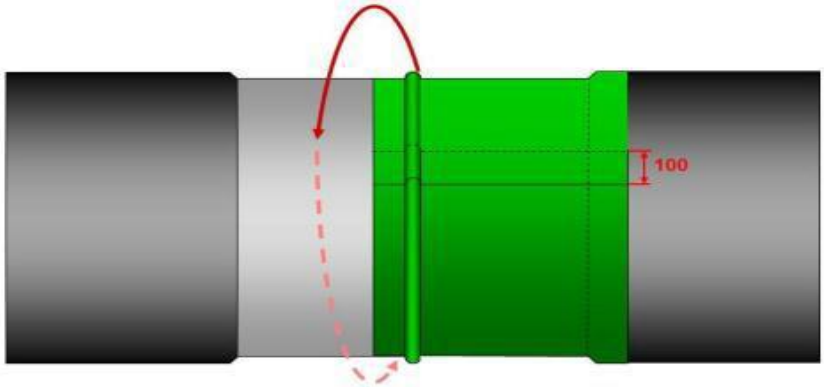
PLQ 13.2 FBMDPE, 3LPE and RPU coating (Stopaq viscoelastic wrappingband application)

As an alternative to PLQ 13.1, the unprotected area at welded joints shall be protected against corrosion as follows:

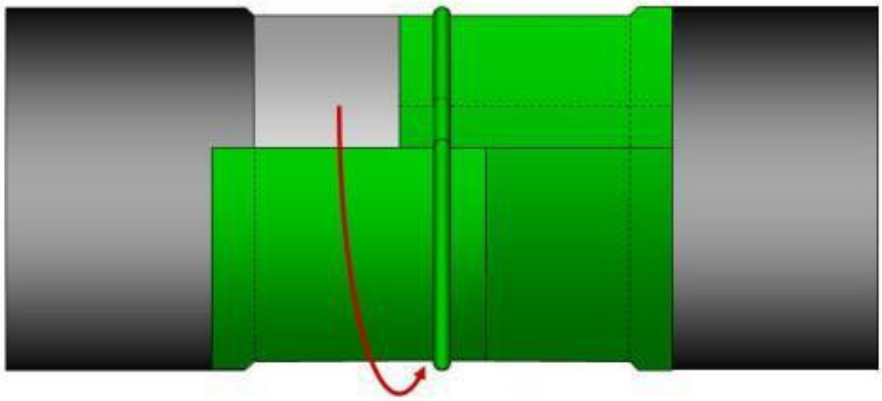
- The cutback of the coating shall be 100 mm from the pipe ends.
- Chamfer any raised edges or steps in the existing coating.
- Abrasive blast clean to Sa 2,5
- Degrease using isopropanol alcohol and a cloth.
- Apply first Stopaq Wrappingband CZH [minimum thickness of 1,5 mm] such that there is

a minimum of 50mm overlap over the weld and a minimum of 50mm overlap over the coating.

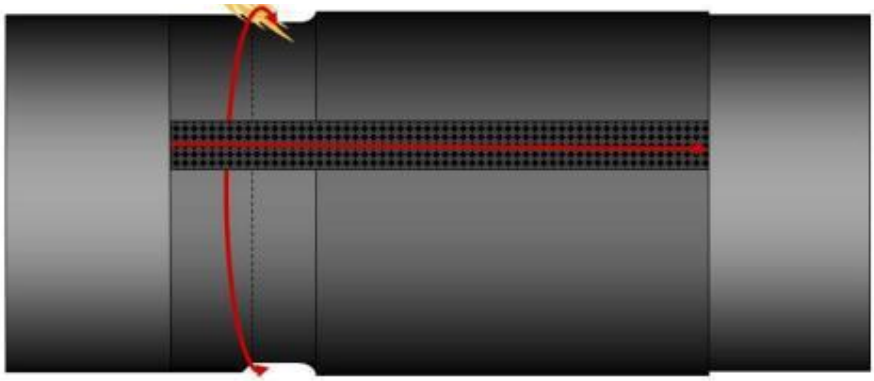
- Where the end of the Wrappingband meets the beginning, peel back the first 100mm of the release foil such that the end can be applied over the beginning with a 100mm overlap.



- Remove the remainder of the release foil and then apply the second Wrappingband in the same manner and remove release foil.



- After removing the release foil, rub the Stopaq by hand to release any trapped air and spark test with 15kV.
- Position the High Impact Shield (HIS) at the 10 o'clock position and wrap around the pipe such that a 100mm overlap results at the joint.
- The HIS shall extend 50mm either side of the Stopaq coating overlap.
- Centre and apply the closure strip on the seam of the HIS. Heat the closure strip and tap on it until attachment is complete. Do not use a siliconized roller.
- Apply heat working from one side to the other against the wind. Apply full heat (100%) to the area there is no Stopaq beneath the HIS.
- Apply 75% heat to area where Stopaq is present beneath the HIS.



- Immediate backfill after application if possible.
- Holiday detection shall be carried out in accordance with NACE SP0188.
- Damaged areas on coatings shall be repaired in accordance with the specifications and guidelines of the coating manufacturer.

PLQ 13.3 Polymer Modified Bitumen (Bituguard) Coating

The unprotected area at welded joints shall be protected against corrosion as follows:

- Where applicable, remove the whitewash for a distance of 150mm from the edge of the factory applied coating. Ensure the end of the factory coating is firmly adhered. Cut back any areas of loose or damaged coating to 10mm beyond the area of damage. Ensure the edge of the factory applied coating is bevelled at 30°or less.
- Chamfer any raised edges or steps in the factory coating.
- Surface preparation shall be abrasive blast cleaning to Sa 2,5 of ISO 8501-1. The white wash on the factory coating to be removed for a distance of 100 mm from the end of the coating.
- The steel surface and 100 mm of the factory coating on both sides of the joint to be coated with Bitumen Primer (Denso Primer D or similar product approved by the Engineer).
- Using hot air or gas torches, apply custom sized Hot Applied EN 10268 Class B HT50°C Bitumen rolls of membrane to achieve the same minimum thickness as the factory applied coating with a minimum thickness of 5 mm. Densotherm HD heat applied bitumen wrapping is also acceptable. The applied membrane shall overlap onto itself or the factory coating by a minimum of 50 or 100mm respectively.
- Ensure a liquid bead of coating is maintained in contact with the steel at all times to prevent air entrapment. The perimeter of the field joint shall be neatly finished off and blended into the factory coating.
- The finished joint shall be free of air bubbles, and shall exhibit the same bond to steel as the factory coated pipe.

Joint preparation shall be subject to witness and hold inspection by the Engineer prior to application of the primer and coating. The finished joint shall be holiday tested at 15kV and any holidays repaired.

PLQ 14 CUT BACK AT PIPE ENDS

Only if it is expected that the pipes will be exposed to corrosive conditions for long periods before it is installed, the unprotected grit blasted bare steel surface at the ends of pipes, specials and fittings to be welded on site shall be painted with a temporary paint product in the factory, to prevent corrosion of the pipe end before the permanent joint corrosion protection is applied on Site. Alternatively the uncoated steel surface could be temporarily protected by a pressure sensitive tape. The temporary paint and remains of the tape (after being removed by hand) shall be completely removed by abrasive blast cleaning as part of the surface preparation process. For each project the Contractor shall consult with the Engineer whether the temporary paint on the pipe ends is required.

PLQ 15 UV PROTECTION

All pipes with FBMDPE, 3LPE or Bituguard coatings shall be painted with a white PVA or acrylic (to be approved by the Engineer) for protection against UV. The overcoat to be maintained by applying additional layers until the pipe is backfilled.

PLQ 16 ADDITIONAL EXTERNAL PROTECTION FOR PIPES CAST INTO CHAMBER WALLS

After the concrete has cured for 7 days, wire brush or scabble the exterior and interior surfaces of the wall to remove laitance. Dry brush to remove all loose powder.

Mix ABE Super Laykold and water (1:1 ratio) and apply as a primer to the concrete and the pipe surfaces. After 1 hour apply a thick coat of ABE Super Laykold to the concrete and the pipe and immediately embed 250mm wide ABE non-woven polyester membrane “SBP” into the Super Laykold. After 3 hours apply another coat of Super Laykold.

Similar products approved by the Engineer can also be used.
This additional protection is required on the inside and outside of chamber walls.

There must be no contact between the steel pipe and the chamber reinforcement.

PLQ 17 JOINT BETWEEN EPOXY LINING AND CEMENT MORTAR LINING

The joint between epoxy lining and cement mortar lining shall be protected as follows:

- Unprotected steel surface to be abrasive blast cleaned to Sa3.

- Epoxy lining to be light abrasive blast cleaned to a surface profile of 60 – 85 micron over a distance of 50 mm minimum.
- Pro-Struct 617NS mortar filler to be applied into the joint between the epoxy and the cement mortar and finished to a smooth surface at a 45-degree angle to the pipe surface.
- Epoxy paint (approved by the Engineer) to be applied on the blast cleaned steel surface, the Pro-Struct 617NS mortar filler and on the cement mortar lining for a minimum distance of 50mm, with a minimum dry film thickness of 500 micron.

PLQ 18 MEASUREMENT AND PAYMENT

If corrosion protection and painting is not measured separately in the Bill of Quantities, the price for corrosion protection and painting shall be deemed to be included in the price for the pipes, fittings and specials.

PLS: CEMENT MORTAR LINING OF PIPELINES

INDEX

PLS 1 SCOPE

This specification covers the cement-mortar lining of steel pipelines.

PLS 2 MATERIALS

PLS 2.1 Cement

a) Cement shall comply with the latest requirements of SABS ENV 197-1 Type CEM 2A.
b) Pozzolanic material shall not be used in addition to or to replace a portion of the cement.
c) Cement used for the trial mortar mix to be specified in the tender and all cement used for this contract shall be produced from the same factory unless otherwise permitted by the Engineer in writing. The name of the factory shall be stated by the tenderer.
d) Cement shall be from the same order of delivery. All cement in storage for longer than eight (8) weeks and all cement in unsealed pockets shall be removed from storage and be discarded.
e) Cement shall be delivered to the site in a dry condition undamaged by exposure to the weather and shall be stored on the site in approved weather and damp-proof conditions. The floor shall be at least 300 mm above ground-level and covered with a waterproof membrane.
f) All cement spilled from broken pockets on working surfaces or storage floors shall not be used on the work. It shall be swept up each day and removed from the work together with all broken pockets of cement.

PLS 2.2 Sand

a) Sand for cement-mortar shall be river sand, natural pit sand, crusher sand or a blend of the sands provided it is clean and the grains are inert, hard, durable and uncoated. The supplier and type of sand and its typical grading envelope shall be stated by the tenderer.
b) Sand shall be well graded and a sieve analysis of a representative sample carried out in accordance with SABS method 829 shall show that it complies with the following grading requirements:

Sieve size (mm)	**Percentage passing by mass**
1,180	100
0,075	0 to 10

c) Sand shall be free from injurious amounts of dust, clay lumps, shale, soft or flaky particles, mica, loam, oil, alkali, and other deleterious substances. The maximum percentage by mass of deleterious substances shall not exceed the following limits:

Deleterious substances	Percentage by mass
Shale	1
Clay lumps	1
Mica and other deleterious substances	2
Sum of all deleterious substances	3

d) The water demand of the sand is defined as the quantity of water in litres required to make one cubic metre of a mortar which having a sand to cement ratio by mass of 1,0 has a consistence of 8,5 mm DB penetration when tested in accordance with BS 4551 : 1980. The water demand of the sand shall not exceed 340 ℓ/m3.

e) The water demand of the sand shall be determined from at least three trial cement-mortar mixes each of a different water content and shall be stated by the tenderer.

f) Sand tested for organic impurities in accordance with SABS Method 832 shall yield a test solution not darker in colour than the reference solution.

g) The chlorine content of the sand determined by SABS Method 830 shall not be greater than 0,01 per cent (mass/mass).

h) The Contractor shall submit samples of the sand to the Engineer for his approval before use. Prior to commencing the work the Contractor shall submit a report in detail from an approved testing laboratory showing that the sand complies with the specification.

i) The testing laboratories of the SABS, CSIR, CCI, or other laboratories subject to the prior approval in writing of the Engineer, will be accepted as approved laboratories in which tests or designs required by the specification may be carried out.

j) Sand shall be stored on site on an impermeable surface, protected from the weather, and washed sand shall be allowed to drain freely for at least 24 hours before use. The Engineer may require the Contractor to test the sand daily (or more frequently if necessary) for moisture content, impurities and grading before use.

PLS 2.3 Water

Water for mortar shall be clean and free from injurious amounts of dissolved mineral salts, organic matter or other substances which may impair the strength or durability of the mortar and shall generally conform to the recommendations in the appendix to BS 3148.

PLS 2.4 Admixture

a) Admixture is any other material apart from cement, sand and water that is added to the cement-mortar or painted onto the bare steel surface prior to cement-mortar application.

b) No admixture shall be used that has a deleterious effect on the electrochemical passivation of the steel surface by the cement-mortar or on the water flowing in the pipe after the lining has been placed. In addition chloride based admixture or admixture that

amperes the durability, fatigue strength or ability of the mortar to resist impact loadings shall not be used.

c) Prior written approval of the Engineer shall be obtained for the use of any admixture and the Contractor shall submit test data to substantiate the admixture performance.

PLS 2.5 Welded Steel Fabric

Welded steel fabric shall conform to SABS 1024, except that wire diameter and mesh sizes shall conform to this Specification.

PLS 3 CEMENT-MORTAR FOR LINING

PLS 3.1 Composition

Cement-mortar for steel pipe lining shall be composed of cement, sand, water, and if required, admixture, that are well mixed and of proper consistency to obtain a dense, homogeneous lining of the required thickness that will adhere firmly to the pipe surface.

PLS 3.2 Proportions

a) The mortar mix shall be designed to produce mortar which will attain the specified compressive and flexural strengths and which will in addition have high density and impermeability.

b) Cement-mortar shall have a maximum water to cement ratio by mass of 0,36:1 and a maximum sand to cement ratio by mass of 1,5:1 (for drag trowel and hand application) and 2:1 (for centrifugal span lining).

c) The workability of the mortar shall be the consistence measured by the dropping ball penetration test carried out in accordance with BS 4551:1980.

d) The proportions of cement, sand and water shall be based upon laboratory tests made with the cement, sand and water to be used on the work. These proportions together with the design workability shall be stated by the tenderer.

e) The exact proportions of the constituents shall be determined by the characteristics of the sand used, the condition of the cleaned pipe surface, the thickness of the lining, the size of pipe and the lining equipment used.

f) Two mortar mixes shall be designed: one suitable for machine application and one suitable for hand application where machine application is impracticable. Guide workability levels for designing these mixes are a 9 mm penetration and a 6 mm penetration respectively.

g) The Contractor shall timeously submit a report of the proposed cement-mortar mix designs to the Engineer for his approval before the work begins. This report, from an approved testing laboratory, shall show that the mixes comply with the specification and shall give for each design mix for at least three different water contents, one of which

corresponds to the design workability level stated in the tender, the consistence obtained when using the materials proposed for the work.

PLS 3.3 Strength

a) The mortar compressive and flexural strength shall be determined from 160 mm by 40 mm prisms stored, demoulded, cured and tested in accordance with the "ISO" SABS method 866. High frequency (200 Hz) vibration shall be used to compact the mortar when moulding in order to expel all the air entrained when mixing. A minimum period of 2 minutes shall be used.

b) The minimum 7-day compressive and flexural mortar strengths below which not more than 5 per cent of results may fall are 30 MPa and 5,5 MPa respectively. The corresponding 28-day mortar strengths are 42 MPa and 6,5 MPa respectively.

c) At least 6 representative mortar prisms shall be made for each day of machine lining applicable. Three of these prisms shall be tested at 7-day's age and 3 at 28-day's age. The 6 prisms shall be made from one batch of mortar sampled whenever possible from the hopper of the lining machine.

PLS 3.4 Batching, Mixing and Workability

a) All mortar shall be batched and mixed in mechanical mixers of good condition under the supervision of a competent and experienced person.

b) All materials shall be batched by mass and the combined error in weighing the materials shall not exceed 2 per cent. Equipment performance shall be checked when required by the Engineer and the Contractor shall provide apparatus as required for this testing.

c) All weighing and measuring equipment shall be checked daily, and if necessary adjusted, before cement-mortar mixing commences.

d) The quantity of water used in each batch of mortar shall be carefully adjusted to maintain the cement to water ratio required for the approved mix.

e) Allowance must be made for the moisture content of the sand which shall be determined either by weighing and drying or by the speedy moisture meter. Allowance shall also be made for moisture collecting on the interior of pipe surface, the method of transporting the mortar from the mixer to the lining machine and the trowelling system used.

f) Mixing shall be continued for not less than 90 seconds after all the materials including water are in the mixer. All mortar shall be thoroughly mixed and the whole of each batch shall be uniform, free of lumps and free from segregation. The minimum time of 90 seconds may be increased at the discretion of the Engineer.

g) Adequacy of mixing shall be judged visually and if in the Engineer's opinion mixing is unsatisfactory, the mixer shall be replaced by a machine which will produce acceptable mixing.

h) Any batch not complying with the specification shall be removed from site or disposed of as directed by the Engineer or Inspector.

i) The workability of the freshly mixed mortar shall be determined periodically from a sample taken immediately prior to being transported to the lining machine, or where practicable from a sample taken at the lining machine itself.

j) There shall be no retempering of the mix after discharge from the mixer. Only fresh mortar shall be used, mortar in a mixed state for longer than 1 hour shall be discarded.

PLS 3.5 Once the optimum workability for the day's run is determined the consistence shall not vary by more than 1 mm DB penetration.

PLS 4 ACCESS OPENINGS AND ACCESS POINTS FOR IN SITU APPLIED LININGS

PLS 4.1 The Contractor shall provide access openings in the pipeline for inspection, cleaning and lining work by cutting out a suitable section of piping. On completion of the lining operation, the Contractor shall replace the relined cut out section by means of electric arc welding carried out in accordance with the requirements of Section PLN of the Particular Specification.

The average spacing and dimension of the access openings required shall be stated by the tenderer.

PLS 4.2 Welding can be inspected by means of ultrasonic or radiographically testing. This inspection will be carried out in accordance with BS 3923 and API 1104 by an inspection authority appointed by the Engineer. All defects not complying with API 1104 shall be ground out and repaired to the approval of the Engineer. The costs of all repairs and consequential inspection shall be borne by the Contractor.

PLS 4.3 The actual position of each opening shall be sited so that it does not interfere with anchor blocks, valve chambers, scour piping, etc., and so that it does not cause an obstruction to traffic, access to properties, structures etc. The position of each access opening to be approved by the Engineer. Access openings shall not interfere with pipe joints, expansion joints, etc.

PLS 4.4 An access point is an opening to the pipe interior such as an access manhole or large diameter air valve saddle. It may be used for inspection, cleaning, cement-mortar lining or curing as required by the Contractor in which case it becomes his responsibility to control all access at the point until the blank flange and/or air valve is refitted and bolted up by the Contractor prior to filling the pipe with water.

PLS 4.5 The Contractor is responsible to prevent animals, reptiles, etc. from entering the pipe.

PLS 5 CLEANING PIPE SURFACES

PLS 5.1 The Contractor shall clean the steel surface to be cement-mortar lined so as to provide a clean, firm and sound surface free from contaminants such as loose rust, loose mill scale, weld slag, loose corrosion products, dust, soil, grit, oil, grease, accumulations of water and water soluble salts, which can adversely affect the adhesive bond of the freshly applied mortar and the electrochemical passivating mechanism of the cement-mortar.

PLS 5.2 Mechanical cleaning by hand or machine methods or both shall be used. Details of the method and equipment to be used for cleaning shall be submitted with the tender. Solvent emulsions shall be used to remove oil or grease followed by thorough rinsing with clean water. Compressed air tools or equipment used inside the pipe, shall be fitted with an adequate oil removal filter and moisture drain trap which shall be inspected and cleaned regularly.

PLS 5.3 The interior surface of the installed pipeline shall be cleaned to a degree of cleanliness equivalent to preparation grade St 2 of SABS Method 767 (thorough scraping and wire brushing).

PLS 5.4 At the start of the contract after cleaning but before any lining is carried out a standard of cleanliness for the pipe surface which is assessed for freedom from dust and debris using transparent cellophane tape in accordance with SABS Method 769 is to be agreed upon between the Engineer and the Contractor and will be strictly adhered to for the duration of the contract.

PLS 5.5 Cleaning of the pipeline surfaces shall be completed not less than one day or more than two days in advance of the lining operation and no lining shall be carried out unless the cleaned surface has been inspected and approved by the Engineer.

PLS 5.6 Immediately prior to the machine application of lining, excessive condensation and pools of water, rust dust, sand, mud, loose mortar, rebound debris and other foreign materials that have accumulated since the cleaned pipe section was inspected and approved shall be removed by suitable methods that are to be agreed upon before the lining is applied.

PLS 5.7 The Contractor shall provide 60 watt halogen or 20 watt fluorescent lamps to illuminate the cleaned pipe and provide suitable movable lamps to illuminate the surfaces when the Engineer carries out testing and inspection.

PLS 5.8 The Contractor shall provide his workmen and the Engineers representative with protective clothing and appliances such as dust respirators, goggles, face shields and masks to prevent bodily harm while carrying out the cleaning operation.

PLS 5.9 Cleaning water, rust and debris removed from the pipeline shall be collected, loaded and transported at a maximum of 3 day intervals but should the local accumulation become excessive it shall be removed at shorter intervals as determined by the Engineer.

Dirty cleaning water shall not be disposed of in a manner that will cause soil erosion in the working area. The rate for cleaning shall include for collecting, loading, transporting and disposal of the cleaning water, rust and debris at permanent disposal sites.

PLS 6 APPLICATION OF MORTAR LINING

PLS 6.1 Machine Application of Mortar Lining

a) For shop applied linings pipes shall be adequately supported.

b) The lining shall be applied in one layer by use of a machine with an applicator head which will centrifugally or otherwise place mortar against the surface of the pipe without injurious rebound and with sufficient velocity or pressure to cause the mortar to be densely packed and to adhere in place. Details of the machine to be used shall be submitted in the tender. The use of compressed air in direct contact with the cement-mortar will not be permitted in the process of mixing or application. The rate of travel of the machine and the rate of discharge of mortar against the wall of the pipe shall be entirely mechanically controlled so as to produce a smooth lining of uniform thickness through the interior of the pipeline. The lining machine shall be provided with attachments for mechanically trowelling the mortar. Both the application and trowelling of the mortar shall take place at the rear of the machine so that the freshly placed and trowelled mortar will not again be disturbed or touched until after it has set. The trowel attachment shall be such that the pressure applied to the lining will be uniform, producing a smooth surface without shoulders or undulations, and producing a lining of uniform thickness.

c) The Contractor shall only be permitted to place a double layer (or skin) on approval of the Engineer. A double layer (skin) shall be placed within 24 hours after the first layer has been placed. A minimum layer thickness of 5 mm is required. The total cost for a double layer will be for the account of the Contractor.

PLS 6.2 Centrifugal spun lining of pipes

The coating, if applicable, shall be suitably protected against mechanical damage during the handling and spinning operations. Before being placed in the spinning machine, the pipe shall be suitably braced with external stiffening rings, which shall not be removed until the appropriate one of the following periods has elapsed from the time of placing of the lining:

a) 72 hours when water curing is used.

b) 36 hours when steam curing is used.

End gauge rings shall be securely attached to the pipe ends to control the lining thickness, to act as a stop end to prevent mortar leakage and to stiffen and hold the pipe ends round.

Each pipe shall be rotated in a spinning machine with its axis horizontal during and for a suitable period after the placing of the lining. The speed of rotation shall be such as to produce a uniform distribution of the cement mortar over the interior surfaces of the pipe. Sufficient mortar to line completely one pipe to the appropriate nominal thickness shall be mixed in one batch, and it shall be of such consistency as to minimise segregation during spinning. The mortar shall be placed in the pipe immediately after mixing and before initial set has taken place, and in a manner providing uniform longitudinal distribution of the batch from end to end of the pipe. As soon as the mortar lining has achieved a uniform thickness over the whole interior surface of the pipe, the speed of rotation shall be increased to a speed that will compact the mortar and is not less than a peripheral speed of 17 metres per second. The required speed shall be maintained for such a period as will give the maximum density of mortar and smoothness of surface, and sufficient bonding to permit removal of the pipe from the machine without injury to the lining. All water and latence expelled during spinning shall be removed in such a manner that the surface of the lining is smooth, level and true.

After the lapse of a suitable period after spinning (as determined by experiment), the spun lining shall be given a steel trowelled or smoothing bar finish. A second towelling may be necessary to remove all laitance and produce a smooth and hard finished surface.

For spigot and socket joints, the concrete lining shall be ended as shown on Figure 1 at the end of this specification.

PLS 6.3 Pipe Ends for Shop Applied Linings

For flanged pipes and specials and pipes intended for jointing by couplings, concrete lining shall be ended flush with pipe ends with a 6mm bullnosing of edges by means of a nosing tool.

For pipes to be butt welded, the lining shall terminate 50 mm from the internal end of each pipe and the end of the lining shall be bevelled to form an undercut angle of approximately 85 degrees between the clear end of pipe barrel and the lining end. The unlined surface of 50 mm wide from each end may be protected by strips of pressure sensitive plastic tape, firmly pressed into the surface to exclude all air, moisture and to give temporary protection between the works and butt welding on the site.

For spigot a socket joint with a fillet weld, the cement mortar shall end as shown on figure 1 attached.

PLS 6.4 Hand Application of Mortar Lining

a) In addition to the repair of but welded joints, hand applied mortar shall be allowed only where machine application is impracticable. Bends less than 22,5° shall be lined by machine unless stated by contractor in the tender to the contrary. The Engineer may order the correction of defective lining to be carried out by hand application of mortar lining.

b) Any voids related to flexible couplings will be filled by hand with mortar and finished flush with inside wall of pipe prior to application of mortar lining.

c) Areas to be hand lined shall be cleaned and all dust removed with a soft wire hand brush.

d) Cement slurry shall be applied to the cleaned pipe and existing cement lining as a bond coat in a layer no more than 2 mm thick after wetting the existing lining.

e) Cement slurry consist of cement, water and admixture. A suitable admixture is a styrene-butadiene copolymer latex (SBR) manufactured for use with Portland Cement as a bonding agent (Nitobond or Duralatex or a similar product approved by the Engineer). The proportion of cement, water and admixture shall be in accordance with the manufacturer's specifications and submitted to the Engineer.

   A typical proportion is a SBR/Water mix of 1:1 and add cement to form a slurry consistency.

f) The cement-mortar shall be applied before the slurry is dry. Admixture shall be used in the cement mortar and the proportion shall be in accordance with the manufacturer's specifications and submitted to the Engineer. A typical proportion is a SBR/Water mix of 1:3 added to the cement/sand mix.

g) Hand applied mortar shall be finished with steel trowels and the quality, thickness, uniformity and surface finish shall be substantially equivalent to the machine applied mortar lining.

   Care shall be taken to maintain full lining thickness at the intersection of branch and pipeline barrels.

h) All hand finishing work in a section of pipeline, including hand patching of defective lining, shall be completed within 24 hours after completion of the machine application of mortar lining to that section. If necessary application of mortar lining by machine shall be delayed or stopped to assure compliance with this provision.

i) The cost of hand application of mortar lining and all hand finishing work shall be included in the rate for lining.

j) Hand applied linings of specials (bends, tees, reducers, etc.) of nominal diameter 600 mm and larger to be handled or transported after application of the lining and windows at access openings for all pipe diameters shall be reinforced by tack-welding 100 mm x 50 mm x 2,5 mm diameter steel mesh to the inside of the pipe in such a way that it is not in

contact with the pipe except where welded. The minimum cover over the mesh shall be 10 mm.

PLS 6.5 Spigot and Socket Joints for steel pipes

Refer to Figure 1 at the end of this specification

At spigot and socket pipe ends the internal protection shall be done in accordance with the following:

- Prior to the joining of the pipes the vertical surfaces of the cement-mortar lining and the steel surfaces of both pipes shall be coated with a slurry. Mix a bonding agent (Supercrete from Samson or a similar product approved by the Engineer) with water (2:1 ratio) to form the slurry. The surface of the cement-mortar must be wet when it is coated with the slurry. Mix the slurry with an expansive cementitious grout (Standard Bedding grout from Samson or a similar product approved by the Engineer). While the slurry is still wet the grout shall be trowelled to the vertical surface of the cement-mortar lining in the socket.

- Alternatively mix Multibond SBR 1070 with water (1:3 ratio) to form a slurry. Mix cement with sieved plaster sand (1:1 ratio). Add the Mulitbond/water slurry to the cement/sand mix (1:3 ratio) to form a mortar. Apply the Mulitbond/water slurry to the steel surfaces and wet vertical surfaces of the factory cement mortar lining and wait till it is tacky and then apply the mortar to the vertical surface of the cement-mortar lining in the socket.

- Push the spigot into the socket and tack weld. The excess grout which has been squeezed out of the joint shall then be removed from the pipe and the joint shall be smoothed with scraper or a sponge on a rope where man access into the pipe is not feasible. Complete the welding before any movement at the joint is allowed and while the grout is still wet.

- The joint shall be welded at low amps and with thin rods to reduce the temperature of the steel at the grout.

All mix ratios above are per volume.

The Contractor shall keep the joint covered with wet hessian on the outside until it is covered with soil to ensure proper curing of the mortar.

The Contractor shall conduct tests to determine the optimum jointing procedure and to proof that the above methods are producing satisfactory results (to the satisfaction of the Engineer) before installation of the pipes commences. If the pipeline is not accessible for visual internal

inspection of the joints, the Contractor shall conduct CCTV inspections of the joints immediately after the completion of the first ten joints and a regular basis thereafter to proof the quality of the joint repairs.

PLS 6.6 Moving of pipes

Lined pipes shall not be moved for a period of 7 days and not be transported for a period of 14 days after completion of the lining. Covers on both pipe ends are required during transport and storing at the factory and on site. The manufacturer of the pipes shall ensure that covers remain intact and on the pipe ends at the factory and during transport and off-loading on site.

PLS 7 THICKNESS AND SURFACE FINISH OF LINING

PLS 7.1 The minimum mean thickness of the lining shall be 12 mm per measurement station. The range of mean thickness shall be between 12 and 15 mm. A lining with a thickness of less than 7 mm at any point is unacceptable. The thickness of lining on specials shall generally comply with the above provided that the minimum cover of mortar over reinforcement shall not be less than 10 mm. The maximum unbiased standard deviation of thickness shall be 3 mm. The thickness statistics shall be calculated for each measurement station and for all stations in a pipe section between access openings.

PLS 7.2 The finished surface shall be uniformly smooth with no trace of sand or gritty particles. After trowelling the finished surface shall be examined by the Engineer or his representative for quality, and the Contractor shall provide adequate interior lighting for this purpose. The Contractor shall request all inspections in writing once the Contractor has executed his own quality control inspections and must give the Engineer at least 48 hours' notice of his inspection requirements. Adequate time must be allowed for the Engineer to carry out the inspections.

Ridges or uneven build-up caused by irregularity in the travel rate of the machine shall be a cause for rejection of a lining. A "pock mark" or "orange peel" effect shall also be a cause for the rejection of a lining. In all cases the Engineer's decision on quality will be final.

PLS 7.3 The lining shall be well finished with a smooth surface free from excessive laitance and surface irregularities. Projections exceeding a height of 1,5mm shall be removed by trowelling before the cement-mortar has set, or by grinding after the lining has cured.

The thickness of the laitance, if any, shall not exceed 10% of the thickness of the lining, or 1,25mm, whichever is less.

PLS 7.4 The lining surface finish will be measured using a 305mm long straight edge and a 1,6 mm feeler gauge. At each measurement station the gaps between the lining and a straight edge laid parallel to the pipe axis at opposite ends of the pipe diameter, shall be checked to see if

they are greater than 1,6mm. Any one or more gaps bigger than 1,6 mm will result in a failure being recorded for that straight edge location.

PLS 7.5 The ends of only one pipe diameter at each measurement station shall be checked for surface finish and this diameter shall change in a clockwise rotation of 45 degrees to the adjacent diameter at the next measurement station. The surface finish pass rate for a pipe section is the number of straight edge locations measured less the number of failures, expressed as a percentage of the measured locations.

The lining surface finish shall be free from excessive number of defects and shall have a minimum pass rate of 50 percent.

PLS 8 CURING

PLS 8.1 Curing operations shall begin immediately following completion of machine mortar lining of a section of pipeline or the hand mortar lining of an access point, bend, branch, taper, special or access opening. The section of lined pipe shall be sealed off with airtight covers or removable bulkheads over all openings and the lining shall be maintained in a moist condition by the addition of water until in- situ lined pipes are filled with water or for at least 42 days for shop applied linings or up to the date the pipes are delivered to site if it is done between 14 days and 42 days after cement mortar lining. The construction contractor shall be responsible to maintain the cement mortar in a moist condition up to at least 42 days after manufacturing, should the pipes be on site before the expiring of the 42 day period. The method of curing is subject to the approval of the Engineer.

PLS 8.2 The Contractor shall inspect each section that is undergoing curing daily to ensure it has adequate curing moisture and that all seals are in place. If necessary water shall be added to maintain a moist lining and any seal found damaged shall be replaced.

PLS 8.3 The exterior surfaces of pipe exposed to sunlight shall be covered with a minimum of three layers of hessian which shall be sprinkled with water and kept damp in the daytime during the period of lining, finishing and curing so as to prevent cracking of the lining due to temperature effects.

PLS 8.4 During curing period steps shall be taken when necessary to prevent the temperature of the steel shell falling below 2°C.

PLS 8.5 Steam Curing of Shop Applied Linings

The Contractor has to prove that the pipe coating will not be damaged during steam curing.

Immediately after application of the cement-mortar lining, the ends of the pipe shall be completely sealed. After the lined pipe has been standing for not less than 2 hours, steam shall be so injected into it as to raise the temperature at a rate not exceeding 28°C per hour until the temperature of the lining is within the range 55-70°C. Steaming shall continue for a further 6 hours, the temperature of the lining being maintained within the range specified. Steaming shall be discontinued and the pipes shall remain sealed for a further 2 days from the time that the temperature of the pipe has fallen to ambient. During this period precautions shall be taken to prevent the temperature of the steel falling below 2°C.

During the curing cycle, excluding the 2 day holding period, the temperature of at least one pipe out of that day's production, shall be recorded by a suitable automatic recording instrument. If the temperature record reveals that the requirements set out above have not been achieved, then the pipes shall be subjected to the full curing period of at least 7 days.

PLS 8.6 The manufacturer must ensure that the type and quality of the pipe end covers is adequate to ensure it remains intact during storing, transporting and handling.

PLS 9 INSPECTION OF LINING

PLS 9.1 As soon as the lining has hardened to the stage that it will not be damaged by workmen or their means of transport in the pipe, the lined surfaces shall be inspected for surface finish, thickness and other defects and the defective area shall be marked for repair. The Contractor shall provide facilities for lighting and inspection.

PLS 9.2 The Contractor shall make available a suitable trolley for the sole use of the Engineer and/or his representatives.

PLS 9.3 In each pipe section that has been lined and trowelled in a day's run, measurement stations will be marked out at 10 m spacing. The lining at each measurement station will be checked for thickness at 8 points on the pipe circumference, 45 degrees apart starting at the crown of the pipe. The lining thickness at all edges (branches, tees, etc.) will be checked.

PLS 9.4 The lining thickness will be determined with a hand held eddy current thickness gauge supplied by the Contractor that has been calibrated against known thicknesses of mortar taken from the same day's batch of mortar. The thickness gauge will also be used to locate and mark areas of lining between measurement stations that are too thin or too thick.

PLS 9.5 The cured lining of each pipe and special applied in a shop shall be inspected visually for defects before the pipe leave the factory.

PLS 9.6 The inspections and measurements shall be done by the Contractor, to the approval of the Engineer.

PLS 10 DEFECTS

PLS 10.1 Defects in cement-mortar lining which may include but are not limited to sand pockets or porous spots, voids, blisters, excessively cracked areas, excessively debonded areas, areas of lining thinner or thicker than specified, areas of unsatisfactory surface finish and mortar that does not meet the strength requirements shall be repaired by the Contractor notwithstanding that the lined area may previously have been inspected and passed by the Engineer. This may involve the removal of large sections of lining, re-cleaning of the pipe surface and re-lining of the pipe, the costs of which shall be borne by the Contractor.

PLS 10.2 Small defective areas shall be repaired by manual removal of the defective lining and by hand application of mortar lining within 24 hours after lining application. All defective concrete shall be removed and the surrounding area of concrete chipped back to a position where the concrete is firmly bonded to the steel. In removing the defective lining, the mortar shall be cut back to a square shoulder and no chamfered joints will be permitted. Defective areas encompassing the full circumference of the pipe shall be replaced by machine application.

PLS 10.3 Cracks bigger than 1,0 mm shall be repaired by brushing and wiping of cement slurry into the cracks.

PLS 10.4 Defective lining rejected at the time of lining shall be removed before the initial set of the mortar. The removal and disposal of material shall be at the Contractor's expenses.

PLS 10.5 Defective lining removed from the pipeline, waste cement-mortar from trial mixes, cleaning of pump hoses and equipment, and any other debris from the lining operations, shall be collected and temporarily deposited in a suitable heap or container and shall not litter the site. It shall be transported off site twice a week and disposed of.

PLS 11 SAMPLES AND TESTS

The cost of supplying samples and making any test shall be borne by the Contractor unless prior arrangement for payment is agreed to in writing by the Engineer. The Contractor is to allow for these costs in his price.

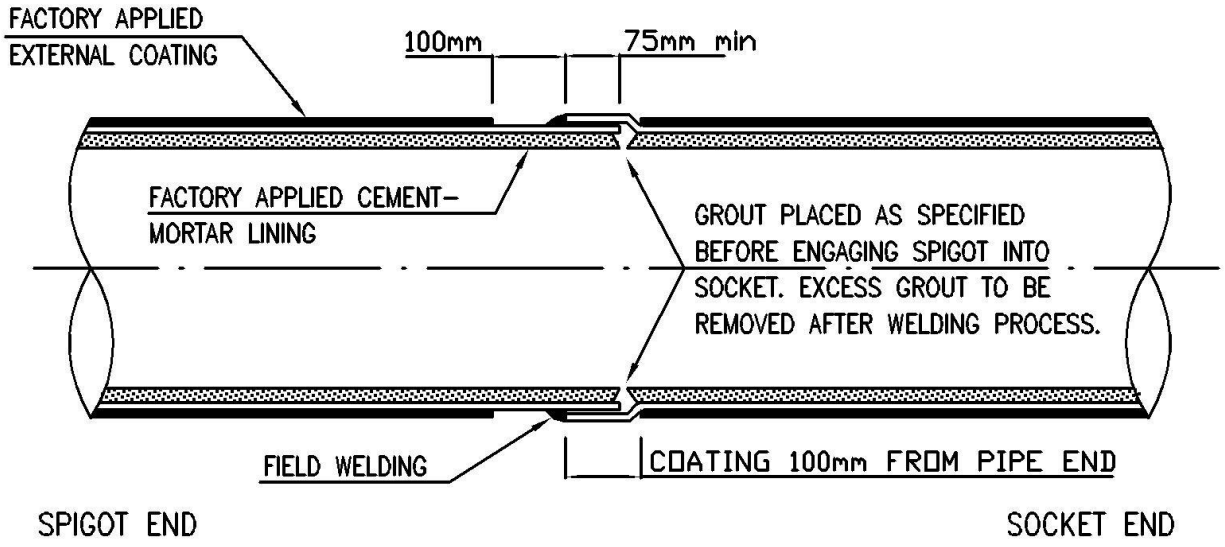
PLS 12 BACKFILLING OF EXCAVATIONS

Backfilling of the excavations may only be carried out after the welding and repair of coating have been approved by the Engineer.

PLS 13 DISPOSAL OF UNDESIRABLE MATERIAL

All material and debris removed from the pipeline shall be loaded, transported and disposed of at approved dumping sites. The removal and disposal of all such material shall be included in the rates for cleaning.

FIGURE 1
SPIGOT & SOCKET PIPE END



PLT: FLOW METERS (GENERAL)

INDEX

PLT 1 SCOPE

This section of the Specification deals with the supply, delivery, installation and commissioning of:

a) in line ultrasonic flow meters;
b) clamp on ultrasonic flow meters
c) flanged mechanical turbine meters
d) electromagnetic flow meters.

PLT 2 IN-LINE ULTRASONIC FLOW METERS

PLT 2.1 General Requirements

An in-line ultrasonic flow meter will consist of:

a) Two machined, stainless steel, weld-on sockets with inserted perspex windows, which are held by two plastic flanges secured with stainless steel bolts and spring washers.

The tenderer shall be responsible for the welding of the sockets on to the pipeline, as well as making good all corrosion protection according to applicable specifications.

b) Two 1 MHz sensing units, connected via co-axial cables of 50 ohms, with a minimum length of 12 m, to the transmitter.

The sensing units are to be removable under full pressure, while the pipeline is operating.

Both sensing units shall be electrically isolated from the pipeline.

c) A transmitter that shall have two output circuits:

i. One circuit for the 4-20 mA output signal to drive an indicator, and if later required a recorder, with maximum load capacity of 1 000 ohm.
ii. The second circuit to drive a 24 V integrator, with a 2% zero flow cut off.

All power requirements other than 230 V will have to be provided for by the successful Tenderer.

The transmitter shall have facilities to adjust for the various pipe diameter and flow rates.

PLT 3 CLAMP-ON ULTRASONIC FLOW METERS

PLT 3.1 General Requirements

Single channel flow meters operated in transit time or time-of-flight mode shall be provided unless otherwise specified. The flow meter provided shall be capable of measuring the instantaneous flow in a pipeline and give the accumulated flow. The installation shall comprise at least two (2) sensing units (transducers) that are connected via co-axial cables and connected to a signal conversion unit. The signal unit shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantaneous flow and totalize flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

Welding of transducers onto the pipe will not be allowed.

The IP rating for the housing of the transducers shall be *submersible.*

The mountings on the transducers shall be manufactured by stainless steel.

The location of the flow meter installation shall be indicated on the relevant drawings, together with the following general information:

- Pipe outer diameter
- Pipe material
- Pipe wall thickness
- Internal lining
- Average thickness of internal lining
- Fluid to to be measured
- Distance between transducers and signal converter
- The operating temperature for all equipment shall be minimum -10°C and maximum 55°C.

PLT 3.2 Flow Accuracy

The flow accuracy (velocity) shall be ± 1% of reading for pipe diameter greater than 150mm and flow velocities greater than 0.3 m/s. For pipe diameters smaller than 150mm, the flow accuracy shall be ± 3%.

The overall rangeability or turn-down ration shall be at least 400:1.

The repeatability for clamp-on transducers shall be 0.2 to 0.5% of full scale reading.

PLT 3.3 Calibration

The Contractor shall allow for the calibration of the flow meter one month after installation by Technology Services International of Eskom enterprises. A certificate of calibration shall be submitted to the Engineer, acceptance of wich signifies final completion of the installation.

PLT 3.4 Guarantee Period

The ultrasonic flow meter shall be guaranteed for a period of at least **24 Months** from date of **successful commissioning.**

PLT 4 FLANGED MECHANICAL TURBINE METERS

PLT 4.1 Equipment Preferred

All mechanical turbine meters shall shall be type Sensus or similar and approved.

PLT 4.2 Accuracy

All mechanical meters supplied in terms of this Contract shall perform to an accuracy of better than ± 2% error over the meters operating range i.e. between Q_t (transitional flow) and Q_n (continuous flow). The performance characteristics of the meters offered shall be equal to or better than the values tabled below:

Size (DN) (mm)	Q_{min} (m^3/h)	Q_t (m^3/h)	Q_n (m^3/h)	Q_{max} (m^3/h)
40	0.3	0.8	40	60
50	0.3	0.8	50	90
80	0.5	0.8	120	200
100	0.8	1.8	230	300
150	1.8	4	450	600
200	4	6	800	1200
250	6	11	1250	1600
300	12	15	1400	2000
400	25	50	2000	3000
500	45	60	3000	4500
600	100	180	3300	6500
800	210	320	6000	12000

PLT 4.3 General Requirements

Meters must be fitted with dry dial registers, which comprise 6 digit cyclometer-type totalizers, registering in kiloliters (kl) or m³. These registers must be sealed to prevent ingress of dirt or moisture. The registers, which are to be fitted as standard, must be able to provide one high frequency opto-type pulse output function and two low frequency reed-type pulse output functions. All flow meters shall be provided complete with frequency converter unit and opto coupler. The frequency converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

No consideration will be given to meter types, which necessitate the use of special tools or fitment of any form of gland in the process of connecting pulser units, or, meters which require a register-change to switch from one volume unit per pulse to another. Dismantling of registers for this purpose will not be acceptable. Tenderers are to provide full details of these aspects with their tenders.

Cover bolts must be of stainless steel material to facilitate easy removal of mechanisms. Meter bodies must be coated with a high quality sintered epoxy powder coating, both internally and externally, to provide maximum protection against corrosion.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

Tenderers must provide full details of the minimum lengths of straight pipe required upstream and downstream for each size of meter offered, to ensure that the accuracy of the meters remain within the stated limits, under normal operating conditions. Preference will be given to meter types requiring a minimum of straight pipe upstream and downstream, as installation space and lay lengths are at a premium.

The performance of the meters offered shall not be affected by outside magnetic influences.

Details of head loss across the meters offered shall be provided by the Tenderer.

PLT 5 ELECTROMAGNETIC FLOW METERS

PLT 5.1 General Requirements

All electromagnetic flow meters supplied under this contract shall be for high measuring accuracy i.e. ± 0.5% of reading plus 0.05% of full scale. The repeatability or reproducibility of measurement shall be ± 0.1% of full scale. The meter shall have a long term zero stabiity of ± 0.2% and linear variation shall be less than 0.2%.

Electrodes shall be manufactured from a high quality metal and shall be removable for cleaning purposes. Removal of electrodes with the line under pressure is preferred.

The minimum downstream and upstream unrestricted straight pipe run required for the specified measurement accuracy shall be stated by the Tenderer.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

The flow meter shall be eqipped with a separate mountable signal converter unit complete with sufficient length of signal cable. The signal converter shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantantaneous flow and totalized flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cublicle supplied under the electrical scope of the Contract.

Electromagnetic meters and converters shall be suitable for outdoor installation and shall be adequately protection against lightning.

PLT 6 DIGITAL INDICATOR/INTEGRATOR

The display shall be a 6-digit, 0.56” (14.2mm) High Red L E D, giving a maximum display of 999999. The decimal point shall be selectable.

A flashing display shall be given during totaliser overflow.

The indicator/integrator shall be powered by 230 V AC at 50 Hz.

The indicator/integrator shall be constructed in such a way that it can be calibrated to the required flow and also by means of a selector button, display the accumulated quantity of water released.

The front bezel shall meet NEMA 4/IP65 requirements

The manufacturer of the indicator/integrator shall comply with ISO 9001 and proof of this to be submitted with the tender documents.

The indicator/integrator shall have a lock-out facility to limit operator entry to the programmable settings and totaliser.

The totaliser shall have a programmable time base with a scale factor of 0.001 to 100.0 and a low-end cut-out.

The remote indicator/integrator if required is to be fitted into an IP 66 enclosure in such a way that the flow reading is clearly visible with space available for the labelling and surge protection as specified.

PLT 7 INSTRUMENT PANELS

All panels will comply with the minimum requirements for an IP 65 rating.

All cable entries will be fitted with the appropriate cable gland. All cable glands will comply with IP 68.

Each enclosure is to be fitted with an M10 brass bolt and two nuts that will act as an earth bar. All surge protection in the enclosure to be grounded onto this bolt.

a) Local indicator/integrator

An instrument panel is required to house the flow meter power supply unit if required, indicator/integrator and surge protection and shall comply with the following:

1. At least 500 mm high, 400 mm wide and 200 mm deep.
2. Constructed from polycarbonate.
3. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
4. Be fitted with a plain painted metal chassis of at least 2.5 mm thick.
5. Be fitted with a polyester internal door for mounting of the totaliser.
6. The external door shall be fitted with a window that allows sight of the totaliser.
7. The external door shall have an extruded polyurethane seal fitted to a groove.
8. Only two closure points that are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
9. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

b) Remote indicator/integrator (if required)

An instrument panel is required to house the remote indicator/integrator and surge protection and shall comply with the following:

1. Constructed from polycarbonate.

2. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
3. Fitted with a polyester internal door or stand-offs for mounting of the totaliser.
4. The external door shall be fitted with a window that allows sight of the totaliser.
5. The external door shall have an extruded polyurethane seal fitted to a groove.
6. Only two closure points which are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
7. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

PLT 8 SURGE PROTECTION

Single phase 230 V AC medium protection units that are certified to withstand surges of up to 75kA.

Two wire, 230 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two wire, 24 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two explosion proof, pipeline spark gaps rated to withstand surges of up to 100kA, complete with pipeline mounting brackets and a fly lead of at least 300mm.
All surge protection units must be grounded to a common earth point in the panel that houses the ultra sonic flow meter. If a nut and bolt arrangement is used it shall be at least an M10 and shall be made of brass. Care has to be taken to ensure that the nut and bolt do not negate the IP 65 rating of the enclosure.

PLT 9 SIGNAL CABLE

All signal cable to be 1,5 mm², 4 core, twisted pair, braided screened cable.

PLT 10 EARTHING

The successful Tenderer is to supply 70 mm^2, stranded copper cable as well as lugs that will fit the cable and an M10 bolt to connect between the equipotential bar and earth mat.

The successful Tenderer is to supply 16 mm^2, green PVC insulated, stranded copper cable to connect between the common earth at the instrument panel and the equipotential bar.

PLT 11 EQUIPOTENTIAL BAR

An equipotential bar with cover must be suitably mounted within each flow meter chamber. Modular terminals should be provided to accommodate 3 connections of up to 16 mm², 3 connections of 16 - 95 mm² and 3 for flat connections up to 30 mm wide.

PLT 12 LABELS

Two types of labels are required. One for the site and installation name, the other giving details of the flow meter characteristics.

Labels to be manufactured from plastic engraved stock with white lettering on a black base.

Lettering to be 10 or 6 mm high x 5 and 3 mm wide and labels to be at least 105 mm X 30 mm.

All labels to be fitted with at least two strips of 12 mm wide double sided tape that run for the total length of the label.

PLT 13 GENERAL REQUIREMENTS

All screws, brackets, cable saddles, nuts, bolts, washers etc. used in the installation of the equipment shall be from stainless steel.

Before delivery to site all equipment and all parts supplied under this contract will be checked and certified at the supplier's workshop to ensure that they are in working condition by a delegated representative of the client.

PLT 14 COMMISSIONING

The equipment as supplied under this Contract shall be commissioned after **one fault free month** of operation.

If during this month the equipment or any part thereof should fail the successful Tenderer shall repair the equipment at his own expense and once again leave the equipment to operate for one fault free month before commissioning. All costs incurred shall be for the successful Tenderer's account. This cycle to continue until one fault free month has been attained.

END OF SECTION

Isinyithi Cathodic Protection

Company Reg # : 2002/002423/07
VAT# : 4570234502

P O Box 2905, Wilkoppen, 2068
13 Robin Drive, Fourways 2191
T: 011 465-1807
E: pipeline@isinyithi.co.za

SPECIFICATION

CLIENT	:	**Phatwe Consulting Engineers / Rustenburg Water Services Trust**
PROJECT	:	**New Bospoort Pipeline**
SCOPE	:	**AC Mitigation and Cathodic Protection Specification**
DATE	:	**March 2021**
REF	:	**6940/161259[1]**

Report by: _____
N C Webb

Internal Review: _____
V Sealy-Fisher

Reports are submitted to clients on a confidential basis;

No reference to the work or test results in any manner will be discussed or made public without written authorisation from the client;

All work is considered proprietary property of the client and is maintained by Isinyithi as such.

Disclaimer: Responsibility rests with the reader to verify the latest revision of the report.

Job Title	**Bospoort Pipeline**
Document title	**AC Mitigation and Cathodic Protection Specification**
Project Number	**6940**
Document Reference	**161259[1]**

Organisation	Name		Date
Isinyithi Cathodic Protection (Pty) Ltd	N C Webb		**10 Mar 2021**

Job Title	**Bospoort Pipeline**
Document title	**AC Mitigation and Cathodic Protection Specification**
Project Number	**6940**
Document Reference	**161259[1]**

Revision	**Date**	**Revision Description**	For review/comment	
0	Aug 2020		**Prepared By**	**Checked by**
		Name	Neil Webb	V Sealy-Fisher
		Signature		

Revision	**Date**	**Revision Description**	Comments incorporated	
1	Mar 2021		**Prepared By**	**Checked by**
		Name	Neil Webb	V Sealy-Fisher
		Signature		

LIST OF TABLES

1 SCOPE

This specification deals with system component design, the manufacture, shop assembly and testing, supply, installation, site testing, site commissioning, all operating and maintenance during the Defects Notification Period of the temporary and permanent Cathodic Protection (CP) systems and alternating current interference mitigation (ACIM) system on the pipeline constructed under this Contract.

The work required shall be done as per the system specifications and requirements set out below under the direction of a specialist AC Mitigation and Cathodic Protection Representative of the Engineer (CP Eng Rep) . Due to the nature of the investigations and system component designs required in this specification, the final testing and design validation regarding the system design work will be monitored by the CP Eng Rep. This will be done progressively during the construction of the pipeline.

This specification shall be interpreted as follows:

a) For Employer's Design it shall be regarded as a Specification.

b) For Contractor's Design of system components it shall be regarded as an Employer's Requirement.

2 DEFINITIONS, ABBREVIATIONS AND REFERENCES

2.1 Definitions

For the purpose of this document:

a. **“Manufacture”** includes, as applicable, the purchase of materials or goods, manufacture, fabrication and assembly, any specified corrosion protection measures and any off-site inspection or testing of materials or parts.

b. **“Installation”** includes, as applicable, all handling and transport from storage, if necessary, all erection and setting to work.

c. **"Performance Specification"** means the Employer’s Requirement.

2.2 Abbreviations and Material Symbols

For the purpose of this Document, the following shall have the meaning given:

A	:	Ampere (unit for electrical current)
AC	:	Alternating current
ACIM	:	AC interference mitigation
ASTM	:	American Society for Testing and Materials
BS EH	:	British European
CD	:	Capacitive discharge
CDT	:	Current Drainage Test
CP	:	Cathodic protection
CSE	:	copper/copper sulphate reference electrodes
CSV	:	Comma separated values
DC	:	Direct current
DCVG	:	Direct Current Voltage Gradient
DFT	:	Dry film thickness
DGPS	:	Differential global positioning system
GPRS	:	General Packet Radio Services
HDG	:	Hot-dip galvanised
HVAC	:	High voltage AC transmission lines
Hz	:	Hertz (unit of frequency)
ICCP	:	Impressed Current Cathodic Protection
ISO	:	International Organisation for Standardization
MMO	:	Mixed metal oxide anode
MOV	:	Metal Oxide Varistor
NACE	:	NACE International.
Ω	:	Ohm
PVC	:	Polyvinyl chloride
r.m.s.	:	root mean square

SACP	:	Sacrificial anode cathodic protection
SANS	:	South African National Standards
SRE		Stationary (permanent) reference electrode
SPD	:	Surge Protection Device
SS-DCD	:	Solid state DC decoupling device
USB	:	Universal Serial Bus
V	:	Volt
VLD	:	Voltage Limiting Device
XLPE	:	Cross-linked polyethylene
Zn	:	zinc

2.3 References

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

3 DESIGN AND GENERAL REQUIREMENTS

3.1 Design

3.1.1 General

The materials used, the component design and the cathodic protection provided shall comply with the relevant system requirements set out below.

3.1.2 Drawings

The Contractor shall be responsible for submitting relevant component design, construction and installation Drawings to the Engineer for approval, within 3 months of the award of the Contract. The Drawings shall include dimensions and material details of plant offered for approval.

The Contractor shall also be responsible for “as-built" drawings of all CP Stations, AC mitigation stations and all hardware and Plant installed as part of this Contract.

3.2 Electrical Continuity

The pipeline must be electrically continuous within defined sections. Where electrical continuity is required as detailed in the drawings and bill of quantities, all flanged components shall be made electrically continuous by means of a continuity bond. Continuity bonding around valve chambers where bolted flanges, dismantling flanges or couplings are found will be achieved either by external buried cables or internal cables mounted on the valve chamber walls, as designated in the bill of quantities.

3.2.1 Continuity bonding around the outside of chambers

Bonding cables will be attached to the pipe(s) each side of the valve chamber wall. Excavation around the chamber will be in accordance with the relevant specifications.

Two off double insulated single core 35 mm² copper cables laid in parallel shall be thermit welded separately directly to the pipe overt.

Continuity bonding shall include excavation, cable connections, making good of coating and lining systems to original coating system, test and back filling. All cables shall be clearly identified by means of permanently marked plastic ferrules with black lettering on a yellow background. Ferrules shall be the slip-on type and matched to the size of the cable.

3.2.2 Continuity bonding around the inside of valve chambers

One off 16 mm² double insulated single core copper cable shall be welded to the pipe overt where the pipe protrudes through the chamber wall on the upstream and downstream sides. The cables coming from the upstream and downstream sides must be installed against the chamber walls using 15mm galvanised conduit and connected via a link panel for selective continuity. Continuity bonding shall include cable connections, making good of coating and lining systems to original coating system, conduit, saddles, terminations and link panel. All cables shall be clearly identified by means of permanently marked plastic ferrules with black lettering on a yellow background. Ferrules shall be the slip-on type and matched to the size of the cable.

3.2.3 Continuity bonding of buried couplings

Buried flanges shall be made continuous by means of 2 off 25 x 5mm steel flat-bars welded across the flanges prior to encapsulation.

Buried VJ couplings shall be made continuous by 2 x 35mm^2, single core, double insulated, black cable welded across the flange and on the barrel of the flange (including 6 x welds and coating make good).

3.3 Cathodic Protection Test Stations

Cathodic Protection and AC Interference Mitigation monitoring test facilities (recording, bonding and current measurement) shall be located inside purposely provided bunkers located as indicated in the installation schedule.

The enclosure shall be manufactured from 30 MPa concrete and shall be a minimum of 150 mm thick and shall be reinforced with hot-dip galvanised (HDG) mild steel (minimum 8 mm diameter).

The vandal resistant enclosure shall be manufactured from 5 mm (min) thick 3Cr12 plate which shall be reinforced as required. Corrosion protection of enclosures shall be multi-purpose epoxy plus re-coatable polyurethane.

A common-key vandal resistant (stainless) steel locking mechanism shall be utilised to lock the 3Cr12 enclosure. Details of the locking mechanism shall be submitted to the Engineer for approval before manufacturing or construction of the enclosure.

The internal enclosure shall be at least 800 mm x 420 mm x 450 mm (H x D x W) and accommodate the 75mm uPVC (Class 12) duct for a portable reference electrode.

The enclosure shall be installed with a concrete foundation, base and 1.2m x 100 mm thick concrete surround with reinforced 100 mm x 100 m x 6 mm HDG mild steel mesh. The reinforcing mesh shall be connected to a cable that is to terminate within the enclosure, should an equipotential plane be required for AC interference mitigation.

Inside the lockable enclosure, the 75mm uPVC (Class 12) tube shall extend above a 2.5mm thick stainless steel Grade 304L gland plate, to permit the portable reference electrode to be installed directly into the soil (via the uPVC duct) with no outside interference.

The Contractor shall submit details and drawing for an appropriate terminal board/link panel of polycarbonate, or GRP, to be mounted in the bunker with associated ducts penetrating through the floor of the bunker for cables.

3.3.1 Recorder-Type Test Point Facilities (Type B)

Type B bunker connection panels require connections for the following:

- Pipe power cable
- Pipe monitor cable
- VLD from gradient control mat
- AC Coupon with 10 ohm 50W resistor
- DC Coupon with 10A slow blow fuse
- Stationary reference electrode
- SSDCD from zinc ribbon (if required)

3.3.2 Bonding Type Test Point Facilities (Type C)

Type C bunker connection panels require connections for the following:

- Pipe power cable
- Pipe monitor cable
- Foreign pipe power cable
- Foreign pipe monitor cable
- VLD from gradient control mat
- AC Coupon with 10 ohm 50W resistor
- DC Coupon with 10A slow blow fuse
- Stationary reference electrode
- SSDCD from zinc ribbon (if required)

3.4 Impressed Current Cathodic Protection

3.4.1 Introduction

It is proposed that shallow horizontal groundbeds be used for the Bospoort Pipeline.

The groundbeds will contain tubular MMO anodes or similar rating silicon iron anodes, encased in galvanised steel canisters, with each canister spliced alternatively to the positive ring main cable. The anode canisters will be 2 m in length, 200 mm diameter, while the spacer canisters will be 1 m long, 200 mm diameter.

Watering systems will be provided so as to enable the groundbed resistance to be more constant and to prevent the groundbeds from drying out.

3.4.2 Dimensions and general description

The actual length of the groundbed is presented in the CP design report. However, each groundbed has the following common features:

- Anodes in canisters
- Coke breeze backfill
- Positive ring main cable
- Splices of the anode tail to the ring main shall be encapsulated in epoxy splicing kits
- Watering system
- Cable warning tape

The watering system will be installed during the groundbed construction in order to ensure an even groundbed resistance over time.

Cable warning tape (yellow on black) will be installed at a depth of 600 mm below surface along the entire length of the groundbed.

3.4.3 Watering System

The watering system will consist of a ribbed and slotted, double walled PVC drainex pipe, 110 mm in diameter. The pipe is covered by one layer of flow net and then by one layer of bidim A2. The pipe lengths are usually 6m in lengths. They need to be coupled together with couplings and the end of the pipe must be closed with a suitable end cap. The drainex pipe will be fed using a 50mm PN 12 HDPE pipe from the closest valve chamber using a suitable ball valve and pressure reducing valve. The pipe will be laid in a dedicated trench from the designated valve chamber to the start of the groundbed.

3.4.4 Coke Breeze

Sasol Corr-Carb pitch coke shall be used or a similar product approved by the CP Eng Rep. The chemical composition is as follows:.

Table 3.1: Table of chemical composition of coke breeze

Element/Compound	Specification	Test Method
Fixed Carbon	99.5% min	**By calculation – 100% minus (%ash + VCM)**
Sulphur	0.25% max	**ASTM D 4239**
Ash & volatiles	0.50% max	**Ash – ASTM D 4422** **Volatiles – BS 1016: Part 4**
Moisture	0.15% max	**ASTM D 3173**
Bulk density	1000 kg/m^3 max	**ASTM D 527**
Resistivity	**55 Ωm max**	**Alusuisse C-109**

The particle size distribution (calculated as per ASTM D 293) shall be a maximum of 100% < 1.0 mm and a min of 5% < 0.5 mm.

The coke breeze will be used to surround the anode in the canister and in addition, the canistered anodes will be located within a coke breeze surround measuring 300 mm by 300 mm.

3.4.5 Anode Canisters

Anodes will be located inside spirally welded galvanised steel canisters, having dimensions of 200mm diameter and 2 000 mm long and will have been pre-packed at the manufacturer's (or supplier's, or installation contractor's) premises. The anodes will be centrally located within the canister, and the annular space between the anode and the canister will be filled with coke breeze.

The ends of the canisters will be sealed and the anode cable will protrude through the side with protective glands.

3.4.6 Anodes

Mixed metal oxide (MMO) or equivalent anodes will be used for the impressed current CP system.

Anodes will be manufactured from tubular titanium metal to ASTM B 338, either Grade 1 or 2, and will be coated with iridium and tantalum oxides. The anode dimensions will be 500 mm x 19 mm diameter x 0.9 mm wall thickness with a minimum capacity of 50 A.y.

The anode to cable connection will be made in the centre of the anode, using a crimped or welded insert over the copper cable to give a resistance of less than 0.001 Ω and a minimum breaking strength of 1200 kg. Heat shrink is used to seal the ends of the wedge and the copper cable.

The ends of the anode will be sealed with a rubber end cap and the annular space between the tubular anode and the copper cable will be filled with a cast resin.

In addition to the certification provided by the manufacturer, two anodes from the batch will be subjected to the following range of destructive tests at an independent laboratory approved by the CP Eng Rep:

Table 3.2: Table of Destructive tests required on two anodes per batch.

Test	Minimum requirements/Test Method
Test solution	10% by volume sulphuric acid
Test temperature	Less than 50 ºC for duration of test
Test Current Density	20 kA/m^2 min
Test Duration	Minimum 35 days at the specified current density
Coating adhesion test	ASTM B 571
X-Ray/NDT	The tubular anode shall be X-Ray'ed in order to ensure that bubbles are not contained within the epoxy sealant
Metallurgical and SEM analysis	Anodes will be sectioned and the MMO coating verified

3.4.7 Cabling

The anode tails will be 10 mm^2 PVC/HMWPE/PVDF.

3.4.8 Cable Warning Tape

Cable warning tape will be inserted above the groundbed, at a depth of 600 mm below surface.

3.4.9 Transformer Rectifier Units

3.4.9.1 Scope

This specification is for the supply and delivery of Transformer Rectifier Units (TRU) for the CP system of the Bospoort Pipeline. TRUs will be standard construction in order to minimise spares requirements and facilitate maintenance.

All documentation related to the supply of CP and ACM equipment shall comply with the requirements of the main contract.

3.4.9.2 General Specification for TRU Cabinet construction

a. General Comments

The TRU's are to be installed in concrete structures (Rocla) in a rural area but with industrial atmospheric pollution. Cold dry conditions occur in winter. All components must be treated so as to provide satisfactory service under the corrosive conditions of the sites.

The general details of the sites are as follows:

Altitude	:	1200 m above sea level
Ambient Temperature	:	-10° to 40° C
Relative Humidity	:	10% to 80%
Lightning conditions	:	8.1 flashes/km^2/annum

The TRU's may be used in environments where metallic dust, soot and grit may be present.

All structure bolts, washers and nuts shall be Grade AISI 304 stainless steel. Bolts with spring washers are preferred and "Nylock" nuts are permissible where devices being secured remain at ambient temperature.

The TRU's will be installed within concrete enclosures, so no TRU cabinet is required and the TRU components shall be mounted on a free-standing frame capable of being located inside the concrete enclosure. The frame shall be made from mild steel that has been hot dip galvanized and must be bolted onto the concrete floor.

All components shall be mounted on one frame, and access to all components, especially in regard to replacement of diodes shall be possible without excessive dismantling.

Suitable lifting lugs (capable of carrying the total mass of the frame and all its components) shall be incorporated onto the frame/cabinet to allow safe handling and installation on site.

TRU's will be powered by single phase 230V AC power.

b. Powder coating for chassis plates

Apply by means of electrostatic spray to ensure a final DFT of 120 micron per coat. Epoxy, epoxy polyester or polyester powder baked at 190 ˚C for 15 minutes. Ethylene vinyl acetate thermoplastic powder coating baked at 220 – 250 degrees Celsius for full curing.

Exterior colours	:	as specified by the Engineer
Interior colours	:	as specified by the Engineer

c. Electronic PC Boards (PCB)

All electronic printed circuit boards shall be coated with a proprietary conformal military spec. coating designed to prevent corrosion to the exposed component leads. All PCB's shall have a primary solder mask and legend.

d. General Specification for electrical wiring

All current carrying conductors shall be insulated to withstand a minimum voltage of 1000V. All wiring shall comply with the provisions of the Wiring Code of Practice; SANS 10142 (latest edition).

Wherever possible flexible, multi-strand cable is to be used.

Joints or splices in any wiring will not be permitted. No more than two conductors shall be connected to any one terminal.

All conductors shall be numbered at both ends with reference to the Schematic Wiring Diagram supplied with the unit.

All conductors excluding busbars shall be routed in trunking or harnessed using polyethylene spiral wrapping.

Thyristor gate leads (if fitted) shall be screened or twisted pair.

All current-carrying conductors shall be multi-stranded, flexible and sized to adequately carry the design current without a rise in temperature.

All conductors shall be terminated at each end with suitably-sized, pre-insulated lugs or pre-insulated ferrules. No trimming of conductor strands will be permitted. All ferrules and lugs shall be crimped with appropriately sized crimping equipment.

Where elevated temperatures are expected beyond the operating range of PVC insulated conductors then the conductors in the heat affected area must be insulated with materials capable of withstanding the elevated temperature environment.

Dimple crimping of lugs and ferrules is not permissible, only hexagonal crimping dies may be utilized when crimping and must be adequately sized and include the cable size marking in the die.

Cable markers must be colour coded as well as have their number embossed indelibly on the marker. i.e.

0- Black
1- Brown
2- Red
3- Orange
4- Yellow
5- Green
6- Blue
7- Violet
8- Grey
9- White

Cable markers must be appropriately sized to suit the insulation size of the cable.

Cable markers shall read from cable to lug on all conductors.

All AC supply conductors shall be colour coded according to the incoming phase and retain the colour nominated throughout the cabinet.

AC carrying conductors must be routed separately from DC carrying conductors.

Grounding cables connected to Surge diversion devices must be kept as short as possible and may not be routed with either AC or DC carrying conductors.

e. Terminals

All terminals shall be completely accessible after completion of wiring.

All terminations made to buss bars shall be provided with spring washers.

All supply power terminations shall be enclosed and be highlighted with a warning label.

Transformer and inductor or smoothing Capacitor terminations shall be covered with a transparent cover prohibiting accidental contact.

Output terminals shall be fully insulated from any metal of the housing or chassis.

All terminals shall be clearly marked and sized according to the current the terminal will carry.

f. General specification for colour coding and labelling of conductors, equipment and components

Positive electrical conductors	Red
Negative electrical conductors	Black
Earth cables	Green with yellow stripe
AC Supply cables	
Phase 1	Red or Brown
Phase 2	Yellow or White
Phase 3	Blue
Neutral	Black
Reference Electrode cable	Yellow
Electrical warning signs	Black on yellow background
Monitor cable	Blue
Transformer Secondary cables	Grey
Component Labels	Black on a white back ground.

All labels shall be engraved sandwich type Gravoply labels. All labels to be mounted with screws or blind rivets only. Silk screen labels or Aluminum anodized labels shall not be utilized.

3.4.9.3 Electrical Construction

a. General

The TRU is to comprise a step-down, double wound transformer with earth screen, coarse tappings and a controlled rectifier bridge to produce a DC output.

The maximum output voltage is to be 50 Volts DC and the output current will be 20 Amps.

A fused isolator shall be provided such that the TRU can be manually disconnected from the load.

The output of the unit will be automatically controlled in one of four control modes as follows:

- Constant output current.
- Constant output voltage.
- Constant Structure to Electrolyte potential.
- Iterative “Instant off” structure to electrolyte potential.

The rectifier bridge will consist of Silicon diodes rated at twice the rated current and a peak inverse voltage of 1600 Volts. The diodes shall be mounted on convection cooled heat sinks. The output of the Unit shall be smoothed and contain a ripple of less than 5%.

b. Automatically Controlled TRU

The main rectifier bridge shall be connected for full wave rectification. The heat sink shall have a thermal switch to automatically interrupt operation of the TRU should the temperature of the heat sink exceed 80˚C and restore operation when the temperature of the heat sink falls to below 80˚C. The primary circuitry of the main transformer will be protected via a D curve 5 kA circuit breaker adequately rated so as to avoid nuisance tripping. The circuit breaker must dis-engage all phases of the TRU when tripping and must be capable of isolating the supply from the unit.

The secondary circuit of the main transformer will be protected via thermal fuses incorporated into each phase between the output of the transformer and the rectifier bridge. The AC fuses must be adequately rated to allow for maximum output current and voltage to be maintained for 1 hour without rupturing. With a 20% increase in output current one of the AC fuses must rupture within twenty minutes of the increase in output current.

The rectifier is to be protected with thermal fuses incorporated into the positive and negative legs. The fuses are to be adequately rated to allow for maximum rated current to be maintained for one hour without rupturing. With a 20% increase in output current one of the DC fuses must rupture within twenty minutes.

All thermal fuses are to be of the mechanical indicating type whereby an irreparable form of mechanical indication occurs when a fuse is ruptured.

c. Transformer

All Transformers shall be double wound to BS171 complete with inter-winding screen. The inter-winding screen must be routed out of the transformer and earthed as close to the transformer mounting as possible.

The transformer is to be vacuum impregnated with a suitable insulating varnish and baked subsequent to vacuum impregnation.

Regulation of auxiliary windings shall not be greater than 3 % and on the main step down winding 10%.

The transformer must have suitable windings on the secondary of the transformer to facilitate coarse selection of the voltage. The windings must be so wound to provide coarse adjustment of 33%, 66% and 100% of the step down voltage.

d. *Earthing /Grounding*

All metal components shall be connected to the common earth and to the AC supply earth.

All electrical circuits shall be floating with respect to earth.

All earth connections within the enclosure must be as short as possible and rated at possible fault current.

Earth buss bar mounting studs must be adequately sized to accommodate collective fault current.

A separate earthing system will be provided for the TRU consisting of copper earth rods and bare copper earthing cable which will have a resistance below 10 Ω.

e. *Auxiliary Power Socket Outlet*

A 15A power socket adequately inspected according to the Occupation Health and Safety Act & Regulations, Act 85 of 1993 as amended, will be provided in the distribution board cabinet located on the inside of the concrete enclosure (Rocla).

f. *Output Control*

The adjustment and control of the output shall be achieved through a magnetic amplifier located in the primary side of the transformer, a fully controlled thyristor bridge or a switch mode integrated unit.

g. *Magnetic Amplifier (optional)*

The magnetic amplifier shall be of the air-cooled type.

The magnetic amplifier shall enable the DC output current of the rectifier to be varied between 7.5% and 100% of the full load current, when connected in series with the primary winding of the rectifier transformer.

The current rating of the magnetic amplifier shall be not less than that of the primary winding of the rectifier transformer.

Alteration of the current output will be by means of a variable DC supply to change the control current to the magnetic amplifier.

The control current must not exceed 1 A.

The magnetic amplifier shall be mounted on the same frame as the rectifier set.

h. Output Control Modes Of Operation

Selection of the control mode as well as adjustment of the limits and control set points must be user programmable and the control equipment must be capable of both local as well as remote selection. Remote selection of the control mode is to be accomplished via the RS 232 port utilizing modbus protocol.

Irrespective of control mode, the TRU control equipment must be capable of output voltage, output current and potential pre-set limits. When the control equipment is changed from one control mode to another control mode, all user programmable parameters must be automatically restored to minimum values to prevent an instantaneous application of output voltage or output current to the load.

The Automatic control equipment must be capable of controlling the application of power to the load in either a pre-programmable incremental percentage of maximum output stepped manner, or in a linear incremental manner, in addition to the aforementioned control modes, the selection must be user programmable.

The input impedance of the reference electrode input to the control equipment must be no less than 500 MΩ and must not adversely load the reference electrode thereby distorting the potential measurement.

Precise control is required and local adjustment of set points and control modes must be via sealed tactile push buttons and not through the use of adjustable potentiometers as these deteriorate with time especially in corrosive atmospheres.

i. Constant Output Current

Irrespective of load circuit resistance the output current of the TRU shall be maintained constant.

j. Constant Output Voltage

Irrespective of load circuit resistance the output voltage of the TRU shall be maintained constant.

k. Potential Control

The output of the TRU must be automatically varied to maintain the potential between a permanently installed reference electrode and the structure, constant.

l. *Meters and Monitors*

The TRU will include high quality meters to indicate the following:

- Output Voltage
- Output current
- Reference Potential
- No DC output current- hour totalizer.

The input impedance of the reference potential digital volt meter must exceed 500 MΩ and must not adversely load the reference electrode or the control circuitry. The accuracy of the reference potential meter must be less than ± 20mV.

All meters must be either LCD or analogue display types and the display must be legible in direct sunlight and from a distance of 2 metres.

Captive (banana) sockets must be incorporated below the meters mentioned above and must be continuously connected to the measurement points mentioned above. The captive sockets connected to the output current measurement point must be labelled with the shunt rating e.g. 50mV = 25 A.

m. *Surge Protection*

- **Mains Surge Protection**

  Surge protection devices must be installed in the incoming mains circuit immediately electrically down stream of the isolating mains circuit breaker. The Surge protection devices must be rated at a discharge current of 40 kA and the maximum permitted operating voltage to be 25% above the RMS value of the applied voltage. The response time of the over voltage device is to be less than 25 ns. Where three phase units are implemented, then the surge protection devices must be connected between each phase and earth. Single phase units to have the surge protection device connected between live and earth.

- **Output Circuit Surge Protection**

  Output Voltage </= 50 V DC

  Surge protection devices must be installed after the DC fuses situated in the positive and negative legs of the TRU. The Surge protection devices must be rated at a discharge current of 40 kA and the maximum permitted operating voltage to be 25% above the RMS value of the maximum output voltage. The response time of the over voltage device is to be less than 25 ns. Two 40 kA surge protection devices must be installed in parallel between the positive leg and earth and the negative leg and earth.

n. Component Layout

Transformers and inductances to be mounted to the bottom of the cabinet/frame and shall not interfere with any gland plate that may be installed. The Rectifier and any other heat sinks are to be mounted in the upper reaches of the cabinet/frame. Trunking and any other heat sensitive devices must be kept well away from the heat bearing heat sinks.

AC and DC current carrying conductors must be routed in separate ducts and or looms and may not be mixed in the same loom or duct.

All components must be accessible from the front and must be mounted such that they are easily removed for repairs and in situ repair work.

All components must be labelled and cross referenced to the laminated schematic drawing mounted in the cabinet.

o. Inspection and Testing

All material, test and compliance certificates must be incorporated into the O & M Manual.

The following tests must be carried out at the manufacturer's works, after successful completion of the tests a certificate will be issued by the manufacturer and signed by the Engineer or his nominated representative. All testing and damaged components resulting from the testing will be at the manufacturer's expense and carried out at the manufacturer's premises. Adequate adjustable load resistances, adjustable power supplies and testing equipment will be made available to the Engineer by the manufacturer to verify specified operational characteristics of the TRU under test.

p. Pre Power-Up Testing

The various earth points, cabinet body, chassis plates and all exposed metal surfaces shall be measured for continuity to the main earth terminal.

The cabinet and AC inputs, the DC outputs shall withstand a 1 kV insulation test. The insulation testing shall be conducted with all circuit breaker and fuses in their normal operating position without power or load connected.

q. Power On Testing

The TRU shall operate for a period of 5 hours continuously at maximum current and at full rated voltage with all doors closed or until the temperature of the Rectifier heat sink is stable for a period of one hour. Where the temperature continues to rise after a period of 7 hours the equipment will be rejected. The ambient, cabinet compartment internal temperature, heat sink temperature and transformer winding temperatures must be recorded during the heat run and plotted upon conclusion of the heat run. K type thermocouples shall be used for the continuous recording of the all the various

temperatures. Immediately after the heat run the aforementioned insulation check will be carried out without the power or load applied. A maximum heat sink temperature of 80 °C is permissible at the highest vertical point of the heat sink.

Control mode testing shall be carried out after the conclusion of the heat run.

r. Constant Current Tests

The manufacturer will demonstrate the TRU's ability to control the output current to within 5 % of the pre-determined set point. The load resistance is to be manually adjusted to ensure that the output current remains constant irrespective of the Load resistance. Four specific current set points are to be set 25%, 50% 75% and 100% of maximum rated output current. Voltage at the given pre-determined set points will be recorded and noted in the O & M Manual.

s. Constant Voltage Tests

The manufacturer will demonstrate the TRU's ability to control the output voltage within 5% of the pre-determined set point. The load resistance is to be adjusted to ensure that the output voltage remains constant irrespective of the Load resistance. Four specific voltage set points are to be set 25%, 50% 75% and 100% of maximum rated output voltage. Current at the given pre-determined set points will be recorded and noted in the O & M Manual.

t. Constant Potential Tests

The manufacturer will demonstrate the TRU's ability to control the electrolyte to structure potential within 40 mV of the pre-determined set point. Current limit and voltage limit features are to be tested and verified whilst carrying out potential mode testing. Dynamic feedback is required to demonstrate the control mode. That is, a simulated CP system must be used to demonstrate the control mode. In the potential mode verification a variable power supply may not be used to simulate the Reference Electrode.

u. DC Overload Testing

A DC overload test is to be carried out upon conclusion of the Control mode demonstration.

The AC fuses must be adequately rated to allow for maximum output current and voltage to be maintained for 1 hour without rupturing.

With a 20% increase in output current one of the AC fuses must rupture within twenty minutes of the increase in output current. The DC fuses must be removed and replaced with link bars during the AC fuse test to verify rupturing capacity of the AC fuses.

The DC fuses are to be adequately rated to allow for maximum rated current to be maintained for one hour without rupturing. With a 20% increase in output current one of the DC fuses must rupture within twenty minutes. The AC fuses must be removed and replaced with link bars during the DC fuse test to verify rupturing capacity of the DC fuses.

Output voltage, Output current, Mains input voltage, Mains input current and time taken for fuse to rupture must be recorded in the O&M Manual.

During the DC overload test no component, cable or terminal shall display any signs of overload damage.

The Engineer may at his discretion call for other pertinent coating, mechanical or electrical tests to be done in order to prove compliance with the specification.

3.4.9.4 Documentation

The TRU shall be supplied with the following documentation

- A removable clear laminated schematic diagram and the laminated schematic diagram shall be located inside the TRU enclosure.
- TRU operation and maintenance manual (O & M) complete with schematic, parts list, fault finding flow chart, operating instructions, original certificates and recommended spare.
- Three copies of the O & M shall be supplied to the Engineer prior to commencement of the manufacturing of the equipment.

3.4.9.5 Guarantee

The equipment shall carry an unconditional guarantee with the exception of damage resulting from vandalism, mechanical damage, external fire, flooding and use outside of operating parameters. Guarantee period in accordance with the conditions of contract.

3.4.9.6 Information to be Provided by the Tenderer

The following information must be provided by the tenderer, prior to the start of manufacture of the units:

a. Transformer

- Type and make
- Type of HV winding
- Type of LV winding
- Rating of primary and secondary winding

b. Rectifier

- Type and make
- Ripple frequency

3.5 AC Interference Mitigation (Increased Voltage Mitigation)

3.5.1 Gradient Control Wires

Gradient control wires or mitigation wires are typically installed parallel to the pipe as a grounding or earthing mechanism. These wires are also referred to as ribbons. The gradient control wires are generally installed for the following two main reasons: (i) to provide an earthing point which earths induced pipeline currents and reduces the overall pipeline voltage, (ii) to reduce the coating stress voltages and touch voltages in their vicinity by changing the potential of the soil around the pipeline (ground potential rise or GPR).

In the case of one ribbon placed parallel to the pipe, it would generally be placed on the side closest to the overhead powerlines and at the invert level of the pipe. The second ribbon would be placed on the opposite side of the pipe. The ribbon should have a minimum separation distance to the pipeline of 200 mm. These ribbons are connected to the pipe by means of a cable through a DC decoupling device.

If the zinc wires are to be installed in discrete sections, it would generally be limited to 400 m in length with the connection to the pipe made in the middle of such a section. In such a case the ends of consecutive sections must be more than 1 m from one another.

Gradient control wires shall be zinc ribbon. The composition of the zinc shall be as per ASTM B418 95 – Type II, and suitable independent compositional testing (once per batch) shall be carried out by an accredited laboratory, in addition to the quality control information presented by the supplier of the zinc wire.

The zinc wire linear weight is linked to its geometry and shall at least adhere to the requirements as specified in Table.3.3.

Table 3.3 : Zinc ribbon specification

Aspect	0.983 kg/m Ribbon	1.785 kg/m Ribbon
Zinc weight	0.893 kg/m	1.785 kg/m
Cross section (D1 x D2)	12.7 mm x 14.3 mm	22.2 mm x 15.8 mm
Radii (R1 x R2)	2 mm x 5 mm	2 mm x 5 mm
Steel Core Wire diameter	≥ 3.3 mm	≥ 3.4 mm
Potential	-1.1 VCSE	-1.1 VCSE

If required, jointing of the zinc ribbon shall be made by exposing the steel core wire and jointing this with a hex crimped ferrule with silver solder. The exposed wire jointed part is then encapsulated with zinc (10 mm minimum cover) by casting this around the joint.

The gradient wire shall be covered with Bedding material used for backfilling the pipe.

3.5.2 Lumped or Nodal Grounding Mat

Lumped grounding or earthing is often required as an additional mitigation measure or as a measure on its own. The gradient control wires are installed for the following two main reasons: (i) to provide an earthing point which earths induced pipeline currents and reduces the overall pipeline voltage,(ii) to reduce the coating stress voltages and touch voltages in their vicinity by changing the potential of the soil around the pipeline (ground potential rise or GPR).

Lumped grounding (earthing) shall be by means of a mat constructed from zinc ribbon. The mat is to be made up by affixing the zinc ribbon at right angles to form a square followed by further zinc ribbon inside this square to form blocks. The dimensions of the square and the spacing of the internal wires shall be in accordance with the specifications and the drawings. At each wire cross point the steel wire core is to be exposed and the steel wire is to be spot welded to one-another. The exposed wire jointed part is then then encapsulated with zinc (10 mm minimum cover) by casting this around the joint.

The grounding mat shall be zinc ribbon. The composition of the zinc shall be as per ASTM B418 -95 – Type II, and suitable independent compositional testing shall be carried out by an accredited laboratory, in addition to the quality control information presented by the supplier of the zinc wire.

The zinc wire geometry shall at least adhere to the following:

Cross section (D1 x D2)	:	12.7 mm x 14.3 mm
Radii (R1 x R2)	:	2 mm x 5 mm
Zinc weight	:	0.89 kg/m
Steel Core Wire diameter	:	3.3 mm
Potential	:	-1.1 VCSE

Such a grounding mat would generally be placed on the side closest to the overhead powerlines and not more than 900mm below finished ground level. The zinc mat would be connected to the pipe by means of two cables directly to the pipe or through a DC decoupling device as specified in the schedule of quantities.

3.5.3 DC Decoupler for Zinc Ribbon and Lumped Zinc Grounding Mat

The grounding (earthing) system that is achieved by zinc material shall not be connected to the pipeline either directly or through a solid-state DC decoupling device (SS-DCD) as defined in the schedule of rates and quantities. Such a device shall be housed in a pre-cast concrete bunker. The device shall be certified by a suitably accredited test laboratory to meet the specifications given in Table 3.4.

Table 3.4 : Performance Specification for DC Decoupling Device for Gradient Control Wire (Ribbon) and Lumped Grounding Mat

Specification /Test	Level /Requirement	Comment
Class 1 impulse current rating	10 kA., 10/350 µsec	to SANS 61643-1 requirement
Front of wave spark-over voltage	≤ 500 V, 1.2/50 µsec	to SANS 61643-1 requirement
Rated AC short circuit	3.7 kA r.m.s., 1 sec, 50 Hz	to SANS 61643-1 requirement
Rated AC load current	45 A r.m.s., 50 Hz, max temp incr. 40º C	at maximum DC blocking voltage, to SANS 61643-1 requirement
AC impedance at 50 Hz	≤ 0.04 Ohm	at rated load current
DC blocking voltage	-3V/+1V(+/-10%)	Progressive characteristic.
DC. leakage (blocked)	≤ 1 mA	at AC load thermal limit
DC current withstand	10 A for 15 mins	without overheating, test in both directions
Housing dielectric withstand voltage	5.8 kV	to SANS 61643-1 requirement
Environmental, enclosure	IP55	adjust upwards for more extreme environments
Ambient temperature range	-15º C to 60º C	
Air clearance and creepage distances	10 mm and 15 mm min respectively	to SANS 61643-1 requirement
Protection against direct contact	no direct contact	Using IEC60529 test finger
Basic insulation level required	2 500 VAC	

Additional requirements for the DC decoupling device are:

- The decoupling device shall comprise a suitably rated diode stack capable of blocking direct current in both directions at the specified voltages.
- The device shall exhibit a progressive, smooth transition from blocking to conduction to and vice versa without commutating.
- A bypass capacitor (network) shall be connected in parallel with the diode stack to conduct 50Hz AC up to the blocking voltage of the diode stack.
- The capacitor (network) shall be protected by a suitably rated surge protection device (SPD) for high voltage and lightning-induced transients. The SPD shall be decoupled from the capacitor and diode network with the appropriate inductance, in accordance with SANS 61312-3. This inductance shall remain effective (i.e. not saturated) during simultaneous transient and maximum DC current conditions.
- The decoupling device shall preferably be of open frame construction to permit maintenance and replacement of component parts. The frame shall be sized to fit on a standard 800 mm x 600 mm chassis plate.
- The decoupling device shall be provided with two M10 terminals at each installation point for the connection of 35 mm² single core cables.
- The housing for the components shall be supplied with a danger warning sign for High Voltage at an obvious place on the unit.

The SS-DCD shall be supplied with wiring diagrams and general arrangement Drawings. All relevant and necessary dimensions together with block wire diagrams shall be supplied prior to manufacture, supply and installation for approval by the Engineer. Details of the enclosure and layout shall also be provided

3.5.4 Equipotential Apron (Mats) / Plane

Gradient control wires or mitigation Equipotential aprons or mats are required at all locations of the exposed pipeline appurtenances (i.e. valve chambers, bunkers and test posts, structures in contact with the pipe, structures housing components that are connected to the pipe) on the pipeline sections where specified.

Equipotential aprons shall be implemented with steel weld mesh mats or rebar grids.

Steel weld mesh installation at chambers or bunkers (or structures) shall be as follows:

The concrete apron is usually placed on the finished ground level around the structure (or buried at a depth as shown on the drawings). The apron shall only be placed on firm undisturbed ground or a compacted prepared base. The dimension of the concrete apron shall be at least 1.2 m from any part of the structure.

A 200 mm x 200 mm reinforcing steel weld mesh of 6 mm diameter steel wire (not galvanized) mesh ref number 193 extending 1.2 m beyond the external wall of the chamber. All overlaps shall be 200 mm minimum joined by welding at least every 400 mm to form an electrically continuous system.

For circular chambers the weld mesh shall be two overlapping panels with a circular cut-out to achieve a 1.2 m distance from side of the chamber – the mesh may be cut square if preferred on condition that the minimum distance of 1.2 m is achieved.

The weld mesh is centrally located in an 85 mm thick Class 15/19 MPa concrete slab.

The mesh panels are connected to the pipeline with two cables through a voltage limiting device and the cables be kept as short as possible (≤ 1.5 m). Refer to section 3.5.5

Continuity in a reinforced steel concrete structure relies on the interconnection of the re-bar (reinforcing). The reinforcing is then equipped with at least two (2) connector plates (5 mm thick steel with a 12 mm hole for cable connection) which is welded to the mesh / re-bar protruding through the wall at suitable positions. The connector plates are connected to the pipeline with a cable through a voltage limiting device and the cables kept as short as possible (≤ 1.2 m).

For air valves using pre-cast concrete rings as walls, the steel reinforcing is generally inaccessible and only the reinforcing in the concrete floor is connected to the pipeline.

3.5.5 Voltage Limiting Device for Equipotential Plane

The equipotential planes for pipelines equipped with a Cathodic Protection system shall not be connected to the pipeline directly, but only through a suitable decoupling device. Such a device shall be housed in a valve chamber or a dedicated enclosed AC mitigation station as appropriate. The device shall be certified by a suitably accredited test laboratory to meet the specifications given in Table 3.5.

Table 3.5 : Performance Specification for Voltage Limiting Device (VLD) for Equipotential Mats or Steel Reinforcing of a Concrete Structure

Specification / Test	Level / Requirement	Comment
Nominal impulse discharge current rating	10 kA., 8/20 µsec wave form	to SANS 61643-1 requirement
Voltage protection level	≤ 400 V	to SANS 61643-1 requirement
Response time	≤ 25 nsec	
Short circuit withstand	3.7 kA r.m.s., 1 sec, 50 Hz	to SANS 61643-1 requirement
Housing dielectric withstand voltage	5.8 kV	to SANS 61643-1 requirement
Maximum continuous AC operating voltage	75 Vr.m.s. (+/-10%)	
Maximum continuous DC operating voltage	100 V (+/-10%)	
Operating state / Fault indication	Green / Red	Mechanical switch
Environmental enclosure	IP55	Adjust upwards for more extreme environments
Ambient Temperature	-15º C to 60º C	
Air clearance and creepage distances	10 mm, 40 mm respectively	to SANS 61643-1 requirement
Protection against direct contact	IP4X	Using IEC 60529 test finger

The housing for the components shall be supplied with a danger warning sign for High Voltage at an obvious place on the unit.

3.6 Cabling

All connections of cathodic protection and AC interference mitigation materials and plant to the pipeline and equipotential apron / mat / structure reinforcing, are to be made with single core multi-strand copper cables. All cables are to be insulated as specified and rated for voltages up to 600 V / 1 000 V. The stranding shall be in accordance with SANS 1507.

Table 3.6 : Cable specification (unless specified otherwise on the drawings)

Purpose	Size (mm2)	Insulation	Colour
Pipe to VLD in chamber/bunker	25	PVC/PVC	Black
Pipe to DC decoupler in chamber/ bunker	35	PVC/PVC	Black
Pipe to a link coupling for monitoring in chamber/bunker	16	PVC/PVC	Black
Pipe to chamber/bunker in ground for monitoring or coupons	16	PVC/PVC	Black
Pipe to chamber/bunker in ground for VLD	25	PVC/PVC	Black
Pipe to chamber/bunker in ground for DC decoupler	35	PVC/PVC	Black
AC Coupon to link coupling in chamber/ bunker	Two Core 6	PVC	Blue
Grounding wire (ribbon)	35	PVC/PVC	Yellow /Green
Grounding to mat/apron/chamber mesh	25	PVC/PVC	Yellow /Green
Continuity bonding in chamber	16	PVC/PVC	Black
Cross bonding and continuity bonding in soil around a structure	2x 35	PVC/PVC	Black
Continuity bonding in soil around a flange	2x 5mm thick steel flat welded to flange	Encapsulate with bituminous product	N/A

The cable to zinc connections shall comprise of suitably sized hex crimped ferrules between the cable and the steel core of the zinc ribbon. The ferrule shall be silver soldered after crimping. The whole joint and an overlapping section past the jointed area shall be encapsulated with an approved self-vulcanizing butyl rubber tape and heat shrink mastic lined tube with a 2.5 mm after recovery thickness.

Splicing of cables underground shall be avoided. However, should splicing be required, a suitable compression fitting and press tool shall be used or alternatively a line tap if an additional cable is to join the main cable. The connections are to be waterproof epoxy filled splicing kits. The cable insulation is to be roughened with 160 grit sand paper before the epoxy is poured into the mould. The epoxy is to completely cover the exposed cable and jointing material and shall fill the mould completely. Sufficient time must be allowed for the epoxy to set (as per manufacturer's instructions) before the joint is buried. The epoxy splicing kit may not be used if the expiry date has passed.

Lug connections shall be made with heavy duty copper with electroplated tin connector lugs of appropriate size. A heat shrink sleeve shall be provided to seal off the break in insulation and the lug and this sleeve is to protrude sufficiently past this point to make a waterproof seal.

Cable markings shall be one of the following types:

- Snap-on plastic marker of suitable size with engraved black lettering on yellow background.
- Stainless steel strip tape with information punched in (minimum letter height 4.5mm) with metal fixing ties.

3.6.1 Cable Connections to Pipe

3.6.1.1 General

A suitable method to secure cables to pipes is required to allow for continuity bonding, cross bonding, pipe to test post connections, CP, ACIM component connections to be made.

The connection of a cable to the steel pipe is preferably made at any thicker part available at the jointing locality – such a thicker part be a pad specifically provided for this purpose, the socket of an insert type connection, a flange, or any other suitable thicker material part.

Cable connection on thin walled pipes (less than 8 mm thick) or pipes lined with epoxy or polyurethane requiring any form of heat must be made with the pipes full of water unless the pipe has been supplied with thermit welding pads. Any such welding must be preceded with by a trial on a spare pipe and the lining subjected to a holiday detection test (spark test) before and after the attachment.

A detailed application and quality control procedure for any proposed cable connection to pipe is required after successful trials have been made and a proposed cable connection method is established.

Thermit welding is the preferred method should it comply with the requirements. Stud welding or thermit welding with solder pads are the alternative preferred method of cable attachment on thin wall pipes (i.e. wall thickness less than 8 mm).

3.6.1.2 Thermit Welding

As far as possible, cables are to be connected to the pipe barrel at a field joint prior to field joint repair and coating make good or at a flange.

The area where thermit welding is to take place shall be thoroughly cleaned to provide an area approximately 75mm x 75mm. All traces of petroleum mastic, concrete, pipeline coating, primer material or any other matter must be removed and the surface is to be brushed with a steel wire brush. Prior to making the weld the area must be roughened using a coarse file or flapper disc, and preheated with a portable gas torch.

The end of the insulated cable must be made bare for at least 25mm. A retaining cap in the bottom of the mould is placed and the weld powder is poured into the mould. The weld is covered with the starting powder. The cable is then placed on the pipe and the mould squarely over the cable, pressing it down firmly. The lid

is closed, the starting powder is ignited with a flint gun which allows the weld to solidify. The mould is removed and the residue is cleaned out in preparation for the next weld.

After the above procedure has been carried out, the weld shall be tested by tapping the weld with a 2kg hammer. Should any movement occur the cable shall be re-welded and re-tested.

3.6.1.3 Stud Welding

Remove section of pipe coating using a portable sanding device. Remove all traces of dirt and degrease.

The weld gun must be manually loaded with an appropriately designed stud and pressed onto the pipe surface in such a way that the supporting feet touch the surface of the pipe. The welding process is initiated by actuating the start button. Against the force of the pressure spring, the gun coil lifts the lifting mechanism with the welding stud off the surface of the pipe by the set gap distance. The power thyristor of the welding unit is triggered. The gun coil is switched off-circuit so that the stud is accelerated back onto the pipe surface by means of the pre-tensed pressure spring. As soon as the ignition tip of the stud touches the surface of the pipe, the welding circuit is closed. The high capacitor discharge current of the welding unit has the effect that the ignition tip of the stud partially evaporates. In so doing, the ignition gap between the surface of the pipe and the stud is ionised and welding arc is ignited.

As a result of the heat charge of the welding arc, the fore-part of the stud and an area of the pipe surface of approximately the same size melt so that a pool of molten mass forms on the areas to be welded. When the stud makes contact with the surface of the pipe, the arc goes out. Before the molten mass hardens the stud is pressed by the force of the spring. The remaining energy of the capacitor battery is discharged in a short circuit. The weld gun can then be removed from the welding stud immediately afterwards.

Connect the lugged cable to pipe using stud welder.

3.6.1.4 Pin Brazing

The technique used shall ensure that metallurgical contact is achieved between the cable and the pipe. Details of the equipment to be used must be submitted to the Engineer before being applied.

The minimum area of coating shall be removed. After connecting the cable the entire exposed area shall be encapsulated in epoxy. The procedure for this is as follows:

- Clean the remaining coating to at least 50mm beyond the final repair limits.
- Construct a dam from a suitable material around the coating repair area.

Apply 2 component (squish pack) over the repair area, ensuring a minimum 1mm cover over the cable connection (Epoxy 151 UW or similar product approved by the Engineer). A minimum overlap of 50mm shall be made over the existing coating.

3.6.1.5 Making Good of the Coating System

All coating repairs at cable connections shall be made in accordance with the repair procedures relevant to the coating system applied to the pipe.

If cables are attached to the barrel of the pipe, these attachments should be made at field joints to minimise the number of repairs required. If the pipe is epoxy lined, then repairs will also be required to the internal lining.

Any attachments to the barrel of the pipe which are buried, will require repair using circumferential wrapping. Patch repairs may not be used in buried applications.

Cable connections to epoxy or [polyurethane] coated fittings in valve chambers shall be encapsulated with epoxy or a heat applied bituminous patch.

4 MATERIALS AND PLANT MANUFACTURING

4.1 General

All materials shall possess qualities adequate for the purpose for which they are to be used. All materials and properties claimed for these materials shall, unless specified otherwise in this document, comply with the requirements of the latest edition of the appropriate South African or other internationally recognised standard specification at the time of Tender.

For each type of Plant, the manufacturer and or supplier shall indicate the materials used for each of the proposed sub-assemblies.

The Plant shall be manufactured using new prime quality materials taking into account the latest technical innovations. Recycled and/or reconstituted materials will only be considered if they are fully justified and approved by the Engineer prior to manufacture and/or supply.

The Engineer retains the right to request and obtain full references of suppliers and materials and Plant supplied as well as all original copies of all the material's Certificates of Conformity regarding raw materials used to manufacture products.

4.2 Compatibility of Materials

The responsibility for selecting materials, which are compatible with the liquids or surroundings with which the Plant comes into contact, to prevent corrosion and/or abrasion rests with the Contractor. The materials used shall be at least equal to those specified in this Specification.

4.2.1 Electrical Cables

All cables supplied and installed shall conform to the requirements of Annexure 1

Cable designations, sizes and insulation requirements are listed in the Bill of Quantities

4.2.2 Stationary Reference Electrodes (SRE)

All stationary reference electrodes (SRE's) shall be designed for permanent burial. All SRE's shall be of the Zinc/Zinc Sulphate (Zn) type and calibrated to a calomel reference electrode with a tolerance <10mV. Certification and approval shall be furnished prior to delivery of any SRE.

4.2.3 Insulating Flange Kit

An insulating flange consists of an insulating gasket, bolt sleeves and washers, appropriately sized steel bolts and nuts and washers and a voltage limiting spark gap for protection of the insulating materials.

The insulating gasket between flanges to be in accordance with Table 4.1 based on pipe diameter and pressure rating. The I.D. of the pipe and gasket shall in all instances be equal.

Table 4.1 : Insulating Gaskets

No	Field Test Pressure (MPa)	Nominal Pipe Diameter (mm)	Insulating Gasket Material
1.	Lower or equal to 4.6	All diameters	3mm aramid fibre/nitrile rubber (Novus 34 or equivalent approved by the Engineer) full face gasket in one piece.

Insulating sleeves shall be a minimum 1mm thick glass fibre reinforced epoxy resin sleeve for each bolt. Total length of sleeves is to be 2-3mm less than the length between inside faces of steel washers. The insulating sleeves shall fit completely inside the insulating washers.

Insulating washers shall be 6mm thick LHM G11 silicon glass with O.D. the same as that of machined steel washer, 2 off for each stud bolt. The I.D. to be a sliding fit over the insulating sleeve.

Steel washers shall be machined with diameter and thickness as indicated in Table 4.2

Table 4.2 :Machined Washers

Stud bolt Diameter (d)	Machined Washer Thickness
d </= 36mm	6mm
36mm < d </= 42mm	8mm
d > 42mm	10mm

Stud bolts and studs shall be grade 8.8 and nuts grade 8 to SANS 1700. Stud bolt diameters shall be selected to the next smaller size for installation in standard drilled flanges. Stud bodies shall be machined down to the next standard smaller size and suitable smaller nut to be used.

Special stepped stud bolts shall be used for blind tapped holes opposite spindles in valve bodies.

Explosion-proof Spark Gap Type ExFS™ L300 shall be installed across the flange faces complete with hot-dip galvanised mild steel mounting brackets to suit the flange bolt, as supplied by Dehn or similar approved by the Engineer. The width of the holding bracket of the explosion-proof spark gap shall be the same as the steel and insulation washers and the bottom end be rounded off to fit into the spot faced area of the valve and/or steel flange.

The outer rims of the flanges must be wrapped circumferentially with a white plastic backed polymer modified bituminous tape, or similar approved, 1,5 to 2,0mm thick with a minimum 25mm overlap. In case of surface irregularities, i.e. raised face flanges, etc., an approved mastic material shall be used to provide a smooth contour for subsequent tape application. A 25mm wide plastic backed electrical tape (SANS 122-1975) coloured red shall be applied in the centre on the horizontal surface. A metal tag shall be attached via a 1mm stainless steel locking wire through a 2mm hole drilled in the tag and in the most overt insulating flange bolt. The following is to be stamped on the metal tag: **"OPERATING INSULATING FLANGE"**

5 INSTALLATION AND OPERATING REQUIREMENTS

5.1 Electrical continuity

The steel pipeline will be electrically continuous in defined sections between in-line valves. Where required, in-line valves will be bonded either internally within chambers through a link panel or externally with buried cables, as detailed in the installation schedule. All buried flanged joints will be bonded prior to encapsulation.

5.2 Insulating Flanges (IF)

In order to effect isolation from the earth conductors of electrical actuators, IF kits will be installed each side of each actuated in-line valve and in accordance with the CP and AC mitigation design.

Insulation at pump stations is installed on the first suitable flange inside the pump station precinct as designated on the drawings.

Insulating flanges are required both sides of electromagnetic flowmeters.

After installation, all insulating joints must be inspected and tested to ensure their compliance with the Specifications and Drawings. The proposed test method and sequence shall be agreed with the Engineer in order to ensure the efficiency and compliance regarding electrical isolation. The inspection shall be witnessed by the Engineer and tested by the Contractor.

5.3 Test Stations

All cables shall be terminated using tinned copper bootlace ferrules or blade/pin lugs. All cables shall be labelled.

All cables will be interconnected through appropriate link panels as shown on the Drawings.

Pipe cables shall be connected directly to the pipe and brought into the test station bunker.

Type B test points shall be installed as indicated in the CP Design document and as directed in the installation schedule.

Stationary reference electrodes and coupons shall be installed at pipe mid-line at Type B locations on the opposite side of the valve chamber to the sacrificial anodes as designated in the installation schedule.

Type C test points are required at all foreign pipeline crossings, and/or parallel sections and/or convergence and/or divergence from the foreign pipelines as indicated on the Drawings or by the Engineer.

Test stations in ACIM areas will incorporate the requisite SSDCD's as detailed in the Installation Schedule.

5.4 AC Interference Mitigation Systems

Installation of AC Interference Mitigation systems shall take place concurrently with pipe laying.

Temporary connections from the zinc ribbon to the pipe may be made prior to installation of bunkers at valve chambers if necessitated by high AC potentials.

Permanent connection of the zinc ribbon will be made directly to the pipe by thermit welding at the nearest field joint

5.5 Permanent ICCP Installation

Groundbed location shall be as indicated on the Drawings or instructed by the Engineer.

The groundbed shall be excavated to 3m depth.

The coke column shall be installed to 150mm depth and the coke shall be thoroughly tamped down prior to the installation of the anodes. Once the anodes and the ring main have been installed, the balance of the coke column shall be installed and tamped down before backfilling.

The feed and return cables from the groundbed shall be routed to the TRU and terminated directly on the TRU.

5.6 Records

The following complete records shall be kept on site for inspection by the Engineer and handed over at the end of the Contract. The location of each excavation, anode excavation and/or anode, test point, AC mitigation enclosure, cross bond to any foreign service pipeline and/or any cable or bond shall be marked and numbered with the allocated tag number before any photo is taken.

5.6.1 Permanent anode ground-beds (ICCP)

a. Individual anode DGPS position and depth of installed anode and photographed;
b. Anode header cable route (all bends) DGPS position and cable depth (no joints).

5.6.2 Test Points and DC Cable Connections to the Pipeline

c. Pipeline depth and DGPS position;
d. Photograph of exposed pipeline (before coating removal - if applicable);
e. Photograph of pipeline with coating removed and/or pipeline cleaned;
f. Photograph of welded cable connections (before priming and re-coating);
g. Photograph of re-coated area
h. Description and photograph of bedding/padding material;
i. Description and photograph of test point foundation;
j. Photograph of test point installation and surround;
k. Photograph of test point terminations and connections;

l. Coupons;
m. SRE;
n. Bunker installation including Concrete Test Results;
o. Details of keys and locks; and
p. Drawings, data sheets, etc.

5.6.3 AC Mitigation Test Points and AC Mitigation Cable Connections

a. DGPS position of zinc ribbon at start point, end point including all bends and description and photograph of zinc ribbon bedding/padding material;
b. Nodal installation details
c. DGPS position and photograph of all zinc ribbon joints;
d. Record and description of all equi-potential earth grids/mats including records of the installation, progressive compaction and reinstatement;
e. Description and photograph of AC mitigation enclosure foundation;
f. Description and photograph of AC mitigation enclosure installation and surround; and
g. Photographs of AC mitigation terminations and connections.
h. Drawings, data sheets, etc

5.6.4 Bonding to Other Pipelines

a. Pipeline depth and DGPS position at crossing and/or bond location;
b. Pipeline exposed (before coating removal) and photographed;
c. Pipeline coating removed;
d. Welded cable connections (before priming and re-coating) and photographed;
e. Re-coated area (full circumferential wrap with 50% overlap) and photographed;
f. Bedding/padding material and photographed;
g. Test point foundation;
h. Test point installation and surround; and
i. Test point terminations and connections.

6 TESTING/COMMISSIONING

All CP and AC interference mitigation plant and material shall be energised and/or tested at the manufacture or Contractors facility prior to site release.

6.1.1 Factory Acceptance Testing

Factory Acceptance Testing (FAT) shall take place at the manufacturer's facility. The FAT shall demonstrate conformance with this specification and shall take place prior to dispatch.

6.1.2 Testing of Insulating Joints (IF Kits)

Insulating joints are to be housed in a well-drained and ventilated chamber / area with inspection access.

Insulating joints shall not leak at field test pressure.

After installation, the insulating joints must be inspected to ensure their compliance with the specifications and drawings and tested for satisfactory electrical insulation. The inspection shall be witnessed by the Engineer.

A radio high frequency tester should be used to test the insulation of the joint. The test shall be performed on each side of the flange as well as on each bolt-nut set individually.

Re-testing must be carried out upon replacing any faulty component.

6.1.3 Testing of Solid-state DC Decouplers

The solid-state DC decoupler (SS-DCD) shall be tested at the Contractor's expense at the Works or at an independent third-party inspectorate's laboratory/works in the presence of the Engineer. A sample of the SS-DCD to be supplied shall be made available for testing purposes. All of the SS-DCD device components shall pass the tests prescribed below and as per the equipment/component type test data sheets. One complete item shall be fully tested to destruction. The Contractor will issue a Test Certificate upon completion of the tests which shall be signed by the Engineer.

The SS-DCD device shall be tested at 125% of the fault current rating and for at least 10 cycles of a standard 50 Hz cycle. The pre-set DC blocking voltage shall be tested and confirmed. At least 125% of the steady state AC shall be passed through the unit for a minimum 15 minute period. No item and/or component of the SS-DCD shall fail. Failure of a single item/ component shall imply complete failure of the SS-DCD device.

The Engineer may also call for other pertinent tests in order to prove compliance.

6.1.4 Current Drainage Testing (CDT)

The pipeline itself must be electrically continuous and all other civil structures and extraneous earths shall be electrically isolated from the pipeline at pump stations, off-takes, chambers, scour valves, air valves, isolating

valves, non-return valves, etc. by means of insulating flange kits, etc. The pipeline shall not be bonded to Foreign Service pipelines unless designed accordingly and subsequent to interference testing.

Refer to specification PSL 4.4 in section C3.4.3 in the Scope of Works for pipeline coating and cathodic protection acceptance testing.

6.1.5 Energising, Commissioning and Hand-Over

The Contractor shall provide a suitably qualified technician and/or technicians to jointly energise and commission the CP system.

This shall include for:

- Energising and commissioning all SS-DCD;
- Commissioning - Corrosion Coupons;
- Commissioning - IR free potentials;
- Commission – interference testing (AC/DC);
- Commissioning - Data logging (CP TP and AC mitigation sites);
- Electrical Completion Certificate; and
- Mechanical Completion Certificate.

The Contractor shall provide the required equipment, vehicles and personnel to effectively carry out the required services.

6.1.6 CP and AC Interference Monitoring

The pipeline potentials (DC and AC) shall be monitored by the Contractor from the time the first pipe section is backfilled until the permanent CP system is commissioned and is handed over. Baseline potential DC and AC readings are required from the pipe sections prior to connecting any CP and ACIM components to the pipe.

Pipe monitoring shall comprise bi-weekly pipe recordings at all monitoring points. DC potentials shall be measured using spot measurements. AC potential and coupon current shall be recorded over a period of 40hours. DC & AC monitoring shall alternate at fortnightly intervals. This information is to be correlated to determine the effective operation of the CP and ACIM systems. The Contractor shall submit bi-weekly reports of the monitoring and recordings to the Engineer for evaluation.

7 STANDARDS

The following Standards and Codes of Practice with all relevant amendments and attachments shall be utilised as part of the Works where details and/or information is not specifically covered within this Specification. Any conflicts and/or contradictions shall be brought to the attention of the Engineer in writing who shall review the conflicts and/or contradictions and submit written clarification in this regard.

In addition, Standards and Codes of Practice listed in the performance specifications included in the Annexures will also apply.

Standards Australia

AS/NZS 4853 Electrical Hazards on Metallic Pipelines.

International Organisation for Standardization

ISO 14555 Welding - Arc stud welding of metallic materials.

International Standards and Procedures

ASTM B – 8	Concentric-Lay Stranded Copper. Conductors
ASTM B418	Cast and Wrought Galvanic Zinc Anodes Used For Cathodic Protection
DIN 50925	Corrosion of metals; proof of effectiveness of cathodic corrosion protection of underground installations
NACE TM0102	Measurement of protective coating electrical conductance for underground pipeline
NACE TM0109	Techniques for aboveground evaluation of the coating condition of underground metallic pipelines
NACE SP0207	Performing close-interval DC pipe-to-electrolyte potential surveys on buried or submerged metallic pipelines
NACE SP0502	Pipeline external corrosion direct assessment methodology
NACE SP0286	Standard Practice: Electrical isolation of cathodically protected pipelines
NACE SP0177	Standard Practice: Mitigation measures of alternating current and lightning effects on metallic structures and corrosion control systems

South African National Bureau of Standards

SANS 121 (ISO 1461)	Hot dip galvanised coatings on fabricated iron and steel articles.
SANS 122	Pressure-sensitive adhesive tapes for electrical purposes (Metric units)

SANS 1411	Materials of insulated electric cables & flexible cords
SANS 1411 Parts 1 to 7	Materials of insulated electric cables and flexible cords
SANS 1507 Parts 1 to 6	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1,900/3,300 V).
SANS 1700 SET	Fasteners
SANS 10064	Preparation of steel surfaces for coating.
SANS 10140	Parts 1 to 3: Identification - Colour Marking.
SANS 10142 Part 1	The wiring of premises Part 1: Low-voltage installations
SANS 10129	Plastic tape wrapping of steel pipelines.
SANS 13509	Cathodic protection measurement techniques
SANS 15589 -1	Cathodic protection of pipeline transportation systems: Part 1: On-land Systems
SANS 50162	Stray Currents
SANS 53509 (EN 13509)	Cathodic protection measurement techniques
SANS 50162 (EN 50162)	Protection against corrosion by stray current from direct current systems
SANS 60479-1 (IEC TS 60479-1)	Effects of current on human beings and livestock

Other Standards and Guidelines

Eskom 240-66418968	Guideline on the electrical co-ordination of pipelines and powerlines

8 GUIDELINES FOR SAFE WORKING PROCEDURES

The following guidelines for safe working procedures at pipeline construction close to high voltage overhead powerlines are applicable:

Attention!

This is not a comprehensive safety procedure. This Procedure provides some of the general safe practices and is not a comprehensive manual. The intention of this procedure is to raise the awareness of potential dangers to the pipeline construction team caused by nearby electrical circuits and to define some minimum safety requirements. The Contractor remains fully responsible for safe working procedure in terms of the Contract.

8.1.1 Introduction

When construction activities occur within electrical power line servitudes, there are a number of issues that need to be considered that are influenced by the relative localities of the pipeline and overhead power line or power cable.

Unsuspected voltage can be present on a pipeline (and pipes ready for constructing a pipeline) through Conductive, Inductive as well as Capacitive coupling between a pipe or pipeline and the nearby electrical circuits.

During a power line fault or lightning strike, very high voltages can be induced in the pipeline, which can damage the cathodic protection systems, rupture the coating, and present a significant safety hazard for any person close to or in contact with the pipeline and its appurtenances. During normal operation the induced pipeline voltages are lower, but could still present a safety hazard and can result in accelerated corrosion of the pipeline.

Any raised electrical potentials found on a pipeline should be reported to a competent person so that the cause is understood and that appropriate mitigation measures can be implemented. This section should not be viewed as a restriction to use better methods and it should be understood that a generalized account does not make provision for unpredictable or un-expected circumstances.

Additional Abbreviations for this Section:

ESA	Electrical Supply Authority
HVDC	High Voltage Direct Current
LVAC	Low Voltage Alternating Current : <1 kV
MVAC	Medium Voltage Alternating Current : 1 kV to 33 kV carried on Distribution Lines (Dx)
HVAC	High Voltage Alternating Current : 44 kV to 132 kV carried on Distribution Lines (Dx)
EHVAC	Extra High Voltage Alternating Current : >132 kV carried on Transmission Lines (Tx)

Note: Direct connection (including arcing danger) is relevant for all overhead powerlines regardless of the system normal voltage it is known for (it therefore includes low voltage system as well).

8.1.2 Normative Documents

The latest edition at time of project commencement of all the normative documents shall be regarded as forming part of this document and shall have equal standing. In case of a conflict this document shall take precedence.

The Contractor is to obtain its own copy of these publication(s) and shall have a copy available at the construction site.

NACE standard SP0177 titled "Mitigation of Alternating Current and Lightning Effect on Metallic Structures and Corrosion Structures"

Attention is drawn to section 5.3: "Construction".

The minimum protective measures for AC influence are provided in the NACE SP0177 standard, and this should be followed on the site of Works.

his document is available from the National Association of Corrosion Engineers (NACE) International and can be purchased online from their web site (www.nace.org).

Eskom guideline titled "Guideline on the Electrical Co-ordination of Pipeline and Power Lines" with unique reference number 240-66418968

A copy of this document can be downloaded from the Corrosion Institute of Southern Africa website (www.corrosioninstitute.org.za under the TAB Core Knowledge – Publications).

The normative and informative documents listed in this Eskom guideline form part of the suite of documentation that shall be applied to the construction activities where applicable.

8.1.3 Electrical Safety Officer

An Electrical Safety Officer (ESO) shall be appointed for the site of Works prior to any work commencing close to or within an electrical powerline servitude.

The ESO shall have sufficient training to understand basic electricity as well as specialist training on steel pipe construction close to electrical powerlines.

The ESO shall have the following minimum qualifications as per Eskom Guideline on the Electrical Co-ordination of Pipeline and Power Lines:

Completed the Eskom's Operating Regulations for High Voltage Systems (ORHVS) responsible person training course

Be authorised by an ORHVS authorised person (GMR2.1) to work without constant supervision in a power line servitude

Completed the South African Electrolytic Corrosion Committee (SAECC) Electrical Safety Officer training course

Experience in the supervision and management of temporary mitigation measures during pipeline construction

The ESO must be furnished with the authority and equipment required to implement and maintain safe working conditions. The ESO shall have the required measurement instruments and equipment to measure AC and DC potentials with respect to adjacent ground and remote earth.

The ESO shall keep a record of any non-compliance and advise the construction manager (site agent) and the project safety officer.

8.1.4 General Safety Requirements

a. All construction personnel and visiting persons entering the site of Works shall be made aware of and able to recognize the potential shock hazards and be trained in appropriate safety measures. The awareness shall be for electrostatic (capacitive), electromagnetic (inductive) and conductive coupling (resistive) conditions.

b. All overhead electrical power lines should be regarded as being “live” (ie connected to a power supply causing a carrying potential (voltage) which is dangerous.

c. The Contractor shall determine and have available on site the local representative name and contact details of the electrical supply utility(s). The Contactor shall have local liaison with the electrical utility to know when planned switching, outages, load changes or any changes that may affect the pipeline induced or capacitive voltages. Work involving contact with the pipe and pipe sections shall be stopped during scheduled switching and re-closing of the electrical power system.

d. Qualified personnel shall measure and record the pipeline voltage to earth to verify that conditions are safe to work (ie Vac < 15 V rms.), on all sections and on each day prior to the commencement of any construction or other activity involving contact with the pipeline.

e. For pipeline voltage measurements, a voltmeter of suitable range and impedance shall be used. Low resistance earth connections shall be used to avoid induction or capacitive pickup on test leads and related items that could result in erroneous readings on a high impedance instrument.

f. Test leads shall be attached to the instrument first and then to the pipeline. After measurement, the leads shall be removed from the pipeline first and from the instrument last.

Each time a voltage measurement is made, the following minimum data shall be recorded:

- location,
- time,
- date, and
- pipe-to-earth voltage.

g. An adequate record keeping systems shall be developed and kept up to date by the Contractor. This record keeping shall include all daily recorded measurements and readings in an orderly manner.

8.1.5 Arrangements Regarding Work Within and Near to a Powerline Servitude

Note: This section is relevant when working near to or within all overhead powerlines and underground cables with a system normal voltage >1 kV (ie all MVAC, HVAC, and EHVAC as well as any DC overhead powerlines).

a. No work may commence within a powerline servitude unless the Electrical Supply Authority (ESA) (Eskom or other institution) has issued a letter of consent and the Contractor has submitted a letter of acceptance to the conditions of the ESA. The application, letter of consent and acceptance letter from the Contractor must be available on site at the site offices at all times.

b. If permission has been granted, the Contractor must give at least 7 working days prior notice of the commencement of work.

c. The Electrical Supply Authority (ESA) (Eskom or other institution) shall at all times have unobstructed access to and egress from its servitude areas.

d. The construction of temporary (or permanent) metallic fences can be extremely hazardous and is prohibited without written approval from the relevant ESA.

e. The use of explosives of any type within 500m of a powerline or cable servitude is not permitted without the written consent from the relevant ESA.

f. Changes in ground level may not infringe the statutory ground to conductor clearances or the statutory visibility clearances.

g. The Contractor is to report any damage to the ESA property, private property or public facilities to the relevant authority. Repair measures are to be agreed upon and a signed off completion inspection release is required from the relevant authority for each case.

h. No excavations are permitted within the following distances of any above ground powerline structure (includes tower structure, guy wires, anchors and any other attachment):

- MVAC & HVAC : 6m
- EHVAC : 20m.

i. No above ground buildings or temporary structures are allowed within the servitude areas and the following additional distances from the centre line of a MVAC & HVAC (ie up to 132 kV) powerline applies:

- all voltages < 22 kV and 22 kV : 9 m
- From >22 kV to 88 kV : 11 m
- From >88 kV to 132 kV : 18 m

j. No above ground buildings or temporary structures are allowed within the servitude areas and the following additional distances from the centre line of an EHVAC (ie >132kV) powerline applies:

- From 220 kV to 275 kV (delta) : 18 m
- From 220 kV to 275 kV (horizontal) : 23.5 m
- From 132 kV to 400 kV (self-supporting) : 23.5 m
- From 132 kV to 400 kV (stayed) : 27.5 m
- From >400 kV to 765 kV : 40 m

k. The ESO must be in contact with the electrical utility to know of planned switching, outages, and load changes that may affect pipeline voltage. Work involving contact with the pipeline shall be stopped during scheduled switching of the electric power system.

l. When the AC mitigation measures agreed upon by the Eskom and the Employer have been installed, an Eskom representative must be requested to inspect all the components of this installation and to perform necessary measurements according to the inspections required.

Final approval of the CP and AC mitigation installation is subject to the outcome of this inspection by Eskom.

8.1.6 General Safe Working Procedures Within and Near to a Powerline Structure

a. No person, equipment or machinery shall enter the HVAC, EHVAC or HVDC servitude without the approval of the ESO. All affected areas shall be suitably demarcated and access restricted to those personnel who have been advised of the hazards and requirements when working underneath or adjacent to HVAC, EHVAC or HVDC power lines.

b. All personnel shall be made aware of and be able to recognize the potential shock hazards and be trained in the approved safety procedures.

c. Pipeline construction personnel shall avoid contact with HVAC, EHVAC or HVDC structures and supports. No mechanical equipment shall come closer than 5 m from any power line tower.

d. Direct connections to the power line tower structures or buried counterpoise earthing system are not permitted under any circumstances. The earthing systems of the power line and the pipeline must be kept separate.

e. Temporary construction sheds, trailers, living quarters, pipe sections, storage areas or vehicle fuelling facilities are not permitted in the HVAC, EHVAC or HVDC servitude.

f. Vehicles such as mobile cranes with extendable members that can potentially exceed the minimum vertical clearance height shall be identified and the operators issued with specific instructions with regard to the maximum permissible extension, prior to doing any work in the HV/EHV servitude.

g. If for any unforeseen reason, the life-threatening situation occurs where a construction vehicle comes into contact with a live HV/EHV conductor or a flash-over occurs, the operator(s) shall remain inside the vehicle and attempt to get it out of the contact situation using ONLY the vehicle's own power. On NO account shall the operator(s) leave the vehicle and on NO account shall any person approach the vehicle, until the contact situation has been reversed, or until the ESO has received confirmation from the electricity utility that the power line has been de-energized. Arcing may temporarily stop due to the action of the protection, however this in itself shall NOT be taken as an indication that the line is safe, since the line may automatically attempt to re-energize. Effective assistance in this

situation entails ensuring that all persons present maintain a safe distance from the vehicle (>10 m) and alarming the electricity utility's operational centre.

h. Any foreign metal structures exposed during trenching inside or alongside HVAC, EHVAC or HVDC servitudes shall be treated as a live electrical conductor, until measurement proves otherwise.

i. The pipeline shall not be bonded to any foreign structures without an assessment by a qualified engineer and written permission from the owner.

j. The use, storage, disposal, treatment or generation of any hazardous substances shall not be permitted in the power line servitude.

8.1.7 Direct Connection (Conductive Coupling)

Note: This section is relevant for all overhead powerlines regardless of the system normal voltage it is known for (it therefore includes low voltage system as well).

a. When a power system with a grounded neutral has unbalanced conditions (eg during a power transmission tower fault) current may flow to the earth. Substantial currents in earth may result from phase-to-phase-to-ground or phase-to-ground faults. The following conditions may result from such faults:

- A metallic structure (eg a steel pipe) in the earth may form part of the current path
- A metallic structure (eg a steel pipe) in the earth that is coated with a dielectric material (ie insulated from the ground) may develop a significant AC potential across such coating.

Such an unbalance situation on medium and high voltage systems (ie >1kV) usually seen as a short and the power supplier's equipment should automatically cut the power supply to that faulted system. Faults on low voltage power systems (ie 1kV and lower) might go undetected for extended periods of time [SANS10280-1Sec 11.1]. Although the raised soil potential is concentrated within the immediate vicinity of the short, the hazardous electrical potential can be transported over long lengths in the metallic structure (eg pipe). Touching the metallic structure during the duration of the short can cause fatal electrical shock.

b. All persons on site of Works shall avoid contact with MVAC, HVAC, EHVAC or HVDC powerline structures and its supports. No mechanical equipment shall come closer than 5m from any powerline structure and associated element.

c. Upon entering or crossing a LVAC, MVAC, HVAC, EHVAC or HVDC powerline servitude, appropriate warning signage shall be erected. Such warning sign shall have the electrical hazard sign with the wording warning against overhead powerlines, viz:

d. A minimum or four (4) signs are to be erected – two facing the approaching direction (one on each side of the pipe route) and the other two the opposite direction (one on each side of the pipe route). The signage shall have reflective markings yellow with black lettering and symbol on steel plate. The overall signage size shall at least be 600mm wide. The signage shall be erected at a suitable height on treated wooden poles (100mm minimum diameter) planted in the ground. The signage shall be maintained in good condition throughout the Contract period and removed upon completion of the project.

e. The minimum vertical clearance between construction equipment and bare overhead conductors shall be in accordance with SANS 10280. The actual height of the conductors at their lowest point shall be measured by means of optical measuring equipment and during a hot day to ensure that this minimum clearance is achieved. The following are minimum clearances for the nominal rms Voltages:

- Up to 44kV : 3.0m
- Over 44kV up to 66kV : 3.2m
- Over 66kV up to 88kV : 3.4m
- Over 88kV up to 132kV : 3.8m
- Over 132kV up to 220kV : 4.5m
- Over 220kV up to 275kV : 4.9m
- Over 275kV up to 400kV : 5.6m
- Up to 533kV DC : 6.1m
- Over 400kV up to 765kV : 8.5m
- Over 765kV : to be obtained by Contractor from the power utility.

f. The above clearances are from Regulation 15 of the Electrical Machinery Regulations 1998 of the OHS Act.

g. Vertical clearance is the open air distance between the top most part of a construction equipment or vehicle and the electrical wire conductor.

h. All work on a pipeline is to be stopped when lightning (electrical storm activity) is imminent or present at the site of Works. Any heavy weather with threatening lightning is sufficient cause to stop the works. Any heavy weather with threatening lightning or actual lightning along any remote part of an electrically continuous pipe shall result in immediate stopping of all works on the pipeline. In his case an electrically continuous pipe includes both sides of the pipe that is joined by means of an isolated joint as such a joint is not necessarily sufficient to block the voltages generated from lightning strikes.

8.1.8 Capacitive Coupling

Capacitive coupling is typically a hazard during construction with respect to electrical shock or arcing when the structure (eg a pipe section) is on isolated supports (eg wooden chocks) prior to being installed into the ground. Although generally not dangerous, it may cause involuntary movements when electrical discharge happens through a person which can cause secondary harm or damages. Monitoring of voltages on pipes stored in this manner within 1km of an overhead electrical servitude is advised. Appropriate grounding of these sections are recommended.

On pipelines paralleling AC powerlines and for pipe routes crossing powerlines, temporary electrical grounds shall be installed and maintained up to backfilling at 300m intervals, commencing from 1km from the powerline coming close to the pipeline or when the AC potentials rise as the pipe approaches the vicinity of the powerline. Sufficient temporary grounds are to remain until adequate permanent grounding connections are made. Temporary ground can be done with adequately sized cables (35mm² insulated stranded copper wire) and a simple driven ground rod. Grounding to any existing semi-conductor may not be done unless authorized by the ESO.

In all servitude areas of HVAC and EHVAC and HVDC power lines, machinery and vehicles with rubber tyres should be equipped with a heavy duty steel chain fixed to the chassis with a length to allow 1m of chain to freely drag along the ground to discharge any electrostatic build-up.

8.1.9 Inductive Coupling

a. Inductive coupling from overhead high voltage powerlines can result in dangerous AC voltages and current flow in the adjacent metallic structure (eg the pipe). Induced voltages may increase during power fault conditions. Pipeline voltage measurements are required on installed pipelines from 2 km of the overhead powerline or if the project specifications require it. These measurements are to be taken with a voltmeter of suitable range and impedance. A low resistance ground shall be established by means of a metal rod driven into the ground. Low resistance connections shall be used to avoid induction or capacitance pickup on test leads and related items that would result in erroneous readings on a high impedance instrument. Voltages more than 15 Vac are considered dangerous and work on pipelines must be stopped if this condition occurs. If AC voltages more than 5 V are measured, mitigation measures should be planned for implementation should an AC voltage of 15V be reached.

b. A suitable recording instrument should be installed to measure AC voltages over a period of 7 days to determine peaks, anomalies and cyclic events if any meaningful presence of AC induced voltages are measured. The frequency of a repeat of the 7 day measurement should be determined in consultation with the powerline representative.

c. At every section of pipeline that experiences a voltage >15 Vac, electrical shock warning signage shall be erected. Such warning sign would have the electrical hazard sign with the wording “Danger – Electric Shock Risk”, viz:

d. Two signs per every 500m of pipeline are to be erected adjacent to the pipeline – the signs are to be affixed back-to-back on one pole facing opposite directions. The signage shall have reflective markings yellow with black lettering and symbol on steel plate. The overall signage size shall at least be 600mm wide. The signage shall be erected at a suitable height on treated wooden poles (100mm

minimum diameter) planted in the ground. The signage shall be maintained in good condition throughout the Contract period and removed upon completion of the project.

e. Pipelines exhibiting voltages greater than 15 Vac rms shall be earthed by means of temporary earth rods of at least 1,8m in length and connected to the pipeline by means a green insulated stranded copper conductor with a cross sectional area of at least 35mm2. Prior to connecting the earth rod to the pipeline, the earth resistance of the earth rod shall be measured and if the earthing resistance is higher than 10Ω additional rods shall be installed in a crow's-foot configuration with a spacing of 2m.

Pipelines parallel to AC power systems shall be earthed opposite the midpoint of each span, maximising the distance to the nearest HVAC or EHVAC structure.

The temporary connections to the pipeline shall be made with earthing clamps that apply firm pressure at the contact point with a mechanically sound connection, and with the coating at the contact point removed down to the bare metal.

Temporary ground rods shall be installed at intervals of 300m or less (the evaluation and optimum solution is to be determined for each site),

Temporary earths shall be left in place until immediately prior to backfilling. Sufficient temporary earths shall be maintained on each section until adequate permanent grounding connections have been made.

f. When the pipeline voltage remains above 15 Vac rms in spite of the temporary earth rods, temporary earth mats that extend a minimum of 1 m outside the work area shall be used. The connection between the pipeline earthing clamp and the temporary earth mat shall be made with 25 mm² or larger stranded copper cable. There shall be no contact between persons over the earth mat and those not over the mat, including the handing over of tools or materials.

g. To prevent the risk of personal injury or arc burns, the connection and disconnection of temporary earths shall be carried out in the following order:

For connection:

- the earthing clamp is connected to the pipeline,
- the earthing cable is connected to the earth rod,
- the earthing cable is connected to the earthing clamp.

For disconnection:

- the earthing cable is disconnected from the earthing clamp,
- the earthing cable is disconnected from the earth rod,
- the earthing clamp is removed from the pipeline.

h. The above measures shall be provided when any activity takes place where contact with the pipe is required, eg for welding pipes together, cutting of pipe, surface preparations and coating operations, coating applications at field joints, coating repairs, bolting fittings onto flanged ends of the pipe, etc.

i. When cutting pipe, adequate bonding across the location of the cut shall be ensured irrespective of the AC voltage measured between the pipeline and earth The AC potential on the pipe shall be measured and additional earthing installed if this voltage exceeds 15 V AC rms before the cutting commences.

j. For lowering pipe into the trench that is to be connected to the installed pipeline, the coated pipe section shall be handled with non-conductive slings. All contact with the bare part of the pipe shall be avoided until the pipe is connected with the grounded pipe.

k. Bonding cables should be provided to bridge any gap between two pipe sections (eg where a valve is to be installed).

l. Work over insulating joints, flanges or couplings may only proceed after the AC voltage status has been measured. A temporary bond across the flange or the use of a properly sized temporary earth mat shall be used to protect personnel while they work on the pipe.

m. Where coating is to be applied at field joints or for any other reason (such as repairs), precautions shall be taken to ensure that equipment contacting the bare pipe is adequately bonded and earthed.

9 OPERATING AND MAINTENANCE MANUALS

The following data and documentation as minimum shall be submitted in a Data Pack or as part of the Operating and Maintenance Manuals.

a. Data Pack (electronically and 3x paper copies):
b. As-built drawings
c. Workshop drawings
d. FAT and SAT documentation
e. Coordinates of all AC Mitigation & CP components to sub-meter accuracy. DGPS raw data files of TRU, TP, ACM, groundbed and cable routes
f. Signed off installation sheets
g. Method statements
h. Specification and data sheets, certificates and details of all temporary and permanent CP materials used
i. All information required in terms of the Specification including all photographs, DGPS raw data files, etc
j. Operation and Maintenance Manuals for all electrical and mechanical components

Operating and Maintenance Manual to contain as a minimum:

- Operating and maintenance instructions for electrical and mechanical components; and
- Operating and maintenance instructions for remote monitoring.

10 MEASUREMENT AND PAYMENT

The CP and AC Interference Mitigation systems shall be deemed to be fully inclusive of all sundry items, such as cable joints, ferrules, lugs, heat shrink, labels, etc., All equipment required to install these sundry items shall also deem to be included in the installation costs such as hydraulic crimping tools, heat guns, grinders, etc. The tendered rates or sums shall cover the cost of anything not specially mentioned, but which an experienced Contractor can reasonably foresee as being required to enable the apparatus and equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of plant or part thereof is not specifically mentioned in the Bill of Quantities.

Tender rates or sums shall include for secure packaging to ensure that plant items are not damaged prior to installation and cover costs of delivery, storage, etc.

10.1 Surveys by the Nominated Subcontractor (CP Specialist) Unit: PS

A CIPS/DCVG coating integrity survey will be undertaken by the Nominated Subcontractor (CP specialist) once the pipeline is installed for the Taking Over Certificate (TOC) and at the end of the Defects Notification Period (DNP) for the Final Certificate (for Fidic Conditions of Contract). For General Conditions of Contract TOC will mean Certificate of Completion, DNP will mean Defects Liability Period and Final Certificate will mean Final Approval Certificate.

A Current Demand Test (CDT) will be conducted by the Nominated Subcontractor (CP specialist) once the pipeline is installed for the TOC.

DC interference current assessment and interference survey of foreign services will be conducted by the Nominated Subcontractor (CP specialist).

Provisional sums are included, and a provision is made against this item for a percentage allowance for overheads, charges and profit on the net cost of the items.

10.2 Supply of cable Unit: m.

The rate tendered shall include for full compensation of all costs incurred in the manufacture, procurement, supply and delivery to site of all materials and equipment required for installation of cable inside the trench.

Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

10.3 Installation of cables Unit: No.

The rate tendered shall include for full compensation of all costs incurred for the complete installation of cables. The rate shall further include all terminations, cable ties, cable labels, thermit welding, coating make good, cable warning tape and galvanised conduit where required

Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

10.4 Supply and installation of CP & ACM equipment — Unit: No

The rate tendered shall include for full compensation of all costs incurred in the manufacture, procurement, supply and delivery to site of all materials and equipment required and the complete installation of the plant as detailed in the BOQ.

Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

10.5 Trenching for cables — Unit: m

The rate tendered shall include for full compensation of all costs incurred for excavating the trench. The rate shall include all materials and equipment required for excavating and backfilling the trench.

The rate shall further include for suitable bedding and backfill material around the cables.

Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

10.6 Supply and installation of backfill for anodes — Unit: m^3

The rate tendered shall include for full compensation of all costs incurred in the supply and installation of the anode backfill. The rate shall include all materials and equipment required for placing the backfill.

Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

10.7 Coating integrity testing.

The rate tendered shall include for full compensation of all costs incurred in the provision and execution of DCVG and CDT surveys and tests undertaken by the contractor during construction.

No compensation will be made for works required to investigate and/or repair defects identified during these tests. Repeat surveys or tests to prove compliance will not be compensated.

Payment will only be effected after full compliance of the items with the Specification has been certified by the Engineer.

10.7.1 Construction DCVG testing — **Unit: sum**

10.7.2 Current Drainage Testing during construction — **Unit: sum**

11 ANNEXURE 1 : PERFORMANCE SPECIFICATION / DATA SHEET: CATHODIC PROTECTION CABLES

Performance Specification / Data Sheet : Cathodic Protection Cables				
Referenced Standards:				
ASTM D3222	Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials			
SANS 1507-1 to 6	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 1 to Part 6			
SANS 1411-1 to 7	Materials of insulated electric cables and flexible cords Part 1 to Part 7			
ISO 9001:2000	Quality Control and Assurance Specification			
Design and Operating Details :				
Design Life:	Min	25 years and/or as required by the Design Specification		
Ambient Temperature:	Min	-6℃	Max	+48℃
Burial Temperature	Min	06C	Max	+15℃
Installed Conditions:	Buried soil/electrolyte environment appropriate for service conditions			
	Anode Cable Insulation to be suitable for installed conditions - low pH, Acidic, Oxygen or Halogen Gas evolution			
	Cables to be fully UV Stabilised for RSA Conditions			
Quality Control and Accreditation	ISO 9001:2000 Certified Accreditation / SANS 1507 / SANS 1411 Certified and Accredited Supplier			
Dimensions and Description:				
1	Length (Min)	Minimum - As Specified (Maximum 5% Tolerance on supplied length)		
2	Length (Max)	Maximum - As Specified (Maximum 5% Tolerance on supplied length)		
3	Cross Section (mm2)	As Specified with SANS 1507/SANS1411 Maximum Allowable Tolerance on supplied cable.		
4	Voltage Drop (V)	Maximum Value as determine over length and specified cross sectional area as agreed by client and in accordance with SANS10142		
5	Operating Temperature	Maximum Value as determine over length and specified cross sectional area as agreed by client and in accordance with SANS 1411/1507		
Anode Cabling Details				
Insulation Layer	Colour	Insulation	Rating	
Inner:	As Specified	XLPE	SANS 1507/1411 and suitably rated for service conditions - Original Manufacturers Certificate of Conformity	
Middle / Outer (Double Insulated Cables):	As Specified	PVC	SANS 1507/1411 and suitably rated for service conditions - Original Manufacturers Certificate of Conformity	
Inner – ICCP Anode	As Specified	PVDF	ASTM D3222 and suitably rated for service conditions - Original Manufacturers Certificate of Conformity	
Steel Wire Armoured Cables (SWA):	As Specified	Outer PVC	SANS 1507/1411 and suitably rated for service conditions - Original Manufacturers Certificate of Conformity	
Labelling:	Ferrule Type (Black on yellow) suitably rated for service conditions - (Nominally every 10m for buried cables)			

	Numbering/labelling in accordance with relevant block or relevant wiring diagram		
Inspection, Testing and Documentation			
Test Item	Rating		Minimum Compliance
Cable Insulation Test (660V/1000V)	Max	1KV	Original Test Certificate from cable manufacturer and testing as per relevant SANS1507 requirement
Cable Resistance Test (660V/1000V)	SANS	As applicable	Original Test Certificate from cable manufacturer and testing as per relevant SANS1507 requirement
Cable Conductor (Material and Capacity)	SANS	As applicable	Original Test Certificate from cable manufacturer and testing as per relevant SANS1507 requirement
Documentation	**Details and Requirements**		
ISO 9001:2000 Certification:	Certified Copy of Valid Certificate		
Cable Suppliers Original Test Reports:	SANS 1411 / ASTM D3222 Original Test Certificate from cable manufacturer. Certified Copy of Valid Certificate		
	SANS 1507/SANS 1411 Manufacturing Accreditation Certificate. Certified Copy of Valid Certificate		
	Material COC, Waybills, Delivery Notes, Delivery Documentation, etc.,		

C3.4.3.2 PARTICULAR SPECIFICATIONS FOR ELECTRICAL AND ELECTRONIC WORKS

The following Particular Specifications for electrical works will be applicable to this Contract:

EMCC MOTOR CONTROL CENTERS AND DISTRIBUTION BOARDS

INDEX

EMCC MOTOR CONTROL CENTERS AND DISTRIBUTION BOARDS

EMCC 1 SCOPE OF WORKS

As specified in the Project Specifications.

EMCC 2 STANDARDS AND TESTS

The motor control centres shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply;

Table 1: Applicable Standards

Standard No.	Description
SANS 10142	Code of Practice for the wiring of Premises
BS 159	Bus bars
SANS 1195	Bus bars
SANS 1091	Paint colour
BS 3938	Current Transformers
SANS 60044	Current Transformers
NRS 029	Current Transformers
BS 89	Ammeters
BS 638	Welding cables
SANS 1576	Welding cables
SANS 156	Moulded Case Circuit Breakers
SANS 767	Earth leakage protection units
SANS 1574	Electric cables and flexible cords
NRS 002	Graphical symbols for electrical power, telecommunications and electronic diagrams
SANS 1213	Mechanical cable glands
SANS 1433-1	Terminal blocks having screw and screw less terminals
SANS 1433-2	Flat push-on connectors
SANS 1473-1	Low-voltage switchgear and control gear assemblies: Type-tested and partially type-tested assemblies
SANS 1473-2	Low-voltage switchgear and control gear assemblies: Busbar trunking systems
SANS 1619	Small power distribution units (ready boards) for single-phase 230V service connections
SANS 1765	Safety of distribution boards
SANS 10292	Earthing of low-voltage distribution systems

Standard No.	Description
SANS 60439-2	Low-voltage switchgear and control gear assemblies: Particular requirements for busbar trunking systems
SANS 60439-4	Low-voltage switchgear and control gear assemblies: Particular requirements for assemblies for construction sites
SANS 60947-2	Low-voltage switchgear and control gear: Circuit breakers
SANS 60947-3	Low-voltage switchgear and control gear: Switches and disconnectors
SANS 60947-4-1	Low-voltage switchgear and control gear: Contactors and motor starters (Electromechanical)
SANS 60947-4-2	Low-voltage switchgear and control gear: Contactors and motor starters (semiconductor motor controllers)
SANS 60947-4-3	Low-voltage switchgear and control gear: Contactors and motor starters (For non-motor loads)
SANS 60947-5-1	Low-voltage switchgear and control gear: Electromechanical control circuit devices
SANS 60947-5-2	Low-voltage switchgear and control gear: Electrical emergency stop device with mechanical latching function
BS 89	Ammeters
NEMA ICS 18	Industrial Control and Systems: Motor Control Centres
UL 845	UL Standard for Safety for Motor Control Centres
IEEE C37.20.7	Arc-resistant or arc-containing low voltage MCCs shall be tested, rated, and labelled in accordance with the requirements of IEEE C37.20.7 'IEEE Guide for Testing Metal enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults'

EMCC 3 QUALITY ASSURANCE

The manufacturer of the MCC shall have a minimum of **25-years' experience** in the manufacturing and assembly of Low Voltage motor control centres and distribution boards.

Motor control centres and distribution boards shall be designed and manufactured in accordance with all the above mentioned standards.

EMCC 4 PRE – MANUFACTURE SUBMITTALS

EMCC 4.1 Manufacturer Drawings

MCC elevations showing dimensional information including details such as, but not limited to, the following:

1. MCC height (less any removable lifting angles or eyes);
2. MCC width;
3. MCC depth;

4. Location of shipping splits;

EMCC 4.2 Structure Descriptions Showing the Following

1. Bus ratings;
2. Enclosure ratings;
3. Short-circuit withstand ratings;
4. Cascaded systems;
5. Type 1, type 2 or full coordination system;
6. Other information as required for approval.

EMCC 4.3 Product Data

Data sheets and publications on all major components including, but not limited to, the following:

1. Motor starters
2. Overload relays
3. Circuit breaker and fuse information including time current characteristics
4. Control power transformers
5. Pilot devices
6. Relays
7. Timers

EMCC 4.4 Specifications Response

All clarifications and exceptions to the project specifications must be clearly identified and marked up on the drawing.

EMCC 4.5 Specifications Response

Provide a copy of the manufacturer's installation instructions that includes the following:

1. Receiving, handling, and storage instructions;
2. Nameplate data, serial numbers, UL markings, and short circuit ratings;
3. Installation procedures including splicing procedures, terminations and connections;
4. Conduit and cable installation;
5. Installing and removing plug-in units;
6. Operation of operator handles and unit interlocks;
7. Checklist before energizing;
8. Procedure for energizing equipment;
9. Maintenance procedures.

4.6 Final Submittals

1. The contractor shall provide certification that the all components or MCC has been installed in accordance with the manufacturer's instructions and with local codes and standards that govern MCC installations.
2. The contractor shall provide certification that all circuit breaker settings have been adjusted per field requirements.
3. The contractor shall provide certification that all power fuses have been selected and installed per field requirements.
4. The contractor shall provide certification that all solid-state motor overload settings have been adjusted per installed motor characteristics.
5. The contractor shall provide certification that all settings for solid state devices such as reduced voltage solid-state controllers and variable frequency drives have been adjusted per the specific application requirements.
6. The contractor shall provide certification that any timing devices have been properly adjusted.
7. Test reports indicating manufacturer's standard testing was performed.
8. MCC installation instructions
9. Installation/operation instructions for major components such as, automatic transfer switch and circuit breakers
10. MCC spare parts listing and pricing
11. Technical details and descriptive literature regarding all equipment and instruments offered;
12. Three paper prints of all of the above for final hand-over.

All settings as above detailed shall be indicated on the final drawings.

EMCC 5 DELIVERY, STORAGE AND HANDLING

The contractor shall coordinate with the Engineer manufacturer for entry into the building.

The contractor shall store the MCCs in a clean, dry, and heated space.

The contractor shall protect the units from dirt, water, construction debris, and traffic.

During storage the contractor shall connect internal space heaters (if specified) with temporary power.

EMCC 6 MANUFACTURER

EMCC 6.1 Ratings

The MCC shall be rated for the system voltage as indicated in the Project Specifications.

The MCC horizontal and vertical power bus bracing shall be rated to meet or exceed the available fault current as indicated in Project Specification.

All MCC units shall have a full rated short-circuit rating that meets or exceeds the available fault current as indicated in the Project Specification.
All circuit breakers used in the motor control centre shall have full-rated short-circuit interrupting ratings based on the applied MCC voltage.

The manufacturer shall be certified by South African Bureau of Standards or accredited testing facility which is to approval of the Engineer in manufacturing motor control centres or distribution boards to the specified withstand fault current as detailed in the project specification. If the contractor does not have certification to build motor control centres or distribution boards to the rated withstand fault current as specified in the project specifications, it will be to the cost of the contractor to fully type test the assemblies at South African Bureau of Standards at the contractors cost.

The contractor shall have certificate from South African Bureau of Standards which is higher or is equal to the specified withstand fault current.

Motor control centre and distribution board shall be type tested as laid out South African Bureau of Standards to the rated withstand fault current as indicated in the Project Specification.

EMCC 6.2 Enclosure

The motor control centre or distribution board shall be suitable for the environmental conditions in which it operates. The motor control centre and distribution board shall be protected against corrosion.

Any point of a motor control centre or distribution board that has to be reached during normal operation shall not exceed a height of 2,2 m above floor (or walking) level. However, the board may be mounted higher if it can be disconnected from the supply by a switch-disconnector or circuit breaker that is less than 2,2 m above floor level.

The motor control centre board or distribution board shall be of the free standing floor mounted type with a minimum IP rating of 55 (insect proofed enclosure). The motor control centre or distribution board shall be constructed with a minimum of 2mm steel which will rest on a rigid

channel iron or similar frame and for outdoor 3CR12 rigid channel shall be used, and shall be bolted down in position by means of M16 high tensile stainless steel bolts grouted into the concrete floor, the bolts shall be inside the board.

The panel door shall be provided with a locking system suitable for padlocking. The locking system shall consist of a 3-way locking mechanism locking the door at the top, middle and bottom. The unit doors shall be capable of being opened at least 110 degrees.

The motor control centre or distribution board shall be provided with removable covers on the sides and hinged panels on the front. All removable covers shall be suitably braced and reinforced to ensure rigidity.
The board shall be provided with readily removable, sectionalized, rigidly supported unpainted 3CR12 cable end support gland plates along the entire length of the board and at least 230 mm above floor level.

This compartment shall if necessary consist of an outer and inner shell with at least 10 mm insulation or polystyrene between the inner and outer shell all round to keep the temperature inside the compartment at least 5 Degree Celsius below the temperature surrounding the compartment in summer complete with ventilation fans.

The board shall be suitably sized to accommodate without cramping, all the switchgear and equipment specified. Motor starter panels shall be a segregated system with each motor starter housed in a separate panel complete with door interlocked main switch. Where motor starter panels are installed on top of each other cable access shall be provided from the side of each panel by means of a common cable marshalling panel. Provision shall be made for pre-wiring between the starter panel and cable connecters inside cable marshalling panel to facilitate site cable connections.

All switch gear, instruments and equipment for the control of any specific motor or other electrical device, shall be mounted flush behind a common hinged panel, with only operating handles, push buttons and instrument faces protruding through neatly machine punched holes in the panel.

Sufficient provision for ventilation and heat dissipation as per the equipment ratings and manufacturers requirements shall be allowed for. The contractor shall prove to the Engineer by means of Anemometer or Differential that the requirements and manufacturer’s requirements are met.

Screwed-on engraved labels in English shall be provided below all switchgear and equipment on and in the panels, to facilitate identification.

All unpainted parts shall be plated for corrosion resistance.

The systems shall be designed to allow for **30%** for future extensions.

EMCC 6.2.1 *Indoor*

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy duty rust proof hinges.

Each panel shall be supplied with concealed hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be Cadmium plated. The use of self-tapping screws will not be permissible.

EMCC 6.2.2 *Outdoor*

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy duty stainless steel hinges.

Each panel shall be supplied with concealed stainless steel hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be stainless steel plated. The use of self-tapping screws will not be permissible.

The outdoor motor control boards shall be constructed of at least 2mm powder coated 3CR12 steel. Vermin proofed IP 54 rated ventilation openings shall be provided in doors and side panels. A 3CR12 roof shall be added to all outdoor motor control centres and distribution boards with a minimum slope of 1/10.

EMCC 6.2.3 *Busbars*

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. Provision shall be made at the end of each busbar for future extensions. Bus bars shall comply with the requirements of BS 1433, SANS 1973-8 and SANS 1195. A solid copper earth bar shall be provided inside the board above the gland plate along the entire length of the board.

Busbars shall be rigidly supported at suitable intervals to prevent undue damage resulting under short circuit conditions. Ceramic or other approved busbar insulators shall be used. The busbars shall be arranged horizontally with the longer sides of the cross-sections in the vertical plane and one behind the other, in the horizontal plane, at 90mm centres.

Busbars shall be clearly and indelibly marked in the middle of the bus bar Red, White and Blue for the three phases and Black for Neutral.

The earth bars shall be drilled and provided with 6 mm diameter and 10 mm diameter 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.

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. Spare connections shall be provided complete with bolts, nuts, washers and spring washers.

EMCC 6.2.4 *Electronic Equipment*

Where electronic equipment such as transmitting I/O units are incorporated in an outdoor distribution or motor control board, this equipment shall be installed in a separate and special compartment and all wiring shall be terminated on rail mounted terminal strips for field connection of all monitoring and control cables.

The doors of this compartment must be labelled: "Electronic Equipment".

All the electronic equipment but not limited to HMI, power supply, PLC CPU, Ethernet switch, fibre switch, all I/O cards, UPS and telemetry and 30% additional space for the future. All equipment shall be mounted flush behind a common hinged panel, with laminated, shatterproof and tinted glass for viewing purposes.

Sufficient provision for ventilation and heat dissipation as per the equipment ratings and manufacturers requirements shall be allowed for. The contractor shall prove to the Engineer by means of Anemometer or Differential that the requirements and manufacturer’s requirements are met.

The tier shall be designed to house all of the above equipment and the manufacturer shall coordinate with communication and instrumentation specialist.

EMCC 6.2.5 *Treatment And Painting Of Metal Parts*

All metal parts shall be treated before powder coating in accordance with standard corrosion protection standards and the appropriate coating system shall be selected for the specific application. Motor control centre outer surfaces shall be powder coated colour B26, SANS 1091. (Electric orange)

An average of 2 mil thick electrostatic powder paint coat shall be applied, the contractor shall have a Rugged, fully electronic coating thickness gauges present for testing the thickness of the paint.

EMCC 7 GENERAL REQUIREMENTS

EMCC 7.1 Internal Wiring

The internal wiring of the boards shall consist of coloured PVC-insulated conductors of adequate copper cross-section, which shall be neatly installed horizontally and vertically in PVC trunking. Numbered ferrules of an approved type (clip on type not acceptable), shall be provided on each end of each wire, to facilitate the tracing of circuits.

Control circuits shall be colour coded as follows;

Three Phase	-	Red
Three Phase	-	Blue
Three Phase	-	White
Single Phase	-	Red
A.C. Neutral	-	Black
Earth	-	Green and yellow
110V D.C. Positive	-	Brown
110V D.C. Negative	-	Black
24V D.C. +ve	-	Grey
24V D.C. –ve	-	Purple
4-20mA +ve	-	White
4-20mA –ve	-	Black
All other voltages	-	To be confirmed with Engineer.

EMCC 7.2 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in a distribution board and motor control centre, this equipment shall be installed in a separate and special compartment.

Sufficient room shall be provided for the rail mounted terminal strips and all wiring shall be terminated on these rail mounted terminal strips for field connection of all monitoring and control cables.

EMCC 7.3 Cable terminations

Low voltage cables shall be terminated with cable glands manufactured of bronze and comprising a barrel with sealing washer and bush nut screwed into one end and a compression nipple with wire clamping ring screwed onto the other end and shall bear the SABS mark of approval. The opposite end of the compression nipple must have a male electrical thread with locknut. The glands shall be suitably sized for the relevant cables, be of the adjustable type complete with armour clamps and with watertight neoprene shrouds.

Cable terminating glands for outdoor use shall be IP68 rated and provided with waterproofing double inner seals as well as waterproofing seals on nipples. Cable termination glands for high humidity and possible temporary water submerged conditions as for instance in filter lower gallery areas at water treatment plants shall also be IP68 rated with waterproofing double 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. Flameproof glands for indoor and outdoor use shall be used where the hazardous area classification and explosion protection rating is supplied by the Engineer.

EMCC 7.4 Labelling of Switchboards and Motor Control Boards

A screwed on engraved label of the black on white "traffolyte" 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 the English language in 6 mm high lettering.

Each board shall further be provided with a screwed on reverse engraved yellow Perspex nameplate with black 20mm high lettering to identify the board in the English language on the outside of the door at the top thereof.

EMCC 7.5 Motor starter panels

Motor starters shall be contained in its own separate compartment in the motor control board or distribution board.

EMCC 8 MOTOR STARTERS AND ACCESSORIES FOR SWITCHBOARDS

EMCC 8.1 Direct-on-Line starters (400V motors)

These starters shall be of the manually operated (locally and remotely) type and each starter shall be contained in its own separate compartment on the relevant motor control board.

Each of these units shall comprise amongst other the following components:

a) 1 Only mains **Type 2 Coordinated** fused or circuit breaker switch/circuit breaker connected to the busbars of the board and interlocked with the door of the compartment to prevent opening of the door with the switch closed and to prevent closing of the switch with the door open
b) 1Set of HRC control fused links with carriers and basis where necessary;
c) All necessary relays as required
d) 1 Only mains **Type 2 Coordinated** contactor;
e) 1 Set of START and STOP push buttons;
f) 1 Only mains operated timing device to limit starts per hour; and
g) 1 Only power factor correction capacitor unit for motors of 5 kW and more.

The following protective and indicating devices complete with the necessary suitably rated potential fuses, current transformers, test blocks and auxiliary relays;

a) 1 Only electronic type motor protection relay for motors > 7,5kW or more or as specified;
b) 1 Only motor under current relay (Where specified)
c) 1 Only instantaneous indicating ammeter for motor current;
d) 1 Only ammeter selector switch for motors >5 kW;
e) 3 Only Current transformers for motors > 5 kW;
f) 1 Only running hour meter;
g) 1 Only anti-cycle timer; and
h) 1 Only thermistor relay for motors > 22kW or more
i) 1 Only Start delay timer for motors >15kW and higher
j) 1 Only blue LED type indicator light to indicate the time delayed starting period
k) 4 Only LED type indicator lights as follows; Red – 'Motor Stopped'; Green - 'Motor Running'; Yellow – 'Motor Tripped'; and Red - "Emergency stop engaged". Optional: Yellow - 'Supply on'; Blue – 'Motor start delay'; and Green – 'Healthy'.

It shall further be possible to trip and lock out the starter by means of a remote stop button to be provided at the relevant motor.

Provision shall also be made for locking the mains fused switch handle in the OFF position.

EMCC 8.2 Star/Delta Starters (400V motors)

These starters shall be of the automatic star/delta type and each starter shall be contained in its own separate compartment on the relevant motor control board.

Each of these units shall comprise amongst others provided for direct-on-line starters the following components as:

a) 1Only Mains **Type 2 Coordinated** Contactor;
b) 1 Only Star **Type 2 Coordinated** Contactor;
c) 1 Only Delta **Type 2 Coordinated** Contactor;
d) 1 Only Star to Delta timer of the clockwork or electromagnetic type;
e) 1 Only Mains operated timing device to limit the starts per hour;
f) 1 Set START and STOP pushbuttons
g) 1 Only Three phase Power Factor Correction Capacitor unit for motors of 5kW or more
h) All necessary relays

EMCC 8.3 Variable Speed Drives

These variable speed drives shall each be contained in its own separate panel, manufactured and equipped to the satisfaction of the variable speed drive manufacturer to suit their own requirements with regard to ventilation of the variable speed drive. Small drives below 1kW can be combined into one panel but sufficient ventilation by means of extractor fans must always be allowed for

The variable speed drive panel shall be equipped with ventilation fans and air filters. The ventilation fan shall be interlocked with the relevant motor and shall only be in operation when the motor is running. Failure of the ventilation fan shall stop the motor and a visible indication of the cause of the failure shall be provided on the panel.
The frequency converter shall make use of flux vector control without encoder or tacho generator feedback and shall incorporate direct torque control technology so that the overall effectiveness of the drive shall only be limited by the performance of the motor.

Semi-conductor switching shall be determined by the values of flux and torque and shall not have a predetermined pattern as in conventional pulse width modulation flux vector drives.

Each of these drives shall comprise amongst others the following components:

a) 1Only main isolator/circuit breaker that shall be interlocked with the door of the panel to prevent opening of the door with the switch closed and to prevent closing of the switch with the door open
b) 3Only ultra rapid fuses rigidly connected to the load side of the above mentioned mains

isolator and the rating of which shall comply with the manufacturers specifications for the drive

c) 1Only direct torque control frequency converter
d) 1Only door mounted control panel complete with cable connections (also for small drives)
e) 1Set of START and STOP push buttons for manual control of small drives
f) One dial type potentiometer for manual speed control.
g) 1Only manual/off/auto selector switch for manual control of small drives
h) 1Only Thermistor relay for motors of 22kW or more
i) 1Only external EMC line filter
j) All equipment necessary for remote emergency stop device.
k) All bus system interface equipment necessary for remote speed control via a monitoring and control SCADA system as well as PLC control.
l) All equipment necessary for remote motor status and speed monitoring.
m) 4Only LED type indicator lights as follows; Red – 'Motor Stopped'; Green - 'Motor Running'; Yellow – 'Motor Tripped'; and Red - "Emergency stop engaged". Optional: Yellow - 'Supply on'; Blue – 'Motor start delay'; and Green – 'Healthy'.

A 3CR12 steel gland plate must be provided at least 250mm above floor level for cable connections.

The control panel shall be the user interface for monitoring, adjusting parameters and controlling the drive operation. It shall be possible to:

a) Enter start-up data into the drive.
b) Control the drive with start, stop and reference signals.
c) Display actual values of motor performance.
d) Display information on at least the five most recent faults.
e) The drive shall satisfy the following technical requirements.
f) The static speed control error shall not exceed ± 0,5% of motor nominal speed.
g) Fundamental power factor shall be at least 0,97 at nominal load.
h) Efficiency shall be at least 98% at nominal power level.
i) The drive shall operate satisfactorily under all ambient temperature conditions between -5°C and + 40°C at an altitude of 1260m above sea level and humidity up to saturation point.
j) The drive shall provide output protection for motor overload, over current, short circuit at start, earth fault, missing motor phase and over frequency.
k) The drive shall satisfy the following minimum harmonic voltage limits: Total harmonic distortion of 6%, odd harmonic distortion of 4% and even harmonic distortion of 2%. The Contractor shall measure these harmonic distortion parameters after commissioning of the system and if the equipment fails to comply with this requirement, the Contractor will have to rectify the same to the satisfaction of the Engineer.
l) The drive shall be equipped with an AC choke for harmonic current reduction and shall be placed on the AC side of the rectifier bridge in order to protect the rectifier semiconductors

against power line transients.

m) Torque step rise time shall typically be less than 5ms.

n) Stringent precautions must be taken in the design of the protection equipment to assure adequate lightning and surge protection.

EMCC 8.4 Electronic Soft Starters

The soft starter shall be installed in the relevant motor starter panel but sufficient ventilation by means of extractor fans must always be allowed for and shall be interlocked with the relevant motor and shall only be in operation when the motor is running. A bypass contactor for motor running conditions is a requirement and shall either form part of the soft starter or shall be a separate unit.

The soft starter shall have soft start and stop programmable capabilities with torque and current control. The normal motor protection facilities such as over/under-current, start limit, long start time, electronic overload, phase loss and phase sequence and load loss shall be available.

At least a 2 line 16 character LCD display unit with control function keys shall form part of the soft starter and shall preferably be separate motor starter front panel mountable. The LCD unit shall display all statistical data and trip conditions and shall allow functional key changes to programmable parameters.

The full motor protection capabilities shall be maintained when motor is operating in bypass contactor mode.

RS 485, MODBUS, PROFIBUS communication shall be possible.

EMCC 8.5 Induction Soft Starters

The induction type soft starter shall be installed in the relevant motor starter panel but sufficient ventilation by means of extractor fans must always be allowed for and shall be interlocked with the relevant motor and shall only be in operation when the motor is running. A bypass contactor shall be provided to bypass the soft starter.
The series impedance type starter shall incorporate reduced starting current and ensure gradual increase in the motor terminal voltage in smooth step-less manner.

The design of the induction soft starter shall allow the motor to generate adequate starting torque to overcome the load torque and friction to ensure smooth acceleration.

The soft starter shall allow five starts per hour.

EMCC 8.6 Mains surge arrestors

When a surge arrestor is installed in systems with a main breaker with 250Amps or 5kA fault current, the surge arrestor shall be pre-fused to prevent the units creating a danger when subjected to high fault currents. Surge arrestors shall be pre-fused to the manufactures requirements. All surge arrestors shall be **connection type 2** as per the latest addition of the SANS 10142.

EMCC 8.6.1 *Building With external lightning protection*

The main distribution board surge arrestors shall be combined type 1 & 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 10/350µs at a maximum discharge current of 100kA.

Any distribution board feeding from the main distribution board shall have surge arrestors and shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EMCC 8.6.2 *Building With NO lightning protection*

The surge arrestors shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EMCC 8.7 Moulded case circuit breakers

All moulded case circuit breakers shall be as specified in the schedules of equipment for distribution boards and shall comply with the requirements of SANS Specification no. 156.

The required frame sizes or rupturing capacities required are specified in the schedules for each board.

Each circuit breaker shall be provided with non-adjustable time-delayed trips.

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.

EMCC 8.8 Fused switches

All fused switches shall be of the "load-breaking" and "fault-making" type complying with BS-5419 where applicable and fitted with HRC cartridge fused links to BSS-88. Auxiliary contacts shall be provided where relevant for signal purposes.

EMCC 8.9 Current limiting circuit breakers

The current limiting circuit breakers shall be capable of remaining in service and of carrying their normal rated current after having interrupted the maximum short circuit current of 200 kA rms at least three times.

The current limiting circuit breaker shall be equal and similar to the specified Merlin Gerin type.

EMCC 8.10 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.

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.

EMCC 8.11 Indicating instruments

All indicating instruments shall comply with the requirements laid down in BS 89: Part I: 1970 for instruments of a 2,5 Accuracy Class. All indicating instruments shall have 96mm square dials.

The maximum demand ammeters shall be of the 6A combined maximum demand registering and instantaneous indicating type having MISC movement and thermal demand indication with an integrating time lag of 15 minutes. The ammeter scales shall be direct reading with a full-scale 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 5A instantaneous indicating meters with MISC movement and direct reading scales. The meters shall be able to withstand over currents 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 power factor meters shall indicate from 0,7 lagging to 0,7 leading.

The running hour meters shall have cyclometer dials indicating up to 5 digits and two decimals. (12345,67)

EMCC 8.12 Instrument selector switch

A four-position rotary type instrument selector switch shall be mounted directly below the relevant instrument 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 Bakelite, 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 consist of Bakelite and shall have the positions for the three phases and "OFF", engraved on it in 5mm high lettering.

EMCC 8.13 Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of BS 775 for "CLASS UR" contactors of the "CLASS II MECHANICAL DUTY CLASS / TYPE 2 COORDINATION" and "A3 Make and Break Category".

All contactors shall be provided with arc extinguishers, and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with an AC, closing coil suitable for continuous operating and at least 15 closing operations per hour at system voltage. The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EMCC 8.14 Time switches

The time switches shall be suitable for use on a 231 volt, 50 cycle per second AC supply and shall be of the microprocessor type.

The time switches shall be digital timers suitable for rail or surface mounting and shall be programmable with daily and weekly programs, switching intervals of 1 minute and switching accuracy precise to the second.

The time base shall be of the quartz type with LED display for time, weekday, holiday program, switching position and manual override and shall have a power reserve of 250 hours at full operation. The time switches shall have a switching capacity of 16 A at 231 V.

EMCC 8.15 Isolators

All isolators shall be of the "Load-breaking" and "fault making" type and shall comply with the requirements of BS 5419-1977 where applicable. Where relevant, isolators shall be provided with auxiliary contacts for signal purposes.

EMCC 8.16 400 Volt air-break contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of IEC 158-1 for Class AC 3 contactors of Intermittent Duty Class 0,3.

All contactors shall be provided with arc extinguisher and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with a 240 Volt, 50 Hz closing coil suitable for continuous operation and at least 15 closing operations per hour. In rural areas contactor coils must be rated to operate satisfactorily between 75% and 130% of nominal voltage.

An adequate number of auxiliary contacts shall be fitted.

The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EMCC 8.17 Earth leakage units

The earth leakage units shall consist of a combination of a earth leakage relay and a moulded case circuit breaker and shall have a sensitivity as specified, it shall conform to SANS 767.

EMCC 8.18 Terminals

Terminals may be of the bolted type otherwise they shall be of rail mounted clamp type.

All types of terminals and their insulation shall have a minimum comparative creep index of 500 to BS 3781.

EMCC 8.19 Clamp type terminals

These terminals shall be not less than 8 mm wide.

Screws and connectors shall be electroplated to prevent corrosion. The connectors shall be such that the screws will not loosen due to vibration. Current carrying parts shall be of serrated silver plated copper or brass. Only one connection shall be allowed per connector. For more connections the number of terminals shall be increased and bridge pieces shall be used.

EMCC 8.20 Surge Protection

EMCC 8.20.1 *Surge Arrestors*

Surge arrestors shall be supplied and installed under this contract where applicable.

EMCC 8.20.2 *Main supply protection*

Surge arrestors as specified shall be installed at the main incomer of each distribution board, motor control centre or any type of kiosk.

EMCC 8.21 Power factor correction capacitors for 400 Volt motors

Each of these capacitors shall be of the indoor switchboard mounting 400 Volt 50 cps three-phase self-contained type with a dead casing and shall fully comply with the requirements laid down in BS 1650-1971.

Each capacitor unit shall be of carefully selected rating to correct the power factor of its associated motor to 0,95 at full load and should not exceed a value which compensates for 85% of the no-load magnetizing current.

The dielectric shall consist of plastic film and low-loss paper situated between aluminium foil and impregnated with a synthetic liquid agent with scavenger additive.

The capacitor losses shall not exceed 1 Watt/kV.Ar.

The capacitor units shall have the following admissible overloads at an ambient temperature of 40°C and an altitude 260 m above sea level.

10% excess volts continuously;
50% excess current continuously; and

30% excess kV.Ar continuously.
Each of these capacitor units shall be provided with discharge resistors and a fuse in each winding element that will disconnect the affected element in event of a di-electric breakdown. A time controlled contactor shall connect and disconnect the capacitors to the starter control circuit.

EMCC 9 DANGER SIGNS

Danger signs on aluminium plates shall be supplied on each door of an outdoor motor control centre or distribution board and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

EMCC 10 ELECTRONIC LEVEL CONTROL

The micro based electronic controllers which will be mounted in the starter panels shall be easy to calibrate and reliable in service.

The power units for all the pumps in a specific pump station shall be installed in a separate compartment of the starter panel and clearly labeled in accordance with the pumps it controls.

These level controls shall be designed to automatically select the pump sequence to ensure that all the pumps will at random be a duty pump.

Where a controller controls only two pumps and one pump is always a standby pump, the standby pump shall automatically become the next duty pump after each duty cycle, unless one pump is taken down for service. When that occurs, the duty pump shall remain on duty until the normal operation is restored.

When a pump selected for duty fails to respond to the start signal from the control, then the next duty pump shall automatically start-up after five minutes.

The level controller must also stop all the pumps, whether on manual or automatic selection, when the pump has reached a predetermined low level.

The transducers shall be designed to operate in air, been capsulated, of rugged construction and impervious to submergence. The transducer shall not form part of the MCC scope of supply

The coaxial cable between the transducer and power unit shall be of sufficient length to avoid any joints in this cable, as no joints will be permissible.

EMCC 11 EMERGENCY STOP PUSH BUTTONS AND WEATHERPROOF ISOLATORS

Each of these units shall consist of a totally enclosed outdoor type heavy duty "push and turn to lock" stop push button station with a cable gland entry at the bottom to accommodate a 4 core 2,5mm² LT PVC SWA PVC cable.

Where installed at motor positions the emergency stop push buttons shall not form part of the MCC scope of supply.

EMCC 12 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 10142.

Earth resistivity measurements of less than 1 ohm will be acceptable at motor control centres and distribution boards.

EMCC 13 INFORMATION TO BE SUBMITTED WITH TENDERS IN RESPECT OF THE 400 VOLT 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;
b) Three paper prints of an outline drawing of each motor control centre and distribution board indicating the main overall dimensions and general lay-out of the boards; and
c) Three paper prints of an outline drawing of the front end processor cabinet indicating the main overall dimensions, general layout and type of material employed on the face of the panel.

EMCC 14 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

a) Wiring diagrams of all motor control centres and distribution boards.
b) Schematic single line diagrams of all motor control centres and distribution boards.
c) Elevations showing dimensional information including details such as, but not limited to, the following:
    - motor control centres and distribution boards height (less any removable lifting angles or eyes)
    - motor control centres and distribution boards width
    - motor control centres and distribution boards depth
    - Location of shipping splits
d) Structure descriptions showing the following:
    - Bus ratings
    - Enclosure ratings
    - Short-circuit withstand ratings
    - Other information as required for approval
e) Conduit locations

f) Required bus splices
g) Unit descriptions including information such as, starter sizes, circuit breaker frame sizes, circuit-breaker continuous ampere ratings, and pilot devices
h) Nameplate information
i) Manufacturer drawings shall be provided in PDF format
j) Data sheets and publications on all major components including, but not limited to, the following:
- Motor starters
- Overload relays
- Circuit breaker and fuse information including time current characteristics
- Control power transformers
- Pilot devices
- Relays
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

EMCC 15 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection.

The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

The cost of all tests must be included in the tender price.

EMCC 16 TESTING OF 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.

EMCC 17 CONCRETE PLINTH FOR OUTDOOR STARTER PANELS AND PEDESTALS

The plinth shall be cast 150mm below as well as 150mm above the ground level. It shall have neatly bevelled edges and shall be 75mm wider than the panels all round.

An opening of sufficient width to allow for cable entry shall be provided under the starter panels.

The grade 304 stainless steel foundation bolts for mounting of the panels shall be cast or grouted into the plinth. The plinth shall be in Class 20/19 concrete and shall be suitably reinforced if necessary.

It is recommended that the casting of these foundations must be carried out by the Civil Contractor at the cost of the Contractor under this Contract in accordance with his instructions and under his supervision.

EMCC 18 INSTALLATION OF DISTRIBUTION BOARDS AND MOTOR CONTROL BOARDS

Each of the relevant distribution boards and motor control boards shall be built into walls or securely bolted down on the floor or plinth, as may be required, by means of the requisite number of foundation bolts grouted into the floor in the positions indicated on the drawings.

These positions shall be confirmed with the Engineer on site, prior to installation.

a) Contractor shall install MCC in accordance with manufacturer's instructions.
b) Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer's torque requirements.
c) Contractor shall select and install fuses in fusible switches based upon field requirements.
d) Contractor shall adjust circuit breaker settings based upon field requirements.
e) Contractor shall adjust solid state overloads to match the installed motor characteristics.

EMCC 19 TESTING AND COMMISSIONING OF DB/MCC 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 meter and protection measured;
c) The insulation of all primary circuits between phases mutually and between each phase and earth shall be measured;
d) All fused links shall be checked for electrical continuity; and
e) All control supplies shall be checked.
f) All adjustable protection devices shall then be set and the boards commissioned all in consultation with and to the instruction of the Engineer.

EMCC 20 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions *in triplicate*, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide *3 x "soft copies*" of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick).

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

EMCC 21 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EMCC 21.1 Design, Drawing and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For motor control centres and distribution board's installation, design information shall include, but limited to as listed in this Particular Specifications.

	Pay Item	***Unit***
(a)	Provide MCC design drawings and wiring diagrams as specified	Sum
(b)	Provide operating and maintenance manuals and "as built" drawings as specified	Sum

EMCC 21.2 SUPPLY AND DELIVERY TO SITE

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For motor control centres and distribution boards, the rate tendered shall be for the complete motor control centres and distribution board's and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications Section C3.4.2.

	Pay Item	***Unit***
(a)	Supply and delivery to site of a complete MCC	Each

EMCC 21.3 INSTALLATION

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning

Install of motor control centre and switchgear shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the motor control centres and distribution board's installation switchgear complies with the requirements and serves the intended purposes.

Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of motor control centres and distribution board's installation but not limited to.

Pay Item		***Unit***
(a)	Site installation of MCC	Each

EMCC 21.4 COMMISSIONING

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

Pay Item		***Unit***
(a)	Commissioning of MCC	Each

END OF SECTION

EPLC ELECTRICAL/ELECTRONIC: PROGRAMMABLE LOGIC CONTROLLERS

INDEX

EPLC ELECTRICAL/ELECTRONIC: PROGRAMMABLE LOGIC CONTROLLERS

EPLC 1 SCOPE OF WORKS

As specified in the Project Specifications.

EPLC 2 CONDITIONS TO SERVICE

The PLC Units will be installed inside MCC (Motor Control Centres) Panels and/or in the PLC cabinets where required. The typical areas where PLC installation shall be required are the following:

- An industrial WTP (Water Treatment Plant)
- An industrial WWTP (Wastewater Treatment Plant)
- A Pipeline Project with Pump Stations/Reservoirs/Feeder Tanks, etc.
- Mining areas
- Power Plants
- Substations
- And all subsequent areas where Control Systems are required

EPLC 2.1 Abbreviations

PLC	-	Programmable Logic Controller
CPU	-	Central Processing Unit
HMI	-	Human Machine Interface
UPS	-	Uninterrupted Power Supply
SFC	-	Sequential Function Chart
SRS	-	Software Requirements Specification
I/O	-	Input and/or Output (Analog and/or digital)
CF	-	Control Function
CFS	-	Control Function Section
CSC	-	Computer Software Configuration item
CSC	-	Computer Software Component
CSU	-	Computer Software Unit

EPLC 3 STANDARDS AND TESTS

All materials and equipment to be supplied and installed under this contract shall be new and of the best quality available, as specified.

All materials and equipment shall comply with the requirements laid down in the latest editions of the BS, SANS and IEC specifications and their amendments (if any) as well as those laid down

in this specification. All material and equipment shall bare the SABS mark, if material and equipment are offered not baring the mark, test certificates shall be submitted from independent testing agent, of the standard compliance of equipment.
The workmanship and finish of work shall be of a high standard throughout and to the satisfaction of the Engineer.

Similar equipment supplied under this contract must be identical in all respects and it shall be possible to interchange any of the same equipment under this contract.

a) Compliance with Laws and Regulations

The work shall be carried out strictly in accordance with and all material and equipment supplied shall comply with the following laws and regulations (the latest edition) of the where applicable:

- "Code of Practice for the Wiring of Premises", SANS 10142, as amended;
- The machinery and Occupational Safety Act (Act No 6 of 1983) as amended;
- The "Electrical Supply By laws and Regulations" of the Supply Authority;
- The local Fire Office Regulations;
- The Post Office Regulations:
- "Code of Practice for the Installations and Maintenance of Electrical Equipment used in Explosive Atmospheres" (SABS 086).

The Contractor shall be responsible for serving all notices and paying all fees due in terms of the above laws and regulations.

b) Standard Specifications

The work shall be carried out strictly in accordance with and all material and equipment supplied shall comply with The Occupational Health and Safety Act (Act No. 85 of 1993) as amended.

The following Standard Specifications and drawings shall apply:

SANS 156	-	Moulded Case Circuit Breakers
SANS 1574	-	Electric cables and flexible cords
NRS 002	-	Graphical symbols for electrical power, telecommunications and electronic diagrams
SANS 1433-1	-	Terminal blocks having screw and screw-less terminals
SANS 1433-2	-	Flat push-on connectors

IEC 68	-	Shock and vibration resistance
IEC 1000	-	Electrostatic discharge and electromagnetic interference
IEC 1131	-	Standard software

EPLC 4 RADIO AND TV INTERFERENCE

All equipment installed under this Contract shall comply with the Government Notice No R.2246 and any other applicable codes, rules and/or regulations in respect of radio and TV interference.

Any equipment found producing interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any additional cost.

EPLC 5 PROGRAMMING AND CONFIGUTATION

a) Programmable logic software

All PLC software shall be structured in a logical manner representing the key process units and control regimes required for plant control.

b) Programming

The contractor shall program the PLC including all functions and operations to comply with the plant and/or pump control philosophy and/or any other equipment as provided by the engineer. The contractor shall insure that at tender stage they are familiar with the standards and protocols used by the client and shall allow for adaptability of the offered system. The client's standard IP addressing and network configuration shall be used to ensure smooth integration.

c) Execution of control regimes

Control programs shall be executed at PLC level always. Approval to execute any control functions at supervisory level shall be obtained from the Engineer before commencement of the development of the software.

d) Configuration

Where required, the contractor shall allow for the following scenario:

i) Interface and configuration to an existing SCADA System, as per the existing Client's specification, and shall include all the relevant graphics required for integration to the new

equipment.

A system specialist shall be required to complete this task and the contractor shall allow adequate time to complete, test (FAT), pre-commission and commission the complete integrated system, consisting of both the new and the old installations.

EPLC 6 PROGRAMMABLE LOGIC CONTROLLER HARDWARE

EPLC 6.1 Hardware Configuration

Normally the hardware configuration will be a single CPU with I/O modules as required mounted on a 19-inch rack back plane.

Where required, Remote I/O shall be installed within close proximity to a PLC unit. Based on the distance between the Remote I/O unit and PLC unit, this shall determine which physical media type is to be used (Multimode Fibre Optic or Ethernet CAT5e).

All designs shall be backed up with design calculations, compliance to network standards and compliance to international communication standards and protocols (ANSI, IEEE, IEC, etc.)

EPLC 6.2 Enclosures

PLC/Remote I/O equipment shall be mounted in an IP54 enclosure with a suitable viewing window in front of the modules. The enclosure will form part of the MCC (Motor Control Centre) and in the event that no MCC is available a separate enclosure shall be supplied.

EPLC 6.3 General

The unit shall comprise of a PLC with interface modules, a power supply, input and output modules, network modules and shall be suitable for 19 inch rack mounting, unless specified differently by the Engineer. All equipment shall be housed in a steel cabinet that will form part of that specific MCC unless the application requires a separate control cabinet installation.

The technical requirements for the different modules forming part of the overall PLC System are discussed below:

EPLC 6.4 Power Supply

The standalone single slot rack mounted power supplies shall operate from 24VAC/24VDC/230VAC and shall have sufficient capacity for the application. The Power Supply module shall be fed by a regulated UPS supply. The power supply shall provide all regulated DC back plane power necessary for all the installed modules. The power supply shall have over and under voltage protection for added security.

The stand-alone single slot rack mounted power supplies shall operate from UPS fed - 230 V-AC and be sufficiently sized based on the requirements of this project in terms of its power capacity.

The UPS backup shall provide power for a minimum duration period of one hour.

The power supply shall provide all regulated DC back plane power necessary for the installed modules.
The power supply shall have over and under voltage protection for added security.

Allowed interruptions of power supply should DC and AC power supplies should be less than 10mS and 0.5 seconds respectively.

EPLC 6.5 CPU

The CPU module shall be a back plane slot mounted controller containing on board executive memory, application memory and communication ports. It shall be possible to perform field upgrades through a field bus communications port. The front panel of the CPU shall be equipped with status and fault LED's to facilitate fault diagnostic procedures. The CPU shall have a multipoint interface for an external programming device as well as an Ethernet RJ45 port.

The technical specifications of the CPU Unit (unless specified differently by the Engineer) shall be as follows:

- The CPU should have the following minimum processing times for:
    a. Bit operations : ≤ 50 nanoseconds
    b. Word operations : ≤ 60 nanoseconds
    c. Fixed point arithmetic operations : ≤ 80 nanoseconds
    d. Floating point arithmetic operations : ≤ 300 nanoseconds
- The CPU should have minimum IP20 degree of protection
- The CPU shall have a real time clock for the generation of time related information
- The CPU shall have surge protection
- The CPU shall have diagnostics like alarms (including diagnostic alarm, hardware interrupts, wire break)
- The CPU shall have diagnostics indication LEDs (including run, stop, error, send, receive, etc.)
- The CPU shall have shock resistance according to IEC 60068-2-27.
- The CPU module shall be a back plane slot mounted controller containing the required integrated program memory and data memory.
- Sufficient programming memory and a processor with a very fast processing speed shall be made available.
- The programming memory shall have 30% spare capacity, after all the required design

requirements have been met.

- The size of the processor selected shall be done such that the utilization factor will be at most 70% of its processing (CPU clock speed) capability. This then leaves at a minimum 30% available processing capability for future expansion
- **Note:** The proof of the CPU Utilization factor (based on the current I/O requirements), for each individual CPU Unit is required by the Engineer and shall form part of the overall Data Pack.
- Ethernet and engineering interface communication ports must be available on the CPU
- It shall be possible to perform field upgrades, as well as firmware upgrades, through the Field bus communications port/Ethernet port
- The CPU shall support at least the following **IEC 1131-3** programming languages:
  - Sequential Function Chart;
  - Structured control language (SCL)
  - Function Block Diagram
  - Ladder Diagram
  - Structure Text
  - Instruction List

- The CPU shall be equipped with either a lithium battery or an internal energy storage element, for backing up the RAM holding application programs

EPLC 6.6 Communications Processor

- The communications processor shall provide communication links with other programmable controllers to other required network communication (i.e. PROFIBUS, Industrial Ethernet) connections apart from the PLC CPU communication interfaces.

EPLC 6.7 Software (General)

- All PLC software shall be structured in a logical manner representing the key process units and control regimes required for plant control.
- System diagnostics should provide all relevant information regarding errors present in the system; also, the software should allow automatic updating of the system diagnostics when modifying the hardware configuration and also fast fault localization.
- All PLC software shall be fully documented and the documentation shall consist of the following as a minimum:
  - Functional specification of the plant to be controlled
  - Process control logic diagrams
  - Sample report forms
  - Sample alarm report details (list and format of reports)
  - Fully annotated listing of the full software package

- Full input/output listings
- Full allocated register listing with functional description
- Program software in electronic format
- All documentation is subject to the approval of the Electrical Engineer.

EPLC 6.8 Software (Development)

- The Sequential Function Chart (SFC) language, used to structure the internal organization of a program, and four inter-operable programming languages: Instruction List (IL), Structured Control Language (SCL) , Ladder Diagram (LD), Function Block Diagram (FBD) and Structured Text (ST) should correspond to the textual high-level language ST (Structured Text) defined in the standard IEC 61131-3 and fulfils base level and reusability level requirements according to PLC open standard

EPLC 6.9 Digital I/O Modules

- The digital I/O modules shall accept inputs from plant controls and auxiliary multiple operations and provide control outputs to plant operations.
- The modules shall be complete with I/O connectors. 24VDC input and output modules will be preferred.
- These modules shall also be capable to accept floating alarms of duration of 20 milliseconds. as well as steady alarms from normally closed controls.
- A typical response time of 1ms for change of state shall be acceptable.
- All inputs and outputs shall be 2,5 kV isolated from the logic components.

EPLC 6.10 Analogue I/O Modules

- These modules shall accept analogue inputs from plant transducers and provide control analogue outputs to plant operations and shall be capable of converting 0-5V, 0-10V, 0-20mA or 4-20mA signals as may be required.
- All analogue inputs and outputs shall be galvanically isolated.
- The input modules shall have a typical accuracy of at least ±0.05% of full scale while the accuracy of the output modules shall not exceed ±0.2% of full scale.
- The input modules shall have broken wire fault detection capabilities, diagnostic functions, monitoring the supply voltage, should have an IP20 degree of protection, diagnostic functions, Diagnostic LEDs for status of inputs and maintenance

EPLC 6.11 Distributed (Remote) I/O Modules

- The distributed I/O module shall be a standalone unit with an integral 230V AC power supply and equipped with digital and analogue I/O as listed in the attached I/O list. The module shall, preferably, have an Ethernet port and the distributed I/O module should have

minimum IP20 degree of protection

- The distributed I/O module shall be connected via Ethernet/IP to the main PLC unit
- The Engineer must firstly approve if the contractor offers an alternate communication protocol (for e.g. PROFIBUS, PROFINET, EtherNet/IP, Modbus TCP/IP, etc.)

EPLC 6.12 Optical Link Modules

The back plane mounted optical link modules for fibre optic cables shall allow networks to be configured in linear, ring and star structures and shall be supplied complete with the necessary cable connectors, interface cards and bus connectors.

EPLC 6.13 Fibre optic to RJ45 converters

Where specified fibre optic to RJ45 converters shall be installed. These units shall be secured in an acceptable manner.

EPLC 6.14 Distributed I/O

The distributed I/O module shall be a standalone unit with an integral 230V AC power supply and equipped with digital and analogue I/O as may be required. The module shall have an Ethernet port (unless specified differently by the Engineer)

EPLC 6.15 I/O Allocations for Plant Availability

The allocation of input and outputs shall be in a logical manner. The allocation shall be on the basis of process units or streams or drives such that the failure of a card will cause minimum loss of plant availability.

Specifically for any motor starter the inputs shall be grouped on one card. The number of inputs allocated to a motor starter is such that they can be grouped on a 16/32 way digital input card and/or 4/8 way analogue input card so that at most two motor starters are allocated to one card. The allocation of inputs and outputs for motor starters shall be such that a duty and standby motor starter are not together on the same I/O cards.

EPLC 6.16 Documentation

All PLC hardware and software shall be fully documented and the documentation shall consist of the following as a minimum:

- Functional specification of the plant to be controlled
- All proposed PID Loops including diagrams
- Process control logic diagrams

- All Loop diagrams
- Layout/images of Graphical Faceplates for proposed Plant Sites
- Sample report forms
- Layouts of proposed Trending Faceplates
- Sample Alarm report details (list and format of reports)
- Fully annotated listing of the full software packages
- Full input/output listings
- Full allocated register listing with functional description
- Program software in electronic format
- All documentation is subject to the approval of the Electrical Engineer.

EPLC 7 COMMUNICATION

EPLC 7.1 General

PLC communication shall utilize Ethernet as a standard, unless another standard is specifically mentioned by the Engineer.

The Contractor shall list three different protocols they intend using over the Ethernet physical standard. The Contractor shall ensure that the three different protocols they select, are not only compliant with their own equipment but with all the major Control System equipment suppliers (Siemens, Honeywell, Rockwell, Schneider, ABB, GE, Mitsubishi, etc.) as well.

The Contractor may give their preference for any of the three protocols selected, but must include valid reasons for their choice. The Engineer however reserves the right to decide which protocol shall be best suited to the installation requirements.

EPLC 8 INTERLOCKING CONTROL USING COMMUNICATION NETWORKS

Where it is necessary to execute process control on a PLC and/or supervisory network the following shall apply:-

Safety interlocks where human or equipment safety is a criterion may be communicated over a PLC to PLC network. The interlocks may not be communicated over a higher level supervisory network. This requirement does not negate the requirement to have hardwired safety stop controls on all drives and switchgear.

Non-essential interlocks, the failure of which will not cause harm to persons or equipment may be communicated with prior permission over a supervisory communications network. Preference, however, is to keep all interlocking at the field bus or Ethernet level unless rate of communication is compromised due to excessive traffic levels.

Data for the purpose of reporting and management information shall be channelled through the supervisory level network (Full duplex Ethernet Network). Such data shall preferably not be transmitted on the field bus or Ethernet sub-network level unless a supervisory level channel is not available for this purpose.

EPLC 9 HARDWARE CONFIGURATION UNIT BASIS

Hardware shall be configured on a per "unit" basis, which means each pump set shall be configured in a module with equipment dedicated to that pump set only. It shall be configured on a unit by unit basis only, thus ensuring that the failure of any one item will affect only a single pump set at any instant in time.

It may however, be necessary to serve a pump set PLC hardware with common services such as UPS (Uninterruptible Power Supplies) Units.

For this purpose the pump sets shall be provided with the following:

- A control console located on the operating floor in a position where the operator is able to overlook the pump sets, unless otherwise specified.
- A HMI (Human Machine Interface) terminal is required to display all process and fault information, unless otherwise specified. The normal control functions shall be executed by way of soft keys on the HMI Unit.
- An "Emergency Stop" push button for each pump set in the pump station mounted on the control console, unless otherwise specified. The emergency stop push button shall have a red mushroom operator and shall be of the latching, twist to release type.
- Stop circuits shall be hardwired in the main circuit breaker control circuit as the primary trip route and shall also be wired into the PLC control circuit.
- Emergency trip push buttons shall activate both the trip coil and no volt release coil of the main circuit breaker or contactor where used.

EPLC 10 HMI TERMINAL - PROCESS INFORMATION

The monitoring and control functions of each pump set shall be accessible on the HMI.

The device shall be programmed that the control soft keys of each pump set are the same. To ensure that this requirement is maintained, a standard software package shall be applied to each pump set. Variable speed pump sets shall have the facility for speed adjustment added.

The HMI shall have a minimum 10,4 inch colour screen and HD definition pixilation. Sufficient application memory shall be available to ensure at least 50% spare memory with the required applications loaded. The HMI shall be equipped with an Ethernet port for PLC communication.

As a minimum, the following basic process information shall be displayed for each pump set or pump stage as applicable:

Operating Parameters

- Suction pressure
- Delivery pressure
- Delivery flow rate
- Running hours - accumulated total and since last start
- Accumulated kWh
- Tank Levels
- Hour operational schedule

Valve Parameters

- Suction valve position indication
- Delivery valve position indication

Pump Parameters

- DE and NDE bearing temperatures
- Thrust bearing temperature
- Vibration measurement (vertical, horizontal and axial directions)
- Volute temperature

Motor Parameters

- DE and NDE bearing temperatures
- Phase stator temperatures
- Motor power
- Motor current
- Motor speed (variable speed drives only)
- Power factor (variable speed drives)
- Vibration measurement (vertical, horizontal and axial directions)

Auxiliary Devices

- Device run and stop indication
- Device fault indication
- Flood alarm

The following basic information Faceplate screens shall also be provided

- Faceplates showing process information for each individual pump
- Faceplate showing overview of pump sets
- Faceplates for each Area or Sub-area
- Faceplates for Auxiliary Systems (CP, AC Mitigation Systems, etc.)
- Faceplates for Auxiliary Systems (Fire Detection, Intruder Detection)

- Faceplates for Alarming
- Faceplates for trending
- Faceplate for all MV Protection settings and adjustments
- Faceplates for all interlocks (Hardwired & “Soft” wired)
- Faceplate showing a main Overview of entire process
- Faceplate for main 11kV electrical power supply system with status indication for all circuit breakers and associated equipment.

EPLC 11 SCADA INTERFACE

To facilitate an interface with a SCADA system the PLC’s shall all have Ethernet communication ports as a minimum requirement, unless specified differently. Depending if sub-networks are required, field bus communication ports shall also be required.

The intention is that all main water pump sets be controlled from the relevant local control panel as well as from the SCADA system. However, process data will be collected utilizing the Ethernet standard for information, control, alarming, reporting and trending on the SCADA system.

Provision shall be made for control of the pump sets via the SCADA system by means of a selector switch panel on the motor starter panel located in the pump station which shall have the functions – **Remote Mode / Local Mode / Maintenance Mode**, unless otherwise specified. Switching of this selector switch while a pump is running shall not trip the relevant motor.

EPLC 12 TERMINAL STRIPS IN PLC PANELS.

Wiring directly to the PLC I/O cards is not permitted. All wiring shall be by way of two sets of terminals arranged such that one set of terminals are grouped on a cable by cable basis and the second set of terminals reflect the PLC I/O card slots. Patch wiring shall be provided between each of the terminal strips as required.

Terminals used in PLC cubicles shall be of the knife type, unless specified differently.

EPLC 13 PLC SOFTWARE DEVELOPMENT

EPLC 13.1 Software

IEC 1131 Standard software with up and down load capabilities programmable over the Ethernet network and complies with a standard Graphical User Interface 64/128 bit operating system for network applications, shall be used.

The software shall allow the reusability of function blocks as building blocks in future applications and shall have a built-in PLC simulator that will allow the running of the IEC program for debugging purposes.

EPLC 14 IDENTIFICATION

This specification describes the procedure for the development of PLC software. All PLC software developed shall conform to the conventions and standards described in this procedure. The documents described in this procedure shall be produced as outputs during the software development process, and together they will enable the maintenance and re-use of software, and they will simplify configuration management of software items.

EPLC 15 SOFTWARE ENGINEERING REQUIREMENTS

PLC software shall be designed for continuous reliable operation.

The software shall be designed for maintainability. This particular requirement enforces the following constraints on the software development:

It shall be possible to change the software in response to changing requirements by modifying only those sections of code that are directly related to the change in process requirements.
The code shall be written on the premise that it shall be possible to make changes to local code sections without affecting the functionality of other code.

The program style shall be direct and simple wherever possible. This will enable future modifications to be performed by programmers that may not have been involved in the development of the original system. Convoluted programming techniques shall not be used.
Convoluted programming techniques tend to mask the essential design of the program. Such techniques shall only be used when the programmer has no alternative, or when the benefit (efficiency, size, execution time etc.) significantly outweighs the cost.

All PLC programs shall be extensively documented to convey the intended function of the program. The intended function of the PLC programs shall therefore be very well described in the documentation, thus allowing for the total understanding of what the PLC programmer intended to achieve with the PLC program. Copies of the PLC programs (both soft copies & hard copies) shall be given to the Engineer.

EPLC 16 CSCI (COMPUTER SOFTWARE CONFIGURATION ITEMS)

High-level plant "classes" identified during the analysis phase shall be mapped to CSCI (Computer Software Configuration Items). Child classes shall be mapped to CSC (Computer

Software Components) and CSU (Computer Software Units), in accordance with the class hierarchy of the system.

Each CSCI shall be comprehensively documented in a SRS (Software Requirements Specification).

A CSCI, CSC and CSU shall be characterized by one or more control function instances. These instances may be grouped into one or more control function types. Control function types include interlocks, trips, control algorithms and other functional and logical entities that are required for interaction with and control of a specific piece of plant equipment.

EPLC 17 SRS (SOFTWARE REQUIREMENTS SPECIFICATIONS)

Each CSCI must be specified by means of a SRS. The SRS shall meet the following minimum requirements:

Each plant component that has been subjected to object-oriented analysis shall be described by a set of overview class hierarchy diagrams that illustrates the inheritance relationships that are inherent in the system. The class hierarchy diagrams shall illustrate inheritance in:

- The PLC Input & Output points
- Discrete and batch control functions, e.g. interlocks, trips, start-up sequences
- Continuous process control functions, e.g. PID (Proportional - Integral - Derivative) Control
- The analog and digital values that are generated by the PLC software and/or communicated to the SCADA system, e.g. metering information

The SRS shall contain an introductory subsection that describes the purpose of the software system, and in particular, the role of the PLC software in the system.

The SRS shall specify the names and descriptions of all analog and digital plant inputs and outputs that are communicated to or from the PLC.

The SRS shall incorporate several subsections called Control Function Sections (CFS), each describing a number of instances of a specific control function. For example, a PLC program may implement several PID control loops. The software segment specification would then incorporate a "PID Control Loops" section, in which each PID control loop is described in detail, in keeping with a standard layout.

The SRS shall list and describe all digital or analog values that are generated by the PLC software (or that are scanned into the PLC) and then transmitted to the SCADA system.

The SRS shall include a detailed explanation of how the PLC driven systems operate in conjunction with the hard-wired systems.

EPLC 18 GENERIC LAYOUT

Each CFS shall conform to the following generic layout:

- Control Function (CF) type and instance number - this number shall be unique for each instance in a control function class hierarchy

Name	-	A short text label that describes the control function.
Description	-	Textual explanation of the behavior of the control function.
Software Algorithm	-	Explanation of the PLC logic that is used to implement the control function. The names of all the PLC inputs and outputs that are used shall be given in the algorithm description

- SCADA indication - the SCADA indication details of the CF (Control Function) are given, including the location of the indicator, the colour of the indicator, and the message details.
- Notes and associated conditions - any settings that may be relevant to the CF, or any conditions such as alarms or pre-conditions that relate to the CF shall be documented.
- For example, the requirements section may incorporate a subsection describing the interlocks that pertain to the particular class. Each interlock description shall incorporate the following:

Interlock number	-	This number shall be unique for each interlock in a class hierarchy
Name	-	A short text label that is normally the same as the interlock message
Description	-	Textual explanation of the function of the interlock
Software Algorithm	-	Explanation of the PLC logic that is used to implement the interlock. The names of all the PLC inputs and outputs that are used shall be given in the algorithm description.
SCADA indication	-	The SCADA indication details of the interlock are given, including the location of the indicator, the colour of the indicator, and the message details.
Pre-conditions	-	These are any pre-conditions that must be satisfied before it can be confirmed that the interlock is unhealthy. In some cases it may be necessary to explain the algorithm and PLC logic of the pre-conditions and any overrides that may be present.

EPLC 19 NAMING AND DOCUMENTATION OF SOFTWARE

Each PLC program shall be documented in a manner that allows the reader to understand the functionality of the program, and to locate the desired section of ladder logic.

A short "Program description" document shall be produced for each PLC program. The primary functions of the program shall be listed in this document. For example, the program might monitor and control electricity reticulation, provide water quality monitoring functions, and allow for the control of certain pump sets.

Each PLC program shall consist of several segments. Segments are used to divide the program in to logical sections. Segments are the basic schedulable entities within the PLC software. Each segment shall be documented by means of an SFC list. The SFC list gives some indication as to the purpose and structure of the program. Segment comments may be up to one page in length.

PLC segments consist of several SFCs. Each SFC shall be documented by means of a list of networks within the SFC. The list shall identify which of these networks are implemented as macros and which are specific and unique to the SFC. This list is intended to give some indication as to the purpose and structure of the SFC. SFC comments may be up to one page in length.

Each SFC consists of a number of networks. The logic employed in each network shall be described in the network comments that may be up to one page in length. Where a network is implemented by a macro, the macro comments may be copied to the network comments screen, or the network comments screen may simply reference the macro comments. Macro comments and network comments shall describe the PLC logic in terms of "power flow" that is regulated by the opening and closing of coils.

Each coil and register that is used in the PLC program shall be described in the comments field that may be 50 characters long (10+10+10+20).

Print outs of appropriate ladder logic shall be attached to all network comment documents.

EPLC 20 MACROS

Macros shall be used wherever possible in the implementation of PLC software in order to promote software re-use.
Common software elements shall be identified from the plant class hierarchy.

A set of macros shall be associated with a specific plant class hierarchy, although a direct mapping of macros to entities in the hierarchy may not result in optimal re-usability. In such instances, the macros shall rather be designed for optimal re-usability.

The PLC logic used in macros shall be described in the macro comments screen.

The design of macros shall not be explicitly documented. The software segment specification relating to each software segment identified in the plant class hierarchy shall describe the functional and behavioural aspects of the PLC software. If the software has been implemented in

terms of macros, then the reader shall know this from the network comments that are associated with the relevant software.

EPLC 21 OPERATIONS MANUAL

An "Operations Manual" shall be delivered with the software. This manual shall contain the following information:

- Details of all instruments and devices that shall be connected to the PLC
- Details of PLC - network connections.
- A user document that describes how the PLC program shall operate in conjunction with new/existing SCADA systems, hard-wired systems and mimic panels
- This document shall inform the user of alternative control options, and give some idea of how the PLC system integrates with the plant and its hard-wired systems.

EPLC 22 TEST SPECIFICATION

A test plan shall be developed for each software segment whilst the software segment specification is being drawn up.

The test plan shall focus initially on verifying the architectural design of the program that is that the partitioning into segments, SFCs and networks has been performed in an intuitive and logical manner.

Each trip, interlock and data output shall be tested by varying all pre-conditions and overrides. The test scenario for each case shall be comprehensively described. Details of how to model a particular override or pre-condition by modifying the hard-wired configuration shall be given. Explicit criteria shall be given in terms of which the interlock or trip shall be deemed to have passed or failed the test.

EPLC 23 WALK-THROUGHS

Structured walk-throughs and code inspections shall be carried out during the development of each software segment.
Walk-throughs shall initially focus on verifying the architectural design of the program that is that the partitioning into segments, SFCs and networks has been performed in an intuitive and logical manner.

Ladder logic networks shall be tested individually. All possible coil status permutations shall be identified for each network. Factors that may cause coil statuses to change shall be identified and the ramifications of changing coil statuses shall be investigated. Where registers are used in the networks, factors affecting register values shall be identified, and tests shall be devised to investigate the behaviour of the software when register values change to and from critical values.

A checklist shall be used to allow PLC programs to be checked for common PLC programming faults. The checklist shall be maintained on an on-going basis to ensure that the maximum number of common errors can be detected before testing and commissioning.

EPLC 24 TEST PROCEDURE

Software testing shall be carried out on site.

Before testing begins, the plant to be used in the on-site tests shall be de-commissioned and configured for testing.

Trips, interlocks and data outputs shall be tested individually. These tests shall follow the test specification that was produced in parallel with the software segment specification.

A test compliance document shall be completed during the test phase, and this document shall be included in the project documentation.

EPLC 25 CHANGE MANAGEMENT

Changes to the functionality of a program may be required if the system fails due to an identifiable fault in the program, if the requirements change such that the change in specification forces a change in the software, or if sub-optimal system behaviour can be improved through software modification.

Faults reports shall be generated by the plant operators, and they shall be passed on to the software configuration manager. Similarly, any change in requirements that leads to a change in specification shall be passed on to the software configuration manager.

Changes shall first be made to the software requirements specification. The ramifications of making the changes shall be investigated, and the software modules (segments, SFCs, networks) that are affected shall be identified and modified.

Before the software changes are effected, a test plan shall be produced that describes how the changes are to be approved. This test plan shall be incorporated in the project documentation in the "Change control" section.

A walk-through inspection shall be held once the changes are complete. The primary goal of this inspection shall be to determine that all possible side effects that may be produced by the changes have been anticipated and explicitly dealt with.

Minutes from this inspection shall be appended to the body of the main project documentation in the "Change control" section.

The modified software shall then be tested according to the test procedure that was produced when the specification was amended.

EPLC 26 MEASUREMENTS AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below.

EPLC 26.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For programmable logic controller's, design information shall include, but limited to as listed in this Particular Specifications. A Control System integrator/specialist shall be required to complete this design and engineering tasks and the contractor shall allow adequate time for the complete design and engineering of the PLC Control System.

Pay Item		***Unit***
(a)	The Contractor will provide the following design calculations, Drawings and wiring diagrams for approval by the Engineer: a) Fibre loss design calculations in excel format which will include but limited to From, To, Distance losses and Tag numbers and total losses through the fibre network [fibre losses] b) Electrical Load lists in excel format of all PLC equipment. c) Engineer design drawings of network layout which contains all IP addresses, equipment and drawings. d) Report which will include antennae radio paths, drawings which have line of sight of all locations in AutoCad Format, Connection speeds with the radio or wireless communication, details of all Radio & Wireless Radio losses e) Input and Output schedules in excel format which contains all tag numbers, names, commands, and description of all I/O f) Loop diagrams in AutoCAD format g) Cable schedules in excel format which will include but limited to From, To, Distance and Tag numbers h) AutoCAD drawing of all equipment positions, equipment layouts, cable layouts, rack layouts, rooter / modems, switches connections and layouts. i) P&ID drawings of the entire system which is implemented and equipment in AutoCAD format which shall strictly accordance to ANSI/ISA-5.1 [American national Standard] j) Functional design specification which will include but not limited to all	Sum

mimic diagrams, control procedures compared to control philosophy and a detail description how the PLC will control the entire system [broken down into each component].

(b)	Provide operating and maintenance manuals, data sheets of all equipment and "as built" drawings	Sum

EPLC 26.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For Programmable Logic Controllers System, the rate tendered shall be for the complete Programmable Logic Controllers System and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications.

Pay Item		***Unit***
(a)	Supply and delivery of a complete PLC and peripheral equipment installed in or other specified enclosures, all as specified	Each
(b)	Supply and delivery of a complete UPS as specified	Each
(c)	Supply and delivery of a complete HMI as specified	Each

EPLC 26.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of Programmable Logic Controllers system shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the PLC system complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of Programmable Logic Controller System but not limited to.

Pay Item		***Unit***
(a)	Site installation of a complete PLC and peripheral equipment installed in or other specified enclosures, all as specified	Each
(b)	Site installation of a complete UPS as specified	Each
(c)	Site installation of a complete HMI as specified	Each

(d)	Site cable connections and programming of all PLC Systems	Sum

EPLC 26.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

Pay Item		***Unit***
(a)	Commissioning of a complete PLC system and peripheral equipment installed in or other specified enclosures, all as specified	Each
(b)	Commissioning of a complete UPS as specified	Each
(c)	Commissioning of a complete PLC System HMI as specified	Each
(d)	Commissioning of a PLC system programming and operation of plant in automatic and manual mode	Sum

END OF SECTION

ESCA SCADA - SUPERVISORY CONTROL AND DATA ACQUISITION

INDEX

ESCA SCADA - SUPERVISORY CONTROL AND DATA ACQUISITION

As specified in the Project Specifications.

ESCA 1 ABBREVIATIONS

SCADA	-	Supervisory Control And Data Acquisition
ECI	-	External network – control network Interconnection
IRA	-	Interactive Remote Access to a control network
ICC	-	Inter-Control Centre access to a shared control net
CNH	-	Control Network Host
AFD	-	Automation Field Host
FCN	-	Field Control Network within single control area
CCN	-	Control Centre Networks within single control area
SED	-	Standalone Embedded Device
ACI	-	Inter-Area Communication within hierarchical multi-area control network

ESCA 2 STANDARDS

The SCADA shall conform to and be in accordance with the latest applicable IEC, ISO, and IEEE Standards:

The following Standard Specifications and drawings shall apply:

Standard No.	Description
SCADA	Supervisory Control And Data Acquisition
ECI	External network – control network Interconnection
IRA	Interactive Remote Access to a control network
ICC	Inter-Control Centre access to a shared control net
CNH	Control Network Host
AFD	Automation Field Host
FCN	Field Control Network within single control area
CCN	Control Centre Networks within single control area
SED	Standalone Embedded Device
ACI	Inter-Area Communication within hierarchical multi-area control network

ESCA 3 HARDWARE CONFIGURATION

The SCADA system shall consist of multiple servers, work stations, engineering stations, Historian, off-site disaster recovery sites and software responsible for communicating with field equipment like PLC's, RTU's and smart sensors. Where required, the SCADA system shall comprise only of a master station for instances where the installation is small. Instances where

dual-redundant or hot-standby formation SCADA systems are required, redundant servers, dual networks and redundant switches shall be installed for increased reliability.

ESCA 4 ALARMS

The effective management of all alarm signals received on the SCADA system is required to ensure the effective management of plant and equipment. The alarm management is required to prevent the following scenarios:

a) Alarm flooding leading to the overwhelming of the operator's cognitive abilities.
b) Alarming of insignificant criteria leading to unnecessary actions by the operator's.

The flooding of alarms with any proper form of alarm management shall lead to distractions on the part of the operator's, thus decreasing vigilance in the long run. The alarm management system shall provide all the requirements needed to ensure an efficient and stringent alarm management system.

Some of the alarm management capabilities shall include the following:

a) Alarm grouping
b) Alarm filtering
c) Alarm inhibiting
d) Alarm shelving
e) Alarm suppressing

The alarm management system shall be able to do statistical analysis on alarms and also provide advanced alarm reporting. The system management of alarms shall be categorized according to groups and certain priorities.

These shall be assigned according to a hierarchical structure depicting priority importance (normally from top to bottom, with the top alarm having the highest priority).

ESCA 5 SCADA PROTOCOLS

Any previous legacy SCADA protocols proposed shall be ModBus RTU, ModBus TCP, Profibus and Profinet. However, the more recent and more secure SCADA protocols shall conform to the IEC 60870 Part 5 Standard. These are defined under the following sections:

a) IEC 60870-5-1 sTransmission Frame Formats
b) IEC 60870-5-2 Data Link Transmission Services
c) IEC 60870-5-3 General Structure of Application Data
d) IEC 60870-5-4 Definition and Coding of Information Elements
e) IEC 60870-5-5 Basic Application Functions

f) IEC 60870-5-6 Guidelines for conformance testing for the IEC 60870-5 companion standards
g) IEC 60870-5-101 Transmission Protocols, companion standards especially for basic tele control tasks
h) IEC 60870-5-102 Companion standard for the transmission of integrated totals in electric power systems
i) IEC 60870-5-103 Transmission Protocols, Companion standard for the informative interface of protection equipment
j) IEC 60870-5-104 Transmission Protocols, Network access for IEC 60870-5-101 using standard transport profiles

The other approved SCADA Standard protocols shall be IEC 61850 and DNP3. The contractor shall confirm with the Engineer the list of proposed protocols they intend using, if different. The Engineer reserves the right to refuse certain protocols that do not comply with the requirements.

ESCA 6 DESIGN PHILOSOPHY

The SCADA system shall be designed to withstand temperature fluctuations, vibrations, and voltage fluctuations. Redundancy, where required shall be incorporated through redundant hardware and redundant communication paths. The contractor shall give through a proposal on how they intend achieving redundancy, if required on the SCADA system. The Engineer shall approve the proposal before the contractor can implement the design.

ESCA 7 SECURITY

SCADA systems shall be designed to be open, robust, and easily operated and repaired. The SCADA system shall however be designed utilizing the latest in security enhancements and features, thus ensuring data protection, integrity and privacy.

Any vendor, whose SCADA packages have been under recent attacks within the last 12 months, shall provide proof of the total eradication of any malware, worm and viruses infected in their subsequent software packages, wherever they were installed.

Furthermore, the specific vendor shall provide a root cause analysis why the infection/attacks were able to manifest itself in their software and what measures were taken to eradicate the infections.

The vendor shall also prove the commitment from their company to prevent further malware attacks on their software in the future by outlining their global security implementation strategy.

Failure to provide these requirements to the Engineer shall void their SCADA package from the selection process. The SCADA vendor shall ensure that the below mentioned security issues are encompassed and dealt with effectively in their SCADA packages.

The main reasons why security issues arise are the following:

a) The general lack of concern about implementing security and authentication when doing the design, during installation and during operation of the SCADA networks. The contractor shall ensure all required security measures have been put in place during the design, installation and operation of the SCADA system, including the use of advanced encryption standards.
b) The incorrect belief that SCADA systems have the required security by simply using specialized protocols and proprietary interfaces. The contractor shall ensure all required security measures has been implemented when interfacing to existing or legacy systems and third-party equipment.
c) The incorrect belief that SCADA networks are secure just because they have been physically secured.
d) The incorrect belief that SCADA networks are secure just because they have been disconnected from the Internet. The contractor shall ensure that where access to the SCADA system is required via a router, that stringent IT policy implementation has been effected over the entire OSI model, including the physical, data link and network layers.

SCADA systems face many threats to their data integrity and security. Some of the main security threats are the following:

a) The unauthorized access to the control software through human access. This is when changes are done either intentionally or accidentally by virus infections and other software threats residing on the control host machine. The contractor shall ensure the risk unauthorized access is diminished by selecting a SCADA system that has lines of specialized industrial firewalls and VPN solutions for TCP/IP-based SCADA networks. The contractor shall further ensure that the hardware supplied have all their I/O ports blocked from people accessing the equipment using USB sticks, SD cards, CD's or DVD's.
b) The unauthorized access to the control software through packet access to the network segments hosting SCADA devices. This can be through physical access to SCADA-related network jacks and switches. The contractor shall ensure IT security policies are implemented on all levels of the OSI model.

ESCA 8 GENERAL REQUIREMENTS

The SCADA system shall utilize client/server technology to support multiple users operating in a networked environment. A configuration server shall be required for managing and saving the configuration information.

The configuration server shall be able to support multiple simultaneous client connections, whilst providing users with shared access to a system's configuration information and real-time plant data. A communication server shall also be provided.

The configuration server shall store the data in a single database per each system. The storing of duplicated data shall not be allowed. Only common file formats that are widely used and accepted in the industry shall be accepted.

The system shall be so designed that all engineering tasks are not done in the runtime environment. This is to ensure very little process interruption.

The SCADA system shall have tools for seamless integration. The SCADA system shall have very good workflow automation and be able to do bulk import and export functions.

The SCADA system shall have a comprehensive range of engineering tools that can do easy configuration of control systems. The SCADA system shall consist of system libraries consisting of reusable software components.

The SCADA system shall be able to configure user information for the Windows and Engineering databases. It shall further allow for creation of user profiles along with their roles and certain project access permissions.

ESCA 9 PROJECT ADMINISTRATION

The SCADA system shall be able to manage the inflow and outflow of information by multiple users on automation projects.

The SCADA system shall allow certain designated individual with project administration privileges to perform various activities including but not limited to user assignments to projects, offline and online back-up of projects, project database maintenance and upgrade of projects from previous versions

The SCADA system shall allow a multi-user engineering environment providing high flexibility and efficiency for system configuration, documentation, commissioning and maintenance tasks.
Note - The SCADA system shall provide an Audit trail to enable effective management of changes. All changes to information within the automation system shall be carefully controlled to ensure all modifications are traceable and accountable.

The audit trail shall consist of any user actions which include system changes made at any engineering workstation onto a central database. These events shall be recorded onto an Historian for future audit purposes.
Users, with the applicable project administration privileges shall be capable of performing the following activities:

- Creation of System design projects
- Offline and online back-up of projects
- Project database maintenance

Upgrade of projects from previous versions

A multi-user accessible engineering platform shall be provided to attain a high level of flexibility and efficiency when doing system configuration, documentation, commissioning and maintenance. Engineering tasks shall be accessible by multiple users at any given time.

The option shall be available for an Engineer/s to reserve a complete application or some part of it for their exclusive access. This shall enable multiple users to be able to work on the same project at the same time without interfering with each other's work.

The SCADA system shall have an effective audit trail to provide effective change management. Changes within the automation system configuration shall be carefully controlled via the audit trail to ensure all modifications are traceable and accountable.

The audit trail functions shall include the tracking of user's actions, the archiving of user actions including any system changes made at any engineering workstation onto a central database.
The SCADA shall have graphical user interfaces, object-related context menus, navigation windows, help functionality and a host of other features to provide sufficient guidance to the user.

Within the engineering environment, users shall be able to navigate from a specific tag to its associated control logic diagrams/P&ID/Loop Diagram. Links to 3rd party documentation like PDF user manuals, excel reports, etc. shall also be possible.

The engineering builder tool shall allow users to build projects through a simple drag and drop application. The engineering builder tool shall make the drawing of any logical and detailed network architecture easy. It shall allow for the easy configuration of communication ports.

The engineering builder tool shall be able to do the following:

- Design and draw logical and detailed network architectures
- Do the automatic configuration of the communication ports of a project
- Publish network addresses to all reachable PC nodes
- Have access to updated design information available for the updating of the main project design
- Provide easy generation of reports and any documentation required

The SCADA system shall have a central data base for all tag information. There shall not be any replication of changes in multiple databases. The SCADA system shall allow for easy database filtering via a user friendly menu for easier and faster configuration work.

The SCADA system should be so designed to allow Engineers to be able to import and export any amount of tag data, perform automatic searches and replace operations using any type of

complex query commands. The SCADA system shall allow users to navigate directly from any tag to its related configuration document.

The SCADA system shall have the functionality to save multiple macros for future use. The SCADA system shall also have a standard library wherein function blocks (objects) can be used by simple “drag and drop” functionality for projects.

The standard library shall contain components, general layouts, loop diagrams, hook-up layouts, devices, P&I diagrams, equipment & instrumentation symbols, operation and control processing function blocks, I/O configuration, I/O lists, coding and any dimensions, etc.

The library shall also have the functionality of saving any macros, symbols, shapes, control logic templates, etc. that have been designed on previous projects.
The standard library shall also have the functionality of allowing the regular updating to this library of new function blocks, macros and code. This shall be at no extra cost to the SCADA system, but as a “self-learning” function of the library.

The SCADA system shall have standard Control Logic Templates, thus allowing for the reduction in time and costs normally associated with the implementation of a control project. The SCADA system shall allow for the functionality of designing, editing or maintaining Control Logic Templates.

The SCADA system shall have the functionality of handling large amounts of data by being able to:
Allow the import of process points and/or I/O spread sheets from which configuration can be done

- Allow the import of signal lists and their properties
- Allow the control of hardware
- Allow the assignment of I/O and the instantiation of I/O templates
- Allow the instantiation of Control Logic Templates

The SCADA system shall allow for the automatic updating to of all the above mentioned lists, using a central engineering database. SCADA systems that require the re-importing of revisions to the lists mentioned above for any changes made shall not be considered.

The SCADA system shall have the functionality of mapping. Furthermore the mapping shall be saveable for future work. The SCADA system shall have the further functionality of importing specific I/O signals for specific tasks like during the testing and commissioning phases of a project, thus not affecting the main engineering database.

The SCADA system shall have the functionality of fully supporting the configuration, testing, commissioning, maintenance and management of intelligent field and electrical devices like flow

transmitters, pressure transmitters, temperature transmitters, level transmitters, turbidity transmitters, pH transmitters, analytical transmitters, actuators, motor control centres, etc. by using Profibus, ModBus, Ethernet TCP/IP, Hart, etc. communication protocols.

The SCADA system shall have the engineering tools required for the configuration and management of intelligent devices in a graphical environment. Additional tools shall include a batch data manager for the creation, editing, managing, downloading and debugging of function code, whether batch, user-defined or in sequential configuration.

ESCA 10 SCADA HARDWARE CONFIGURATION

The server setup for the SCADA system shall encompass front and back end server/s arrangements. When clients request information (via the client access portal) to a specific folder, the front end server/s shall check the Active Directory to find a list of all the back end server/s having the information the client is searching for.
The setup for the front end and back end server/s topology shall ensure the following:

a) The Client access to requested information/folders is done on the front end server/s.
b) The front end server shall authenticate the user on an active directory.
c) The front end server shall determine firstly (without any client intervention required), in which location/folder the requested information resides and secondly on which back end server (if there are more than one back end server/s) the requested information is residing.
d) The front end server shall “learn” from each previously processed request for information, so that instead of searching the entire data base again for previously requested information, the front end server/s can go directly to the correct data base holding the required information, thus minimizing search time.
e) An algorithm shall manage the search for information on the back end server/s, whilst balancing the work load to each back end server/s.
f) If one of the back end servers is off-line, the algorithm shall divert the search request to another/other back-end server/s that also has the exact same information.
g) The algorithm shall divert all requests for information towards the remaining available back end server/s equally, thereby ensuring correct load balancing.
h) Whenever a back end server is again on-line, the algorithm shall redistribute the traffic flow evenly (load balancing) over all the available back end server/s (those holding the requested files).

The algorithm shall also regulate the workflow such that one particular back end server is not “overworked”, whilst another is hardly ever accessed.

Note: Project administrators shall inform all users if any folders/files have been removed from the back end server/s.

Dual authentication shall be required on both the front end and back end server/s.

Between the Client station and front end server, authentication is required. Authentication shall also be required between the front end and back end server/s. Basic authentication and forms-based authentication shall be acceptable, provided the contractor has reviewed the hardware/software firewall requirements
Basic authentication shall encompass the requirements for a user name and password of the user requesting folder/file access to the server, via a client access terminal. This shall be done in the following format: domain\username.

When using forms-based authentication, SSL encryption shall be required between the client access and front end server/s as well, especially where the front end server/s and back end server/s have separate subnets or use external networks. SSL shall protect user passwords from any network packet sniffing software.

Note: SSL shall be always configured on the front end server only in a front end/back end server configuration. For situations where there are only back-end servers (no front end/back end server configuration) and clients are directly accessing them, SSL configuration shall be a requirement

If there is a considerable decrease in performance due to SSL connections, a SSL accelerator shall be required to the front end and back end topology.

The type of SSL accelerator selected shall depend on the number of front end servers in your topology. If the quantities of front end servers are minimal, then the option of using SSL accelerator cards shall be acceptable due to its lower cost, effectivity to handle SSL tasks and simple installation.

For each accelerator card required, the SSL certificate of each accelerator card requires configuration and there are administrative costs as well.

If the quantities of front end servers are many, then a separate SSL accelerator device shall be required. The setup in this case shall be simpler as it only requires configuring once, no matter how many front end servers are in your setup.

Internet Protocol Security (IPSec) shall be a requirement for all communication between the front end and back end server/s setup.

The type of IPSec protocols allowed shall be Authentication Header (AH) and Encapsulating Security Payload (ESP). IP Packets of information that uses AH are not encrypted, but work by adding a checksum to the IP packet. If the checksum is identical between what was sent and what was received, then the message was delivered successfully.

ESP on the other hand works by encrypting the entire contents of the IP packet. The encryption affects the performance on both the front and back end servers, Therefore, the design to the front

and back end topologies shall take due cognizance of any degradation to performance when implementing either ESP or AH.

The perimeter network shall have a firewall server between the front end and back end servers. The firewall server shall have the latest service packs and have extremely stringent security methodologies.
The front-end server/s shall have sufficient memory and very fast CPU clock speeds. The recommended ratio of front end server to back end servers shall be 1:3. The contractor shall indicate any reasons for diverting from this ratio.

Software and/or hardware firewall solutions shall be required. The various methods of firewalls shall be through the use of port filtering, IP filtering and application filtering.
Port filtering shall be the absolute minimum Firewall requirement. Port filtering shall be used to restrict network traffic coming through the firewall and allow access to information sent via specific ports only.

IP filtering shall also be required as a Firewall requirement. This shall restrict traffic through the firewall to specific servers only.

Application Filtering shall also be used as well as a firewall to provide advanced inspection at the application protocol level. This type of firewall shall perform functions such as the filtering of Remote Procedure Call (RPC) interfaces and the validating of any HTTP request syntax applications.

ESCA 11 HISTORIAN

The function of the Historian shall be to analyse and display information in a usable, understandable and meaningful manner so that real-time business decisions can be made.

The requirements of the Historian server shall be as follows:

a) The Historian package shall be complete and already pre-configured. No additional engineering shall be allowed or required.
b) The Historian package shall be able to provide detailed statistical reports for any and every desired time frame.
c) The resolution shall be of a very high quality.
d) Historical data from all the plant equipment shall be seamlessly integrated
e) Data collection shall be event based and in real time with millisecond resolution.
f) Memory and storage requirements shall be well managed when accessing historical data
g) Statistical reports and Trend displays shall be generated on demand and within one second.
h) The Historian package shall have unlimited historical data collection
i) The Historical data reports shall be according to the following requirements:
    i. Shall have access to all historical information and real-time data quickly and

efficiently

ii. Shall have a clearly arranged event historical display with integrated trend data graphics package

iii. Shall enable complex graphics to be read and understood easily

iv. Shall enable Report configuration to be done easily by utilizing simple drag and drop interfaces

v. Shall have OPC server and client to enable easy data exchange with foreign systems

vi. Shall have life cycle management services available

ESCA 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

ESCA 12.1 Supply and Delivery to Site

Pay Item	**Unit**
a) Supply and delivery to site of SCADA system associated hardware, installed as per design requirements and best practice, all as specified.	Sum
b) Supply and delivery to site of SCADA system associated software, installed as per design requirements and best practice, all as specified.	
c) Supply and delivery to site of SCADA UPS	Sum

ESCA 12.2 Installation

Pay Item	***Unit***
a) Installation of SCADA system associated hardware and software, installed as per design requirements and best practice, all as specified	Sum
b) Engineering and configuration of SCADA system associated hardware and software.	Sum
c) Installation of SCADA UPS	Sum

ESCA 12.3 Commissioning

Pay Item	***Unit***
a) Commissioning of SCADA system associated hardware and software, installed as per design requirements and best practice, all as specified	Sum
b) Commissioning of SCADA system associated hardware and software, installed as per design requirements and best practice, all as specified	Sum
c) Commissioning of engineering and configuration of SCADA system associated hardware and software.	Sum
d) Commissioning of SCADA UPS	

END OF SECTION

ECIS CONTROL AND INSTRUMENTATION SYSTEMS

INDEX

ECIS CONTROL AND INSTRUMENTATION SYSTEMS

ECIS 1 SCOPE OF WORKS

As specified in the Project Specifications.

ECIS 2 PRESSURE TRANSMITTERS

The pressure transmitters shall be pipe socket mounted and shall constantly display the relevant pressure and shall be easy to calibrate and reliable in service.

The pressure sensor shall have a ceramic diaphragm with electrodes in the ceramic substrate and diaphragm. A pressure proportional change in the capacitance shall be measured by the electrodes and displayed as the measuring pressure value.

The pressure sensor shall comply with the following technical requirements

Application	-	Measuring of absolute and gauge pressure in liquids
Measuring technique	-	Deflection of diaphragm
Measuring range	-	As specified in Variations and Additions to General and Particular Specifications
Construction	-	304 Stainless Steel housing
Mounting	-	½" pipe socket mounted
Pressure		16 bar or as required for application
Voltage	_	0 – 30VDC
Output	-	4 – 20mA
Accuracy	-	+/_ 0.2%
Reproducibility	-	+/_ 0,3%
Long term drift	-	+/_ 0,1% per year
Protection	-	IP 68

Display	-	Plug in display unit
Sensor cable	-	Screened transposed two-wire cabling

ECIS 3 FLOW METER EQUIPMENT

Flow meters will be supplied and installed by the mechanical contractor if not otherwise indicated. The flow meter controllers as free issue items will have to be installed under this contract in flow meter kiosks complete with a supply of electricity, surge protection and earthing system.

ECIS 4 ELECTRONIC LEVEL CONTROL

The micro based electronic controllers which will be mounted in the motor control centres or as specified and shall be easy to calibrate and reliable in service.

The transducers shall be designed to operate in air, been capsulated, of rugged construction and impervious to submergence.

The transducers shall, where possible, be installed at a point 500mm away from a wall or pipe, which may cause a false signal, and at least 500mm above maximum water level.

The coaxial cable between the transducer and power unit shall be of sufficient length to avoid any joints in this cable, as no joints will be permissible.

The grade 304 stainless steel brackets for mounting of level transducer must be provided and installed under this contract.

ECIS 5 NO-FLOW SWITCHES

The electromagnetic flow monitor shall be pipe socket mounted and shall be easy to calibrate for specific no-flow conditions and shall be reliable in service.

The no-flow sensor shall be steel pipe mounted and shall be supplied complete with a weld stub to ensure correct immersion into the measuring liquid. The weld stub shall be adapted according to the flow measuring pipe diameter.

The no-flow sensor shall comply with the following technical requirements:

Application	-	Measuring of no-flow condition in water pipe lines for pump set protection

Measuring technique	-	The flow sensor shall adopted the electro-magnetic principle of flow velocity measurement at the tip of the no-flow sensor
Measuring range	-	As specified in Variations and Additions to General and Particular Specifications
Construction	-	Die-cast aluminium housing, epoxy coated
Mounting	-	Weld stub mounted
Voltage	_	0 – 30VDC
Output	-	4 – 20mA
Accuracy	-	+/_ 2%
Reproducibility	-	+/_ 2%
Conductivity	-	≥20µS/cm
Protection	-	IP 66 / NEMA 4X / Type 4X
Settings	-	Potentiometer adjustment

ECIS 6 FREE CHLORINE ANALYZER

The free chlorine analyser shall be an enclosed unit with front door mounted free chlorine content display unit with storage space for reagent. The unit shall be wall mountable.

The analyser shall sample every 2,5 minutes and shall use less than 475mL each of indicator and buffer over a 30 day period. A linear peristaltic pump, seal-free mixer, easy-to-clean cell and compact colorimeter shall provide a reliable low maintenance operation.

The analyser shall be equipped with a programmable 4-20mA recorder output and two user selectable alarms and shall be installed on a 230 Volt supply system.

The mixing system shall operate with no moving parts and a self-cleaning stir bar in the sample chamber shall generate a vigorous mixing action for accurate sample analysis. A transparent gasket shall occupy the space between the light source, sample chamber and detector. The optically clear RTV silicon light pipes shall transmit the colorimetric beam and minimize the risk of interference caused by high levels of humidity.
The measuring range shall be 0 to 5 mg/L free or residual chlorine.

Accuracy shall be +/- 5% or +/- 0.035mg/L, whichever is the greater.

The analyser shall be supplied with a three months' supply of reagent

ECIS 7 PH SENSOR

The ph sensor shall be of the pipe insertion mounted type with an LCP body glass electrode and titanium ground rod.

The instrument shall have a pH measuring range of 0 – 14 and temperature range of -5 to 95°C. The sensor shall be rated to withstand a pressure of 6 bar.

The sensor shall have a sensitivity of less than 0.005pH and shall have three measuring electrodes, a standard and process electrode as well as a ground electrode. If necessary, a digital gateway shall be provided with the pH sensor for communication with the same controller as the turbidity sensor.

ECIS 8 TURBIDITY SENSOR FOR LOW TO MEDIUM RANGE TURBIDITY MEASUREMENTS

ECIS 8.1 Turbidity sensor

The Turbidity sensor shall have a pulsed infrared source in conjunction with an automatic cleaning process and shall be a precision bypass sensor suitable for ultra-clear media to media with medium turbidity due to the particular low level of light interference.

The sensor enclosure shall have an IP 65 rating and shall be separately mountable from the controller up to a distance of 50m. Sensor to controller connection cable shall be provided with the sensor unit. The sensor shall be reconcilable with the existing turbidity and pH controllers installed on the plant.

The turbidity sensor shall comply with the following technical specifications:

Measuring technique	-	90° scattered infrared light in accordance with DIN EN ISO 7027
Measuring range	-	0.0001 – 1000 NTU
Precision	-	+/_ 1%
Reproducibility	-	+/_ 0,5%
Air bubble compensation	-	Physical-mathematical

Sample size required	-	Min. 0,2l/min, max. 1l/min. max. 6 bar
Ambient temperature	-	Max. 40° C
Automatic cleaning	-	Wiper cleaning
Materials	-	Quartz measuring window, silicone wiper profile, Noryl GFN2 measuring chamber, ASA housing and stainless steel wiper axle.
Sensor cable	-	+/_ 5m length

ECIS 8.2 Turbidity controllers

The turbidity controller shall be a product from the same manufacturer as the turbidity sensor and shall be capable of receiving data from two sensor units and shall communicate with a PLC by means of RS485/MODBUS protocol. The controller shall be microprocessor-based and housed in a ½ DIN, NEMA 4X enclosure with an IP rating of IP66.

Multiple control functions shall include built-in PID, control contacts and alarm functions.

The turbidity sensor shall comply with the following technical specifications:

Ambient conditions	-	-20°C to 40°C, 0 – 95% relative humidity and non-condensing
Power requirements	-	230V AC
Display	-	Graphic dot matrix LCD, 128 x 64 pixels with LED backlighting
Relays	-	Three SPDT user configurable contacts rated 230V AC 5Amp.
Outputs	-	Two analog 4-20mA
Control	-	PID, high/low phasing, set point, dead band, overfeed timer, off and on delay
Communication	-	RS485 MODBUS
Memory	-	Non-volatile setting memory
Mounting	-	Wall mounting

Certifications - ETL to UL 6101A-1 and CSA C22.2 No. 1010.1

ECIS 9 ROTATING BRIDGE BRUSH GEAR

The brush gear to be installed on the kingpost on the bridge at the centre of the tank to facilitate connections between the incoming supply cable and the cable from the kingpost to the motor starter via the rotating arm shall consist of the following:

- A set of four 20 mm wide and three 8 mm wide brass slip rings on an ebonite or equivalent insulating sleeve (i.e. three slip rings or phase connections, one for the earth connection, three slip rings for the control circuit, namely, start, common and stop connections). Connections to these slip rings shall be effected via an approved heavy duty terminal block with stud type brass terminals onto which the lugs on the cable tails shall be bolted. This terminal arrangement shall be completely independent of fixing screws for the slip rings.
- A set of four main circuits and three control circuit "Morganite" carbon brushes, or equivalent. Each of these brushes shall be spring-loaded to ensure high contact pressure and the springs shall be rust-proofed.

The abovementioned brush gear shall be installed in a weatherproof IP55 grade UV protected and impact proof synthetic housing with removable cover, on the kingpost of the bridge. This brush gear-housing shall be suitably sized to accommodate the relevant equipment without cramping, and shall be insect proofed.

The brush gear housing shall be designed and constructed to prevent the accumulation of gas and the condensation of moisture inside the housing and the pressure of the brushes on the slip rings shall be high enough to obtain a self-cleaning effect during operation.

The driving motor must be provided with a weatherproof emergency stop push button station mounted on the bridge in close proximity to the bridge access ladder. The supply and installation of cables between the motor, emergency push button station, brush gear and kingpost, shall form part of this Contract. The cable shall be installed in a grade 304 stainless steel conduit mounted on the underside of the bridge and secured to the bridge by means of stainless steel conduit saddles.

ECIS 10 SURGE PROTECTION – ELECTRONIC DEVICES

The section is to be read in conjunction with the Particular Specifications of Electrical distribution systems.

Electronic equipment shall be adequately protected on both the incoming and outgoing terminals by means of suitable arrestors compatible with the relevant equipment. 4-20mA signal cables shall be protected on both sides of the cable against surges.

Surge protection shall be provided as specified at flow meters, level sensors and other electronic instruments.
The following surge arrestors shall be supplied and installed for surge protection complete with base element.

ECIS 10.1 Flow meters, level sensors and electronic instruments (4-20ma)

A combined lightning current and surge arrester module with Din rail mounted base and removable surge arrester module. The surge arrestors shall be of sufficient voltage rating and shall withstand a total discharge current of 8/20 magnitude and 20kA rating and a total impulse current of 10/350 magnitude.
At flow meter and level sensor position as well as at the termination point in the MCC/DB)

ECIS 10.2 Earthing at flow meters and level sensors

Apart from earthing already specified the following earthing system shall form part of the installations.

ECIS 10.2.1 At flow meter and level sensor

The earth connection and surge arrestor earth at the flow meters/level sensors shall be connected to an earth mat comprising of 70mm² bare copper conductors installed in a cross configuration with the earth mat centre Cad welded to the 16mm² earth connection at the flow meter. The cross radial shall be at least 2m long with the radial ends connected to a 1,5m long earth spike driven into the ground at each end.

ECIS 10.2.2 Outdoor connection boxes at level sensors and flow meters

The outdoor type connection boxes required at flow meters and level sensors positions for cable connections to surge arrestors shall be equal and similar to the following:

Raised lid type with IP65 rating and equipped with mounting rail for surge arrestors and Teflon compression glands for unarmoured cables and brass compression glands for armoured cables.

All cables in manholes and valve chambers shall be mounted on heavy-duty cable racks.

ECIS 11 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions *in triplicate*, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide *3 x "soft copies"* of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

ECIS 12 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

a) Wiring diagrams.
b) General layouts and Schematic single line diagrams.
c) Elevations showing dimensional information including details such as, but not limited to, the following:
    - height (less any removable lifting angles or eyes)
    - widths
    - depth
d) Structure descriptions showing the following:
    - Other information as required for approval.
e) Conduit locations
f) Unit descriptions
g) Nameplate information
h) Manufacturer drawings shall be provided in PDF format
i) Data sheets and publications on all major components including, but not limited to, the following:

- Instrumentation
- Pipe connections
- Instrumentation
- Additional comments required
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

ECIS 13 MEASUREMENTS AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below.

ECIS 13.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For control and instrumentation, design information shall include, but limited to as listed in this Particular Specifications.

Pay Item		***Unit***
(a)	The Contractor will provide the general layout drawings and wiring diagrams of the enclosure and instrumentation for approval to the Engineer.	Sum
(b)	Provide operating and maintenance manuals, data sheets of all equipment and “as built” drawings	Sum

ECIS 13.2 Supply And Delivery To Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For control and instrumentation, the rate tendered shall be for the complete control and instrumentation and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications.

Pay Item		***Unit***
(a)	Supply and delivery to site respectively one of the following instruments: a) pressure transmitter, b) differential pressure transducers, c) temperature transmitters, d) no flow sensors, e) pH sensors, f) chlorine	Each

	analyzers, g) turbidity analyzers and, kiosk, controller [if required] and electrical equipment complete as specified	
(b)	Supply and delivery to site of a level transducers, controller [if required] and electrical equipment complete with mounting brackets as specified	Each
(c)	Supply and delivery to site respectively one of the following flow meter instruments: a) ultra-sonic flow meter, b) turbine flow meter, c) magnetic flow meter and d) Thermal flow meter with kiosk, controller [if required] and electrical equipment as specified	Each

ECIS 13.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of Programmable Logic Controllers system shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the PLC system complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of Programmable Logic Controller System but not limited to.

Pay Item		***Unit***
(a)	Site installation of respectively one of the following instruments: a) pressure transmitter, b) differential pressure transducers, c) temperature transmitters, d) no flow sensors, e) pH sensors, f) chlorine analyzers, g) turbidity analyzers and, kiosk, controller [if required] and electrical equipment complete as specified	Each
(b)	Site installation of a complete level transducers, controller [if required] and electrical equipment complete with mounting brackets as specified	Each
(c)	Site installation of respectively one of the following flow meter instruments: a) ultra-sonic flow meter, b) turbine flow meter, c) magnetic flow meter and d) Thermal flow meter with kiosk, controller [if required] and electrical equipment as specified	Each

ECIS 13.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply

with the requirements of SABS and IEC standards and applicable portions of "Standards of commissioning".

Pay Item		***Unit***
(a)	Commissioning of respectively one of the following instruments: a) pressure transmitter, b) differential pressure transducers, c) temperature transmitters, d) no flow sensors, e) pH sensors, f) chlorine analyzers, g) turbidity analyzers and, kiosk, controller [if required] and electrical equipment complete as specified	Each
(b)	Commissioning of a complete level transducers, controller [if required] and electrical equipment complete with mounting brackets as specified	Each
(c)	Commissioning of respectively one of the following flow meter instruments: a) ultra-sonic flow meter, b) turbine flow meter, c) magnetic flow meter and d) Thermal flow meter with kiosk, controller [if required] and electrical equipment as specified	Each

END OF SECTION

EG&M GENERAL AND MISCELLANEOUS

INDEX

EG&M GENERAL AND MISCELLANEOUS

EG&M 1 STANDARDS

The following standards, regulation and drawings, etc. shall be applicable to the electrical installations related to this particular specification, whereas the latest applicable South African Bureau of Standards Codes and Standards should be used;

Standard No.	Description
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 1063	Earth rods and couplers
SANS 1213	Mechanical cable glands
SANS 1433-1	Electrical terminals and connectors Part 1: Terminal blocks having screw and screwless terminals
SANS 1433-2	Electrical terminals and connectors Part 2: Flat push-on connectors
SANS 10142	Code of Practice for the wiring of Premises
SANS 10199	The design and installation of an earth electrode
SANS 10292	Earthing of low-voltage distribution systems
SANS 10313	Protection against lightning - Physical damage to structures and life hazard
SANS 60947-5-2	Low-voltage switchgear and control gear Part 5-2: Control circuit devices and switching elements - Proximity switches

EG&M 2 GENERAL REQUIREMENTS

EG&M 2.1 Laws, Regulations and Codes of Practice to be Observed

The work shall be carried out strictly in accordance with the following laws and regulations where applicable;

a) The latest edition of "Code of Practice for the Wiring of Premises", SANS 10142, as amended;
b) Occupational Health and Safety Act (Act No. 85 of 1993);
c) The "Electricity Supply By-Laws and Regulations" of the Local Supply Authority;
d) The local Fire-Office Regulations;
e) The Requirements of the Department of Communications;
f) The Acts and Regulations applicable to the use of explosives;
g) "The Code of Practice for the Installation and Maintenance of Electrical Equipment used in Explosive Atmospheres"

The Contractor will be responsible for serving all notices and paying all fees due in terms of the above laws and regulations.

EG&M 2.2 Radio and TV Interference

All equipment installed under this Contract shall comply with the Government Notice No. R.2246 and any other applicable rules and regulations in respect of radio and TV interference. Any equipment found producing interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any additional cost.

EG&M 2.3 Interchangeability

All equipment must be manufactured to such close tolerances that all similar components and spares must be fully interchangeable without any further alterations or adjustment being necessary.

EG&M 2.4 Water and Debris Accumulation

All outdoor equipment shall be designed so that water and debris will not readily accumulate to cause deterioration of equipment or an electrical discharge hazard. Where this cannot be avoided, such places shall be easily accessible for cleaning.

EG&M 2.5 Colour and Finishing

All metal parts of equipment shall either be finished in baked enamel or powder coating or galvanized (depending on the circumstances) after manufacture and treatment to SANS 064.

Colours of paint to be used shall be confirmed with the Engineer prior to application.

All steel areas subjected to corrosive atmospheres must be hot dip galvanized. The galvanizing must be clean, smooth, of uniform thickness and unblemished. The galvanizing must not affect the mechanical properties of the covered metal.

All drilling, welding, cutting and bending must be complete and the metal must be cleaned of any machining blemishes, mill scale, rust and lubricants before galvanizing. If site trimming, drilling and cutting cannot be avoided then all such denuded surfaces must be dressed with a cold galvanizing paint.

The Engineer must approve any other proposed corrosion protection before it is applied.

Galvanized areas must be kept free of lubricants.

Wire must be galvanized.

EG&M 2.6 Inspections And Tests

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection and all safety clothing prescribed by the Engineer.

The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

The cost of all tests must be included in the tender price.

EG&M 2.7 Performance Tests

On completion of erection and installation the Contractor must carry out the following tests, where applicable, in addition to any other tests, which may be specified elsewhere:

Before commissioning:

- Cable Insulation test.
- Earth continuity test.
- Tests for correct direction of rotation of motors and reverse if necessary.
- Test for correct operation of control gear, setting of overload protection equipment, etc.
- The Contractor must obtain SABS test certificates for samples of insulating oil in HT switchgear and transformers. These certificates must be submitted to the Engineer.

On completion of installation and putting into proper operation all the plant and equipment, the Contractor will be required to make suitable arrangements for the testing of all plant and equipment supplied under this Contract and running the plant for at least one week, during which time he shall also train all the operators in the correct running of the plant. He shall also explain the maintenance manuals to the operator during this time.

The entire cost of testing, including supply of test equipment, must be borne by the Contractor and an adequate allowance for such tests must be made in the Tendered price.

EG&M 2.8 Operating And Maintenance Instructions

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions.

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

The format for the operating and maintenance manual is described in detail elsewhere in this document.

N.B. The prices Tendered in the Schedule of Prices will be held to include for the supply of these operating and maintenance instructions.

EG&M 2.9 Spares

Tenderers shall submit on the appropriate Schedule in this document a list of spare parts and special tools, which is recommended and should be kept by the Employer for maintenance of the plant. Spares, which the Employer decides to order, must be manufactured simultaneously with the rest of the equipment and be subjected to the same tests for dimensions, tolerances, strength, etc. All spares and special tools must be packed separately and the cases appropriately marked. All spares and special tools must be new and unused and where possible should be standard to all sections of the plant.

EG&M 2.10 Labels And Inscriptions

The standard labels on equipment regarding the manufacturer, type, class, rating etc., shall be accepted unchanged.

Engraved laminated plastic labels shall however be provided to indicate a numbering system for relays, fuses, links, lights and selector and control switches and shall correspond to the wiring diagram numbering system. These labels shall be fixed with screws, bolts or rivets.

EG&M 2.11 Name Tags

Identification tags shall be attached to all equipment, sub-assemblies, components such as instruments, fuses etc., cable ends etc. The tags shall be screwed on with brass or plated steel screws (no self-tapping screws will be permitted). Where it is not possible to use screws such as on the cables, other means of attachment must be submitted for approval to the Engineer.

Cables shall be tagged at either end, whether the end terminates in a distribution board or an end box.

All cable cores and internal panel wiring shall be identified at both ends by means of durable colour coded wire marking ferrules in accordance with numbering systems in cable and wiring diagrams. Only closed ring interlocking type identification ferrules shall be used.

Outdoor tags shall be of stainless steel or brass type.

Tags mounted indoors or protected by an enclosure shall be made of Ivorene or similar sandwich material with black letters on a white background.

All lettering and text shall be approved by the Engineer.

Letter sizes must be compatible with the application, e.g.

For fuses, terminals, relays etc	3 to 5 mm
For panels or cubicles	12 to 20 mm
For switchboard or MCC board names	about 50 mm
For building or structure names	about 80 mm

EG&M 3 EMERGENCY STOP PUSH BUTTONS AND WEATHERPROOF ISOLATORS

Each of these units shall consist of a totally enclosed outdoor type heavy duty "push and turn to lock" stop push button station with a cable gland entry at the bottom to accommodate a 4 core 2,5mm² LT PVC SWA PVC cable.

This push button station and weatherproof isolator shall be mounted on a rigid 1meter high grade 304 stainless steel pedestal with 2mm radius rounded edges, designed to be bolted to a concrete floor. (Refer to the relevant drawing.)

An emergency stop push button station shall be installed near the coupling between each motor and its associated pump and shall be connected to the relevant starter panel via the specified cable to stop the motor.

The pedestal shall be securely bolted to the floor by means of stainless steel foundation bolts grouted into the concrete and care shall be taken to ensure that it is installed plumb.

Emergency stop pedestals for submersible pump sets shall be large enough to accommodate a motor cable termination box to facilitate submersible motor cables on DIN rail mounted termination blocks

EG&M 4 CONDUCTOR ENDS

EG&M 4.1 Numbering Of Conductor Ends

Every conductor end whatsoever, with the exception of AC power cables at any terminal shall be numbered.
These numbers shall correspond with those on the circuit diagram and shall consist of the slip on type numbering system (clipped on numbering system will not be accepted). It shall not be possible to remove the number holder without damaging it or cutting off the lug.

EG&M 4.2 Connection Of Conductor Ends

All conductors whatsoever shall be connected at terminals by means of lugs and/or ferrules suitable for the specific conductor and terminal.

EG&M 5 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 10142.

EG&M 6 LIGHTNING PROTECTION

EG&M 6.1 Plant

The lightning protection of the lighting structures, poles and plant of the works, including all the buildings and handrails on the new plant, form part of this contract.

The lightning protection must be a SABS approved scheme and SABS approved drawings of the scheme must be submitted to the Engineer.

EG&M 7 SURGE PROTECTION

Tenderers shall allow in their Tender prices for adequate protection of the equipment supplied and installed under this contract against direct as well as induced voltage surges and spikes which may be experienced on the system.

Surge arrestors shall be provided on each phase as well as neutral on the incoming power supply terminals of each board.

All arrestors shall be connected directly to earth along the shortest possible route and only conductors of adequate rating for the discharge currents catered for shall be used for connections to arrestors.

Tenderers shall submit full particulars of the arrestors offered as well as written confirmation that it will provide adequate protection for the relevant equipment against possible voltage surges and spikes on the system.

EG&M 7.1 Surge Protection Units

The following surge arrestors shall be supplied and installed for surge protection complete with base element.

EG&M 7.1.1 *Main Supply Protection*

Single Din rail mounted mains surge arrestors shall be supplied and installed for each phase and neutral conductor of an electrical board. The surge arrestors shall be of sufficient voltage rating and shall withstand a max discharge current of 8/20 magnitude and 40kA rating.

EG&M 8 NOTICES AND DANGER PLATES

EG&M 8.1 Scope

This specification deals with the provision of Notices and Danger Plates as required in terms of the Occupational Health and Safety Act No. 85 of 1993, as well as any other notices that may be required by law or by the nature of the finished Works.

The following standard specifications are referred to in this specification: -

- SANS 10140; Parts I to IV: Identification colour marking.
- SANS 1186: Symbolic safety signs.
- Occupational Health and Safety Act No 85 of 1993

EG&M 8.2 Materials and Finish

Outdoor signs shall be either of vitreous enamelled type or of cast aluminium with raised or embossed letters.

Indoor notices shall be of non-deteriorating plastic, Perspex or fiberglass.

The colours and sizes of letters and colours of background shall be in accordance with requirements of SANS 0140 and as approved by the Engineer.

Symbolic signs shall conform to the requirements of SANS 1186.
Signs shall be pre-drilled for fixing.

All fixing accessories shall be of non-corrosive material.

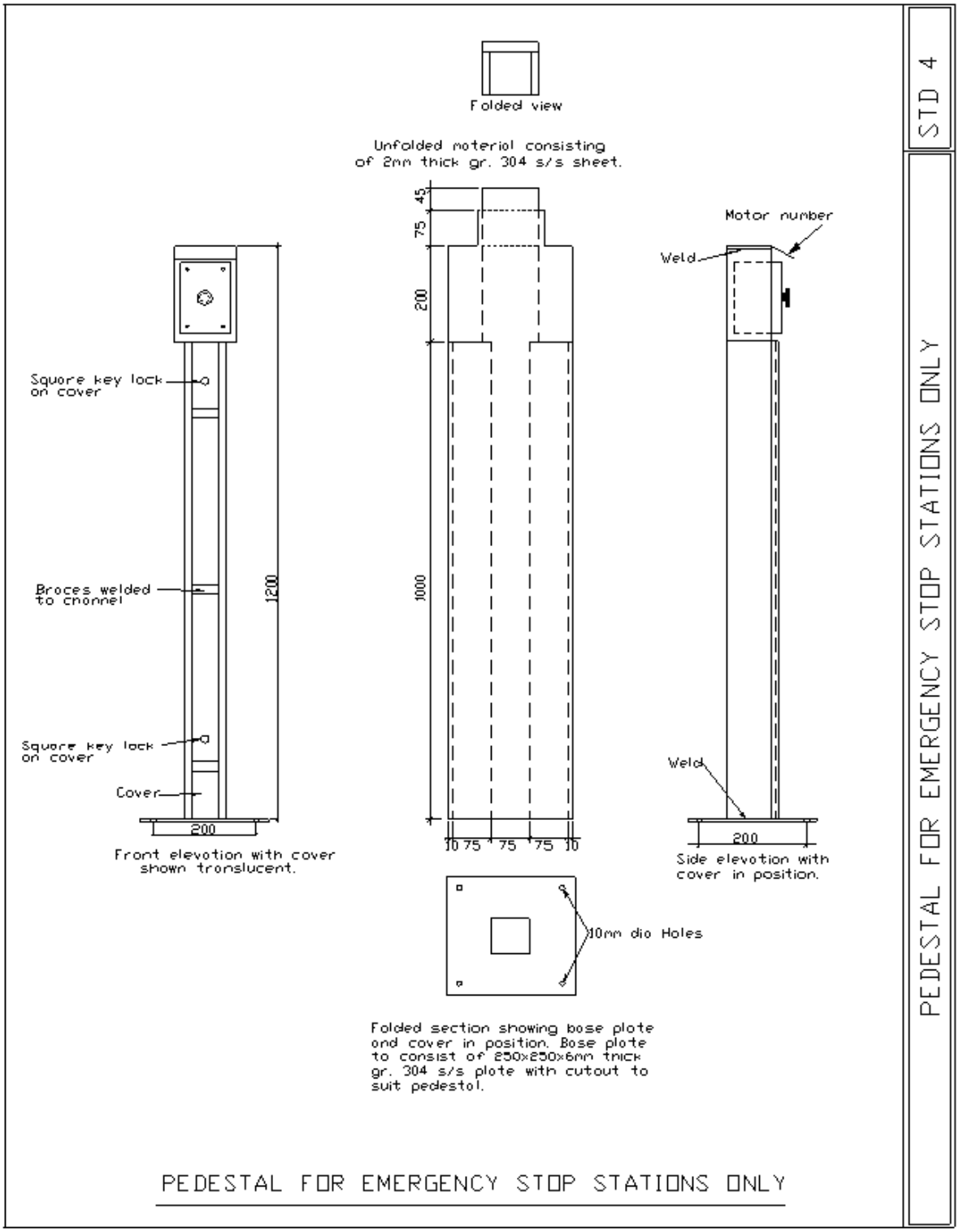
EG&M 8.3 Installation and Erection

The Contractor shall supply and fix permanently in position the signs and notices required by law for all the relevant working areas of the Works. The Engineer shall as prescribed by the relevant Regulations and as agree positions of signs.

EG&M 9 FIRE EXTINGUISHERS

5kg CO2 and powder fire extinguishers shall be supplied and installed in all pump stations and treatment plant buildings in accordance with the requirements of the Local Authority.

EG&M 10 PEDESTAL FOR EMERGENCY STOP AND START STATIONS ONLY



EG&M 11 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions *in triplicate*, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide *3 x "soft copies"* of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

EG&M 12 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

a) Wiring diagrams.
b) Schematic single line diagrams.
c) Elevations showing dimensional information including details such as, but not limited to, the following:
   - E-stop and notices height (less any removable lifting angles or eyes)
   - E-stop and notices height width
   - E-stop and notices height depth
d) Structure descriptions showing the following:
   - Other information as required for approval
e) Conduit locations
f) Unit descriptions
g) Nameplate information
h) Manufacturer drawings shall be provided in PDF format
i) Data sheets and publications on all major components including, but not limited to, the following:

- Pilot devices
- Relays
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

EG&M 13 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EG&M 13.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For general and miscellaneous, design information shall include, but limited to as listed in this Particular Specifications.

	Pay Item	***Unit***
(a)	Provide general layouts drawings, notice drawings and wiring diagrams of the for approval.	Sum
(b)	Provide operating and maintenance manuals, data sheets of all equipment and “as built” drawings	Sum

EG&M 13.2 Supply And Delivery To Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For general and miscellaneous, the rate tendered shall be for the complete general and miscellaneous and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications.

	Pay Item	***Unit***
(a)	Supply and delivery to site of emergency stop station [Refer to EG&M 10]	Each
(b)	Supply and delivery to site of emergency stop station with built in motor cable termination box [Refer to EG&M 10]	Each
(c)	Supply and delivery to site of fire extinguishers	Each

(d)	Supply and delivery to site of all notices as may be required and specified	Sum
(e)	Supply and delivery to site of all earthing requirements in terms of hand rails and building lightning protection as required and specified	Sum

EG&M 13.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of general and miscellaneous equipment shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the general and miscellaneous complies with the requirements and serves the intended purposes. Comply with the requirements of OHSA, SABS and IEC standards and applicable portions of "Standard of Installation", for installation of general and miscellaneous but not limited to.

Pay Item		***Unit***
(a)	Site installation of a complete emergency stop station [Refer to EG&M 10]	Each
(b)	Site installation of a complete emergency stop station with built in motor cable termination box [Refer to EG&M 10]	Each
(c)	Site installation of a complete fire extinguisher	Each
(d)	Site installation of a complete all notices as may be required and specified	Sum
(e)	Supply and delivery to site of all earthing requirements in terms of handrails and building lightning protection as required and specified	Sum

EG&M 13.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

(a)	Commissioning of a complete emergency stop station [Refer to EG&M 10]	Each

(b)	Commissioning of a complete emergency stop station with built in motor cable termination box [Refer to EG&M 10]	Each
(c)	Commissioning of a complete fire extinguisher	Each
(d)	Commissioning of all notices as may be required and specified	Sum
(e)	Commissioning of all earthing requirements in terms of handrails and building lightning protection as required and specified	Sum

END OF SECTION

EPTM: TELEMETRY SYSTEM

CONTENTS

EPTM TELEMETRY SYSTEM

EPTM 1 SCOPE OF WORKS

As specified in the Project Specifications.

EPTM 2 STANDARDS AND TESTS

The motor control centres shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply;

Standard No.	Description
SANS 10142	Code of Practice for the wiring of Premises
EMCC	Particular Specifications for Motor Control Centres and Distribution Boards
EELP	Earthing and Lightning Protection
ETSI EN 301 489-4 V1.4.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services;
ETSI EN 300 019-1-1 V2.1.4	Classification of environmental conditions; Storage. Class 1.2, weather protected;
ETSI EN 300 019-1-2 V2.1.4	Classification of environmental conditions; Transportation. Class 2.3, public transportation;
ETSI EN 300 019-1-3 V2.1.2	Classification of environmental conditions; Stationary use at weather protected locations. Class 3.2, partly temperature controlled locations;
ETSI EN 300	Classification of environmental conditions; Stationary use at non-weather protected locations;
ETSI EN 300 132-2 V2.1.2	Equipment Engineering (EE); Power supply interface at the input to telecommunication equipment; Part 1: Interface operated by Direct Current (DC);
ETSI EN 302 217-1 V1.1.1	Overview and system-independent common characteristics;
ETSI EN 302 217-2-1 V1.1.1	System-dependent requirements for digital systems operating in frequency bands where frequency co-ordination is applied;
ETSI EN 302 217-2-2 V1.1.1	Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for digital systems operating in frequency bands where frequency co-ordination is applied;

Standard No.	Description
CENELEC EN 60950	Safety of information technology equipment;
CENELEC EN 60215	Safety requirements for radio transmitting equipment;
CENELEC EN 60825-1	Safety of laser products, Part 1: Equipment classification, requirements and user's guide;
CENELEC EN 60825-2	Safety of laser products, Part 2: Safety of optical fibre communication systems;
ITU-R Rec. F.746-7	Radio-frequency channel arrangements for fixed service systems;
ITU-R Rec. F.1099-3	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the 5 GHz (4 400-5 000 MHz) band;
ITU-R Rec. F.383-7	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band
ITU-R Rec	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band
ITU-R Rec. F.385-8	Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band
ITU-R Rec. F.386-6	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the 8 GHz band
ITU-R Rec. F.387-9	Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band
ITU-R Rec. F.497-6	Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band;
ITU-R Rec. F.636-3	Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band
ITU-R Rec. F.595-8	Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz band
ITU-R Rec. F.637-3	Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band
ITU-R Rec. F.748-4	Radio-frequency channel arrangements for radio-relay systems operating in the 25, 26, and 28 GHz bands

Standard No.	Description
ITU-R F.1520-2	Radio-frequency arrangements for systems in the fixed service operating in the band 31.8-33.4 GHz
ITU-R Rec. F.749-2	Radio-frequency channel arrangements for radio-relay systems /+ operating in the 38 GHz band
ITU-R Rec. F.750-4	Architectures and functional aspects of radio-relay systems for synchronous digital hierarchy (SDH)-based network
ITU-T Rec. G.703	Physical/electrical characteristics of hierarchical digital interfaces
ITU-T Rec. G.823	The control of jitter and wander within digital networks which are based on the 2048 Kbit/s hierarchy
ITU-T Rec. G.825	The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)
ITU-T Rec. G.826	Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate
ITU-T Rec. G.828	Error performance parameters and objectives for international, constant bit rate synchronous digital paths
ITU-T Rec. G.921	Digital Sections based on the 2048 Kbit/s hierarchy
ITU-T Rec. G.957	Optical interfaces for equipment and systems relating to the synchronous digital hierarchy
ITU-T Rec. G.958	Digital line systems based on the synchronous digital hierarchy for use on optical fibre cable
ETSI TR 101 036-1 V1.3.1	Fixed Radio Systems; Point-to-point equipment; Generic wordings for standards on digital radio systems characteristics; Part 1: General aspects and point-to-point equipment parameters
CEPT/ERC Rec. 74-01 E	Spurious Emissions
CEPT/ERC Rec 14-01 E	Radio-frequency channel arrangements for high capacity analogue and digital radio relay systems operating in the band 5925 MHz – 6425 MHz
CEPT/ERC Rec 14-02 E	Radio-frequency channel arrangements for medium and high capacity digital radio relay systems operating in the band 6425 MHz – 7125 MHz
CEPT/ECC Rec 02-06	Preferred channel arrangement for digital fixed service systems operating in the frequency range 7125-8500 MHz

Standard No.	Description
CEPT/ERC Rec. 12-06 E	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.7 – 11.7 GHz
CEPT /ERC/REC 12-02	Harmonised radio frequency channel arrangements for analogue and digital terrestrial fixed systems operating in the band 12.75 GHz to 13.25 GHz
CEPT/ERC/REC 12-07 E	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the bands 14.5 - 14.62 GHz paired with 15.23 - 15.35 GHz
CEPT/ERC/REC 12-03	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 17.7 GHz to 19.7 GHz
CEPT T/R 13-02	Preferred channel arrangements for fixed services in the range 22.0-29.5 GHz
IEC 297-2	Dimensions of mechanical structures of the 486.6 mm (19 in) series: Cabinet and pitches of the rack structures
IEC 297-3	Dimensions of mechanical structures of the 486.6 mm (19 in) series: Sub-rack and associated plug in units”
IEC 60169-16	Radio-frequency connectors. Part 16: R.F. coaxial connectors with inner diameter of outer conductor 7 mm (0.276 in) with screw coupling - Characteristic impedance 50 ohms (75 ohms)
IEC 60169-29	Radio-frequency connectors - Part 29: Miniature R.F. coaxial connectors with screw-, push-pull and Snap-on coupling or slide-in rack and panel applications; Characteristic impedance 50 ohms
IEC 60603-7	Connectors for electronic equipment - Part 7-1: Detail specification for 8-way, shielded free and fixed connectors with common mating features, with assessed quality
IEC 60835-2-8	Methods of measurement for equipment used in digital microwave radio transmission systems - Measurements on terrestrial radio-relay systems - Adaptive equalizer
IEEE 802.3	Carrier Sense Multiple Access with Collision Detection
FCC 47 CFR Part 101	Fixed Microwave Services
SRSP – 305.9	Technical Requirements for Line-of-sight Radio Systems Operating in the Fixed Service in the Band 5915 – 6425 MHz

Standard No.	Description
SRSP – 306.4	Technical Requirements for Line-of-sight Radio Systems Operating in the Fixed Service in the Band – 6425 – 6930 MHz
SRSP – 307.1	Technical Requirements for Fixed Line-of-Sight Radio Systems Operating in the Band 7125-7725 MHz
SRSP – 307.7	Technical Requirements for Fixed Line-of-sight Radio Systems Operating in the Band 7725-8275 MHz
SRSP – 310.7	Technical Requirements for Fixed Line-of-sight Radio Systems Operating in the Band 10.7-11.7 GHz
NRFP-18	ICASA National Radio Frequency Plan

EPTM 3 RADIO AND TV INTERFERENCE

All equipment installed under this Contract shall comply with the Government Notice No R.2246 and any other applicable codes, rules and/or regulations in respect of radio and TV interference.

Any equipment found producing interference subsequent to commissioning, shall be suppressed or replaced to the satisfaction of the Engineer without any additional cost

The National Radio Frequency Plan-208 allocates the Radio Frequency Spectrum to Radio Services in the Frequency Bands between 8.3 kHz and 3000 GHz. The Contractor will include his price all frequency assignments which shall be in accordance national radio frequency plan and shall be registered.

EPTM 4 PRE – MANUFACTURE SUBMITTALS

EPTM 4.1 Manufacturer Drawings

Telemetry outstations elevations showing dimensional information including details such as, but not limited to, the following:

1. Telemetry outstation height (less any removable lifting angles or eyes);
2. Telemetry outstation width;
3. Telemetry outstation depth;
4. Location of shipping splits;
5. Dimensions.

EPTM 4.2 Structure Descriptions Showing the Following

1. Rating of equipment;
2. Enclosure ratings;
3. Short-circuit withstand ratings;

4. Cascaded systems;
5. Type 1, type 2 or full coordination system;
6. IP Rating;
7. Radio
8. Other information as required for approval.

EPTM 4.3 Product Data

Data sheets and publications on all major components including, but not limited to, the following:

1. Motor starters;
2. Overload relays;
3. Circuit breaker and fuse information including time current characteristics;
4. Control power transformers;
5. Pilot devices;
6. Relays;
7. Timers;
8. Radios;
9. Antennas;
10. Programmable logic Controllers;
11. Digital Input, Digital Output, Analogue Input, Analogue Output, Voltage Free Contact and RTD's Devices;
12. Multicore cables and earth wires;
13. Glands;
14. Indication lights;
15. Terminal blocks.

EPTM 4.4 Specifications Response

All clarifications and exceptions to the project specifications must be clearly identified and marked up on the drawing.

EPTM 4.5 Specifications Response

Provide a copy of the manufacturer's installation instructions that includes but not limited to, the following:

1. Receiving, handling, and storage instructions;
2. Nameplate data, serial numbers, UL markings, and short circuit ratings;
3. Installation procedures including splicing procedures, terminations and connections;

4. Conduit and cable installation;
5. Installing and removing plug-in units;
6. Operation of operator handles and unit interlocks;
7. Checklist before energizing;
8. Procedure for energizing equipment;
9. Maintenance procedures.

EPTM 4.6 Final Submittals

1. The Contractor shall provide certification that the all components or Telemetry outstation has been installed in accordance with the manufacturer's instructions and with local codes and standards that govern South Africa and all listed standards.
2. Test reports indicating manufacturer's standard testing was performed.
3. Installation/operation instructions for major components.
4. Telemetry System spare parts listing and pricing
5. Technical details and descriptive literature regarding all equipment and instruments offered;
6. Three paper prints of all of the above for final hand-over.

All settings as above detailed shall be indicated on the final drawings.

EPTM 5 DELIVERY, STORAGE AND HANDLING

The contractor shall coordinate with the Engineer manufacturer for entry into the building.

The contractor shall store the telemetry system cubicles in a clean, dry, and heated space.

The contractor shall protect the units from dirt, water, construction debris, and traffic.

During storage the contractor shall connect internal space heaters (if specified) with temporary power.

EPTM 6 EQUIPMENT MANUFACTURER

EPTM 6.1 SABS Certifications

The manufacturer equipment shall be certified by South African Bureau of Standards or accredited testing facility which is to approval of the Engineer in manufacturing. If the contractor does not have certification, it will be to the cost of the contractor to test the telemetry system at South African Bureau of Standards at the Contractors cost.

The Contractor shall have certificates from South African Bureau of Standards which is higher or is equal to the specified equipment.

EPTM 6.2 Outstation Cabinets

All equipment shall be housed in epoxy coated 2,0mm thick 3CR12 steel dust and vermin proof cabinets. The cabinets shall have front access only. Cable entrance shall be possible from the bottom. The doors must be fitted with tamper proof locking catches with padlock facilities and shall be of the 3 point type. Concealed chromed steel hinges shall be used on the front door.

The systems shall be designed to allow for 30% for future extensions.

EPTM 6.2.1 Indoor

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy duty rust proof hinges.

Each panel shall be supplied with concealed hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be Cadmium plated. The use of self-tapping screws will not be permissible.

EPTM 6.2.2 Outdoor

All hinged panels shall be reinforced to ensure rigidity and shall be provided with heavy-duty stainless-steel hinges.

Each panel shall be supplied with concealed stainless-steel hinges, each fastened with not less than four (two on each side) brass bolts and nuts. In the case of double doors, the first door shall be locked with two slides on the inside, onto the shell. The second panel door shall close over a drip proof gutter shaped lip on the first one.

All screws, studs, bolts, nuts and washers used for these boards shall be stainless steel plated. The use of self-tapping screws will not be permissible.
The outdoor motor control boards shall be constructed of at least 2mm powder coated 3CR12 steel. Vermin proofed IP 55 rated ventilation openings shall be provided in doors and side panels. A 3CR12 roof shall be added to all outdoor motor control centres and distribution boards with a minimum slope of 1/10.

EPTM 6.2.3 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in an outdoor distribution or motor control board, this equipment shall be installed in a separate and special compartment and all wiring shall be terminated on rail mounted terminal strips for field connection of all monitoring and control cables.

The doors of this compartment must be labelled: "Electronic Equipment".

All the electronic equipment but not limited to HMI, power supply, PLC CPU, Ethernet switch, fibre switch, all I/O cards, UPS and telemetry and 30% additional space for the future. All equipment shall be mounted flush behind a common hinged panel, with laminated, shatterproof and tinted glass for viewing purposes.

Sufficient provision for ventilation and heat dissipation as per the equipment ratings and manufacturers requirements shall be allowed for. The contractor shall prove to the Engineer by means of Anemometer or Differential that the requirements and manufacturer's requirements are met.

The tier shall be designed to house all of the above equipment, and the manufacturer shall coordinate with communication and instrumentation specialist.

EPTM 6.2.4 Treatment And Painting Of Metal Parts

All metal parts shall be treated before powder coating in accordance with standard corrosion protection standards and the appropriate coating system shall be selected for the specific application. Motor control centre outer surfaces shall be powder coated colour B26, SANS 1091. (Electric orange)

An average of 2 mil thick electrostatic powder paint coat shall be applied, the contractor shall have a Rugged, fully electronic coating thickness gauges present for testing the thickness of the paint.

EPTM 7 GENERAL REQUIREMENTS

EPTM 7.1 Internal wiring

The internal wiring of the boards shall consist of coloured PVC-insulated conductors of adequate copper cross-section, which shall be neatly installed horizontally and vertically in PVC trunking. Numbered ferrules of an approved type (clip on type not acceptable), shall be provided on each end of each wire, to facilitate the tracing of circuits.

Control circuits shall be colour coded as follows;

Three Phase	-	Red
Three Phase	-	Blue
Three Phase	-	White
Single Phase	-	Red
A.C. Neutral	-	Black
Earth	-	Green and yellow
110V D.C. Positive	-	Brown
110V D.C. Negative	-	Black
24V D.C. +ve	-	Grey
24V D.C. –ve	-	Purple
4-20mA +ve	-	White
4-20mA –ve	-	Black
All other voltages	-	To be confirmed with Engineer.

EPTM 7.2 Electronic Equipment

Where electronic equipment such as transmitting I/O units are incorporated in a distribution board and motor control centre, this equipment shall be installed in a separate and special compartment.

Sufficient room shall be provided for the rail mounted terminal strips and all wiring shall be terminated on this rail mounted terminal strips for field connection of all monitoring and control cables.

EPTM 7.3 Cable Terminations

Low voltage cables shall be terminated with cable glands manufactured of bronze and comprising a barrel with sealing washer and bush nut screwed into one end and a compression nipple with wire clamping ring screwed onto the other end and shall bear the SABS mark of approval. The opposite end of the compression nipple must have a male electrical thread with locknut. The glands shall be suitably sized for the relevant cables, be of the adjustable type complete with armour clamps and with watertight neoprene shrouds.

Cable terminating glands for outdoor use shall be IP68 rated and provided with waterproofing double inner seals as well as waterproofing seals on nipples. Cable termination glands for high humidity and possible temporary water submerged conditions as for instance in filter lower gallery areas at water treatment plants shall also be IP68 rated with waterproofing double 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.

Flameproof glands for indoor and outdoor use shall be used where the hazardous area classification and explosion protection rating is supplied by the Engineer.

EPTM 7.4 Labelling

A screwed on engraved label of the black on white "traffolyte" 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 the English language in 6 mm high lettering.

Each board shall further be provided with a screwed on reverse engraved yellow Perspex nameplate with black 20mm high lettering to identify the board in the English language on the outside of the door at the top thereof.

EPTM 7.5 Mains Surge Arrestors

When a surge arrestor is installed in systems with a main breaker with 250Amps or 5kA fault current, the surge arrestor shall be pre-fused to prevent the units creating a danger when subjected to high fault currents. Surge arrestors shall be pre-fused to the manufactures requirements. All surge arrestors shall be connection type 2 as per the latest addition of the SANS 10142.

EPTM 7.5.1 Building with External Lightning Protection

The main distribution board surge arrestors shall be combined type 1 & 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 10/350µs at a maximum discharge current of 100kA.

Any distribution board feeding from the main distribution board shall have surge arrestors and shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EPTM 7.5.2 Building With NO Lightning Protection

The surge arrestors shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

EPTM 7.5.3 ANTENNA Lightning Protection

The surge arrestors shall be suitable for multi frequency or for wireless applications and shall have excellent RF endurance performance or adapted to Wireless LAN and Wireless Local Loop applications for use according to the lightning protection zones concept at boundaries and higher and shall be able to withstand a lightning impulse current wave form 8/20µs at a nominal discharge current of 20kA. Shall be IEC 61643-21 complaint.

EPTM 7.6 Moulded Case Circuit Breakers

All moulded case circuit breakers shall be as specified in the schedules of equipment for distribution boards and shall comply with the requirements of SANS Specification no. 156.

The required frame sizes or rupturing capacities required are specified in the schedules for each board.

Each circuit breaker shall be provided with non-adjustable time-delayed trips.

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.

EPTM 7.7 Fused Switches

All fused switches shall be of the "load-breaking" and "fault-making" type complying with BS-5419 where applicable and fitted with HRC cartridge fused links to BSS-88. Auxiliary contacts shall be provided where relevant for signal purposes.

EPTM 7.8 Current Limiting Circuit Breakers

The current limiting circuit breakers shall be capable of remaining in service and of carrying their normal rated current after having interrupted the maximum short circuit current of 200kA rms at least three times.

EPTM 7.9 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.

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.

EPTM 7.10 Indicating Instruments

All indicating instruments shall comply with the requirements laid down in BS 89: Part I: 1970 for instruments of a 2,5 Accuracy Class. All indicating instruments shall have 96mm square dials.

The maximum demand ammeters shall be of the 6A combined maximum demand registering and instantaneous indicating type having MISC movement and thermal demand indication with an integrating time lag of 15 minutes. The ammeter scales shall be direct reading with a full-scale 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 5A instantaneous indicating meters with MISC movement and direct reading scales. The meters shall be able to withstand over currents 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 power factor meters shall indicate from 0,7 lagging to 0,7 leading.

The running hour meters shall have cyclometer dials indicating up to 5 digits and two decimals. (12345,67)

EPTM 7.11 Instrument selector switch

A four-position rotary type instrument selector switch shall be mounted directly below the relevant instrument 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 Bakelite, 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 consist of Bakelite and shall have the positions for the three phases and "OFF", engraved on it in 5mm high lettering.

EPTM 7.12 Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of BS 775 for "CLASS UR" contactors of the "CLASS II MECHANICAL DUTY CLASS / TYPE 2 COORDINATION" and "A3 Make and Break Category".

All contactors shall be provided with arc extinguishers, and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with an AC, closing coil suitable for continuous operating and at least 15 closing operations per hour at system voltage. The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EPTM 7.13 Time Switches

The time switches shall be suitable for use on a 231 volt, 50 cycle per second AC supply and shall be of the microprocessor type.

The time switches shall be digital timers suitable for rail or surface mounting and shall be programmable with daily and weekly programs, switching intervals of 1 minute and switching accuracy precise to the second.

The time base shall be of the quartz type with LED display for time, weekday, holiday program, switching position and manual override and shall have a power reserve of 250 hours at full operation. The time switches shall have a switching capacity of 16 A at 231 V.

EPTM 7.14 Isolators

All isolators shall be of the "Load-breaking" and "fault making" type and shall comply with the requirements of BS 5419-1977 where applicable. Where relevant, isolators shall be provided with auxiliary contacts for signal purposes.

EPTM 7.15 400 Volt Air-Break Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of IEC 158-1 for Class AC 3 contactors of Intermittent Duty Class 0,3.

All contactors shall be provided with arc extinguisher and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with a 240 Volt, 50 Hz closing coil suitable for continuous operation and at least 15 closing operations per hour. In rural areas contactor coils must be rated to operate satisfactorily between 75% and 130% of nominal voltage.

An adequate number of auxiliary contacts shall be fitted.

The contactor may not hum or chatter in service and the contacts may not bounce on closing.

EPTM 7.16 Earth Leakage Units

The earth leakage units shall consist of a combination of a earth leakage relay and a moulded case circuit breaker and shall have a sensitivity as specified, it shall conform to SANS 767.

EPTM 7.17 Terminals

Terminals may be of the bolted type otherwise they shall be of rail mounted clamp type.

All types of terminals and their insulation shall have a minimum comparative creep index of 500 to BS 3781.

EPTM 7.18 Clamp Type Terminals

These terminals shall be not less than 8 mm wide.

Screws and connectors shall be electroplated to prevent corrosion. The connectors shall be such that the screws will not loosen due to vibration. Current carrying parts shall be of serrated silver-plated copper or brass. Only one connection shall be allowed per connector. For more connections the number of terminals shall be increased, and bridge pieces shall be used.

EPTM 8 RADIO SELECTION SLOW SPEED

The radio transceivers shall be of robust construction with Ethernet communication technology for increased data throughput. On an upgrade on an existing telemetry system similar radio communication systems shall be incorporated.

Ethernet communication technology shall be used.

EPTM 8.1 Radio Selection Medium Speed

Industrial protocols will be supported including Ethernet/IP, Modbus TCP/RTU, Profibus DP and Profinet CBA. The Wireless Ethernet Modem further simultaneously functions as a wireless serial modem (RS232/485) providing secure, reliable short- and long-range communication solutions.

Capable of operating in Access Point/Client configuration, functioning as a network Bridge/Router, or serving as a Serial Server (RS232/485), the radio shall offer node to node deterministic mesh network repeatability for further range and multiple channel spacing options to increase network scalability. Radio Integrated Modbus server capability shall allow for all seamless I/O expansion modules.

Industrial applications requiring robust wireless Ethernet connectivity in process/automation applications connecting to PLC's, DCS/SCADA, or field instruments with Ethernet as well as RS232/485 interfaces. Powerful built-in diagnostics and universal industrial connectivity options in a highly configurable platform

2.4-GHz direct sequence spread spectrum (DSSS) wireless transceiver shall be used for medium speed radios. 20-MHz channel with 5-MHz channel spacing from the available 13 channels, starting with the first channel centered on 2.412 GHz.

5-GHz direct sequence spread spectrum (DSSS) wireless transceiver shall be used for High-speed radios. The permitted channel usage shall be confirmed in the country.

EPTM 8.2 Radio Selection High Speed

Industrial protocols will be supported including Ethernet/IP, Modbus TCP/RTU, Profibus DP and Profinet CBA. The Wireless Ethernet Modem further simultaneously functions as a wireless serial modem (RS232/485) providing secure, reliable short and long range communication solutions.

Capable of operating in Access Point/Client configuration, functioning as a network Bridge/Router, or serving as a Serial Server (RS232/485), the radio shall offer node to node deterministic mesh network repeatability for further range and multiple channel spacing options

to increase network scalability. Radio Integrated Modbus server capability shall allow for all seamless I/O expansion modules.

Industrial applications requiring robust wireless Ethernet connectivity in process/automation applications connecting to PLC's, DCS/SCADA, or field instruments with Ethernet as well as RS232/485 interfaces. Powerful built-in diagnostics and universal industrial connectivity options in a highly configurable platform

5-GHz direct sequence spread spectrum (DSSS) wireless transceiver shall be used for High speed radios. The permitted channel usage shall be confirmed in the country.

EPTM 9 SOLAR PANEL AND BATTERIES

Where no electrical supply is available solar panels shall be used to charge batteries via a voltage regulator. A fully operational backup time of 96 hours (4 days) is required unless otherwise specified. Solar panels shall be installed at a radio communication.

The regulator shall be specifically designed for the telemetry use, where radio current draw varies for short durations of transmission. Allowance shall be made for at least 4 station interrogations per hour.

The regulator shall provide

- Over voltage cutout of load if battery voltage is greater than 16V.
- Cyclic charge to keep battery voltage falls below 10V for more than 30 seconds.
- Low voltage cutout of load if battery voltage falls below 10V for more than 60 seconds. Load is reinstated when battery is charged to more than 12V dc.

Batteries shall be selected for the purpose of the application. High peak discharge current during radio transmission shall be used for battery selection. Typically [Nickel Cadmium] batteries shall not be used.

Sealed lead-acid batteries shall be used for capacities up to 65Ampere Hour, and vented lead-acid (Plant) storage cells designed for standby applications shall be used for larger capacities. Liquid based storage cells shall be housed in a separate vented lockable enclosure.

EPTM 10 EARTHING AND LIGHTNING PROTECTION

Shall be done accordance to earthing and lightning protection particular specifications.

EPTM 11 SOLENOID VALVES

Solenoid valves complete with hydraulic pipe couplings shall be provided where indicated for telemetry control of hydraulic controlled valves at reservoir sites. These units shall operate from a 24V DC supply and shall be of the low energy consumption type. The open/close status of the hydraulic valve shall be monitored where possible by means of a limit switch mounted on the hydraulic valve casing. A weatherproof cable termination box must be supplied and installed next to the control valve and provision must be made for connection cables between the termination box, solenoid and limit switch. The control valve will be controlled by means of the level sensor at the relevant reservoir and must be a fail safe operation (valve must close in the event of a power failure).

EPTM 12 NUMBERING OF CONDUCTOR ENDS

Every conductor end whatsoever, with the exception of AC power cables at any terminal shall be numbered. The alphanumeric numbering shall be in accordance with - BS 158 - 1961.

These numbers shall correspond with those on the circuit diagram and shall consist of the slip-on type numbering system (clipped on numbering system will not be accepted). It shall not be possible to remove the number holder without damaging it or cutting off the lug.

EPTM 13 CONNECTION OF CONDUCTOR ENDS

All conductors whatsoever shall be connected at terminals by means of lugs and/or ferrules suitable for the specific conductor and terminal.

EPTM 14 MONITORING SYSTEM

EPTM 14.1 System Organisation

The system will consist of the following organisation which may in future increase in size. The system shall be suitable to be modified to a decentralised type of control with intelligent outstations.

EPTM 14.2 Monitoring

The system shall provide facilities for the monitoring of all status and analog values described as elsewhere.

EPTM 14.3 Status and Analog Indication and Alarms

The system shall provide plant information to the following display devices:

a) Mimic and SCADA Display units

Analog readings shall be in close proximity to related devices on the display screens showing flow rates and shall be continuously updated after outstation scans.

The following indications are catered for:

- Indication of status of all motors and pumps;
- Indication of which relay or any other device caused changes in the system;
- Alarms are indicated visually and audible. When the alarm is accepted the audible indication is cancelled;
- Indication of internal faults in the supervisory system;
- When selected, indication of analog signals at specific points in the system as specified in the relevant clause; and;
- When selected, indication of time, the control equipment and outstations shall give the same indications.

b) Data and Event Recording

The following information shall be recorded by the system:

- Automatic recording of events when a change of status takes place in the system and at the same time, recording time, date, outstation, item, alarm and identification;
- Automatically log all analogue values at preset intervals from a particular outstation;
- Automatically log any number of selected analogs at preset intervals;
- Record keeping of the real time operation of all motors; and
- Keep records of all controls transmitted.

The data logging will be such that it can also be done by manual selection at any time.

EPTM 14.4 Measuring Accuracies

Measuring accuracies of 2,5% full-scale value are required on all analog signals.

EPTM 15 TRANSDUCERS AND INTERFACES

Transducers shall be supplied and installed by the contractor and any other associated devices where it may be necessary in order that supervisory analog quantities can be measured by the telemetry. The monitoring and control system contractor will be responsible for all interfaces between his equipment and that of other contractors.

EPTM 16 FAULT FINDING AND TEST FACILITIES

The equipment shall be designed in such a manner that staff of the Employer with the minimum training in electronics, can do the maintenance on the equipment.

The contractor shall specify all standard and special test equipment required for normal maintenance and testing purposes.

The contractor shall supply a logical step-by-step system of fault location.

A rail mounted terminal strip equal or similar to Klippon Type SAKR shall be mounted in the supervisory panels for the connection between the plant equipment signals and electronic equipment.

EPTM 17 MODULAR DESIGN

The system shall be of modular design in order to facilitate expansion to the system by simple plug-in of additional modules and minimum wiring changes. All modules shall be DIN rail mounted and shall be interconnected by means of bus connectors.

EPTM 18 ANTENNAE

A list must be provided showing which mast is allowed for at each station.

These shall be either:

a) Wall mounted:

A 5mm tubular mast shall be fixed to the wall with a heavy-duty gauge galvanised offset bracket for 500mm roof overhang. The mast shall be either aluminum 50mm diameter, 5mm thick, or steel galvanised 50mm diameter, 2mm thick.

b) Self-supporting 9m:

A 9m flagpole type mast suitable for the size of antenna used, to withstand 140 km/h wind loading shall be provided.

c) Self-supporting 12 to 18m:

Mast above 12m should be lattice type construction. The mast plinth shall be supplied by the Contractor. The contractor shall provide the concrete base with plinth and wire way. A sketch of the civil works must be provided by the Contractor.

d) Self-supporting Above 18m:

Mast above 18m should be lattice type construction. The mast plinth shall be supplied by the Contractor. The contractor shall provide the concrete base with plinth and wire way. A sketch of the civil works must be provided by the Contractor.

EPTM 19 OUTSTATION HARDWARE

EPTM 19.1 Operational Requirements

a) General

The outstation shall comprise of a central processor unit with interface modules, a power supply, standby battery and plant input and output modules and a communication system. All equipment shall be housed in a steel cabinet as specified.

Apart from any other modules being necessary to operate and control the system satisfactorily, the following modules shall be made available on the outstations.

b) Power Supply

The stabilized power supply and battery charger unit shall be capable of re-charging a drained batteries and shall operate from 230 V-AC.

Battery backup for at least 24 hours of normal operation shall be provided for.

General purpose battery up to 5 years in standby service shall be supplied or more than 260 cycles at 100% discharge in cycle service shall be guaranteed.

c) Processor

The CPU module shall have a high-speed RAM for executable program sections with a RAM size that will match the requirements of the application.

Sufficient memory shall be made available to store data for a reasonable period of time in the event of a communication failure.

The CPU module shall be equipped with a CPU watchdog timer circuit that will automatically restart the system in case of severe electrical disturbance. The CPU shall be auto-configuring and shall determine automatically which I/O modules are connected, do data addressing and mode of operation to run. Use of programmer at outstation shall not be necessary.

d) Relay Interface Cards

Relay interface cards shall be available to connect control outputs to outside plant.

LED monitors shall be fitted to this card to aid with fault-finding.

e) Input/Output Modules

The digital I/O modules shall accept inputs from plant controls and auxiliary multiple operations and provide control outputs to plant operations.

These modules shall also be capable to accept floating alarms of duration of as well as steady alarms from normally closed controls.

All inputs and outputs shall be 2,5 kV isolated from the logic components. Inputs and outputs shall be protected against over voltage and over current.

These I/O's shall be isolated from field equipment by means of interface relays installed in the outstation.

f) Analog Modules

These modules shall accept analog inputs from plant transducers and provide control analog outputs to plant operations and shall be capable of converting 0-5 V DC, 4-20 mA or 0-5 V AC signals by using external converters. All analog inputs and outputs shall be galvanic isolated

Surge protection modules as specified shall be installed in the out station.
RS 232 Bus connectors

These modules shall accept data from an external source. The baud rate shall be adjustable from 300, 1200, 2400, 9600 or 19200-baud handshake protocol shall include XON/XOFF, CTS/RTS and direct.

g) Outstation General

The outstation shall be capable of scanning all inputs and storing data in memory for collection by the mother station.

It must also be possible to perform sequence control and interlocking of plant equipment.

h) Outstation Antennas

Antennas shall be installed at all outstations which will suite the application, speeds shall be detailed in Project Specification.

This high-gain shall band antenna shall be used for low speeds. The antenna shall cover virtually all of the international wireless, cellular and mobile data bands.

The minimum antenna shall operate in two frequency bands 2.4 GHz and 5 GHz.

This Antenna shall have a minimum 13dBi gain at 2.4GHz band and 18dBi gain at the 5GHz band. The housing shall be made of ABS which shall have cataristic for high impact resistant plastic and is also resistant to acids and other chemicals that may occur in industrial plants.

i) Time-Tagging

Events shall be time stamped at the outstations. Only a real time clock at the outstation will be acceptable which shall be hardware based with a crystal. Accuracy of time tagged events should be 20ms between events and 100ms between events at different outstations.

j) Digipeating

The telemetry system shall have the facility to repeat commands destined from or to a remote station, via another station (Digipeating, or Store-and-forward). The digipeat "map" shall be stored in E2PROM (non-volatile memory) at relevant stations, and be able to be programmed with local programmer (e.g. LAP-TOP) or remotely via the communications medium. The digipeat map shall allow for input/output data to be transferred from any remote site to any other remote site and/or Central Station.

k) Programmable Logic Controllers

Where logic control is required at an outstation for pump control programmable logic controllers shall be used. **Programmable Logic Controller Particular Specifications shall be followed.** These PLC's shall be of reputable brand name, to allow after sales programming support by specialist vendors. The telemetry interface to PLC will be serial communications.

EPTM 20 DANGER SIGNS

Danger signs on aluminium plates shall be supplied on each door of an outdoor motor control centre or distribution board and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

EPTM 21 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness.

The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection.

The instruments must have valid test certificates issued by an accepted testing authority and the results of the test done must be recorded on a test certificate, of which the Engineer must receive two copies. The Engineer reserves the right to call for a calibration test on any instruments used during the test.

The cost of all tests must be included in the tender price.

EPTM 22 TESTING OF TELEMETRY SYSTEM AT THE MANUFACTURER'S WORKS

Each telemetry outstation 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) Primary and secondary injection tests shall be carried out on all switching, protection, metering interlocking and indication circuits.
c) Load Mismatch Test, Output Open and Short Circuit Protection Test, Output Open and Short Circuit Protection Test, Linearity Test, Modulation Input Impedance Test, Modulation Sensitivity Test, Modulation Frequency Response Test, Ground Isolation Test, Turn-On and Turn-Off Characteristics Test, Occupied Bandwidth test, Transmitter Quality Test, Transmitter Phase Noise Test, Transmitter Bit Error Probability and Additive Noise at GPS Frequencies.

The manufacturer shall submit three copies of test certificates giving details of conditions and results of tests carried out to the Engineer.

EPTM 23 CONCRETE PLINTH FOR OUTDOOR TELEMETRY SYSTEM

The plinth shall be cast 150mm below as well as 150mm above the ground level. It shall have neatly bevelled edges and shall be 75mm wider than the panels all round.

An opening of sufficient width to allow for cable entry shall be provided under the starter panels.

The grade 304 stainless steel foundation bolts for mounting of the panels shall be cast or grouted into the plinth. The plinth shall be in Class 20/19 concrete and shall be suitably reinforced if necessary.

It is recommended that the casting of these foundations must be carried out by the Civil Contractor at the cost of the Contractor under this Contract in accordance with his instructions and under his supervision.

EPTM 24 OPERATING AND MAINTENANCE INSTRUCTIONS

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide 3 x “soft copies” of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard

pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

EPTM 25 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EPTM 25.1 Design, Drawing and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. Telemetry system design shall include but limited to as listed in this Particular Specifications.

Pay Item		***Unit***
(a)	Provide a complete Telemetry System design, deign drawings and wiring diagrams as specified	Sum
(b)	Provide operating and maintenance manuals and “as built” drawings as specified	Sum

EPTM 25.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For Telemetry System, the rate tendered shall be for the complete Telemetry System and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in the Project Specifications.

Pay Item		***Unit***
(a)	Supply and delivery to site a complete Telemetry System	Sum
(b)	Supply and delivery to site a complete Solar Plant	Sum

EPTM 25.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning

Install of switchgear shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the switchgear complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of switchgear but not limited to.

Pay Item		***Unit***
(a)	Installation to site a complete Telemetry System	Sum
(b)	Installation to site a complete Solar Plant	Sum

EPTM 25.4 Commissioning

Pay Item		***Unit***
(a)	Commissioning to site a complete Telemetry System	Sum
(b)	Commissioning to site a complete Solar Plant	Sum

END OF SECTION

EELP EARTHING AND LIGHTNING PROTECTION

INDEX

EELP EARTHING AND LIGHTNING PROTECTION

EELP 1 SCOPE OF WORKS

As specified in the project specifications.

EELP 2 STANDARDS AND TESTS

The earthing and lightning protection shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply;

Table 2: Applicable Standards

Standard No.	Description
OHSA	Occupational Health and Safety Act
SANS 10089-1	Electrical Code for Petroleum Industry
SANS 10121	Cathodic Protection of Buried and Submerged Structures
SANS 10123	The Control of Undesirable Static Electricity
SANS 10142	Code of Practice for the wiring of Premises
SANS 10198-12	Installation of Earthing System
SANS 10199	Design and installation of an Earth Electrode
SANS 10199	The Design and Installation of and Earth Electrode
SANS 10200	Neutral Earthing in Medium Voltage Industrial Power Systems
SANS 10292	Earthing of Low Voltage (LV) distribution systems
SANS 10313	The protection of structures against lightning
SANS 1063	Earth rods and Couplers
SANS 1063	Earth Rods and Couplers
SANS IEC 61000-5-2	Electromagnetic Compatibility (EMC) Part 5: Installation and mitigation guidelines Section 2: Earthing and Cabling
SANS IEC 61024-1	Protection of Structures against Lightning Part 1: General principles
SANS IEC 61024-2	Protection of Structures against Lightning Part 2: Risk Management
SANS IEC 61024-3	Protection of Structures against Lightning Part 3: Physical damage to structures and life hazard
SANS IEC 61024-4	Protection of Structures against Lightning Part 4: Electrical and electronic systems within structures
SANS IEC 61312-1	Protection against Lightning Electromagnetic Impulse Part 1: General principles
SANS IEC 61312-4	Protection against Lightning Electromagnetic Impulse Part 4: Protection of Equipment in existing structures
SANS IEC 61643-1	Surge Protective Devices Connected to Low Voltage Power Distribution Systems Part 1: Performance requirements and testing methods

Standard No.	Description
SANS IEC TS 61312-2	Protection against Lightning Electromagnetic Impulse (LEMP) Part 2: Shielding of structures, bonding inside structures and earthing
SANS IEC TS 61312-2	Protection against Lightning Electromagnetic Impulse (LEMP) Part 2: Shielding of structures, bonding inside structures and earthing

The lightning protection system shall be designed to protect lives and property from the destructive effects of lightning. The lightning designer shall assess corrosion effects of the lightning protection system and design accordingly.

The installation shall satisfy the requirements of all relevant South African Statutory Regulations.

Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

EELP 3 GENERAL REQUIREMENTS

Equipment and materials to be used, shall be of high quality, and shall comply with all relevant specifications, codes as mentioned in this particular specification as well as the Occupational Health and Safety Act of 1993(Act 85 of 1993).

Where equipment and material does not comply with the relevant particular specifications it shall be submitted to Engineer for approval before installation.

All materials used for the earthing and lightning protection system shall withstand the electric and electromagnetic effects of lightning current and predictable stresses without being damaged.

Materials and sizes shall be chosen bearing in mind the possibility of corrosion of either the earthing and lightning protection system or the structure to be protected.

The installation shall be in accordance with SANS 10313: Code of Practice for the protection of structures against lightning and the requirements of this specification.

All equipment and material shall comply with the relevant National and International standard standards as listed in the specification. Where equipment does not comply it shall be submitted to the Engineer for approval.

The system of protection will be finials/air terminals, down conductors and earth spike or roof conductors, down conductors and earth spike.

EELP 4 OPERATING CONDITIONS

All material and equipment supplied and fitted must be designed and manufactured for successful operation under the prevailing environmental conditions.

EELP 5 GENERAL PRINCIPLES

Evaluation of Risk: The risk of lightning strike shall be evaluated as described in SANS 10313 and SANS IEC 61024-2.

Effective height of a structure: The effective height of the highest point shall be determined by considering the average height of building, trees and structures and land profile of the surrounding area.

Ground flash density (Ng): The ground flash density (Ng) for general buildings, structures and installations shall be estimated from the average ground flash density given in Annexure C of SANS 10313 as a general guide.

EELP 6 AIR-TERMINATION SYSTEM

The air-termination system should be composed of any combination of the following elements:

- Rods;
- Stretched wires;
- Meshed conductors.

For the design of the air-termination system the following methods should be used:

- Protective angle method
- Rolling sphere method
- Mesh size method

The air-termination system shall be designed and installed in accordance with all the relevant SABS / SANS / IEC standards as mentioned in this document.

EELP 7 LIGHTING PROTECTION SYSTEM

The requirement of the SANS 62305-3 shall comply for the system. The lighting protection system earthing shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1.

EELP 8 EXTERNAL LIGHTNING PROTECTION SYSTEM

The requirement of the SANS 62305-3 and SANS 10313 shall comply for the system. Earth electrodes shall be designed in accordance with SANS 10199.

EELP 8.1 General

External down-conductors shall be installed between the air-termination system and the earth termination system.
The average distance between the down-conductors shall comply with SANS IEC 62305-3.
Down-conductors shall be uniformly placed along the perimeter of the structure and with a symmetric configuration. Down-conductors shall be arranged in such a way that from the point of strike to earth several parallel current paths exist and the length of the current paths is kept to a minimum. The formation of loops shall be avoided.

In order to reduce the probability of damage due to lightning current flowing in the lightning protection system, the down-conductors shall be arranged in such a way that from the point of strike to earth:

a) several parallel current paths exist;
b) the length of the current paths is kept to a minimum;
c) equipotential bonding to conducting parts of the structure is performed according to the requirements

The down-conductor system shall be designed and installed in accordance with all the relevant SABS standards as mentioned in this document.

EELP 8.2 Construction

The down-conductors shall be installed so that, as far as practicable, they form a direct continuation of the air-termination conductors. Down-conductors shall be installed straight and vertical such that they provide the shortest and most direct path to earth.

Down-conductors shall not be installed in gutters or down-spouts even if they are covered by insulating material.

Down-conductors of a lightning protection system not isolated from the structure to be protected may be installed as follows:

a) wall is made of non-combustible material, the down-conductors may be positioned on the surface or in the wall;
b) wall is made of readily-combustible material the down-conductors may be positioned on

the surface of the wall, provided that their temperature rise due to the passage of lightning current is not dangerous for the material of the wall;

c) wall is made of readily-combustible material and the temperature rise of down conductors is dangerous, the down-conductors shall be placed in such a way that the distance between them and the wall is always greater than 0,1 m. Mounting brackets may be in contact with the wall.

When the distance from down-conductor to a combustible material cannot be assured, the cross-section of the conductor shall be not less than 100mm².

EELP 8.3 Natural components

The following parts of the structure should be considered as natural down-conductors:

a) The metal installations provided that:

The electrical continuity between the various parts is made durable in accordance with SANS 62305-3.

Their dimensions are at least equal to that specified in SANS 62305-3 for standard down conductors.

a) the metal of the electrically-continuous reinforced concrete framework of the structure;
b) the interconnected steel framework of the structure;
c) the facade elements, profile rails and metallic sub-constructions of facades, provided that

Dimensions conform to the requirements for down-conductors shall be as SANS 62305-3 and that for metal sheets or metal pipes thicknesses shall be not less than 0,5mm.

Electrical continuity in a vertical direction conforms to the requirements of the SANS 62305-3.

EELP 8.4 Test Joints

At the connection of the earth termination, a test joint should be fitted on each down conductor, except in the case of natural down-conductors combined with foundation earth electrodes. For measuring purposes, the joint shall be capable of being opened with the aid of a tool. In normal use it shall remain closed.

The joint should be capable of being opened with the aid of a tool for measuring purposes, but normally it should be closed.

EELP 9 INTERNAL & EXTERNAL LIGHTNING PROTECTION SYSTEM

The SANS 62305-3 shall apply. For the protection against over-voltages of internal systems, see SANS 62305-4.

EELP 10 EARTH-TERMINATION SYSTEM

The design shall cater for the dispersion of the lightning current into the ground, whilst minimizing any potentially dangerous over-voltages, the shape and dimensions of the earth-termination system are the important criteria.

The lightning protection system earthing shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1. ***ALL EARTHING AND BONDING ABOVE GROUND SHALL BE DONE WITH KWENA-ANTI THEFT CABLE.***

The requirements of SANS 62305-3 apply with the additions given in 10.2 and 10.3. Earth rods shall comply with the requirements of SANS 1063, and earth electrodes shall be installed in accordance with the requirements of SANS 10199. Specific attention is drawn to the requirements for explosive manufacturing and storage areas.

ALL EARTHING AND BONDING ABOVE GROUND SHALL BE KWENA ANTI-All earthing and Bonding may it be above ground.

EELP 10.1 Earth Resistivity and Electrode

Necessary earth resistivity tests on site, and invite to the Engineer for inspections must be arranged. Tests will be in accordance with the requirements of BS 1013.

After all earth electrodes/trench earth's have been installed, an earth megger shall be used to test the earth resistance at the earth bar or connection point to the main station earth and the results recorded. Note that all ECC connections, and any other bonding material shall be disconnected from the earth connection point whilst the earth is being tested.

The following are the maximum acceptable earth electrode resistances: Electrical Earth

a) Main substation - 1 ohm
b) Buildings Ring Earth - 1 ohm
c) Transformer Yard - - 1 ohm
d) Miniature substations and kiosks - 1 ohm
e) High masts - 5 ohms
f) Instrument Earth - < 1 ohm

EELP 10.2 Type B Arrangement

Type B arrangement as per SANS IEC 62305-3 shall be used.

Ring conductor external to the structure which will be in contact with the soil for at least 100% of its total length, or a foundation earth electrode. Earth electrodes may also be meshed.
The number of electrodes shall not less than the number of the down-conductors, with a minimum of two.

EELP 10.3 Installation of earth electrodes

The embedded depth and the type of earth electrodes shall be such as to minimize the effects of corrosion, soil drying and freezing and thereby stabilize the conventional earth resistance.
The requirements of SANS 62305-3 apply with the additions given in 10.2 and 10.3.
Earth rods shall comply with the requirements of SANS 1063, and earth electrodes shall be installed in accordance with the requirements of SANS 10199.

EELP 11 COMPONENTS

Components of a lighting protection system shall be manufactured from the materials listed in SANS IEC 62305-3 or from other materials with equivalent mechanical, electrical and chemical (corrosion) performance characteristics.

Earth electrodes shall be designed in accordance with SANS 10199.

EELP 11.1 Fixing

Air-terminations and down-conductors shall be firmly fixed so that the electrodynamic or accidental mechanical forces will not cause conductors to break or loosen as per SANS IEC 62305-1.

EELP 11.2 Connections

The number of connections along the conductors shall be kept to a minimum. Connections shall be made secure by such means as brazing, welding, clamping, crimping, seaming, screwing or bolting. Connections of steelwork within reinforced concrete structures shall conform to SANS IEC 62305-3.

EELP 12 EQUIPOTENTIAL BONDING

Equipotentialization shall be achieved by interconnecting the lightning protection with all structural metal parts, all below indicated but limited to the following:

a) metal installations,
b) internal systems,
c) external conductive parts and lines connected to the structure.

Have a nominal cross-sectional area of at least 2,5 mm2 copper or equivalent for indoor, and outdoor shall be aluminium, the conductors will be either cast in to the concrete or shall be so arranged that it cannot be tampered with.

EELP 12.1 Lightning equipotential bonding for external conductive parts

For external conductive parts, lightning equipotential bonding shall be established as near as possible to the point of entry into the structure to be protected.

Bonding conductors shall be capable of withstanding the lightning current flowing through them evaluated in accordance SANS IEC 62305-1 and SANS 10142.

The requirements of SANS 62305-3 and SANS 10142 shall apply. For the protection against over-voltages of internal systems, see SANS 62305-4.

EELP 12.2 Lightning equipotential bonding for internal systems

Lightning equipotential bonding shall be installed strictly according to SANS 10313, SANS 10142 and SANS IEC 62305-3.

EELP 12.3 Lightning equipotential bonding for lines connected to the structure to be protected

Lightning equipotential bonding for electrical and telecommunication lines shall be installed in accordance with 6.2.3 of SANS IEC 62305-3.

EELP 13 TOUCH AND STEP VOLTAGES

The requirements of SANS 62305-3 apply.

EELP 14 RISK MANAGEMENT

The requirements of SANS 62305-2 apply. The Contractor shall allow for the purchase of the spreadsheet-based risk calculator which has been developed by IEC TC 81 (see annex E in SANS 62305-2:2011). The software program can be purchased directly from the IEC and shall be submitted as proof of design.

EELP 15 MAST PROTECTION FOR THATCHED ROOFS

The requirements of SANS 62305-3 shall apply with the additions given in 11.2 to 11.7. Metals used in the construction of a thatched roof shall be bonded and earthed. Water pipes, vent pipes, tanks, gas pipes, antennas, telephone and bell wires, burglar alarms and electrical wiring and conduit within 1 000 mm of the thatch shall be shielded, bonded and earthed as per SANS 10142-1.

EELP 15.1 Dangerous Sparking

Dangerous sparking between an lightning protection system and a metal, an electrical or a telecommunication installation can be mitigated which is detailed SANS 62305-3.

EELP 15.2 Ageing of thatch

Ageing of the thatch, flammable gases could evolve within the thatch and the thatch could ignite.

EELP 15.3 Metals in or on the thatch

The requirements of SANS 62305-3 shall apply.

EELP 15.4 Protection by masts

At least lightning protection level III (see SANS 62305-3) shall apply in the case of thatched structures.

EELP 15.5 Earthing of masts

All free-standing masts shall be earthed in accordance SANS 10199, and shall comply with SANS 62305-3.

EELP 16 STRUCTURES WITH EXPLOSIVE OR FLAMMABLE SUBSTANCES

The requirements of SANS 62305-3 apply with the additions given in 12.2 and 12.3.

EELP 17 DESIGN REQUIREMENTS

The requirements of SANS 62305-3 and SANS 10313 shall apply.

EELP 18 INSPECTION OF LIGHTING PROTECTION SYSTEM

The requirements of SANS 62305-3 apply and all required forms shall be in place for Engineers inspection. An Installation safety report see annex A of SANS 10313 shall be issued in respect of

an inspected and compliant lighting protection system by the lighting protection system designer and installer.

EELP 19 DANGER SIGNS

Danger signs on aluminium plates shall be supplied on each door and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

EELP 20 EARTH BAR

A copper earth bar shall be provided and mounted not less than 40mm from the wall or fixed structure approximately 1000mm above the final floor level and final position will be confirmed with Engineer in the position as indicated on the drawings and agreed on site. The mounting shall be electrically insulated from the wall.

A solid 200 mm x 30 mm x 5mm copper earth bar shall be provided. The earth bar shall be provided with 6 x 6mm holes evenly spaced along the entire length. 6 mm ϕ cadmium plated high tensile steel bolts complete with nuts and lock-washers shall be provided for each hole. Serrated washers shall not be used between the copper earth bar and the lug.
The earth bar shall be connected with a 70mm² Kwena Anti-Theft conductor to the building earth-termination system (system earth mat) and the tenderer shall allow for 100m of Kwena Conductor to the earth bar for tender purpose.

EELP 21 INFORMATION TO BE SUBMITTED BY THE SUCCESSFUL TENDERER

The successful Tenderer /Contractor shall submit three prints of the under mentioned drawings to the engineer for approval, before manufacturing.

a) Earthing and Lightning Protection drawings.
b) Multiview Projections including elevations showing dimensional information including details such as, but not limited to, the following:
   - Front views
   - Side views
   - Rear view
   - Floor plan view
   - Roof view

All drawings will be obtainable from the Engineer.

a) Structure descriptions which will be indicated on Multiview protections and elevations showing the following:
   - All Bonding
   - All Earthing and Lightning Protection equipment.

- Earth Mat locations
- Conductor Network
- Fixings
- Air terminals
- Conductor Joint clamps
- Earth Electrode Positions
- Earth Inspection Pits
- Other information as required for approval

b) Conduit locations

c) Unit descriptions including information such as, clamps, conductor sizes, earth electrode depth, earth inspection pits all as mentioned above (item c).

d) Design and manufacturer Engineers approved drawings shall be provided to the Engineer in PDF format.

e) Data sheets and publications on all major components including, but not limited to, the following:

- Aluminium Conductor
- KWENA Bonding Conductors
- Clamps
- Control power transformers
- Pilot devices
- Relays
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout / as built.

EELP 22 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EELP 22.1 Design, Drawings and General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. Earthing and Lightning Protection System installation, design information shall include, but limited to, the following:

- Manufacturer's product data of lightning protection and earthing and all related components.
- Dimensioned and Professional Engineer signed drawings of lightning and earthing system showing accurately scaled basic units including, but not necessarily limited to, auxiliary compartments, unit components and combination units all as specified under

this specification.

	Pay Item	**Unit**
(a)	Provide design drawings and design information for Earthing and Lightning Protection System	Sum
(b)	Provide operating and maintenance manuals and “as built” drawings as specified	Sum
(c)	Provide risk management calculations and IEC Program as specified	Sum

EELP 22.2 Supply and Delivery to Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory applied corrosion protection, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For miniature substation, the rate tendered shall be for the complete miniature substation and shall include, but not limited to, the detailed in this particular specification. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications Section C3.4.2 .

	Pay Item	**Unit**
(a)	Supply and delivery to site of lightning protection system complete as specified	Each
(b)	Supply and delivery suitable earth-termination system, earthing and earth mat as specified	Sum
(c)	Supply and delivery suitable earth bar as specified	Each
(d)	Supply and delivery all connection points, terminals, interconnections, bonding points and test joints for the entire system including for “natural” components;	Sum

EELP 22.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning.

Install of earthing and lightning protection system shall be accordance with the manufacturer's written instructions and recognized industry practices, to ensure that the earthing and lightning protection system complies with the requirements and serves the intended purposes. Comply with

the requirements of SABS and IEC standards and applicable portions of "Standard of Installation", for installation of earthing and lightning protection system but not limited to.

	Pay Item	**Unit**
(a)	Site installation of lightning protection system complete as specified	Each
(b)	Site installation of suitable earth-termination system (system earth mat) and earth mat as specified	Sum
(c)	Site installation of suitable earth bar as specified	Each
(d)	Site installation of all connection Points, terminals, interconnections, bonding points and test joints for the entire system including for “natural” components;	Sum
(e)	Earthing resistance survey upon completion of the excavations and test report	Sum

EELP 22.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, testing apparatus, instruments and equipment, any/all equipment required for testing purposes and to prove performance, any/all temporary works, and compilation of final commissioning report.

Contractor shall submit three copies to the Engineer. Contractor shall notify the Engineer one week in advance of the test so that the Engineer may be present.

	Pay Item	**Unit**
(a)	Commissioning of complete lightning protection system, inclusive of down conductor, earth-mat and earth spikes, etc.	Sum
(c)	Certificate of compliance of lightning protection system	Sum

END OF SECTION

ESPL SMALL POWER AND LIGHTING INSTALLATIONS ON BUILDINGS AND STRUCTURES

INDEX

ESPL SMALL POWER AND LIGHTING INSTALLATIONS ON BUILDINGS AND STRUCTURES

ESPL 1 SCOPE OF WORKS

As specified in the Project Specifications.

ESPL 2 STANDARDS

The following standards, regulation and drawings, etc. shall be applicable to the electrical installations related to this particular specification, whereas the latest applicable South African Bureau of Standards Codes and Standards should be used;

Table 3: Applicable Standards

Standard No.	Description
BS 3676	Switches for household and similar fixed electrical installations. Specification for general requirements
SANS 156	Moulded-Case Circuit Breakers
SANS 164	Plug and socket-outlet systems for household and similar purposes for use in South Africa
SANS 201	Energy Efficiency in Buildings
SANS 474	Code of practice for electricity metering
SANS 475	Luminaires for interior lighting, street lighting and floodlighting - Performance requirements
SANS 890	Ballasts for fluorescent lamps
SANS 950	Un-plasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations
SANS 1012	Electric light dimmers
SANS 1085	Wall boxes for the enclosure of electrical accessories
SANS 1091	National colour standard
SANS 1195	Bus bars
SANS 1213	Mechanical cable glands
SANS 1239	Plugs, socket-outlets and couplers for industrial purposes
SANS 1411	Materials of insulated electric cables and flexible cords
SANS 1619	Small power distribution units (ready boards) for single-phase 230V service connections
SANS 1765	Machine-made textile floor coverings - Determination of thickness
SANS 1777	Photoelectric control units for lighting (PECUs)
SANS 10142	Code of Practice for the wiring of Premises
SANS 10114-1	Interior lighting Part 1: Artificial lighting of interiors
SANS 10114-2	Interior lighting Part 2: Emergency lighting
SANS 60309-1	Plugs, socket-outlets and couplers for industrial purposes Part 1: General requirements
SANS 60309-2	Plugs, socket-outlets and couplers for industrial purposes Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories
SANS 60570	Electrical supply track systems for luminaires
SANS 60669-1	Switches for household and similar fixed-electrical installations Part 1: General requirements
SANS 60669-2-1	Switches for household and similar fixed electrical installations Part 2-1: Particular requirements - Electronic switches

Standard No.	Description
SANS 60669-2-2	Switches for household and similar fixed electrical installations Part 2-2: Particular requirements - Electromagnetic remote-control switches (RCS)
SANS 60669-2-3	Switches for household and similar fixed electrical installations Part 2-3: Particular requirements - Time-delay switches (TDS)
SANS 60669-2-4	Switches for household and similar fixed electrical installations Part 2-4: Particular requirements - Isolating switches
SANS 60669-2-5	Switches for household and similar fixed electrical installations Part 2-5: Particular requirements - Switches and related accessories for use in home and building electronic systems (HBES)
SANS 60906-3	IEC system of plugs and socket-outlets for household and similar purposes Part 3: SELV plugs and socket-outlets, 16 A 6 V, 12 V, 24 V, 48 V, a.c and d.c
SANS 60921	Ballasts for tubular fluorescent lamps - Performance requirements
SANS 60947-1	Low-voltage switchgear and control gear Part 1: General rules
SANS 60947-2	Low-voltage switchgear and control gear Part 2: Circuit-breakers
SANS 60947-3	Low-voltage switchgear and control gear Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
SANS 61084-All	Cable trunking and ducting for electrical installations
SANS 61347-All	Lamp control gear Part
SANS 10292	Earthing of low-voltage (LV) distribution systems

ESPL 3 SPL CABLING AND ACCESSORIES

ESPL 3.1 PVC Insulated Conductors

PVC insulated conductors shall be of high conductivity, stranded copper with Polyvinyl Chloride insulation of 600/1 000 volt grade.

The wiring of circuits shall be carried out on the "loop-in" system and no jointing of conductors in conduit runs or cutting away of wire strands will be permissible.

Connectors for use in conduit boxes shall be of the heavy brass terminal type mounted in porcelain insulators.

All plug circuits shall consist of 2 x 4mm² PVC insulated conductors plus 1 x 2,5mm² bare copper earth wire in Ø20mm conduit.

All lighting circuits shall consist of 1,5mm² PVC insulated conductors in 20mm conduit. For fluorescent lights an additional 2,5mm² bare copper earth wire shall be provided and thoroughly bonded to each fitting.

Connections between lamp holders of incandescent fittings and the conduit boxes shall consist of asbestos insulated wire or other approved heat resistant conductors.

ESPL 3.2 Conduit And Conduit Accessories

Conduit, conduit accessories and conduit fittings shall be hot-dip galvanized both on the inside and outside

Only brass bushes and bush nuts will be acceptable.

The conduit installation shall be carried out on the "loop-in" system and no conduit shall have a diameter of less than 20 mm. All conduits shall be built into walls, concrete ceilings etc., and no conduit will be allowed on the surface.

All conduit ends shall be remerged and all joints securely screwed together. No inspection bends or elbows will be allowed in the installation. Running joints may only be used where unavoidable and shall be provided with lock nuts. All screwed joints shall be thoroughly painted with "Red Lead" in order to prevent corrosion.

No conductor may be drawn into any conduit, unless all foreign materials, moisture and sharp edges have been removed.

In event of a conduit terminating in any sheet metal box, two lock nuts and a brass bush or one lock nut and a bush-nut shall be used.

Standard round conduit boxes shall be used for light points and draw boxes. Draw boxes shall be provided with enamelled metal cover plates with brass screws.

Standard 100 x 50 x 50 mm hot dipped galvanised pressed steel boxes shall be used for all switch boxes.

Standard 100 x 100 x 50 mm hot-dipped galvanised pressed steel boxes shall be used for all plug boxes and telephone outlets.

Expansion boxes shall be provided at all expansion joints in the building. Such expansion box shall comprise a flush hot dipped galvanised sheet steel box with blank enamelled steel cover plate secured in position by means of brass screws. The conduit on the one side shall be securely fixed to the box, while the conduit on the other side shall be able to move freely in the box in order to provide for movement of the building. The conduit on the one side shall be bonded to that on the other side inside the box by means of flexible copper connections with clamps, bolts and nuts, in order to ensure earth continuity.

The conduit shall be installed in the concrete ceilings along the shortest possible routes, with the cover plates of draw boxes on the final ceiling surface. Conduit shall be installed as near as possible to the neutral axis of concrete beams, slabs and columns and deep conduit boxes shall be used.

All unwired conduits should be equipped with hot dipped galvanised draw wires with at least 200 mm ends on each end of the conduit. The ends of the draw wire shall be neatly coiled in the draw boxes.

ESPL 3.3 Standard 100 X 100 X 50 mm And 100 X 50 X 50 mm Boxes

The above mentioned boxes shall be heavy gauge, hot-dip galvanized, pressed steel boxes.

ESPL 3.4 Cover Plates

All cover plates (switch boxes, plug boxes and draw boxes) should be of baked enamelled steel. The colour to be approval by the Engineer, with input for the Architect and Client.

ESPL 4 LIGHTING INSTALLATIONS

ESPL 4.1 Light Switches

Light switches shall comply with SANS 10142 and BS 3676.

Standard mounting box for all light switches: 100 x 50 x 50mm, hot dip galvanized and neat rounded corners

Light switches current rating: >16Amp and suitable for the load it is connected to.

Flush mounted switches: micro type with white rocking lever

Watertight switches to be installed in cast iron boxes, inclusive of watertight cover plates and clearly marked with "ON" and "OFF" positions.

The switch lever shall be protected where it protrudes through the cover plate.

ESPL 4.2 Light Fittings

Light fittings shall be of the latest technology lamps and control equipment as prescribed. LED lights shall be installed as specified.

Fluorescent light fittings shall be equipped with electronic ballasts.

Fluorescent lamps colour temperature: 3 000°K unless otherwise specified.

Light fittings with filament lamps installations: wiring between the terminal box and the lamp holder shall have heat resisting insulation.

ESPL 4.3 Insect Killers

As specified in the project specifications.

ESPL 5 SMALL POWER INSTALLATIONS

ESPL 5.1 Power Outlets

Plug outlets shall be of the combined 3 pin, 13Amp or 16Amp socket and switch combination.

Type: flush mounted units, with a white rocking lever.

Mounting box: 100 mm x 100 mm x 50 mm and neat rounded corners.

The switch lever shall be protected where it protrudes through the cover plate.

ESPL 5.2 Three Phase And Multi-Pin Plug Outlets

Three phase plug outlets shall be either;

- 63A, 400V, 5 pin units complete with plug and interlocked isolating switch; or
- 32A, 400V, 7 pin units complete with plug and interlocked isolating switch.

ESPL 5.2.1 *Isolator Installation*

Isolation installation: 100x50x50mm, IP 65 weatherproof wall box as indicated on the drawings, as required.

Isolators shall be one of the following and as specified;

- 20A double pole;
- 30A double pole;
- 60A double pole;
- 30A triple pole; or
- 60A triple pole.

Mounting height (kitchens and other areas where cupboards are fitted): 1050 mm AFFL
Mounting height (gate motors): 500mm AFFL

Isolator units to be installed in an accessible location and in close proximity to the particular equipment (ex. air-conditioning units, geysers, extractor fans, gate motors, etc.) and as indicated on the drawings.

ESPL 6 DISTRIBUTION BOARDS

Each of the relevant distribution boards shall be built into walls or securely bolted down on the floor or plinth by means of the requisite number of foundation bolts grouted into the floor in the positions indicated on the drawings.

These positions shall be confirmed with the Engineer on site prior to installation as follows;

a. Contractor shall install distribution board in accordance with manufacturer's instructions.
b. Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer's torque requirements.
c. Contractor shall select and install fuses in fusible switches based upon field requirements.
d. Contractor shall adjust circuit breaker settings based upon field requirements.
e. Contractor shall adjust solid state overloads to match the installed motor characteristics.

ESPL 6.1 Wall Surface Mounted Type Mounted Lv Db Specifications

DB board type:

- Surface mounted with doors, 1,6 mm sheet steel, with a bonding tray, chassis and removable panel.

Bonding trays:

- Adequately sized in order that all the relevant equipment is installed without cramping and adequately braced with suitable gaskets.

DB Doors:

- Secured with robust and rust proofed hinges. A single door shall not be wider than 600 mm.
- Rust proofed handles and latches. Ball type batches will not be acceptable.

DB chassis:

- Rigid and facilities shall be provided on the chassis for mounting all the relevant equipment.

Mounted:

- Panels shall be mounted in order that all equipment are flush behind the panel with only operating handles and push buttons projecting through neat machine punched slots in the panel.
- Panels shall be provided with chromium plated brass handles to facilitate removal.
- The panel shall be rigid and readily removable without necessitating the disturbance of any of the equipment on the board.

Colouring:

- Interior surfaces of the board shall be powder coated white .
- Exterior surfaces (including panels) in colour B26, SANS 1091 (Electric orange).
- Powder coating shall be of the best quality with high shock and scratch resistance.
- Before powder coating, metal parts shall be thoroughly degreased and cleaned by shot blasting to be free of rust, mill-scale and other foreign materials.

Gland Plate:

- A 3CR12 steel gland
- Fitted to the bottom section of the board to facilitate termination of cables by means of cable glands.

Busbars:

- Shall consist of tinned solid high conductivity copper mounted on suitable busbar insulators.
- Connections to busbars shall be done with suitable lugs sweated or crimped to the conductor ends, and cadmium plated high tensile steel bolts, nuts and washers.

Copper multiway neutral and earth bars:

- Shall be equipped with cadmium plated high tensile steel bolts, nuts and washers for connection of the various conductors.
- The neutral bar shall be mounted on busbar insulators, but the earth bar shall be thoroughly bonded to the metalwork of the board.

The internal wiring of the boards:

- Done with PVC insulated conductors arranged neatly horizontally, vertically and at right angles in front of the chassis.
- The conductors shall be neatly bunched by means of cable ties. (String will not be acceptable.)

Labelling:

- An engraved plastic label of the black on white sandwich type shall be screwed to the panel below each item of equipment.
- For single pole equipment a number system shall be used.
- A neatly typed legend card behind clear "Perspex" in a metal frame should be provided. The frame shall be mounted on the inside of the switchboard doors.

Sundries:

- All bolts, nuts, washers and screws used on should be rustproof.
- The use of self-tapping screws will not be be allowed.

ESPL 6.2 Wall Flush or Semi-flush mounted DB Specifications

Flush and semi-flush mounted distribution boards shall be manufactured as follows;

- Constructed of 1,2mm sheet steel (minimum) and shall comply with SANS 1180 Part 1.
- Including rust hot dipped galvanised wall tray.
- Braced with of suitable gussets.
- Suitable sized to accommodate equipment without cramping as specified in the schedules.
- Expanded metal to be spot-welded at the rear of all wall trays for 110mm walls.
- Formed with bevelled or flat edges and neatly mitred and shall accommodate the panel chassis and door/s.
- The lip for the mounting of the circuit breaker carriers, and front panels shall form part of the architrave frame.

Panels Door specifications:

- Rigid and manufactured with a smooth flat finish.
- Suitably braced to ensure stiffness,
- Recessed flush in the architrave.
- Door catches shall be equal and similar to "Union" manufacture, as follows;
  - Cat No. 51741 (solid, no lock), or
  - Cat No. 5174 (with built-in lock),
- Single doors to be constructed of sheet steel and shall open at least 150 degrees.
- The distance between panel and inside of door(s) shall be not less than 40mm.
- Circuit breaker carriers specifications;
- Rigid construction for mounting of equipment.
- Fixed to the architrave frame and provided with the necessary means for fixing of circuit breakers, isolators, etc.
- Width of carriers for compact circuit breakers shall be such that a distance of 10mm is maintained between the carriers.

Mounted:

- Panels shall be mounted in order that all equipment are flush behind the panel with only operating handles and push buttons projecting through neat machine punched slots in the panel.
- Panels shall be provided with chromium plated brass handles to facilitate removal.
- The panel shall be rigid and readily removable without necessitating the disturbance of any of the equipment on the board.
- Panels shall be attached to architrave by means of captive fasteners (with screw driver slots).
- Self-tapping screws are not acceptable.
- Panels can also be fitted by means of two guiding pins at the bottom or on the hinge side of the door.

Slots for equipment:

- Slots for equipment installed separately shall have the exact dimensions to accommodate only the specific equipment, as per example main switches, earth leakage relays, etc.
- A maximum tolerance of approximately + 1mm shall be maintained on all sides between slots and equipment.
- Power meters:
- Where required, power meters shall also be flush mounted behind the panels and Contractors are required to co-operate with the supply Authorities in this respect.

Busbars specifications:

- Consist of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 1195 for each phase and neutral and are to be installed in a group in the top section of all distribution boards.
- Busbars to be installed either horizontally or vertically.
- Busbars must be so arranged that horizontal bars are placed one above the other and vertical bars placed side-by-side, with the flat surface facing front wards to facilitate connections and clear of all equipment.
- Where necessary, busbars shall either be twisted to a 45° angle or shall be stepped in the horizontal plane.
- 50mm spacing between bars to be provided.
- A set of busbars should be installed in each section of a distribution board feeding more than two three phase connections including future equipment.
- These busbars shall not be mounted directly onto the terminals of any triple pole circuit breakers, fuse-switches or isolators.
- Busbars shall be mounted on coloured "ceramic" or "paxalene" or similar insulators. Colour of insulators shall be in phase colours, red, white, blue and black for neutral.
- Busbars for single pole circuit breakers shall consist of solid copper with a minimum cross-section of 1,5mm x 19mm and shall be fixed directly to the terminals of the circuit breakers. Single pole circuit breakers should be grouped distinctly separate for the three phases, in horizontal rows (one above the other) in the following sequence, red, white and blue, starting with red on top.
- Connections to busbars shall be done with lugs, sweated or crimped to cable ends and bolted to busbars with cadmium plated 6mm diameter steel bolts (machined bolts) and nuts. Bolts shall be of the hexagonal head type, with 6mm thread and must be provided with washers, spring washers and hexagonal nuts.
- Busbars are to be drilled and tapped and bolts must be screwed into the busbars from the rear. Connection facilities to busbars shall make provision for the number of three phase connections as well as spare connections specified.
- Spare bolts, complete with washers and nuts, are to be screwed into each busbar, to allow for future extensions.
- Busbars shall be mounted on a rigid chassis and the use of two chassis for the mounting of a busbar will not be permitted. Only similar metals shall be used for busbars and

connections thereto.

- Each busbar shall be provided with one large terminal for the main conductor. All busbars must be accessible from the front.

Wiring specifications;

- Wiring is to be carried out from the sides and in front of the chassis with conductors neatly arranged in horizontal, vertical and at right angles rows and bound together by means of perforated plastic tape (string will not be acceptable).
- Each conductor within the harness shall be kept parallel to the others without twisting or spiralling and shall be free of links.
- Only one conductor per connection point will be permitted
- All wiring is to be kept free and away from any exposed terminals, or other non-insulated current carrying parts.
- Looping from terminals of main switch, circuit breakers, or isolators will be limited to a maximum of only two outgoing circuits per DB, more than two circuits shall be connected to the busbars.
- Only copper conductors will be permitted.
- Internal wiring in the DBs, shall consist of stranded conductors and shall be in the colours of the relevant phases being red, white, blue and black for neutral.
- Colour taped conductors will not be permitted
- Switch boards shall be supplied completely wired and ready for connection.

DB powder coated finish specifications:

- All metal parts shall be degreased, rinsed, pickled, rinsed, phosphate, neutralized and then to be thoroughly dried.
- The above process is to be followed by the following powder coating process, before distribution boards are delivered for installation.
- Powder coating finishing shall be colour B26, SANS 1091 (Electric orange) or a colour as described by the Architect. Care to be taken that all edges are properly covered with powder coating.

Labelling:

- Screwed-on, engraved labels, of the white-on-black type, shall be provided on the front of the DB to identify the equipment and instruments as indicated on the proposed layout.
- Inscriptions shall be 6mm high lettering on Ivorene labels. Fixing screws shall be chrome or brass 6BA roundhead.
- **Note:** All grouped SP circuit-breakers on distribution boards and cubicles must be numbered with suitable engraved printed plastic or Ivorene plates indicating numbers of circuit controlled.
- A neatly typed legend card behind clear "Perspex in a metal frame shall be provided for this purpose.
- The frame shall be spot welded on the inside of the switchboards doors.

ESPL 7 ACCESSORIES FOR SWITCHBOARDS

ESPL 7.1 Mains Surge Arrestors

When a surge arrestor is installed in systems with a main breaker with 250Amps or 5kA fault current, the surge arrestor shall be pre-fused to prevent the units creating a danger when subjected to high fault currents. Surge arrestors shall be pre-fused to the manufactures requirements. All surge arrestors shall be **connection type 2** as per the latest addition of the SANS 10142.

ESPL 7.2 Building with External Lightning Protection

The main distribution board surge arrestors shall be combined type 1 & 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 10/350µs at a maximum discharge current of 100kA.

Any distribution board feeding from the main distribution board shall have surge arrestors and shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.

Each distribution board shall be equipped with mains surge arrestors.

ESPL 7.3 Building With No Lightning Protection

The surge arrestors shall be type 2 and voltage compatible to the relevant installation and shall be able to withstand a lightning impulse current wave form 8/20µs at a maximum discharge current of 40kA.
Each distribution board shall be equipped with mains surge arrestors.

ESPL 7.4 Moulded Case Circuit Breakers

All moulded case circuit breakers shall be as specified in the schedules of equipment for distribution boards and shall comply with SANS 156.

The required frame sizes or rupturing capacities required are specified in the schedules for each board.
Each circuit breaker shall be provided with non-adjustable time-delayed trips.

ESPL 7.5 Current Limiting Circuit Breakers

The current limiting circuit breakers shall be capable of remaining in service and of carrying their normal rated current after having interrupted the maximum short circuit current of 200 kA RMS at least three times.

ESPL 7.6 Contactors

All contactors shall be of the totally enclosed, three pole, double air break per pole, automatic magnetic type complying with the requirements of BS 775 for "CLASS UR" contactors of the "**CLASS II MECHANICAL DUTY CLASS**" and "**A3 Make and Break Category**".

All contactors shall be provided with arc extinguishers, and readily replaceable silver or silver-alloy contacts rated for at least 2-million "on" and "off" switching operations at rated current.

Each contactor shall be provided with an AC, closing coil suitable for continuous operating and at least 15 closing operations per hour at system voltage. The contactor may not hum or chatter in service and the contacts may not bounce on closing.

ESPL 7.7 Time Switches

The time switches shall be suitable for use on a 230 volt, 50 cycle per second AC supply and shall be of the microprocessor type.

The time switches shall be digital timers suitable for rail or surface mounting and shall be programmable with daily and weekly programs, switching intervals of 1 minute and switching accuracy precise to the second.

The time base shall be of the quartz type with LED display for time, weekday, holiday program, switching position and manual override and shall have a power reserve of 250 hours at full operation. The time switches shall have a switching capacity of 16 A at 230V.

ESPL 7.8 Earth Leakage Units

The earth leakage units shall consist of a combination of a earth leakage relay and a moulded case circuit breaker and shall have a sensitivity as specified, it shall conform to SANS 767.

ESPL 8 EARTHING

The contractor shall do all the bonding and earthing in accordance with the latest addition of the "Code of Practice for the Wiring of Premises" SABS 10142.

Earth resistivity measurements of **less than 1 ohm** will be acceptable at motor control centers and distribution boards.

ESPL 9 DANGER SIGNS

Danger signs on aluminum plates shall be supplied on each door of an outdoor motor control center or distribution board and shall be in accordance with the Occupational Health and Safety Act, Act 85 of 1993.

ESPL 10 INSPECTIONS AND TESTS

All equipment will be inspected by the Engineer and tested in his presence both in the factory during manufacturing and on site during installation. The Engineer will do all inspections accompanied by the Contractor and the Contractor will do all tests with the Engineer as witness. The Engineer will require seven (7) days notification to avail himself for any test or inspection and the Contractor must arrange for the maximum number of inspections and tests to be done on the same day. The Contractor must provide all testing facilities and instruments, all equipment required for a test or inspection.

The cost of all tests must be included in the tender price.

ESPL 10.1 Testing Of Distribution/Motor Control Boards

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.

ESPL 10.2 Operating And Maintenance Instructions

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions *in triplicate*, with the necessary drawings and diagrams clarifying the instructions. The Contractor will also provide *3 x "soft copies"* of the complete manual in PDF format on a Suitable sized USB Flash Drive (Memory Stick)

Instructions are to be made up in book form and particular reference is to be made to:

- Maintenance of equipment;
- Precautions to be taken in running the plant;
- All instruments and components must be fully described in data sheets supplied by the relevant suppliers;
- Wiring diagrams of the complete electrical installation.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that this may be used frequently without falling apart. Standard pamphlets may be supplied as addendums, bound separately in a good quality file to serve as reference but will not be allowed as part of the main manual.

ESPL 11 SUPPORTING DOCUMENTATION

ESPL 11.1 Information to Be Submitted With Tenders: 400v Db

Before manufacturing, 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;
b. Three paper prints of an outline drawing of each motor control centre and distribution board indicating the main overall dimensions and general lay-out of the boards; and
c. Three paper prints of an outline drawing of the front end processor cabinet indicating the main overall dimensions, general layout and type of material employed on the face of the panel.

ESPL 11.2 Information Required With Tender Submission

The following information regarding the switch- and distribution boards shall be submitted with each tender.

a. The name and address of the switchboard manufacture.
b. Descriptive literature and technical information of all equipment and instruments offered with the boards.
c. Wiring diagrams of all distribution boards.
d. Schematic single line diagrams of all distribution boards.
e. Elevations showing dimensional information including details such as, but not limited to, the following:
    - Distribution boards height (less any removable lifting angles or eyes)
    - Distribution boards width

- Distribution boards depth
- Location of shipping splits

f. Structure descriptions showing the following:

- Bus ratings
- Enclosure ratings
- Short-circuit withstand ratings
- Other information as required for approval

g. Conduit locations

h. Required bus splices

i. Unit descriptions including information such as, starter sizes, circuit breaker frame sizes, circuit-breaker continuous ampere ratings, and pilot devices

j. Nameplate information

k. Manufacturer drawings shall be provided in PDF format

l. Data sheets and publications on all major components including, but not limited to, the following:

- Motor starters
- Overload relays
- Circuit breaker and fuse information including time current characteristics
- Control power transformers
- Pilot devices
- Relays
- All clarifications and exceptions must be clearly identified

After completion of the work, the contractor shall submit three final copies of each of the above-mentioned drawings showing the final layout and wiring diagram of the boards.

ESPL 11.3 As Built Information

On completion of the works, but before the certificate of completion will be issued, the contractor shall submit to the Engineer, as built information in electronic format indicating in a satisfactory manner:

a) The exact position of all electrical installation equipment in the buildings
b) Distribution board as built wiring diagrams
c) Certificate of Compliance for all building installations

Electronic copies of the various plans for the marking up of the information required will be supplied to the contractor on request.

ESPL 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

ESPL 12.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For distribution board's installation, design information shall include, but limited to as listed in this Particular Specifications.

Pay Item		***Unit***
(a)	Provide design drawings and wiring diagrams as specified	Sum
(b)	Provide operating and maintenance manuals and "as built" drawings as specified	Sum
(c)	Allowance for short circuit analysis and coordination study and protection setting calculations	Sum

ESPL 12.2 Supply And Delivery To Site

Pay Item		***Unit***
(a)	Supply and delivery to site of complete electrical installation equipment as specified	Sum

ESPL 12.3 Installation

Pay Item		***Unit***
(a)	Installation of complete electrical installation as specified	Sum

ESPL 12.4 Commissioning

Pay Item		***Unit***
(a)	Commissioning of complete electrical installation as specified	Sum

END OF SECTION

EMCA MULTICORE CABLES AND EARTHWIRES

INDEX

EMCA MULTICORE CABLES AND EARTHWIRES

EMCA 1 SCOPE OF WORKS

As specified in project specifications

EMCA 2 STANDARDS AND TESTS

Cables shall conform to and be in accordance with the latest applicable South African Bureau of Standards Codes and Standards:

The following Standard Specifications and drawings shall apply:

Standard No.	Description
SANS 97	Electric cables - Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV
SANS 1339	Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 1713	Electric cables - Medium-voltage aerial bundled conductors for voltages from 3,8/6,6 kV to 19/33 kV
SANS 10142	Code of Practice for the wiring of Premises
ITU-T G.651.1	Design of the multimode Fibre Optic network

EMCA 3 CONSTRUCTION DETAILS

EMCA 3.1 Low Voltage Cables

All multi core cables shall be stranded metal annealed copper conductor, PVC insulated, PVC bedded, single wire armoured and PVC sheathed in accordance with SANS 1507 as amended to date for cables with copper conductors and insulated for 500/3300 volt grade.

Cables for status and analogue signals shall consist of the requisite size and number of copper twisted pairs, individually and overall screened, PVC sheathed, steel wire armoured and PVC covered, complying with the requirements of SANS 1507 where applicable.

Cables and earth wires for a specific application shall be selected strictly in accordance with the requirements laid down in SANS 10142 in respect of current rating and voltage drop. Where practicable the earth continuity conductor shall form an integral part of the cable.

EMCA 3.2 Medium Voltage Cables

These cables shall be manufactured in accordance with NRS. 013-1991 and comply with SANS 97 - 1991. All the 11 kV cables shall have copper conductors and shall be suitable for use on an unearthed system.
Three core cables shall be of the fully impregnated belted type. The cable shall have a helical fibrous bedding, lead alloy E sheath, single wire armour and a PVC serving as laid down in the Variations and Additions to the Standard and Particular Specifications, all in accordance with SANS 97 - Table 18. Single core cable shall be fully impregnated, screened general purpose cable with copper conductors suitable for an earthed system. The cables shall be in accordance with Table 11 of SANS 97, shall have a lead alloy E sheath and a PVC anti-electrolytic over sheath. (Type PEC)

EMCA 3.3 Fibre Optic Cables

EMCA 3.3.1 *Communication Network (Fibre Optic Cable - Multimode)*

The multimode Fibre Optic communication network shall have both uplink and downlink connections available.

EMCA 3.3.2 *Technical Design Requirements*

The design of the multimode Fibre Optic network shall include, amongst others the following minimum design requirements:

a) Detailed optical power budget calculations
b) Transceiver SFP details
c) Fibre link lengths
d) dB losses per each patch cord/lead used
e) Any Mid-couplers used
f) Type of Patch panels installed (8-way, 16-way, etc.)
g) Type of connectors used (LC, ST, etc.)
h) Amount of splicing joints made

The design of the multimode Fibre Optic network shall conform, amongst other international standards to the following international standard: **ITU-T G.651.1** specification.

The distances between the sites that will be interconnected will be indicated on the specific drawings and/or project specifications. The contractor shall however confirm these distances as part of their final design.

No splicing of Fibre Optic cable joints shall be allowed, except for termination of the Fibre Optic cables in the patch panels at all the respective sites. The design of the entire multimode Fibre Optic network shall be based on international standards, including but not withstanding the **ITU-T G.651.1** specification. The design shall include, amongst others the technical details specified below:

a) **Type of SFP transceivers selected** - Shall include the following design details:
   - Optical Power Budget (PB)
   - Minimum Optical Power transmission values (dBm)
   - Minimum Receiver sensitivity values (dBm)

b) 76
   - dB losses from connectors;
   - dB losses from patch cords;
   - dB losses from patch panels;
   - dB losses from mid-couplers;
   - dB losses from pig-tails;
   - dB loss/km for each specific Fibre Optic link (@ 850nm wavelength)

EMCA 3.3.3 *Express/Emergency Joints*

Each Fibre Optic link shall be installed without the need for any splicing joints in-between sites. Only splicing at the patch panels on either side (at both sites) is expected. Express or Emergency splicing joints shall only be done when a Fibre Optic cable has been damaged and needs to be temporarily repaired to restore service.

Before commencing with any such endeavours, the Contractor shall firstly request permission from the Engineer if the need to make an Express or Emergency splicing joint arises. The Engineer reserves the right to decline such a request from the Contractor. An express joint shall always be a temporary measure only and the repaired cable shall be replaced as soon as possible (The Contractor shall communicate the time frame on the replacement of the affecting Fibre Optic link to the Engineer).

For Information: The overall design of the Fibre Optic network shall ensure the optimal Optical Power Budget (**PB**) shall remain after installation, to cater for any such temporary Express or Emergency splicing joints, without affecting the overall Quality of Service (QoS) relevant to the Fibre Optic Link affected.

EMCA 3.3.4 *Optic Fibre Optical Characteristics*

The multimode Fibre Optic cable shall conform to the following **Optical** properties and characteristics:

a) 8 cores
b) Typical Core Diameter - 50 µm;
c) Cladding Diameter - 125.0 ± 1 µm;
d) Primary Buffer >250 µm;
e) Secondary Buffer >900 nm;
f) Bandwidth at 850nm – 1000 MHz/km;
g) Cable Fibre Attenuation – <5dB/km @ 850nm, <3dB/km @ 1300nm;
h) Each Optical Fibre shall consist of a doped silica core surrounded by a concentric silica cladding;
i) The Fibre shall be a matched clad design; and
j) The coating shall be dual layered and UV-cured acrylate.

EMCA 3.3.5 *Optic Fibre Mechanical Properties*

The multimode Fibre Optic cable shall conform to the following **Mechanical** properties and characteristics:

a) The cable shall consist of a dielectric, glass reinforced plastic (GRP) rod to prevent bucking of the cable;
b) Water-blocking technology shall be used to impede migration of water through the cable core;
c) Fillers shall be included in the cable core to aid in symmetry of the cable cross-section if needed;
d) A water blocking tape shall be applied longitudinally around the outside of the stranded tubes or fillers;
e) The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and any foreign matter;
f) High tensile strength dielectric yarns shall be helically stranded evenly around the cable core to improve tensile strength;
g) Ripcords shall be provided in the cables for easy sheath removal;
h) The armoured cables shall contain two ripcords under the steel armour;
i) The armoured cable shall contain corrugated steel tape/steel wire, plastic coated on both sides for corrosion resistance;
j) It shall be applied around the outside of the water blocking tape over the dielectric tensile strength members;
k) This shall be done with an overlapping seam with all the corrugations in line;
l) The outer jacket shall be applied over the corrugated steel tape/steel wire armour;
m) The outer jacket / sheath shall be HDPE;
n) The minimal outer jacket thickness shall be 2.0 mm;
o) The cable jacket on the armoured cables shall contain no metal elements and shall be of a consistent thickness;
p) The shipping, storage, and operating temperature range of the cable shall be -40ºC to

+70ºC;

q) The installation temperature range of the cable shall be -30ºC to +70ºC;
r) Cable Sheath Marking - All cables shall have sequential length markings along the cable sheath;
s) The height of the marking shall be approximately 2.5 mm; and
t) As required by Section 350 G of the NESC, ANSI C2-1993, all cables shall have a visual identifier to identify them as telecommunications / data-communications cables.

EMCA 3.3.6 *Fibre Optic Cable Installation Requirements*

The Fibre Optic cable shall be installed in 50mm cable ducts. The requirements for the cable duct shall be as follows:

a) Direct burial type of duct
b) 50mm outside diameter
c) UV rated
d) Pre-installed pull tape
e) Silicone lined for reduction in friction
f) Manufactured according to SABS ISO 9001
g) Jointing of duct only via high compression couplings
h) Ducts shall have a pressure rating > 9 Bar

Where the cable route changes direction (termination of fibre links into buildings, change of direction due to services and infrastructure, etc.), manholes/handholes shall be constructed or installed if of the pre-cast/polyethylene type.

The Contractor shall be required to survey the route prior to the commencement of the installation of the multimode Fibre Optic cables to determine the following:

a) The length of the route that requires the Fibre Optic cable;
b) The terrain conditions and terrain accessibility;
c) Crossings including existing services, streams, rivers, pipelines, etc.;
d) Location and condition of existing manholes (where applicable);
e) Distances between existing manholes (where applicable);
f) Distances between planned new manholes;
g) Accessibility of the terrain, if the use of mechanical hauling equipment is preferred;
h) However, the pulling in of multimode Fibre Optic cables by hand is preferred;
i) Identification and allocation of correct spare pipe to be utilised if available;
j) Once the above has been verified, a proper hauling schedule shall be compiled;
k) Cables are normally available in full drum lengths from the cable supplier and it is essential to make optimum use of the available lengths;
l) Confirm the available lengths from cable supplier before the hauling schedule is compiled;
m) Ensure that the cables are drummed correctly to suit the direction of pull; and

n) Drums shall be unloaded from its transport vehicle using a JCB or fork-lift truck.

EMCA 4 JOINTING OF CABLES

EMCA 4.1 Low Voltage Cables

Joints will only be allowed where more than one full drum length of cable is necessary to complete a specific circuit and must be restricted to the absolute minimum. All joints shall be made to the best practice by competent cable jointers using first class material. The contractor shall maintain the electrical continuity of the armouring in an approved manner at all straight through joints.

Heat shrinkable cable joint kids that will suit the relevant cable size shall be used for all low voltage cable joints

EMCA 4.2 Medium Voltage Cables

On 11 kV cables, straight joints shall be made by means of heat-shrinkable straight through joints for unearthed paper insulated cables up to 11 kV. All cable joint kits shall comply with NRS 053 Specifications

The joints shall be made to the manufacturer's instructions and with materials stipulated in such instructions.
The cores of the cable shall be joined colour to colour or number to number.

EMCA 4.3 Fibre Optic Cables

Joints in fibre optic cable must be avoided as far as possible due to losses in signal strength when jointed.

The joints shall be made to the manufacturer's instructions and with materials stipulated in such instructions.

EMCA 5 TERMINATION OF CABLES

EMCA 5.1 Low Voltage Cables

Low voltage cables shall be terminated with cable glands manufactured of bronze and comprising a barrel with sealing washer and bush nut screwed into one end and a compression nipple with wire clamping ring screwed onto the other end. The opposite end of the compression nipple must have a male electrical thread with locknut. The glands shall be suitably sized for the relevant cables, be of the adjustable type complete with armour clamps and with watertight neoprene shrouds.

Cable terminating glands for outdoor use shall be IP68 rated and provided with waterproofing double inner seals as well as waterproofing seals on nipples. Cable termination glands for high humidity and possible temporary water submerged conditions as for instance in filter lower gallery areas at water treatment plants shall also be IP68 rated with waterproofing double 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.

EMCA 5.2 Medium Voltage Cables

Medium voltage cable terminations shall be heat shrinkable termination kits and shall comply with NRS 053 Specifications.

The cable terminations shall be made to the manufacturer's instructions and with materials stipulated in such instructions.

EMCA 5.3 Fibre Optic Cables

Fibre optic cables shall be terminated by means of suitable glands, ST connections and bus terminals capable of direct connection to the bus interfaces on the bus stations. These bus stations will be housed in separate panels of various motor control centres.

EMCA 6 CONCRETE CABLE SLABS

The cable slabs supplied and installed under this Contract shall be formed solidly out of concrete with steel reinforcing and shall have dimensions of 1 000 x 350 x 100 mm. Alternative block sizes will be considered. The following concrete mixture is desired:

1. Portland cement (dry) - 1 part per volume
2. Clean dry river sand - 3 parts per volume
3. Crushed stone (size 10 mm) - 6 parts per volume

EMCA 7 CABLE TRAYS AND CABLE LADDERS

Heavy duty cable trays and cable ladders manufactured from hot dipped galvanised steel or grade 304 stainless steel, as specified in the Variations and Additions to the Standard and Particular Specifications, shall be supplied and installed as indicated on the drawings. The height of the cable ladder sides shall be 76 mm with the width to suit the number and size of cables to be installed.

EMCA 8 INSTALLATION OF CABLES

EMCA 8.1 Cable Handling

NOTE - Under no circumstances shall the drums be dropped from the transport vehicle onto the ground.
Small drums can be rolled carefully to the installation point. Drums shall never be allowed to roll freely down a slope. In most instances a drum trailer or similar arrangement shall be used. Battens shall only be removed when ready for installation. When deploying cable from a rotating drum into a trench or duct, it shall be ensured that the drum stand or trailer is firmly located and that rotation of the drum during installation shall not cause any problem.

The Contractor shall ensure that the drum does not lie flat during installation and that coils are pulled off thus causing corkscrew twists. This shall be avoided at all cost as this will cause cable damage and installation problems, the replacement costs for the cable of which shall be for the contractor's account. No bends, kinks, damaged cable shall be accepted.

To minimize problems which may arise due to water/moisture contamination, the following guidelines shall be adhered to:

a) Do not cut or break into cables until it is absolutely necessary;
b) Before cutting into or breaking, pump out any standing water in the manhole or trench if applicable;
c) Before cutting or breaking cable, check weather conditions and if applicable cover the manhole/trench with a tent or waterproof covering (Rain, Thundershowers, Hail, etc.);
d) When terminating or splicing always arrange the cable working position 'above ground' so as not to allow the cables to lie on the ground or in water;
e) If a cable end has to be created by cutting through a continuous cable, fit a waterproof sealing end cap until such time is required to open the end of the cable for termination or splicing; and
f) If cut cables have to be left for a considerable period of time like overnight or longer, then the cable shall have to be sealed to prevent water ingress.
g) Where patch panel are installed, the patch panels shall be earth bonded to earthing bars.
h) The Contractor shall strictly comply to all the manufacturers recommendations, and everything shall be accordance to Aberdare Cable Facts and figures booklet. Extreme care shall be used not to damage cables as cable replacement shall be at the contractor's expense.
i) The Contractor shall use the Aberdare Cable Facts and figures booklet to submit a detailed quality control plan and submit to Engineer for approval.

EMCA 8.2 Cable Trenches

The contractor will 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. The Contractor however will be responsible for the bedding and filling soil in cable ducts where necessary. A sealing screed to cover the cable duct shall be provided by others unless otherwise stated in the Variations and Additions to the Standard and Particular Specifications and relevant drawings.

The Contractor may need to adjust trench depths to accommodate bedding where required. The padding and bedding materials shall be sieved to a maximum allowable of 4mm size, approved by the Engineer. Large objects shall not be dumped into the trench. Removal of rubble shall be the responsibility of the Contractor.

All ducts and pipes shall be well sealed at entry/ exit points of manholes/handholes. General Backfill shall consist of the material excavated from the trench, provided that:

a) The material is easily workable and compactable;
b) The material is free from organic material (roots, grass etc.) rubbish, clay lumps and aggregates stuck on the 4mm sieve shall be disposed of; and
c) The material has suitable moisture content and is not too dry.

If the site materials cannot meet these requirements, then suitable material shall be imported. Compaction of suitable bedding material of thickness 100 mm shall be achieved by passes over the whole trench bed, preferably using a Power Vibrating Rammer or a 5 kg hand rammer as an alternative. The cable/duct/sleeve shall then be laid on the prepared bed. For any variations to this procedure, approval shall firstly be required from the Engineer.

An appropriate amount of slack shall be looped and retained where splices are to be made (at all designated sites). Self-expanding polystyrene type foam shall be injected into the communication tube openings after the cable has been pulled in to seal the ends of the tubes and to stop the ingress of sand, rodents, etc. at these manholes.

All trenches shall be backfilled with suitable material that is easily workable and compactable. The backfill material shall be free from grass and roots. If the backfill material is too dry, it shall be moistened prior to placing and compacting.

Each layer of 150 mm thick compacted backfill shall be tested to the following requirements using the standard 5 kg DCP test method or an appropriately SABS recognised Density Test Method:

Road Trenches: Minimum of 5 blows per 100 mm penetration

Sidewalk, driveways and median trenches: minimum of 3 blows per 100 mm penetration

Verge trenches: minimum of 2 blows per 100 mm penetration

Trenches in the verge (unhardened areas) may be backfilled and compacted in 300 mm loose layers. All test results shall be recorded and handed to the Engineer. The Engineer reserves the right to carry out their own DCP testing and should minimum requirements not be achieved on completed work, the Contractor shall be required to remove and redo the operation to ensure compliance.

The procedure to deal with existing services shall be as follows:

a) Where required trenches have been identified in areas by the Contractor, and where infrastructure are/may be prevalent, pilot holes shall be dug at intervals along that run.
b) These pilot holes shall be dug either as per one or a combination of the following:

    - ≤ 20 m for trenches less than equal to 200m
    - ≤ 25 m for trenches greater than 200m
    - Or as per the site requirements and/or site instruction.

c) Pilot holes shall be dug at points where the new trench crosses known existing services, according to way leave plans and/or other drawings and including verbal communication from the client's site personnel.
d) The pilot holes shall be at least 150 mm deeper and wider than the proposed excavation so as to reveal the presence of any services belonging to other administrations.
e) These Pilot holes shall be dug by hand, and with the utmost of care.
f) All excavation work shall be performed under the supervision of a responsible and competent person who shall be competent to exercise such supervision.
g) Failure to abide by any of the above instructions, may/can lead to damages to existing services. The contractor shall be liable for all damages to existing services, and the subsequent repairs shall be carried out by the contractor without any delay.

The trench shall be laid out in such a position that the cables/ducts/sleeves shall be laid at least 300 mm from power cables. Where this is not possible with services that are in the way of the cable/duct/sleeve and if there is insufficient space for the 300 mm separation, then the cable/duct/sleeve shall be tunnelled 300 mm underneath the other services. Storm-water gutters and drains shall not be obstructed.

Where it is not possible to get the minimum required depth, the cables/ducts/sleeves must be boxed in concrete to a required thickness of 50 mm and strength of 20 MPa. Trenching for cables shall be excavated in straight lines in accordance with the servitude/way leave plan, except where

obstruction or other conditions occur. These areas shall be pointed out to the Engineer for his approval on any route diversions.

Before commencing with cable/duct/sleeve-laying operations in an excavated trench the Contractor shall suitably prepare the trench floor to provide firm support for the cable/duct/sleeve over their full length. To this end he must ensure that the trench floor is free from all loose and or unsuitable material, including soil saturated with water, evenly levelled and at the proper depth required for the cable/duct/sleeve.

The Contractor shall exercise due care in trimming and/or undercutting trench floors to ensure that only the necessary amount of ground is removed. Should the Contractor remove, either by neglect or bad workmanship more ground than is necessary, he shall at his own cost fill such excess excavation with compacted bedding material.

The Contractor shall pay particular attention to the proper compaction of bedding, padding and backfilling material. The approved type of marker tape, orange in colour and a minimum width of 150mm (warning tape with inscription: "**Warning - Fibre Optic Cable Below**" for Fibre and **Electric Cable Below**) shall be laid 300 mm above the cable/duct/sleeve over the entire length of the cable/duct/sleeve run. A high standard of compaction effort shall be incited upon in all cases where fine materials are approved as bedding and padding.

The Contractor shall supply tamping tools for the manual compaction of padding material immediately adjacent to and between the cable/duct/sleeve. A suitable tamping tool shall be provided similar to the following:

a) A tamping foot made up of a 37 mm diameter steel rod 300 mm long securely attached to a vertical handle made up of 20 mm steel rod 1.35 meters long.

During the compaction of padding and backfill material the Contractor must exercise due care to ensure that cable/ducts/sleeves are not disturbed or damaged in any way. The use of non-cohesive, single size, graded sand or crusher sand for bedding, surround blankets and backfilling of trenches shall not be permitted.

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 Employer.

Cable trenches for low Voltage power and lighting cables shall be deep enough to facilitate the laying of these cables at a depth of minimum of **750mm** below final ground level.

Trenches for Medium Voltage power cables shall be deep enough to facilitate the laying of these cables at a depth of **1000mm** below 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 or sifted soil [4mm sieve – the soil shall first be approved by the Engineer] 75 mm over and 75 mm below the cable. Clayey soil will not be accepted as bedding.
o cable trench shall be back-filled before the cable(s) in the trench has been inspected and approved by the Engineer.

EMCA 8.3 Under Ground Cable Pipes

Cable pipes will be supplied and installed by others unless indicated otherwise on the drawings.

Each cable pipe shall be sealed by the Contractor under this Contract at both ends by means of bitumen impregnated jute bags or similar material, after the cable has been installed.

EMCA 8.4 Cable Slabs

Where electrical cables cross above other services such as water pipes, sewerage pipes, other electrical cables, pilot cables and telephone cables or where danger exists that cables may be damaged due to excavations by others cables shall be protected by means of reinforced concrete slabs. The concrete slabs shall protect the cable for at least 0,5 m in both directions of the crossing.

Where electrical cables cross underneath other services such as water pipes, sewerage pipes, post office cables etc. a concrete slab shall be placed above and axial with the other service and should the free space between the two services be less than 300 mm an additional slab shall be placed axial with the electrical cable between the two services.

Where cables are laid down a grading and a possibility exist that the cables might be washed open due to rain, then cable slabs shall be placed on top of the cables for the entire length of the grading.
The concrete slabs shall be supplied and installed under this Contract.

EMCA 8.5 Cable Crossing With Other Services

EMCA 8.5.1 *General*

Where a cable is laid above another service it shall not be less than 750 mm below ground level, and if this is not possible, the cable shall be laid underneath the other service and shall be

protected by means of concrete slabs in the manner prescribed. The deeper or shallower positions of the cable shall only apply for a distance of 1 m on both directions of the crossing.

If not possible to cross underneath the other service the matter shall be referred to the Engineer for a decision.

EMCA 8.5.2 *Clearances*

The following minimum clearances shall be maintained between electrical cables and other services:

DESCRIPTION	VERTICAL	HORIZONTAL
Telkom cables	0,3m	0,3m
Other water pipes	0,3m	0,3m
Sewerage pipes	0,3m	0,8m
Storm water pipes	0,3m	0,6m
Other Electrical cables	150mm	150mm

EMCA 8.6 Cables must be Laid without Delay

The cables shall be laid with the minimum of delay in order to backfill the trenches as soon as possible.

The Contractor shall, however not backfill the trench until each length of cable has been tested, inspected and approved by the Engineer.

Only one cable shall be laid at a time and the Contractor shall ensure that cables already laid are not damaged.

EMCA 8.7 Method

All cables shall be handled with the utmost care and shall be laid in accordance with the best methods observed in good modern practice. All cables shall be run out on rollers in order to prevent abrasion and no cable shall be dragged along the ground. No cable shall be bent to a radius of less than 12 times its overall diameter.

a) In Concrete Ducts

Cables shall be laid neat parallel with each other on the floor of the duct with the maximum spacing. Any other cables shall be installed on cable ladders secured to the vertical sections of the cable ducts.

b) On cable ladders

Cable shall be installed neat and parallel with each other with the maximum spacing. On Horizontal sections the cables shall be secured to the cable ladders with intervals of not more than 2m. On vertical sections or where the cable ladders are installed at an angle the cables shall be secured to the cable ladders with intervals of not less than 500mm with suitable strapping material approved by the Engineer.

Either stainless steel or hot dipped galvanized steel cable strapping material shall be used on outdoor cable installations depending on the cable rack or ladder material.

Sections of the cable ladders shall be electrically connected and provision shall be made for crimping and expansion of the racks.

c) In Trenches

Two or more L.T. cables in the same trench shall be laid in a straight line and in parallel and not less than 75mm apart between cable route turning points, except where otherwise approved. Cable routes shall always follow routes parallel to permanent structures to facilitate as built information.

H.T. cables in the same trench shall be laid parallel and not less than 150mm apart, except where otherwise approved.

All L.T. power cables shall be laid 750mm below final ground level and H.T. power cables shall be laid 1 m below final ground level.

The contractor shall provide 3m slack at each end in each run of power cable and its associated earth wire and bury the same in the ground as near to the relevant end as possible. Where the cables and earth wires are to be installed in open ducts outside buildings, the slack shall be coiled in the ducts.

The separation between any signal cable and the nearest parallel power cable shall not be less than 150mm.

d) Against Walls

Cables and earth wires to be installed on walls, where approved by the Engineer, shall be neatly installed on heavy-duty hot dipped galvanised steel cable racks. Cables and earth wires on outside walls shall be installed in a similar manner or in suitably sized hot dipped galvanised conduit from 300 mm below up to 2,4 m above final ground level or as required. These conduits shall be secured to the walls by means of hot dipped galvanised steel bat holders at intervals not exceeding 600 mm. (Hospital Saddles).

Saddles shall only be secured by means of round-headed hot dipped galvanized screws and plugs of an approved type. (Wood will not be accepted as plugging material.) Plugs will not be allowed in joints between bricks.

e) On Poles

Cables and earth wires to be installed on poles shall be secured to the poles at intervals not exceeding 600 mm by means of 25 mm x 1,5 mm adjustable Grade 304 Stainless Steel straps. Each cable together with its associated earth wire shall be installed in a suitably sized stainless steel pipe or channel from 300 mm below up to 2,4 m above ground level. This pipe or channel shall be secured to the pole by means of 25 mm x 1,5 mm adjustable stainless steel straps at intervals not exceeding 600 mm. To avoid metallic action between different materials Neoprene rubber strip shall be installed between the pole and the strap.

f) Cable Channels on Structures and in Buildings

Where cable channels have been provided on structures and in buildings these must be backfilled with river sand by the contractor.

g) Cables connected to motors and other equipment

Cables and earth wires connected to motors and other equipment shall be secured between the cable channels, cable rack or cable tray to the point of termination by means of a heavy-duty hot dipped galvanised type of cable support. The cable shall be secured to the cable support by means of steel straps or other acceptable strapping material.

EMCA 8.8 Inspection of Cables and Cable Trenches

After the cables have been installed and spaced on top of the 75mm thick layer of sand in the trenches, the installation shall first be inspected and approved by the Engineer before the trenches may be refilled. Should the Contractor not meet with the requirement, or if he fails to give the Engineer sufficient notice of an inspection, portions of the trenches or the complete trench shall have to be re-excavated by the Contractor at his own expense for inspection by the Engineer.

A logbook with three copies per page shall be kept by the Contractor on the site, in which each part of the installation that has been inspected can be recorded after inspection and approval.

EMCA 8.9 Backfilling of Trenches

Once the cable has been laid, straightened, inspected, approved and covered with the top layer of bedding soil, the trenches shall be backfilled with soil which does not contain more than 40 %

rock or shale and will pass through a sieve with 100 mm diameter holes that has been approved by the Engineer.

Back filling of cable trenches shall be done in layers of 150 mm and shall be compacted and consolidated to 95% modified AASHTO. Test shall be carried out to ensure the required compaction at the cost of Contractor.

The Contractor shall maintain the closed up sections of the cable trenches in a proper, safe condition for the duration of the contract. Where the soil in the trenches subsides it shall be refilled and compacted to the satisfaction of the Engineer.

Bedding: This shall refer to the material constituting the even floor of an excavated trench onto which a duct or a bank of ducts is laid (+/-100mm).
Padding: This shall refer to the material installed around and/or between ducts up to a level of at least 150 mm above the duct or bank of ducts.
Backfilling: This shall refer to the material installed above the padding material layer to complete the refilling of an excavated trench.

The 3 layers of material in the backfilled trench shall be classified as bedding, padding, and main backfill. The bedding and padding material shall not be too fine, and shall be free of large stones (it shall be evenly graded between 0,6 mm and 19 mm). Clay type material shall not be acceptable (the PI shall not exceed 12 and the compaction factor shall not exceed 0.4).

EMCA 9 INSTALLATION OF CABLE TRAYS AND CABLE LADDERS

The cable ladders shall be secured on suitable lengths which shall be suspended from the roof slab by means of suitable lengths 8 mm dia threaded hot dipped galvanized steel rods or secured to the walls with suitable sized hot dipped galvanized steel Rawl type bolts and shall be secured to the channel sections by means of two hot dipped galvanized nuts and washers.

The different parts of the trays and ladders must be thoroughly bonded electrically and mechanically to each other.

The cable trays and ladders shall be installed neatly, level and square/parallel to walls.

Cable straps suitable for the specific cable shall be employed to secure the cable onto the tray. Outdoor cable straps shall be stainless steel and cables shall be secured on intervals not exceeding 600mm. Cables on cable trays or ladders in outdoor environments shall be covered with removable cable tray or ladder covers of similar material.

EMCA 10 CABLE SUPPORTS TO MOTORS AND OTHER EQUIPMENT

Cables to motors and other electrical equipment shall be supported by means of hot dipped galvanized cantilever brackets and cable supports. Cables shall be strapped to these supports by means of acceptable strapping material.

EMCA 11 WIRE TRUNKING

Heavy duty hot dipped galvanised wire trunking of sufficient dimensions shall be installed against all large capacity pump set concrete plinths for installation of pump set protection sensor monitoring cables. The monitoring cables shall be installed in hot dipped galvanised conduit from the trunking to the sensor position.

EMCA 12 SENSOR TERMINATION CUBICLE

All large capacity pump set sensor cables shall be terminated in a powder coated mild steel frame mounted termination cubicle with lockable front door secured against the pump set plinth. DIN rail mounted cable conductor termination blocks shall be installed inside the termination cubicle for cable conductor termination.

EMCA 13 CABLE MARKERS

Cable ends shall be properly labelled with reference to equipment, section of plant and other requirements specified by the client at both cable ends.

Cable markers with lead labels cast into the top of the cable markers shall be supplied and installed along the cable routes under this Contract as follows:

Along straight runs of the route, not further than 25 m apart;

At turns - one on each side of the turning point, 900 mm from such turning points;
At each branch, 3 markers - i.e. one on each side of the branch, 900 mm from the branch.

The cable markers shall be installed deep enough to ensure that the top of the marker will protrude 50 mm above final ground level.

EMCA 13.1 Name Tags

Identification tags shall be attached to all cable ends. The tags shall be secured to cables by means of cable ties to the approval to the Engineer.

Cables shall be tagged at either end, whether the end terminates in a distribution board or an end box.

All cable cores and internal panel wiring shall be identified at both ends by means of durable colour coded wire marking ferrules in accordance with numbering systems in cable and wiring diagrams. Only closed ring interlocking type identification ferrules shall be used.

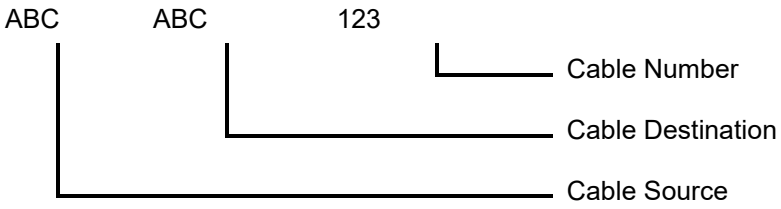
Outdoor tags shall be of stainless steel or brass type and shall be secured by means of similar strapping material.

Tags mounted indoors or protected by an enclosure shall be made of Ivorene or similar sandwich material with black letters on a white background.

All lettering and text shall be approved by the Engineer.

Letter sizes must be compatible with the application and shall not be smaller than 8mm.

a) Cable Naming Convention



b) Table of Areas

Example of area abbreviations:

ILW	-	Inlet works
IMC	-	Inlet motor control centre

c) Example of cable schedule;

Cable Number	From	To	Grade (V)	Size mm²	No. of cores	Length (m)
ILW-IMC-001	Inlet works	Inlet motor control centre	400	185	4	55
IMC-SCR-001	Inlet works MCC	Screen 01	400	10	4	25

EMCA 14 WARNING TAPES

Warning tape shall be installed along all trench excavated cable routes 300mm above the cables.

Warning tape shall have a minimum width of 300mm and have a bright orange colour with the wording “Danger”. The minimum thickness shall be 800 gauge.

EMCA 15 EARTH WIRES

Earth wires shall be installed with L.T. cables as and where indicated on the drawings or specified herein and shall consist of bare hard-drawn copper wire.

These earth wires shall be installed at the same depth as the relevant cables, with at least 75 mm clearance between any earth wire and the nearest cable, unless specifically approved otherwise.

No joint will be allowed in any run of earth wire.
Each earth wire shall be terminated at each end by means of a suitably sized bolted lug either sweated or crimped onto the wire. The lugs shall be bolted onto the relevant earth bars or earthing terminals.

EMCA 16 TESTING OF CABLES

EMCA 16.1 Low Voltage Cables

On each completed section of laid and jointed cable, the insulation shall be tested to approval with an approved "Megger"-type instrument of not less than 500 V.

EMCA 16.2 Medium Voltage Cables

On each completed section of laid and jointed high tension cable a high voltage test shall be carried out. The test shall be performed according to SABS 97 of 1991. Alternating or direct current may be used.
A certificate shall be submitted confirming the successful testing of the relevant cable.

EMCA 17 ROUTE PLANS TO BE SUBMITTED BY THE CONTRACTOR

On completion of the works, but before the certificate of completion will be issued, the contractor shall submit to the Engineer, route plans in electronic format indicating in a satisfactory manner:

(a) The exact cable routes with reference to fixed points (e.g. buildings);
(b) The exact lengths of cable (HT and LT) installed between terminating points and between

joints where relevant; and

(c) With reference to fixed points the exact positions of cable joints (e.g. buildings).

Electronic copies of the various plans for the marking up of the information required will be supplied to the contractor on request.

EMCA 18 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

EMCA 18.1 Design, Drawing And General

The rate tendered shall include for the provision of the necessary design information for all items measured under the respective schedule. For multicore cables and earthwires, design information shall include, but limited to as listed in this Particular Specifications.

The Contractor shall be required to complete this design and engineering tasks and the contractor shall allow adequate time for the complete design and engineering of the multicore cables and earthwires.

	Pay Item	***Unit***
(a)	The Contractor will provide the following design calculations, drawings, method statements, cable routes, cable schedules in excel format which will include but limited to From, To, Distance and Tag numbers all to the approval of the Engineer [Refer to particular specification EMCA 3.3.2, 8.7 & 17]	Sum
(b)	Provide operating and maintenance manuals, all data sheets [a) cables, b) joint kits, c) ladders, d) glands, conduit, fasteners and all that are used and etc] and furthermore the Contractor to supply as built" drawings	Sum

EMCA 18.2 Supply And Delivery To Site

Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, factory acceptance testing, transport, import duties, handling and possibly double handling, delivery to and off-loading at Site as well as temporary storage prior to installation. For multicore cables and earthwires, the rate tendered shall be for the multicore cables and earthwires and shall include, but not limited to, as detailed in this Particular Specifications. Any special devices shall be listed separately in Variations and Additions to the Standard and Particular Specifications and schedule of quantities.

	Pay Item	***Unit***
(a)	Supply and delivery to site of multicore cables and earthwires and cable name tags for the following cables as per the particular specification	Meter (m)
(b)	Supply and delivery to site of all multicore cables and earthwires termination materials [equal or similar to Enviro Glands, neoprene shrouds, lugs, insulating, materials, cable ties and corrosion proof bolts, washers, spring washers, nuts, etc] to terminate the following cables as per the particular specification	Each
(c)	Supply and delivery to site of cable route markers	Each
(d)	Supply and delivery to site of concrete cable slabs	Each
(e)	Supply and delivery to site of [**Type**] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular specification	Meter (m)
(f)	Supply and delivery to site of [**Type**] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular specification	Each
(g)	Supply and delivery to site of all [**Type**] heavy-duty cable ladder supports, bolts, holders and etc that is required as per the particular specification	Sum
(h)	Supply and delivery to site of pump set sensor termination cubicles	Each
(i)	Supply and delivery to site of HPDE heavy-duty cable sleeves, joints, sealing rings, couplings, end plugs, spacer modules, bell mounth, manderel, duct brush flexibend, stainless steel draw wire long bend as per the particular specification	Meter (m)
(j)	Supply and delivery to site of all Equal or similar Pratley EZEE-Fit with solid cover IP68 including non sparking connectors, insulating sleeves, identification tag, mounting screws, locknuts , lockout device with lock, lid securing chain and all accessories	Each
(k)	Supply and delivery to site of all 316 Stainless Steel Conduit with saddles, fasteners, surface mounted against brick or concrete every 500mm and all accessories	Meter (m)
(l)	Supply and delivery to site of all soil for the bedding of cables during excavations including cleaning of cable routes complete as per particular specification.	m^3

EMCA 18.3 Installation

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, grouting, but not limited to and getting ready for testing and commissioning. Install of multicore cables and earthwires shall be accordance with the manufacturer's written instructions and recognized industry practices, the above particular specification, to ensure that the multicore cables and earthwires complies with the requirements and serves the intended purposes. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of Installation" and particular specification, for installation of multicore cables and earthwires but not limited to.

	Pay Item	***Unit***
(a)	Installation of all multicore cables and earthwires and cable name tags for the following cables as per the particular specification	Meter (m)
(m)	Installation of all multicore cables and earthwires termination materials [equal or similar to Enviro Glands, neoprene shrouds, lugs, insulating, materials, cable ties and corrosion proof bolts, washers, spring washers, nuts, etc] to terminate the following cables as per the particular specification	Each
(n)	Installation of cable route markers	Each
(o)	Installation of concrete cable slabs	Each
(p)	Installation of [**Type**] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular specification	Meter (m)
(q)	Installation of [**Type**] heavy-duty cable ladder, trunking, welded wire mesh and accessories including all necessary supports, clamps strapping, brackets, reducer splice, hangers, threaded rods, trunking, bolts, nuts and anchor bolts etc as per the particular specification	Each
(r)	Installation of all [**Type**] heavy-duty cable ladder supports, bolts, holders and etc that is required as per the particular specification	Sum
(s)	Installation of pump set sensor termination cubicles	Each
(t)	Installation of HPDE heavy-duty cable sleeves, joints, sealing rings, couplings, end plugs, spacer modules, bell mounth, manderel, duct brush flexibend, stainless steel draw wire long bend as per the particular specification	Meter (m)
(u)	Installation of Equal or similar Pratley EZEE-Fit with solid cover IP68 including non sparking connectors, insulating sleeves, identification tag, mounting screws, locknuts , lockout device with lock, lid securing chain and all accessories	Each
(v)	Installation of 316 Stainless Steel Conduit with saddles, fasteners,	Meter

	surface mounted against brick or concrete every 500mm and all accessories	(m)
(w)	Installation of all soil for the bedding of cables during excavations including cleaning of cable routes complete as per particular specification.	m³
(x)	Excavating, back filling, consolidation, importation of soil and dumping of all rock and stone removed during excavations including cleaning of cable routes all according to particular specification (including hand excavations where necessary along existing cable routes.	Sum

EMCA 18.4 Commissioning

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, all testing apparatus, instruments and equipment, any/all consumables required for testing purposes and to prove performance, any/all temporary works, any/all control checks, and compilation of final commissioning report. Comply with the requirements of SABS and IEC standards and applicable portions of "Standard of commissioning".

Pay Item		***Unit***
(a)	Testing and commissioning of all cables	Sum
(b)	Updating, verifying and submission of Electronic Cable schedules with Tag numbers and final agreed lengths	Sum
(c)	Surveyor to mark-up as-built cable route plans and all mark-up must be on made on the AutoCAD format	Sum

END OF SECTION

ESLS SITE LIGHTING SYSTEM

INDEX

ESLS SITE LIGHTING SYSTEM

ESLS 1 SCOPE

As specified in the Project Specifications.

ESLS 2 STANDARDS AND TESTS

The following standards, regulation and drawings, etc. shall be applicable to the electrical installations related to this particular specification, whereas the latest applicable South African Bureau of Standards Codes and Standards should be used;

Standard No.	Description
SANS 156	Moulded case circuit breakers
SANS 1777	Photoelectric control units for lighting
SANS 10142	Code of Practice for the wiring of Premises
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300V)
SANS 1063	Earth rods and couplers
SANS 1213	Mechanical cable glands
SANS 1433-1	Terminal blocks having screw and screwless terminals
SANS 10199	The design and installation of an earth electrode
SANS 10292	Earthing of low-voltage distribution systems
SANS 10313	The protection of structures against lightning

ESLS 3 15M MAST SITE LIGHTING SYSTEM

The site lighting system will consist of a 15m mast, fitted with 160 W LED flood lights complete with control gear as specified in the project specifications.

Each scissor mast shall be equipped with three (3) floodlights and shall be balanced for easy and safe lowering of mast.

ESLS 3.1 Adjusting Of Luminaires

The Tenderer must allow in his Tender for at least one visit to site after dark for adjusting of the luminaries in the presence of the Engineer.

ESLS 3.2 15m Scissor Type Masts

The hinged masts complete with the foundation, prescribed luminaires, circuit breakers inside the mast must be supplied and installed under this contract.

ESLS 3.3 Lighting Columns

The columns offered shall have an overall floodlight mounting height of 15 meters. The cross section and wall thickness of the columns offered shall be determined by the Tenderers on the basis of working loads. However, the manufacturer shall reinforce the column in those sections which are stressed by the frame during raising and lowering to ensure that the metal in these sections shall not crack, tear, stretch or be damaged in any way. The top of the columns shall have suitable mounting brackets to suit the floodlights offered.

ESLS 3.4 Construction

The column shall be continuously tapered and shall be equipped with tamper-proof locking device for the raising and lowering action of the column.

ESLS 3.5 Protection and painting

All steel parts of the mast and head frame shall be heavy duty hot-dip galvanised.

ESLS 3.6 Electrical equipment and mounting plate

Each flexible multi core cable shall be 600/1000V rated, with a minimum 4 mm² diameter PVC/SWA/PVC copper cable with suitable number of cores. Each core shall be rubber insulated and the multi core cables shall be overall sheathed to give a circular form. The final sheath shall be of chloroprene.

The cable shall have numbered cores with one green/yellow earth core.

The cable shall be provided with an approved tension sock at the point of suspension.

In the event of the luminaire control gear being situated at the bottom of the mast, special cables shall have to be used to allow for the higher voltage, as required. Details of these cables have to be submitted to the Engineer for approval.

ESLS 3.7 Access door to electrical equipment

The access door shall be close fitting, vandal resistant and weatherproof.

ESLS 3.8 Transport

Special care must be taken in the handling of the galvanised mast during loading and off-loading to avoid any damage to galvanised surfaces. During transit, the mast must be supported on wooden blocks and secured in position to avoid surface damage.

ESLS 3.9 Guarantee

The manufacturer shall guarantee the column against faulty workmanship, incorrect design and material specification. Should the column be damaged due to any of the above, the manufacturer shall replace the damaged mast and fittings at own expense. All electrical equipment shall be guaranteed against faulty workmanship for a period of one year as described in the Conditions of Contract.

ESLS 3.10 Installation of masts

The masts shall be installed in accordance with the manufacturer's Specification.

ESLS 3.11 Earthing

Each mast shall be earthed by means of at least 4 x 1,2m earth spikes to allow an earth resistance of 1 ohm or less. Each spike shall be connected with a 70mm² bare copper conductor to the bolting-down assembly inside the concrete foundation. Approved clamps shall be used to ensure positive contact at the connection point between the copper and steel.

The earthing of the electrical installation of the mast is by means of the earthing supplied with the feeder cable. The earth bar in the distribution board shall be connected to the earth stud in the mast.

ESLS 3.12 Pole Lightning arrestor

The contractor shall install a pole lightning arrestor on the top of the high mast to protect the luminaires from direct lightning strikes.

A "Copper weld" copper steel bi-metallic rod with a spindle on top shall be used for the pole arrestor. The minimum length of the pole arrestor shall be equal to the radius of the luminaire cluster with the luminaires installed. The diameter of the "Copper weld" rod shall be submitted to the Engineer for his approval.

The pole arrestor shall be attached to the top column of the mast by means of two non-ferrous mechanical clamps and bolts. A 70mm² single core copper earth conductor shall be installed inside the mast. A cable lug shall be crimped on the two ends of the earth conductor for bolting to the earth bar and pole arrestor as appropriate. Any type of brazing will not be permitted.

ESLS 3.13 Delivery

Prices quoted shall make provision for supply, delivery and installation of material on site.

ESLS 4 STREET TYPE SITE LIGHTING SYSTEM

ESLS 4.1 Street Lighting System

A standard type streetlight mast for suburban routes with total length of 8,5m and single outreach arm of 0,5m complete with 36W LED light fitting and 36W LED lamp shall be supplied and installed as specified and indicated on drawings.

The mast shall be complete with base plate, bottom cable entry, switchgear compartment with removable cover, cable gland plate, 5A circuit breaker and mounting strip for clip on terminal blocks.

ESLS 4.2 Protection and Painting

All steel parts of the mast and head frame shall be heavy duty hot-dip galvanized.

ESLS 4.3 Electrical Equipment and Mounting Plate

Each mast shall be equipped with a hot dipped galvanized gland plate with provision for two number 2 PVC SWA PVC cable glands as well as Din rail mounted type connector blocks for conductor connection and 5 Amp circuit breaker.

ESLS 4.4 Flexible Multi Core Mast Cables

Each flexible multi core cable shall be 600/1000V rated, with a minimum 4 mm² diameter PVC/SWA/PVC copper cable with suitable number of cores. Each core shall be rubber insulated and the multi core cables shall be overall sheathed to give a circular form. The final sheath shall be of chloroprene.

The cable shall have numbered cores with one green/yellow earth core.

The cable shall be provided with an approved tension sock at the point of suspension.

ESLS 4.5 Access Door to Electrical Equipment

The access door shall be close fitting, vandal resistant and weatherproof.

ESLS 4.6 Transport

Special care must be taken in the handling of the galvanised mast during loading and off-loading to avoid any damage to galvanised surfaces. During transit, the mast must be supported on wooden blocks and secured in position to avoid surface damage.

ESLS 4.7 Installation Of Masts

The masts shall be installed in accordance with the manufacturer's Specification.

ESLS 4.8 Earthing

The earthing of the electrical installation of the mast is by means of the earthing supplied with the feeder cable. The earth bar in the distribution board shall be connected to the earth stud in the mast.

ESLS 5 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

ESLS 5.1 Supply and Delivery to Site

Pay Item	***Unit***
Supply and delivery to site of complete mast as specified	Sum
Supply and delivery to site of complete streetlight pole as specified	Sum

ESLS 5.2 Installation

Pay Item	***Unit***
(d) Installation of complete mast as specified	Sum
Installation of complete streetlight pole as specified	Sum

ESLS 5.3 Commissioning

Pay Item	***Unit***
(a) Commissioning of complete mast as specified	Sum
Commissioning of complete streetlight pole as specified	Sum

END OF SECTION

C3.5B EMPLOYER'S OCCUPATIONAL HEALTH AND SAFETY SPECIFICATION

RLM/RWST/OMM/0101/2024/25 - RE-ADVERT: APPOINTMENT OF A CONTRACTOR FOR CONSTRUCTION OF BOSPOORT NORTH RESERVOIR AND ACCESS ROAD

Developed by Pieter Herbst

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

Employer's Occupational Health and Safety Specification

INDEX

1. DEFINITIONS

a) "**Construction Regulations**" means the Occupational Health and Safety Act's, No 85 of 1993, Construction Regulations 2014 that has come into effect on August 7, 2014;

b) "**agent**" means a competent person who acts as a representative for a client;

c) "**angle of repose**" means the steepest angle of a surface at which a mass of loose or fragmented material will remain stationary in a pile on the surface, rather than sliding or crumbling away;

d) "**bulk mixing plant**" means machinery, appliances or other similar devices that are assembled in such a manner so as to be able to mix materials in bulk for the purposes of using the mixed product for construction work;

e) "**client**" means any person for whom construction work is being performed;

f) "**competent person**" means a person who -

- 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
- is familiar with the Act and with the applicable regulations made under the Act;

g) "**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;

h) "**construction site**" means a work place where construction work is being performed;

i) "**construction supervisor**" means a competent person responsible for supervising construction activities on a construction site;

j) "**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;

k) "**construction work**" means any work in connection with -

- the construction, erection, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure; or
- the construction, erection, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system; or the moving of earth, clearing of land, the making of excavation, piling, or any similar civil engineering structure or type of work;

l) "**construction work permit**" means a document issued in terms of regulation 3;

m) "**contractor**" means an employer who performs construction work;

n) "**demolition work**" means a method to dismantle, wreck, break, pull down or knock down of a structure or part thereof by way of manual labour, machinery, or the use of explosives;

o) "**design**" in relation to any structure, includes drawings, calculations, design details and specifications;

p) "**designer**" means -

- a competent person who -
  - prepares a design;
  - checks and approves a design;
  - arranges for a person at work under his or her control to prepare a design, including an employee of that person where he or she is the employer; or
  - designs temporary work, including its components;
  - an architect or engineer contributing to, or having overall responsibility for a design;
  - a building services engineer designing details for fixed plant;
  - a surveyor specifying articles or drawing up specifications;
  - a contractor carrying out design work as part of a design and building project; or
  - an interior designer, shop-fitter or landscape architect;

q) "**excavation work**" means the making of any man-made cavity, trench, pit or depression formed by cutting, digging or scooping;

r) "**explosive actuated fastening device**" means a tool that is activated by an explosive charge and that is used for driving bolts, nails and similar objects for the purpose of providing fixing;

s) "**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;

t) "**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;

u) "**fall protection plan**" means a documented plan, which includes and provides for -

- all risks relating to working from a fall risk position, considering the nature of work undertaken;
- the procedures and methods to be applied in order to eliminate the risk of falling; and
- a rescue plan and procedures;

v) "**fall risk**" means any potential exposure to falling either from, off or into;

w) "**health and safety file**" means a file, or other record containing the information in writing required by these Regulations;

x) "**health and safety plan**" means a site, activity or project specific documented plan in accordance with Rustenburg Water Services Trust health and safety specification;

y) "**health and safety specification**" means a site, activity or project specific document prepared by Rustenburg Water Services Trust pertaining to all health and safety requirements related to construction work;

z) "**material hoist**" means a hoist used to lower or raise material and equipment, excluding passengers;

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

aa) "**medical certificate of fitness**" means a certificate contemplated in regulation 7(8);

bb) "**mobile plant**" means any machinery, appliance or other similar device that is able to move independently, and is used for the purpose of performing construction work on a construction site;

cc) "**National Building Regulations**" means the National Building Regulations made under the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), and promulgated by Government Notice No. R. 2378 of 30 July 1990, as amended by Government Notices No's R. 432 of 8 March 1991, R. 919 of 30 July 1999 and R. 547 of 30 May 2008;

dd) "**person day**" means one normal working shift of carrying out construction work by a person on a construction site;

ee) "**principal contractor**" means an employer appointed by the client to perform construction work;

ff) "**Professional Engineer or Professional Certificated Engineer**" means a person holding registration as either a Professional Engineer or Professional Certificated Engineer in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000);

gg) "**Professional Technologist**" means a person holding registration as a Professional Engineering Technologist in terms of the Engineering Profession Act, 2000;

hh) "**provincial director**" means the provincial director as defined in regulation 1 of the General Administrative Regulations, 2003;

ii) "**scaffold**" means a temporary elevated platform and supporting structure used for providing access to and supporting workmen or materials or both;

jj) "**shoring**" means a system used to support the sides of an excavation and which is intended to prevent the cave-in or the collapse of the sides of an excavation;

kk) "**structure**" means -

- any building, steel or reinforced concrete structure (not being a building), railway line or siding, bridge, waterworks, reservoir, pipe or pipeline, cable, sewer, sewage works, fixed vessels, road, drainage works, earthworks, dam, wall, mast, tower, tower crane, bulk mixing plant, pylon, surface and underground tanks, earth retaining structure or any structure designed to preserve or alter any natural feature, and any other similar structure;
- any falsework, scaffold or other structure designed or used to provide support or means of access during construction work; or
- any fixed plant in respect of construction work which includes installation, commissioning, decommissioning or dismantling and where any construction work involves a risk of a person falling;

ll) "**suspended platform**" means a working platform suspended from supports by means of one or more separate ropes from each support;

mm) "**temporary works**" means any falsework, formwork, support work, scaffold, shoring or other temporary structure designed to provide support or means of access during construction work;

nn) "**the Act**" means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993);

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

oo) "**tunneling**" means the construction of any tunnel beneath the natural surface of the earth for a purpose other than the searching for or winning of a mineral.

2. INTRODUCTION

The objective of this specification is to ensure that Principal contractor and contractors achieve an acceptable level of safety performance.

This document forms an integral part of the contract and Principal contractor and contractor shall make it part of their contract with their sub-contractors and suppliers.

Compliance to this document does not absolve Principal contractor and contractors to comply with the minimum legal requirements and Principal contractor and contractors remains responsible for the Health and safety of their employees, in terms of the Occupational Health and Safety Act 85 of 1993 and the Construction Regulations 2014 and any other requirements.

3. SCOPE OF THESE SPECIFICATIONS

These specifications are applicable to the specific scope of work the BOSPOORT AT RUSTENBURG, NORTH – WEST construction project, including management, planning, engineering, design and construction of projects.

The content of this specification has the objective to assist principal contractor and contractors entering into contracts with Rustenburg Water Services Trust that they comply with the Occupational Health and Safety (OH&S) Act, No. 85 of 1993.

Compliance with this document does not absolve the Principal contractor and contractors from complying with minimum legal requirements and each employer remains responsible for the health and safety of his employees and those of his Mandataries.

Principal contractor and other Contractors should therefore insist that this specification form part of any contract that he may have with other Contractors and/or Suppliers.

4. LEGAL REQUIREMENTS AND REFERENCE DOCUMENTS

All employers onsite have a moral and legal duty to ensure that their workplace is safe from hazards to the health and safety of their workers and shall as a minimum comply with the requirements of the Occupational

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

Health and Safety Act 85 of 1993, its regulations and all associated standards as per section 44 of the Act and any other legislation and industry accepted standards pertaining to their scope of work.

An updated copy of the Act and Construction Regulations 2014 must be kept on site.

5. LETTER OF GOOD STANDING

Principal contractor and contractors shall be in good standing with the Compensation Commissioner or approved organisation as required by the Compensation of Occupational Injuries and Diseases Act 130 of 1993 and the Construction Regulation 4(g) prior to commencement of work.

6. NOTIFICATION OF CONSTRUCTION

The appointed principal contractor has the responsibility to notify the Department of labour of the intended construction before commencement of construction.

7. REVIEW OF SHE PERFORMANCE

7.1. Risk Assessment

Construction Regulation 2014 section 5.1.a. Rustenburg Water Services Trust shall prepare a baseline risk assessment for an intended construction work project;

Construction Regulation 2014 section 9.1 Principal contractor and contractors performing construction work shall before the commencement of any construction work and during construction work, cause a risk assessment to be performed by a competent person appointed in writing and the risk assessment shall form part of the health and safety plan to be applied on the site and shall include at least-

The identification of the risks and hazards to which persons may be exposed to, including ergonomic hazards;

The analysis and evaluation of the risks and hazards identified;

A documented plan of safe work procedures to mitigate, reduce or control the risks and hazards that have been identified;

A monitoring plan; and
A review plan;

To ensure safety of employees and compliance to legislation, Principal contractor and contractors will be required to conduct three types of risk assessments and all employees must be trained in the risk assessments via an induction program and records of such must be kept for auditing purposes.

a) Baseline Risk Assessment

Before the commencement of construction work contractors must, taking into consideration the baseline risk assessment and these health and safety specification of develop a site specific Risk Assessment for all operations that have contracted for.

b) Issue Based Risk Assessment

An issue based risk assessment must be completed for any work that falls out of their original area of responsibility, or if changes in conditions arise or the need arises due to incidents that occurred during the construction phase.

c) Continuous Risk Assessment

In order to maintain a safe and incident free project, continuous risk assessments must be done and for example;

- Daily supervisors task specific risk assessment
- Arranged health and Safety audits that take place at least once a month
- Daily site/tool/equipment/plant/facilities inspection
- Toolbox talks/Safety talks on a weekly basis
- General awareness programs, and
- Planned job observations.

d) Daily supervisors task specific risk assessment

It is required of Principal contractor and contractors supervisors to do a daily task specific risk assessment before any task commences in their area of responsibility during the daily task planning discussion. Participation and input of the team of workers is of critical importance.

This is to establish what activities are planned, what hazards and risks are attached to these activities and what pre-cautionary measures should be taken.

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

This risk assessment must be recorded and the responsible supervisor and his team must sign this document as proof that they are aware of the hazards and risks of the planned task and that appropriate precautionary action have been discussed and taken. Such proof must be kept in the safety file.

This risk assessment is compulsory before a task commences and work will be stopped if it has not been completed. Appropriate disciplinary action will be taken against the responsible Construction manager/supervisor of Principal contractor or contractor if this risk assessment has not been completed.

e) Inspections

Principal contractor and contractors must inspect site/tool/equipment/plant/facilities on a daily/weekly/monthly basis as established in their baseline and issue based risk assessment for their scope of work to ensure that it is safe for use, create no hazard and poses no risk to persons and property.

f) Audits

Monthly Audits

As per section 5 of the Construction Regulation 2014 Rustenburg Water Services Trust and/or its Agent will be conducting monthly audits at times agreed with the Principal contractor and the same will be done by Principal contractor on their appointed contractors.
The scope of the audits will focus on legal compliance and requirements of these specification and the Principal contractor and contractors' scope of work and area of responsibility and accountability on this specific contract to ensure their Health and safety plan and file has been implemented, adhered to and maintained.

Rustenburg Water Services Trust, its agent or the principal contractor reserves the right to conduct unannounced ad hoc audits and inspections as it deems necessary in the interest of health and safety onsite.

A representative of Principal contractor and contractors and where applicable a relevant Health and Safety Representative must accompany the auditor on all Audits.

Contractors have to audit their sub-contractors as per above and keep records of these audits in their health & safety files, available on request.

g) Reports

Detailed reports of the findings of audits and inspections shall be reported in writing within 7 days to Principal contractor site management and contractors. Results must be discussed at project management and health

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

and safety meetings. Copies of audit reports shall be kept by Principal contractor and contractors in their health and safety file.

Non-conformance close-out reports

Non-conformances reported via audit or inspection reports as above must be closed out and a report sent to the auditor and Principal contractor management within the time prescribed by the auditor, inspector or any authorised person.

8. STOP WORK NOTICE

Rustenburg Water Services Trust reserve the right through his agent, Principal contractor, safety officer or any person authorised thereto, to stop any operations onsite including that of contractors' teams and persons, if the supervisors daily task specific risk assessment has not been completed or should it be found that any operations are unsafe and in non-compliance with legislation, their health and safety plan and this specification.

The stop work order will only be lifted after the construction manager/construction supervisor of the offending contractor has rectified the unsafe condition and have discussed the non-conformance with its workers in the form of a toolbox talk/relevant training and after proof has been provided of compliance to the person who issued this notice. A copy of the stop work notice will sent to Rustenburg Water Services Trust CEO and its agent.

!!!!NOTE!!!!

Any expenses incurred by Rustenburg Water Services Trust due to any non-conformance by the Principal contractor and/or contractor will be for the account of the offending party.

Except for the work stoppage, in addition the Rustenburg Water Services Trust may impose a financial penalty, terminate their contract, withholding payment until compliant or any appropriate action decided upon by Rustenburg Water Services Trust CEO and its agent.

9. SITE MANAGEMENT, SUPERVISION, APPOINTMENTS AND RESPONSIBILITIES

a) Project participants and relationships

Rustenburg Water Services Trust is ultimately responsible for all aspects, i.e. (not limited to) finance, planning, health and safety, environmental protection, engineering construction and will appoint persons, companies who will carry out the work.

b) List of participants:

i) Health and safety agent
ii) Designers
iii) Principal contractor
iv) Contractors
v) Sub-contractors

c) Appointments and responsibilities

Rustenburg Water Services Trust appointments

i) Health and safety agent.
ii) Designers and principal agent.
iii) Principal contractor.

d) Rustenburg Water Services Trust responsibilities as client

Rustenburg Water Services Trust shall:-

- prepare a baseline risk assessment and a suitable site specific health and safety specification for the intended construction work based on the base line risk assessment;
- provide the designer with these health and safety specification and ensure that the prepared health and safety specification are taken into consideration during the design stage;
- ensure that the designer carries out all responsibilities required in Construction regulation 6;
- before appointing any principal contractor ensure that the principal contractor has the necessary competencies and resources to carry out the construction work safely;
- ensure that Principal contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer;

- before any work commences on a site, have Principal contractor health and safety plan and file approved for implementation;
- take reasonable steps to ensure that Principal contractor health and safety plan are implemented and maintained through monthly health and safety audits and document verification;
- where changes are brought about to the design or construction work, make sufficient health and safety information and appropriate resources available to execute the work safely; and
- take reasonable steps to ensure co-operation between all contractors appointed to enable each of those contractors to comply with these Regulations;
- where Rustenburg Water Services Trust requires additional work to be performed because of a design change or an error in construction due to the actions of Rustenburg Water Services Trust ensure that sufficient safety information and appropriate additional resources are available Principal contractor to execute the required work safely.
- Where a fatality or permanent disabling injury occurs on a construction site, Rustenburg Water Services Trust must ensure that a report as contemplated in section 24 of the Act, in accordance with regulations 8 and 9 of the General Administrative Regulations, 2013 is forwarded to the provincial director. This report shall include the measures that the contractor intends to implement to prevent a re-occurrence of such incident and to provide a safe work environment.

e) Rustenburg Water Services Trust appointed agent

i) Agent's responsibilities

The agent shall:-

- act as Rustenburg Water Services Trust representative and the duties that are imposed by Construction regulation 2014 upon Rustenburg Water Services Trust apply as far as reasonably practicable to the agent.
- manage the health and safety on a construction project for Rustenburg Water Services Trust;

f) Rustenburg Water Services Trust appointed Designer

i) Designer of a structure responsibilities

The designer shall

- ensure that the applicable safety standards incorporated into these Regulations under section 44 of the Act are complied with in the design and take into consideration the health and safety specification of Rustenburg Water Services Trust;
- before the contract is put out to tender, make available in a report to Rustenburg Water Services Trust:-

- all relevant health and safety information about the design of the relevant structure that may affect the pricing of the construction work;
- the geotechnical-science aspects, where appropriate; and
- the loading that the structure is designed to withstand;
- inform Rustenburg Water Services Trust in writing of any known or anticipated dangers or hazards relating to the construction work, and make available all relevant information required for the safe execution of the work upon being designed or when the design is subsequently altered;
- refrain from including anything in the design of the work necessitating the use of dangerous procedures or materials hazardous to the health and safety of persons, which can be avoided by modifying the design or by substituting materials;
- take into account the hazards relating to any subsequent maintenance of the relevant structure and must make provision in the design for that work to be performed to minimize the risk;
- carry out the necessary inspections at appropriate stages to verify that the construction of the relevant work is carried out in accordance with his design;

g) Appointed Principal contractor

i) The appointed principal contractor shall make at least the following appoints

All appointments will be accompanied by proof of competence/CV

1) Contractor construction manager

A construction manager who is competent to identify the hazards and risks in the area of his responsibility and has the authority to take action to rectify any unsafe situation as required by section 8 of the OHSACT. The construction manager will be responsible to ensure that construction is done in a safe manner as per section 8.1 of the Construction regulation. A construction manager may only work on the site that he has been appointed for.

2) Assistant construction manager

Where applicable, an assistant to the construction manager who will assist the manager (CR 8.2) in the execution of his duties. An assistant construction manager may only work on the site that he has been appointed for.

3) Construction supervisor

A construction supervisor who is competent to identify the hazards and risks in the area of his responsibility and has the authority to take action to rectify any unsafe situation as required by section 8 of the OHSACT. The construction supervisor will be responsible to ensure that construction is done in a safe manner as per section 8.7 of the Construction regulation. A construction supervisor may only work on the site that he has been appointed for.

4) Assistant to construction supervisor

Where applicable, an assistant to the construction supervisor (CR 8.8) who will assist the manager in the execution of his duties. An assistant construction supervisor may only work on the site that he has been appointed for.

5) Health and safety officer

A safety officer (CR 8.5) with relevant competence (at least have confirmation of application from SACPCMP), to assist Principal contractor and contractors in the implementation and monitoring of the Health and Safety plan.

An organogram with the potential candidates to be appointed in these positions shall be made part of the Health and Safety Plan.

The person making the appointment is required to discuss the responsibilities and authorities with the appointee and it must be agreed upon with appointees and thereafter placed in the Health and safety file and kept on site for audit purposes.

6) Responsibilities of Principal contractor

Principal contractor shall:-

- provide Rustenburg Water Services Trust a suitable, sufficiently documented site-specific health and safety plan, based on these specifications which must be approved by Rustenburg Water Services Trust agent before work commences and be reviewed and updated by Principal contractor as work progresses;
- develop and update a health and safety file which must include all documentation required in terms of the Act and its Regulations and these specifications; and

- on appointing any other contractor, in order to ensure compliance with the provisions of the Act-
  - provide contractors who are tendering to perform construction work for the, with the relevant sections of the health and safety specifications of Rustenburg Water Services Trust pertaining to the construction work which must be performed;
  - only appointed sub-contractors to perform construction work who has the necessary competencies, resources and have appointed a full-time competent construction supervisor (appointment must be in writing) to perform the construction work safely;
  - ensure prior to work commencing that every contractor is registered and in good standing with a registered compensation fund;
  - appoint each contractor in writing for the part of the project on the construction site;
  - approve each contractors health and safety plan and file before they are allowed to commence with work and approval must be done in writing by the Principal contractors health and safety agent/manage/advisor or officer and proof must be available in the principal contractors' health and safety file
  - take reasonable steps to ensure that each contractors health and safety plan is implemented and maintained through monthly health and safety audits and document verification and provide a copy of the health and safety audit to the within seven days after the audit;
  - where changes are brought about to the design or construction work, make sufficient health and safety information and appropriate resources available to execute the work safely; and
  - where Rustenburg Water Services Trust requires additional work to be performed because of a design change or an error in construction due its actions, Rustenburg Water Services Trust shall ensure that sufficient safety information and appropriate additional resources are available to execute the required work safely.
  - take reasonable steps to ensure co-operation between all contractors to enable each of those contractors to comply with these Regulations.
  - hand over a consolidated health and safety file to Rustenburg Water Services Trust upon completion of the construction work

Where a fatality or permanent disabling injury occurs on the construction site, Principal contractor must ensure that a report as contemplated in section 24 of the Act, in accordance with regulations 8 and 9 of the General Administrative Regulations, 2013 is forwarded to the provincial director. This report shall include the measures that the contractor intends to

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

implement to prevent a re-occurrence of such incident and to provide a safe work environment. The incident must be reported to the client or his agent as soon as possible but within 24 hours.

10. COMPETENCE AND TRAINING

a) Induction

Principal contractor as Principal contractor shall ensure that all site personnel and visitors undergo project specific induction before starting work or entering the site. A record of attendance shall be kept in the health & safety file.

b) Awareness (Toolbox talks)

Principal contractor and contractors shall ensure that relevant toolbox talks which deals with the hazards, risks and safe work procedures specific to their activities take place at least once per week.

c) Competency

Definition

A competent person is a person who 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;

Principal contractor and contractors shall:-

- ensure that their employees appointed are competent and that all training required to do the work safely and without risk to health of their or other persons, has been successfully completed before work commences.
- ensure that all operators, drivers and users of construction vehicles, mobile plant and other equipment must be in possession of valid proof of training, valid licenses and/or certificates of the correct code where machinery, plant or equipment is utilised.
- proof of these licenses and/or certificates and/or proof of competence will be kept in the Contractors Health, Safety file.

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

11. COST OF HEALTH AND SAFETY

Rustenburg Water Services Trust shall ensure that potential principal contractors offering a tender for proposed work have made adequate provision for the cost of health and safety measures in terms of his/her documented Health and Safety Plan and measures based on these Health and Safety specifications during the period of the project.

The cost shall be duly quantified and clearly identified for such for example, medicals, PPE, training, special equipment etc.

The same rule on cost of health and safety applies to Principal contractor when contractors and its sub-contractors making a bid for work on this contract.

12. HEALTH AND SAFETY REPRESENTATIVES AND SAFETY COMMITTEES

If Principal contractor or contractors as employers has more than 20 employees on site, he/she shall ensure that Health and Safety Representative is appointed in writing and necessary training is provided. A proof of such training shall be kept on site.

Irrespective whether Principal contractor or contractors has more than 20 workers employed onsite, it is required that at least one Health and Safety Representative is appointed who shall form part and attend the Joint Health and Safety Committee meeting of the principal contractor, irrespective of the number of workers onsite.

The joint Health and Safety Committee meeting may form part of the project progress meetings held by Principal contractor and contractors and minutes, agendas and attendance records of this meeting must be kept in Principal contractor and contractors' health and safety file.

13. SHE MANAGEMENT PLANS

a) Health and safety plan

Based on these specifications, a suitable documented health and safety plan will be submitted to Rustenburg Water Services Trust by Principal contractor. This plan will address the hazards identified and includes safe work procedures to mitigate, reduce or control those hazards identified.

The same requirement exits between the Principal contractor and contractors.

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

b) Public Safety, Edge protection and Barricading, Traffic accommodation and access control

Public safety

Principal contractor and contractors Health and Safety program must provide for public safety, safe traffic accommodation and safe work areas by pre-planning and setting out correct/appropriate hazard warning signs i.e. No Un-authorised Entry, Danger Construction Work in Progress, Excavation warnings, Hard Hat, Lifting Operations and Visitors to Report to Site Office, etc.; to ensure safety at all times and the responsible person is the Site supervisor (8.7).

Edge Protection and Barricading

The Principal Contractor must ensure that all exposed edges and openings are guarded and demarcated always until permanent protection has been erected.

The Principal Contractor has the following options when contemplating the protection of openings, slabs and edges:
A physical barrier at the edge of the opening/slab, which must be strong enough to carry the weight of a person in the process of falling (wire and barricade tape will not be deemed sufficient).

The Principal Contractor's fall protection plan must detail the following safety measures:

- finished floor slab edges;
- stairways;
- floor penetrations;
- lift shafts; and
- all other openings and areas from where a person may fall.

The Principal Contractors fall protection plans must include the strategies for management of edge protection and penetrations.

Barricading onsite must be of high quality to ensure that hazard and risk areas are safe to public, vehicles and workers.

!!!!!!Note: The use of barricade tape and wire is not allowed on this project!!!!!

Traffic management

Traffic control must be dealt with through placement of correct traffic signs and delineators and having flagmen in the appropriate positions.

All roadwork must be planned to limit the interference with normal traffic and during peak traffic hours.

Access control

It is the responsibility of the Principal Contractor to ensure that the site is fenced and has an access gate that will prevent any unauthorised persons from entering the site.

Access to the site must also be refused to any persons who appear to be under the influence of alcohol, drugs or any other intoxicating substance.

Any person onsite who is found to be under the influence of alcohol, drugs or any other intoxicating substance will be removed from site.

c) Working at height

i. Fall protection plan

In accordance with the 2014 Construction regulations Principal contractor and contractors -

- designate a competent person to be responsible for the preparation of a fall protection plan;
- ensure that the fall protection plan is implemented, amended where and when necessary and maintained as required; and
- take steps to ensure continued adherence to the fall protection plan.
- A fall protection plan must include -
- a risk assessment of all work carried out from a fall risk position and the procedures and methods used to address all the risks identified per location;
- a processes for the evaluation of the employees' medical fitness necessary to work at a fall risk position and the records thereof;
- a programme for the training of employees working from a fall risk position and the records thereof;
- a procedure addressing the inspection, testing and maintenance of all fall protection equipment; and

- a rescue plan detailing the necessary procedure, personnel and suitable equipment required to affect a rescue of a person in the event of a fall incident to ensure that the rescue procedure is implemented immediately following the incident.

Principal contractor and contractors must ensure that -

- the appointed construction manager CR 8.1/construction supervisor Cr 8.7 is in possession of the most recently updated version of the fall protection plan.
- all unprotected openings in floors, edges, slabs, hatchways and stairways are adequately guarded, fenced or barricaded or that similar means are used to safeguard any person from falling through such openings;
- no person is required to work in a fall risk position, unless such work is performed safely;
- fall prevention and fall arrest equipment are -
- approved as suitable and of sufficient strength for the purpose for which they are being used, having regard to the work being carried out and the load, including any person, they are intended to bear; and
- securely attached to a structure or plant, and the structure or plant and the means of attachment thereto are suitable and of sufficient strength and stability for the purpose of safely supporting the equipment and any person who could fall; and
- fall arrest equipment is used only where it is not reasonably practicable to use fall prevention equipment.

d) Temporary Works

Definition

"**temporary works**" means any falsework, formwork, support work, scaffold, shoring or other temporary structure designed to provide support or means of access during construction work;

Scaffolding, formwork and support work

It is the Principal contractor's responsibility to ensure that:

- scaffolding, form and support work is erected, used and maintained safely in accordance with Construction Regulation 12 and 16, SA National of Standards Code of Practice, SANS 10085 entitled, "The Design, Erection, Use and Inspection of Access Scaffolding.
- that erectors, inspectors and supervisors have received the relevant training required by the National Qualification Framework Act, 2000 (Act No.67 of 2000),
- persons erecting and inspecting scaffolding, form and support work should therefore be able to ensure that, at the time of handing over to the user, the scaffolding is adequate for its intended purpose.

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

- when using access scaffolding must ensure that such scaffolding, when in use, complies with the safety standards incorporated for this purpose into these Regulations under section 44 of the Act.
- training is provided to all persons who work on these platforms.
- appoint a designer in writing temporary works to design, inspect and approve the erected temporary works on site before use.
- all temporary works operations are carried out under the supervision of a competent person who has been appointed in writing for that purpose.
- all temporary works structures are adequately erected, supported, braced and maintained by a competent person so that they are capable of supporting all anticipated vertical and lateral loads that may be applied to them, and that no loads are imposed onto the structure that the structure is not designed to withstand;
- all temporary works structures are done with close reference to the structural design drawings, and where any uncertainty exists the structural designer should be consulted;
- detailed activity specific drawings pertaining to the design of temporary works structures are kept on the site and are available on request to an inspector, Rustenburg Water Services Trust, its agent and Principal contractor;
- all persons required to erect, move or dismantle temporary works structures are provided with adequate training and instruction to perform those operations safely;
- all equipment used in temporary works structure are carefully examined and checked for suitability by a competent person, before being used;
- all temporary works structures are inspected by a competent person immediately before, during and after the placement of concrete, after inclement weather or any other imposed load and at least on a daily basis until the temporary works structure has been removed and the results have been recorded in a register and made available on site;
- no person may cast concrete, until authorization in writing has been given by the competent appointed person;
- if, after erection, any temporary works structure is found to be damaged or weakened to such a degree that its integrity is affected, it is safely removed or reinforced immediately and adequate precautionary measures are taken in order to –
    - secure any deck panels against displacement; and
    - prevent any person from slipping on temporary works due to the application of release agents;
- as far as is reasonably practicable, the health of any person is not affected through the use of solvents or oils or any other similar substances;
- upon casting concrete, the temporary works structure is left in place until the concrete has acquired sufficient strength to safely support its own weight and any imposed load, and is not removed until authorization in writing has been given by the competent person contemplated in paragraph (a);

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

- the foundation conditions are suitable to withstand the loads caused by the temporary works structure and any imposed load in accordance with the temporary works design.
- provision is made for safe access by means of secured ladders or staircases for all work to be carried out above the foundation bearing level;
- a temporary works drawing or any other relevant document includes construction sequences and methods statements;
- the temporary works designer has been issued with the latest revision of any relevant structural design drawing;
- a temporary works design and drawing is used only for its intended purpose and for a specific portion of a construction site; and
- the temporary works drawings are approved by the temporary works designer before the erection of any temporary works.
- That no person use a temporary works design and drawing for any work other than the structure it was intended for.

e) Environmental protection

Principal contractor and contractors has to perform their work in such a manner to prevent environmental pollution and damage of air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, dust, radiant energy, and radioactive materials, as well as other pollutants and resources encountered or generated by Principal contractor and contractors.

f) Cranage and lifting operations

It is the Principal Contractor responsibility to ensure compliance with the section 22 of the 2014 construction regulation and section 18 of the 2015 Driven Machinery Regulations, which includes inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE and relevant clothing, and training those who use machinery.

The responsibility includes to ensure:

- The crane is designed and erected under the supervision of a competent person;
- Lifting equipment, i.e. slings, hooks, ropes and all other equipment is inspected and certified by a registered test facility;
- Tower cranes must be load tested on erection with a copy of the test certificate kept in the health & safety file;
- The tower crane, alterations and maintenance must be conducted by a competent person;
- That a relevant risk assessment and method statement are developed and applied;

- That the effects of wind forces on the crane are taken into consideration and that a wind speed device is fitted that provides the operator with an audible warning when the wind speed exceeds the design engineer's specification;
- That the bases for the tower cranes and tracks for rail-mounted tower cranes are firm, level and secured;
- That the tower crane operators are competent to carry out the work safely; and
- That the tower crane operators have a medical certificate of fitness to work in such an environment, issued by an occupational health practitioner in the form of Annexure 3.
- Intermediate safety inspections must be conducted at least every 6 months. Records of all maintenance and inspections must be kept in the health & safety file.
- Lifting plans must be developed by a competent person for lifting work and plans must be available onsite when lifting operations are in progress.

g) Excavations CR 13

All requirements with regards to excavations are as set out in the Construction Regulations section13 shall be complied with as a minimum and Principal contractor and contractors shall familiarise themselves with the content thereof and act accordingly.

Where excavations deeper than 1.5 meters are made, this will be preceded by an issue based risk assessment and method statement to be approved by the clients' agent, a competent person appointed by the principal contractors.

Principal contractor and contractors will appoint a competent person to supervise and inspect all excavation work. The findings and recommendations of such inspections will be documented daily and records thereof will be kept for auditing purposes.

Principal contractor and contractors shall ensure that provision is made for barricading, shoring, dewatering and inspection of excavations.

Inspections are to be done in the following instances:-

- Daily (prior to each shift);
- After unexpected fall of ground;
- After substantial damage to supports; and
- After rainfall.

Principal contractor and contractors shall erect warning signs next to an excavation within which persons are working or carrying out inspections or tests.

14. EMERGENCY MANAGEMENT

a) Fire precautions

It is essential for Principal contractor and contractors to properly investigate and plan its fire prevention and protection measures. Fire prevention and protection measures are intended respectively to prevent and restrict the devastating effects of fires, and are therefore critical components of Principal contractor and contractors health, safety and environmental (HSE) management efforts.

Principal contractor and contractors should focus on fire prevention and should ensure that the following measures are in place:

- a properly equipped and trained fire crew to assist in the suppression or containment of wildfires and to maintain fire mitigation measures.
- ensure that staffs are trained and capable of fighting fires.
- identify areas of high fire risk/hazards.
- identify activities in the project that could lead to the ignition of a fire and determine and then implement mitigatory measures.

b) First aid management

The following first aid arrangements must be put into place

Principal contractor and contractors shall have qualified first aiders (when more than 10 employees) and first aid equipment (if more than 5 employees) as required by the GENERAL SAFETY REGULATIONS 3 and ANNEXURE THERETO.

The first aid box shall be inspected by a competent appointed person on a monthly basis and records kept in their health and safety files.

c) Incident Management

i) Recording and investigation of Incidents

Principal contractor and contractors Health and Safety program must make provision for every incident to be investigated by a competent person who will be assisted by supervisors, workers, SHE representatives and other relevant persons.

Where an incident was caused by or occurred involving his staff or property, report all incidents where an employee is injured, has died or there has been damage to property to the client, principal contractor immediately, but at least within 24 hours after the incident and as per Section 24 of the Act & General Administrative Regulation 8 by means of “annexure A” to the inspectorate.

- forward a full investigation report within seven days of the incident to the inspectorate, Rustenburg Water Services Trust and Principal contractor.

- provide Rustenburg Water Services Trust and Principal contractor and with a monthly "incident/near-miss" statistics report

15. MEDICAL EVALUATION OF WORKERS

Principal contractor and contractors must ensure that all his or her employees have a valid medical certificate of fitness specific to the construction work they are to perform issued by an occupational health practitioner in the form of Annexure 3.

16. TEMPORARY ELECTRICAL INSTALLATION

Principal contractor will ensure that the control of all temporary electrical installations at the site is designated to a competent registered person.

Records of the certificate of electrical compliance and weekly inspections of temporary installations must be available in the safety file.

17. STACKING & STORAGE

Principal contractor and contractors Health and Safety program shall make provision that:

- adequate storage areas are provided and is under the supervision of an appointed stacking and storage supervisor,
- storage areas must be kept neat and under control,
- good housekeeping principals are implemented and maintained in storage areas

18. PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT

It is important to note that PPE is the least desirable option to prevent injuries or damage and therefore Principal contractor and contractors must take such steps as may be reasonably practicable to eliminate or mitigate any hazard or potential hazard to the safety or health of employees, before resorting to personal protective equipment;

You shall ensure that your employees are provided with adequate personal protective equipment (PPE) for the work they perform in accordance with the HIRA outcomes and in accordance with the requirements of General Safety Regulation 2(1) of the OHS Act.

It is also the responsibility of Principal contractor and contractors to:

- Inform workers of the potential risks involved in their work
- Provide them with PPE free of charge
- Provide continuous training, exercise control and enforce the wearing of PPE where necessary.
- Instruct employees in the proper use, maintenance and limitations of the safety equipment.
- Ensure that PPE is used as required

A document with all of the above information and the signature of the relevant workers will be kept in the site safety file.

19. HEALTH AND SAFETY SIGNAGE

Principal contractor and contractors Health and Safety program must provide for the relevant signs are placed correctly conspicuous areas in accordance with the risk assessment for example;

- No Unauthorized Entry
- Danger Workman Above
- Hard Hat Area
- First aid facilities
- No Smoking
- Scaffolding Safe for Use or Unsafe For Use

20. PLANT, MACHINERY AND EQUIPMENT

a) Principal Contractor And Contractors Equipment

Plant is operated, maintained and managed under the supervision of a competent appointed person.

Only appointed drivers/operators who have a valid operator's competence certificates, driver's licences and certificate of medical fitness are allowed to operate sites.
All plant and equipment are required to be in good, safe working condition, maintained and serviced in accordance with manufacturer's specifications before it will be allowed to work onsite.

Daily inspection plant, machinery, equipment are required before start of shift and records must be kept in health and safety file.

b) Hired Plant and Machinery

Principal contractor and contractors shall:

- ensure that any hired plant and machinery used on site is safe for use. The necessary requirements as stipulated by the OHS Act 85/1993 and Construction Regulations 2014 shall apply.
- ensure that operators hired with machinery are competent and that certificates, proof of medicals, completed daily inspections and copies of ID documents are kept by the operator and in the site health & safety file.

All relevant Sub Contractors must ensure the same.

21. CONSTRUCTION EMPLOYEES' FACILITIES

Where applicable and reasonably practical Principal contractor and contractors shall:

- provide potable water is available onsite,
- shall ensure that at least one sanitary facility appropriately marked for each sex and for every 30 workers or part thereof,
- Covered eating areas

The above facilities must be kept in a clean, hygiene, safe condition and in a good state.

22. SITE HOUSEKEEPING

Principal contractor and contractors must ensure that:

- housekeeping is continuously implemented and maintained;
- materials and equipment is properly stored;

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

- scrap, waste and debris is removed regularly;
- materials placed for use are placed safely and not allowed to accumulate or cause obstruction to the free-flow of pedestrians and vehicular traffic;
- waste and debris not to be removed by throwing from heights but by chute or crane;
- where practicable, construction sites are fenced off to prevent entry of unauthorized persons;
- an unimpeded work space is maintained for every employee;
- every workplace is kept clean, orderly and free of tools and the likes that are not required for the work being done;
- as far as is practicable, every floor, walkway, stair, passage and gangway is kept in good state of repair, skid-free and free of obstruction, waste and materials;
- openings in floors, hatchways, stairways and open sides of floors or buildings are barricaded, fences, boarded over or provided with protection to prevent persons from falling.

23. HANDLING AND STORAGE OF HAZARDOUS AND FLAMMABLE CHEMICAL SUBSTANCES

Principal contractor and contractors shall:

Commented [WK1]: shouldnt this read "principal contractor and contractors shall ensure" and then remove it from the beginning of each bullet
cause the last two bullets of the list dont read easily

- ensure that the use, transport, storage and disposal of HCS are carried out as prescribed in the HCS Regulations as well as applicable environmental legislation, SANS standards and recommendations in the Hazardous Materials Survey.
- ensure that all there is a register kept for all hazardous chemicals used in their operations on site and that they all have Material Safety Data Sheets (MSDS).
- provide suitable and adequate protective equipment when working in an area where hazardous chemicals and materials are being used;
- ensure that its employees have familiarised themselves with the hazardous material data sheets applicable
- ensure that users are aware of the hazards and precautions that need to be taken when using the chemicals and a competent Hazardous Chemical Substance coordinator must be appointed.
- that First Aiders are aware of the MSDS"s and how to treat HCS incidents appropriately. Copies of the MSDS"s must be kept in the first aid box and in the store.
- that containers are clearly labeled "flammable substances" must be stored separately, away from other materials, and in a well-ventilated area (appropriate cross ventilation).

24. INTOXICATION

No intoxicating substance of any form shall be allowed on site.

Any person who appears to be under the influence of drugs or any conditions which may render, or be likely to render him incapable of taking care of himself or the persons under his charge or suspected of being intoxicated shall not be allowed on the site.

Any person required to take medication shall notify the relevant responsible person thereof, as well as the potential side effects of the medication.

Any person suffering from any illness/condition that may have a negative effect on his/her/anyone other person's health or safety performance must report this to his/her superior.

Principal contractor and contractors shall ensure that no person under his control shall bring any intoxicating substance onto site.

Principal contractor and contractors is expected to subject any person suspected of being under the influence of intoxicating substance to testing for substance abuse and any such person refusing to undergo such a test will be removed from site or denied access to the site.

25. MINIMUM ADMINISTRATIVE REQUIREMENTS

Principal contractor and its contractors shall use the applicable health and safety information in this specification to develop and submit a suitable and sufficient health and safety plan and safety file for the scope of their work.

It is required that the document has a table of content and that each section is separated with dividers.

The work performed by Principal contractor and contractors is subject to South African legislation as well as these specifications as they relate to their scope of work on this project.

Rustenburg Water Services Trust will evaluate, discuss and negotiated the health and safety plan and file with the principal contractor and after final approval issue an acceptance letter to the principal contractor.

The above is applicable between Principal contractor as principal contractor and its contractors and between the contractor and its sub-contractors.

A copy of letter of approval must be presented to the construction manager/supervisor before commencement of work and kept in the health and safety file.

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

If Principal contractor as principal contractor or any contractor onsite is found in noncompliance with the above rule of approval, the Principal contractor or contractor will be issued with a work stoppage notice and not be allowed to work onsite until they are in full compliance

Disciplinary action will be taken against the relevant construction manager or construction supervisor who have allowed this noncompliance.

!!!!!!Note!!!!!!

Example of content of a health and safety file (the following list serves as an example only and it is the principal contractor, contractors and sub-contractors responsibility to ensure that they have covered all aspects and requirements of legislation and governing bodies pertaining to their activities)

1) Scope of work
2) Company emergency numbers
3) Workers and contractors management
   a) List of workers
   b) Copies of workers medicals
   c) Copies of ID documents
   d) List of contractors
4) Daily/Weekly/Monthly inspections of all tools, equipment, and plant used onsite
5) Non-conformance management
   a) Workers non-conformance reports
   b) Client non-conformance reports
   c) Non-conformance close-out report
6) Monthly safety statistics
7) PPE Management
   a) PPE issuing form
   b) PPE inspection
   c) PPE Policy
8) Safety training records
   a) Induction training material
   b) Induction training
   c) Toolbox talks
   d) Emergency procedures
   e) Small tool training
   f) Risk training
   g) Safe work procedures training

h) Working at height training
i) First aid training
j) Fire training
k) Plant operators training
l) Scaffold and formwork erector training
m) Legal liability training for supervisors
n) SHE rep training
o) Incident investigator training
p) PPE training
q) Policies training

9) Records of monthly safety meeting
   a) Agendas
   b) Minutes of meeting
   c) Attendance registers
10) Monthly Safety management/safety file audit result
11) Site safety inspection reports
12) Health and safety policy
13) Company and SHE organogram
14) Proof of good standing with compensation commissioner
15) Site risk assessment
   a) Baseline
   b) Issue based
   c) Daily site supervisors task specific risk assessment
   d) Risk methodology
   e) List of 4 highest risks
16) Site Safety specification
17) Safety management plans
   a) Health and Safety plan
   b) Fall protection plan
   c) Environmental plan
18) Scaffold and formwork design drawings
19) Copy of Mandatory appointments
20) Copy of appointment by Client
21) Copy of contractors appointment by
22) All Health and Safety appointments as per your scope of work
23) Method statements of your activities
24) Incident management
   a) Incident management procedures

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

b) Site incident report list
c) Annex A
d) WCL 2
e) Incident investigation report

25) Hasardous chemicals management
a) List of Hazardous and flammable chemicals used onsite
b) MSDS
c) Hasardous chemicals handling procedures

26) Occupational health and safety act
27) Construction regulations 2014
28) Sans 10085

2) Covid 19 preparedness

ADDITIONS TO HEALTH AND SAFETY SPECIFICATIONS TO INCLUDE COVID 19

Table of content:

CONTRACT NO: RLM/RWST/OMM/0101/2024/25 – RE-ADVERT:
CONSTRUCTION OF BOSPOORT NORTH RESERVOIR AND ACCESS ROAD

1. Introduction

COVID 19 Novel Corona virus has changed the world we live in and how we will live in it in future. Due to this it has become necessary to take special precautions to prevent further spread of this disease.

This document is an addendum to the original project health and safety specifications to assist the principal contractor and contractors to protect their workers

2. References

The Department of Employment and Labour has appealed to employers to use the prescriptions of the Occupational Health and Safety (OHS) Act of 1993 in governing workplaces in relation to Coronavirus Disease 2019 COVID19.

The OHS Act read with the Hazardous Biological Agents Regulations requires the employer to provide and maintain as far as is reasonably practicable a working environment that is safe and without risks to the health of employees.

Section 8(2)(b) requires steps such as may be reasonably practicable to eliminate or mitigate any hazard or potential hazard before resorting to personal protective equipment (PPE). However, in the case of COVID19, a combination of controls is required, although the main principle is to follow the hierarchy of controls.

However, before the implementation of control measures, current risk assessments need to be reviewed and updated, considering the new hazards posed by exposure to COVID-19 in the workplace. This is in accordance with Section 8 (2) (d) of the OHS Act".

3. Workers transport

a. Where possible the contractors must arrange transport of their employees in line with the travel rules of not more than 70% occupancy and social distancing
b. Where not possible to avoid the use of public transport provide employees with information on the virus and precautions to take during public transport travel:

   i. Frequent sanitising
   ii. Maintain social distancing (at least 2 m)
   iii. Always wear a mask
   iv. Couch and sneezing safe practice

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

v. When being couched or sneezed on, turn face away and do not touch face before hands have been sanitised
vi. Do not travel if experiencing symptoms of infection

4. Security/access control/control of visitors onsite

a. The principal contractor must enforce strict access control and no person may enter the site except those who have undergone induction training and who is listed on the employee list.
b. The only exceptions are persons who have pre-arranged official appointment which has been approved by the project construction manager. This person may not enter the site before he is received and escorted by a person designated by the construction manager

5. Pre-construction evaluation, screening and training

Principal contractor and contractors pre-construction requirements:
It is critical that the principal contractor conduct the following preparatory actions before going to site. These actions must be documented and each employee must sign that he/she has undergone this screening and training and understands

a. **Evaluation**:

i. Employees medical evaluation, ensuring annual medical is valid
ii. Screening:

1. Fever screening
2. Health questionnaire (signs and symptoms)
3. Questionnaire of travel during shut down and exposure
4. Employee practical understanding of:
    a. the risks of the virus
    b. how do you get contaminated
    c. how do you get infected
    d. signs and symptoms
    e. prevention

b. Training program

Develop risk-based training and awareness program, policies and procedure for COVID 19 and communicate it with management and employees which include the following:

i. What is COVID 19
ii. How are you infected
iii. Explanation of symptoms and signs
iv. Explain the risk of underlying conditions, i.e.:

1. People 65 years and older
2. People with chronic lung disease or moderate to severe asthma
3. People who have serious heart conditions
4. People who are immunocompromised
5. People with diabetes
6. People with chronic kidney disease undergoing dialysis
7. People with liver disease

v. Self-monitoring and reporting of symptoms, possible exposure or infection to company
vi. How to self-isolate
vii. How to prevent infection:

1. Correct methods of washing and sanitising

   a. Hands
   b. Personal hygiene
   c. Site facilities

2. Social distancing
3. Not touching face
4. The correct way to cough or sneeze
5. Correct use, limitations of and disposal of PPE

viii. What to do if you are not feeling well and are presenting with the symptoms include:

1. Employees

   a. Who to contact at your company?
   b. Relevant company contact numbers
   c. Do not go to work

2. Principal contractor and contractors

a. Responsibilities and procedures followed by company management when employee presents with symptoms, or confirmed to be infected
b. Procedures and care of persons who are in isolation or being treated at hospital or COVID 19 facility
c. Company and employee return to work after recovery procedures

ix. Updated company COVID 19:

1. SHE plan,
2. policies,
3. PPE
4. Method statements
5. Stay at home policy and sick leave
6. Employee assistance/care program

x. Include COVID awareness in every day DSTI

6. Facilities, resources and action required by principal contractor where applicable contractor onsite

a. Appointment and training of security personnel and adequate personnel to conduct procedures of screening, isolating, conducting questionnaire and further actions required if person presents positive COVID 19 symptoms
b. Provide these employees with appropriate PPE for their tasks
c. Procedure for sanitising, screening and recording results
d. Prevention of employees having to come into close-proximity (Queuing or bundling together.)
e. Evaluation of daily screening, reporting to management and if required update procedure and training
f. Adequate and appropriate risk-based:

i. PPE
ii. Sanitising/hand washing facilities at entrance, eating areas, offices, kitchens, toilets
iii. Awareness signage and posters

g. Procedures for sanitising site, offices, toilets, eating areas, meeting rooms
h. Procedures and rules to minimise exposure:

i. Meetings

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

ii. Induction, Toolbox talk, DSTI
iii. Duration and numbers of delegates allowed at meetings
iv. Sanitising of areas, offices, boardrooms and furniture

i. Provide an isolation area/tent/room where person can be interviewed and remain until instructions have been received from the COVID 19 control centre on next step to be taken

CORONA 24 Hour HOTLINE 0800029999

7. Required documentation development and updates

The contractor must develop new and update existing plans, policies and procedures to include COVID 19

a. She plan and policy
b. Company COVID 19 plans, policies, procedures and programs to include:

i. Prevention, exposure, infection
ii. Social distancing during entering and exiting site, meetings, training
iii. Creating different areas for and staggering start of work and lunch-times, training sessions and effective planning of required staff compliments
iv. Cooperation with local police, clinic, emergency services and notifying them of the project and developing beneficial relationships
v. Engaging with CLO and communities and establish a trust relationship by providing relevant information and possible assistance where possible
vi. Emergencies (mass infections)
vii. Post-infection return to work guideline, which include:
minimum medical and practical criteria for return to work, medical evaluation by occupational health practitioner
viii. Employee emotional care and assistance during and post infection
ix. Management and disposal of contaminated PPE and equipment
x. Procedure and planning to maximise social distancing
xi. Managing PPE and other personal waste

c. Updated risk assessment to include COVID 19 hazards and risks

8. Procedures at start at end of shift

a. Include conducting and recording information of:

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

i. Sanitisation
    1. At start of shift all persons must sanitise with soap and water or sanitiser that contains at least 60% alcohol
    2. Site facilities, offices, boardrooms, toilets, eating areas, surfaces

ii. Fever screening and procedure when person has fever
    1. Re-do fever screen and if high fever

        a. Isolate and questionnaire
        b. Procedure if evidence points at infection
        c. Contact call centre and follow instructions
        d. Also follow company procedure for reporting to management, client and authorities

9. Managing and controlling flammable hazardous chemicals

a. The type of sanitiser used for CIVID 19 must have a minimum of 60% alcohol and it is important that adequate stock is held onsite
b. Due to its high alcohol content it poses a fire risk as well as a possible risk of being used by workers for intoxicating purposes which can lead to poisoning
c. It is therefore particularly important to include these risks into account when the risk assessments is updated
d. The principal contractor and contractors must ensure that they provide a flammable liquid storage facility, considering the quantities they will be storing onsite which conforms with local government fire regulations and GSR 4
e. The storage area must be lockable and issuing and stock levels must be controlled by an appointed competent hazardous chemical substance controller
f. Records of stock levels, issuing and usage must be updated daily and any discrepancies must be reported to management and investigated
g. Appropriate and adequate signage must be posted
h. Adequate Alcohol resistant foam or Carbon dioxide (CO_2) must be appropriately positioned
i. Inspections of the flammable hazardous chemicals store must be conducted at least monthly.

10. Contractor management

It is the responsibility of the principal contractor's responsibility to ensure that all contractor comply with the requirements of the addition to the original project health and safety specifications

Employer	Witness 1	Witness 2	Contractor	Witness 1	Witness 2

11. Compliance monitoring and discipline

a. Monitoring of compliance is critical to the prevention program and there may be no tolerance of non-compliance
b. Strict appropriate disciplinary action must be instituted against persons and or employers found in breach of the requirements
c. The client will be responsible compliance through audits and inspections and evaluation of principal contractors reports
d. The principal contractor must monitor compliance through inspections and COVID 19 specific audit of:
    i. Available equipment
    ii. Sanitiser/washing facilities
    iii. Sanitising of site facilities
    iv. Employee screening
    v. Access control
    vi. Availability of isolation facilities
    vii. Separation and procedures followed when employees present with symptoms
    viii. Continues awareness training
    ix. Recordkeeping

e. Any suspected or confirmed infection or noncompliance with the COVID 19 requirements must be reported to the client health and safety agent with immediate effect

12. Additional recourses and recourse management

a. It is a fact that finance and budgets most projects that are currently running have already been allocated and approved and therefore funds should be available from the client to pay contractors
b. It is therefore critical that principal contractor ensure that their payment certificates and related documents are correct and is submitted before deadline dates with their invoices. Many delays in payment from clients are due to incorrect or insufficient documentation that has been submitted late.
c. It is important to understand that the COVID 19 virus has affected all parties and cooperation will increase the probability of completing the project successful
d. It is critical that the client and principal contractor re-negotiate and discuss the project deadlines and budget and agree on solutions to the benefit of all
e. Clients must not delay payment to principal contractors and principal contractors must do the same with their contractors. Delaying payments will have a snowball effect all the way down

to the workers who have in some case already not received salaries or has only received partial payment

f. Businesses most do their utmost to protect the workers who are the most crucial asset of construction

g. Although SMME are businesses in their own right, many of these companies were already struggling financially before lockdown started and the principal contractor could use the assistance of the project CLO to ensure that workers are being paid and if not report it to the principal contractor.

h. All the above requirement and information must be filtered down to the contractors onsite

Risk Hazard Matrix

Probability: 1) Unlikely - 5) Rare - 6) Possible - 8) Likely - 10) Almost certain Occurrence

Consequences: 1) minor or no injury/damage - 2) serious injury/damage - 3)Fatality, major injury/damage - 6) multiple fatalities, major injuries/damage

Rating: less than 7 - Low risk. >< 7 and 15 - Moderate risk. >< 16 and 29 - High risk. > than 29 - Extreme High risk

Multiply the score of the concequence with the score of the probability to get the risk rating

Consequences		Probability				
		Unlikely	Rare	Possible to occur over time	Likely to occur under routine conditions	Will almost certain occur under current conditions
		1	5	6	8	10
Multiple fatalities, major injuries/damage	6	6	30	36	48	60
Fatality, major injury/damage	3	3	15	18	24	30
Serious injury/damage	2	2	10	12	16	20
Minor or no injury/damage	1	1	5	6	8	10

Extreme High Risk

High Risk

Moderate Risk

Low Risk

Baseline Risk assessment							
Site: BOSPOORT AT RUSTENBURG, NORTH – WEST		**14/07/2020**	**Assessor: P Herbst** 				
Description/Area/ Activities/Task	Hazards	Damage to property, injury to person	Recommendations to reduce or control	Likelyhood	Severity	Rating	Rating, L, M, H
Stages 1 to 4							
1) Pre-construction							
Design	Designer not taking 2014 Construction regulation into account during stages 2,3 and 4 Designs does not include safety aspects for safety during constructability, operability and maintainability Designs does not conform to the Design Specification as per the Engineering Scope of Work, checked and signed of by all relevant designers and engineer. Designs does not make provision for anchor points for working at height hook-up Design has made inadequate provision for lightning protection	Serious injury/Multiple fatalities. Property damage Financial loss Environmental impact Prosecution Damage to companies image	Designers are legally required to conform with all legislation and specifically the requirements of section 6 of the 2014 construction regulations.	6	6	36	EH
Surveys	All relevant surveys not completed Recommendations of surveys not adhered to in planning and designs for example: Traffic congestion Exposure to harmful chemicals Contaminated land Etc;	Serious injury/Multiple fatalities. Property damage. Financial loss Environmental impact Prosecution Damage to companies image Harm to health of workers	Emalahleni local municipality must have relevant surveys done including, geotech, ground water, environmental impact, traffic, existing services. Information in the reports must be used by designers in their designs and information that could affect heath and safety in constructability, maintainability and operability must be reported to the client	6	6	36	EH

Ground/soil conditions	Saturated soil Unstable soil Contaminated soil Low water table No Geotech survey completed	Serious injury/Fatalities. Property damage. Tank movement Financial loss Environmental impact Prosecution Damage to companies image	Survey to be done to determine soil conditions and location of underground services Where any uncertainty pertaining to the stability of the soil still exists, the decision from a professional engineer or a professional technologist competent in excavations shall be decisive and such a decision shall be noted in writing and signed by both the excavation supervisor and the professional engineer or technologist.	6	3	18	H
Work permits, licences, way-leaves and authorisations	Legal noncompliance Unknown services	Serious injury/Fatalities. Property damage Financial loss Environmental impact Prosecution Damage to companies image	Emalahleni local municipality and the principal contractor needs to ensure that all relevant work permits, licences, way-leaves and authorisations are in place before work commences	6	3	18	H
Procurement and cost management	Inadequate funds to complete project safe, expected quality and on time Delays in appointment of contractor, designers and specialists Insufficient technical and safety information in tender document Delay in start date will cause pressure on contractor to make deadline Appointment of contractor based on cost and not on competence and health and safety performance	Serious injury/Fatalities. Property damage Financial loss Environmental impact Prosecution Damage to companies image	Emalahleni local municipality project cost management must ensure that the project budget includes all costs including health and safety and procurement must ensure that the principal contractor has provided adequate funds to ensure that the project can completed safe, on time and to the quality expected by the client	6	3	18	H
Time constraints	Client has not allowed for adequate time to complete project to standard and on time	Serious injury/Fatalities. Property damage Financial loss Environmental impact Prosecution Damage to companies image	It is important to ensure that time for the construction is realistic and takes all possible aspects that can cause delays into account	6	3	18	H

Stages 5 and 6							
2) Site establishment, preparation of laydown area and construction site							
Fencing of laydown area	Access to laydown are accessible by unauthorised persons Laydown area to small for volume of construction material	Muscular skeletal injurie. Back injuries Cuts, bruises and fractures Injury to employees Damage to property	Planning of material deliveries to prevent this situation Prior arrangement and planning with principal contractor construction manager	6	2	12	M
Preparing laydown area, office, stores and ablution	Levelling surface Lifting/sling of containers in position on bases with a crane	Cuts, bruises and fractures Injury to employees Damage to property	Pre-planning of site lay-out and activities Ensure that crane and lifting operations are planned equipment certified, operators competent, risk assessment completed and work permit is in place Certified electrician and plumber to connect services and COC issued	6	1	6	L
Employees facilities	No shaded eating area Inadequate toilet facilities for both sexes and inadequate signage posted. Toilets not serviced on regular basis. No or inadequate potable water	Contamination of food through exposure to site dust, rain and elements. In-hygienic condition which could also lead to disease.	Suitable shaded eating are which protects the employees from the elements must be provided. Principal contractor must ensure that there are adequate male and female toilets available onsite as per construction regulation 2014. Facilities for both sexes must have signs showing male and female. Facilities to be kept clean and hygienic and toilet paper provided.	6	2	12	M

3)Material delivery, loading, offloading, manual and mechanical handling of materials, plant, equipment							
Delivery, loading and off-loading of construction material	Vehicles entering / leaving site Small manoeuvre space Inadequate warning systems in place when reversing and offloading Collision with equipment Spillages from materials Workers/machine/plant in same working area Lifting & lowering operations Failure of lifting equipment	Traffic disruption, injuries to people, damage to vehicles & property Environmental damage, Waste generation Possible fatality Damage to material Crushing of persons and materials Damage to toppling crane	Deliveries to be co-ordinated with principal contractors site management Planning of storage areas Vehicles to have reverse hooters / spotter to control reversing Drivers inducted on entering, speed limits displayed Induction training and safety talks, warning lights and acoustic warnings fitted to plant Check test certificate and examination certificate Check certificates for lifting equipment (chains, slings, shackles, etc) Ensure lifting gear is rated to carry load (SWL) Ensure materials being lifted are properly packaged and slung Be aware that there should be a minimum clearance of 600mm between any slewing parts of a crane and any fixed installation to prevent being trapped Access to the work area during lifting operations is to be restricted to those involved with and competent in the work in hand. Only competent banksmen to be used The crane driver and the banksmen are to ensure that the signals given are clearly understood Supervisor to plan procedures Good housekeeping practices should be implemented	6	2	15	M
Manual and mechanical handling	Employees not instructed on lifting and manual handling SWP Employees not obeying safety rules Improper lifting techniques. worker falling/tripping. Fall of material being carried Incorrect equipment/plant used for lifting Struck by falling load No risk assessment and permit available	Cuts, bruises and fractures Injury to employees Damage to property	Personnel should be aware of safe manual handling techniques Personnel to wear Personal Protective Equipment when carrying items, e.g.: safety footwear and gloves Ensure good housekeeping against tripping/fall hazards Worker to get assistance if load too heavy- Team lift where necessary Utilise mechanical lifting and carrying aids where possible Personnel to ensure item being carried, moved is properly bonded or will not be liable to break apart whilst being manually handled assessment and work permit required	6	1	6	L

Stacking and storage	Materials and equipment being stacked incorrect No storage and stacking plan Collapses of stacked material Not adequate storage space in designated laydown area	Injury to people Damage to plant, vehicles and equipment Damage to property Obstruction of emergency escape routes	Supervisors and employees to adhere to the safe stacking principles. Inspection registers to be completed as required. Stacking only in the designated areas Stacking and storage plan required from principal contractor Planning of material deliveries to prevent this situation	6	2	12	M

Delivery of building material	Small manoeuvre space	Damage to property	Planning of storage areas	6	2	12	M
	Workers/machine/plant in same working area	Possible Fatality, fractures, cuts & bruises	Induction training and safety talks, warning lights and acoustic warnings fitted to plant	6	3	18	H
Loading and off-loading of vehicles	Lifting & lowering Operations Failure of equipment Failure of lifting equipment Fall onto and from hazards	Falling material Crushing by materials Hand injuries to the slingers Toppling crane Fatality	Check test certificate and examination certificate Check inspection have been carried out Check certificates for lifting equipment (chains, slings, shackles, etc) Ensure lifting gear is rated to carry load (SWL) Ensure materials being lifted are properly packaged and slung Be aware that there should be a minimum clearance of 600mm between any slewing parts of a crane and any fixed installation to prevent being trapped Access to the work area during lifting operations is to be restricted to those involved with and trained in the work in hand. Do not allow members of the public to gain access to the area Only trained banksmen to be used The crane driver and the banksmen are to ensure that the signals given are clearly understood	6	2	12	M
Loading and offloading of vehicles	Loading and offloading of trucks & other materials Lifting & lowering Operations Failure of lifting equipment Untrained employees Dropping load onto fingers, legs or feet.	Injury too hands, legs and feet Possible fatal injury Damage to material falling off truck Damage to vehicle or third party vehicles Back injury	All employees to be inducted regarding the use of PPE and its maintenance Supervisor to plan procedures Good housekeeping practices should be implemented Truck driver to be responsible for his load	6	3	18	H

Manual Handling of materials	Employees not instructed on SWP Improper lifting techniques. Operative falling/ tripping. Contamination from the substance being carried Fall of material being carried	Muscular skeletal injurie. Damage to property. Back injuries	Personnel should be aware of safe manual handling techniques Personnel to wear Personal Protective Equipment when carrying items, e.g.: safety footwear and gloves Ensure good housekeeping against tripping/fall hazards Operative to get assistance if load too heavy- team lift if necessary Utilise mechanical lifting and carrying aids where possible Personnel to ensure access equipment, ladders will take weight of operative and load being carried Personnel to ensure item being carried is properly bonded or will not be liable to break apart whilst being manually handled	6	2	12	M
3) Legal compliance							
Compliance with national, international, provincial, local legislation and laws, industry and Emalahleni local municipality and any other applicable standards, rules, regulations, licence and requirements	Emalahleni local municipality, appointed designers, consultants, specialists, principle agent, construction health and safety agent, safety manager and officers, principal contractor and employees in non-compliance with these requirements Non-compliance not reported and recorded No action taken to rectify non-compliance Non-compliance not closed out	Multiple injuries, fatalities, damage to property, environmental damage, catastrophic result Financial loss/claims Prosecution Damage to public image	All project participants must adhere to at least the following, but not limited to: •Applicable National Legislation, international, provincial, local legislation and laws Regulations (laws, decrees...) Ensure that the latest version of the requirements are used	6	6	36	EH

3) Site establishment							
Working onsite without hoarding	Public exposure to construction activities, excavation, noise, dust	Vehicle collides with person resulting in fatality Injuries to persons Damage to property	Worksite emergency response plan Trained first aiders on site Proper hoarding of construction area Traffic control for vehicular movement Person controlling traffic wearing reflector jackets, use a flag and visible signage Use of experienced contractor with competent supervisor Signage to include “No unauthorized entry” and “Warning – Construction Site”	6	3	18	H
Installation of Hoarding.	Unsafe use of PPE. Obstacles on ground may cause tripping and falling Material may dislodge causing employee to fall Untrained employees working with portable electrical equipment Unsafe electrical tools Unsafe extension cords Incompetent workers Hoarding not stable and secure	Loss time injuries Severe injuries Property damage Loss in production Fatalities Electrocution	All employees to be trained on safe use of PPE. Good housekeeping All equipment and tools to be checked daily Provide safe access at all times Lift all cables off ground where possible All workers to be trained for the task at hand Only competent workers to use electrical tools Ensure that Hoarding posts are secure in the ground	6	3	18	H
	The erector not following the specific position as indicated by the Engineers Drawing. When digging for fence poles, services can be damaged. When fence Y-Standards get knocked it can damage services.	Loss time injuries Severe injuries Property damage Loss in production.	All employees to be trained on safe use of PPE. Good housekeeping All equipment and tools to be checked daily Provide safe access at all times All workers to be trained for the task at hand Only competent workers to use electrical tools	6	2	12	M
Uncontrolled access of job-seekers, criminal elements.	Rioting and violence.	Injury to employees, fatalities, damage to property and loss of production.	Develop site specific emergency contingency plan. Contact local police unit to ensure fast re-action. Place plan in conspicuous place. Ensure that supervisors and workers know the emergency drill.	6	3	18	H
Employees accommodation onsite	Accommodation not to standard, workers sleeping on ground, poor ventilation, or adequate for number of employees	Employees can get ill, personal belongings can be damaged.	Accommodation to be planned in advance by principal contractor and standard in line with legislation must be applied. Accommodation must have adequate ventilation, beds that is off the floor and no over-crowding.	6	1	6	L

Employees facilities	No shaded eating area	Contamination of food through exposure to site dust, rain and elements.	Suitable shaded eating are which protects the employees from the elements must be provided.	6	2	12	M
	Cooking facilities not to standard and no washing facility.	Living area contaminated by food scraps causing infestation of mice, rats and other insects which could lead to disease.	The cooking rea must be protected from the elements, have adequate waste disposal bins, and not create a fire risk.	6	2	12	M
	Inadequate potable water.	Employees can suffer from dehydration or even stomach disease due to the use of unsafe water.	Adequate potable water must be provided onsite.	1	2	2	L
	No or inadequate showers available.	In-hygienic condition which could also lead to disease.	Showers should be adequately enclosed and have running water.	6	1	6	L
	Inadequate toilet fascicles for both sexes and inadequate signage posted. Toilets not serviced on regular basis.	In-hygienic condition which could also lead to disease.	Adequate serviced toilets must be available onsite as per construction regulation 2014.	1	1	1	L
4) Exposure to climate, weather and natural hasards							
Conducting construction activities in nature	Safety and Health Risk from the Environment	Snake bite Bee Stings Dog Bites	Qualified first aider required for site who can treat snakebite Snake bite kit to be on hand Check area before working Find out nearest hospital and get emergency telephone numbers	5	2	10	M

Conducting construction work in adverse weather conditions	Exposure to sun, extreme heat, cold, wind, rain, lightning	Dehydration Heat exhaustion Skin cancer Hypothermia, colds, flu Loss of productivity Fatality	Each employee performing manual labour in high temperatures exceeding 30 degrees must be declared medically fit for specific work before work conditions Have workers acclimatised before starting work Induct employees to take at least 600 millilitres of water every hour and on how to avoid heatstroke provide affected employees with prompt first-aid treatment in the event of heatstroke Provide sun protective clothing and cream Provide waterproof clothing of a type that will effectively protect the wearer against harm Schedule work in such a way that it would not warrant the use off PPE (Waterproof Clothing)	6	3	18	H
Exposure to dehydration / heat exhaustion	Employees being exposed to elements Unfavourable work conditions Excessive exposure to high temperatures	Danger to employees fainting at work, possibly while at height Heatstroke	Each employee performing manual labour in high temperatures exceeding 30 degrees must be declared medically fit before work commences and thereafter yearly by a registered medical practitioner or a registered nurse and be issued with a fitness certificate Have workers acclimatised before starting work Induct employees to take at least 600 millilitres of water every hour and on how to avoid heatstroke Provide affected employees with prompt first-aid treatment in the event of heatstroke	5	2	10	M

5) Installation and fitment of electrical system, fittings and equipment							
Installation of and working with high and low tension cables and equipment	Exposure to electricity by persons with lack of knowledge on safe work procedure	Shock Burns Fire Death Damage to property	All electrical wires must be sealed All electrical connections must be correct and properly sealed Do not touch electrical wires Wear the correct personal protective equipment, even if switched off, when working with electricity Keep water away from electrical wires Switch off electricity when working with electricity or near electricity especially if water is used Prevent tools and other equipment from touching electrical wires Use insulated tools and equipment Electrician to certify that electricity is switched off Lock out/Tag out system to be used to prevent accidental activation of electricity All electricity must be switched off when working near electricity with water	6	3	18	H
	Working at height	Fatality, major fractures, cuts and bruises	Job specific training, Induction training and safety talks and planning and supervision	6	3	18	H
	Working with grinder, abrasives and cutting flame	Fire, inhalation of dust, eye injuries and burns	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	1	6	L
	Lack of knowledge on safe work procedure	Shock Burns Fire Fatality Property damage	Only trained, competent workers may work on electrical system. Certified supervisor must be onsite at all times	6	3	18	H
Installation of systems, distribution boards and equipment	Exposed wires Unauthorized people gaining access to DB board Faulty switches Overloading of wiring Not following lock-out procedures Incompetent electrical installer	Electrocution Fire Property damage Serious injuries/fatality.	Distribution boards to be properly earthed Earth leakage relays should always be functional. All openings on DB box to be blocked to prevent rodents Lock out procedures to be in place. C.O.C must be available.	6	3	18	H

Chasing into concrete using a grinder.	Exposure to dust, noise, particles and vibration Contact with existing services. Fall from height. Use of incorrect blade.	Cuts Inhalation of dust. Hearing loss if prolonged exposure to noise. Eye injury. Fractures	Correct PPE use. Correct training received. Use eye protection. Checking plan and conducting services surveys	6	2	12	M
Install cable (surface)	Use of impact drill Noise. Striking or being struck by falling objects. Flying particles including dust. Use of hand/power tools. Contact with existing services.	Hearing loss if prolonged exposure to noise. . Cuts. Eye injuries Cuts abrasions.	Correct PPE. use. Correct training received. Checking plan and conducting services surveys Inspect equipment before shift Maintain equipment to manufacturers standard..	6	2	12	M
6) Cranes, lifting, slinging and lifting equipment							
Lifting and Rigging.	Lifting equipment not maintained & inspected frequently can cause injury or damage to property. Operator, rigger and banksman not competent or experienced.	Serious Injury/ fatal. Property damage. Loss of income.	Adhere to lifting and rigging procedures. Only competent employees to operate lifting equipment. Only certified lifting equipment to be used. All lifting equipment to be fitted with SWL identifying tags.	6	3	18	H
Crainage	Incompetent crane operator Defective crane Hitting person/property whilst maneuvering crane into position Outrigger hitting person/property during extension and lowering Improper hooking offload resulting in dropping part or entire load Use of damaged slings/chains Incorrect slings used for load Crane tipping over Load test not done. No lifting plan	Loss time injuries Serious injuries Fatalities Property damage	Operator certificate of competency to be kept on file Crane to comply with all requirements as per the construction regulation, driven machinery regulation Banks man to be appointed Only certified chains/slings to be used Correct PPE. to be used Operator to do pre use checklists daily Lifting plan must be developedfor each job	6	3	18	H

7) Working with tools, electric tools, small plant and equipment							
Working with electric tools	Tools not correct for job. Tools not serviced. Broken tools not removed from service. Workers not trained to use tools correctly.	Electric shock Burns. Damaged equipment. Cuts, bruises, fractures	Electric tools and installations to be in good condition Inspect electric tools before use Do not use electric tools in wet/damp conditions Use personal protective equipment such as insulated gloves Electrical installations register to be maintained, inspected by competent person Put on all necessary PPE No unauthorised work Get lock out permit Report to site office Switch off appropriate circuit breaker DB Use a lock out board - place key in pocket Ensure good housekeeping is maintained	6	2	12	M
Working with hand tools	Exposure to defective equipment Incorrect usage of equipment Untrained staff using hand tools	Serious injury. Lost time injury. Personnel injury. Property damage.	Ensure: Tool is correct for job Tool is in good order and suitably sharp Personnel must be competent/instructed in tool usage and tool safely Lighting is sufficient Access is safe, working platform is secure, leading edge is guarded Operative is wearing all necessary PPE	6	2	12	M

8) Excavation, trenching, bulk earthworks, backfill, reinstatement and relevant equipment							
Excavation, trenching, bulk earthworks	Cave-in of trench/excavation	Damage to excavator and possible fatality, injury to persons	Plan and supervise excavations, use of excavation form, Shoring, benching or any other safety measures required by the when ground formation or depth requires, Removal of workers from trench/ excavation at risk is increased due to close working of compactors, change in ground conditions, rain or water seepage	6	3	18	H
	Persons/vehicles falling into trench/ excavation	Fractures, cuts, bruises and injury to persons	Protect vehicles from falling into excavations - provide barriers, signage, etc as necessary	6	2	12	M
	Possibility of hitting existing cables/pipes	Electric explosion, electrocution, fire, lost time through lack of water or electricity and replacement cost	Correct planning and use of excavation planning form, appointment of competent supervisor	6	2	12	M
	Toxic fumes Collapse of adjacent structures Dust Not conforming to the Construction regulations Uncontrolled access Hoarding not erected with sufficient height and safety distance	Suffocation Serious injury/Fatal. Lost time injury. Personnel injury. Property damage.	Survey to be done to determine soil conditions and location of underground services Excavations should be sloped to prevent collapse. If more than 2 meters deep, excavations must be shored, be provided with safe access in case of emergency Record the full details and results of inspections to be kept on site The competent person is to inspect the excavation on site: Daily, Prior to each shift and After rain , after an unexpected fall of ground and after any damage to supports, bracing or shoring Where any uncertainty pertaining to the stability of the soil still exists, the decision from a professional engineer or a professional technologist competent in excavations shall be decisive	6	3	18	H

Compacting and Filling	Contact with tipping materials Contact with moving plant Vehicles/personnel falling into excavations Contact with underground services Hearing Loss Use untrained employees	Serious injury/Fatal. Lost time injury. Personnel injury. Property damage.	Flagmen to control vehicles movement Only trained personnel use plant Personal Protective Equipment to be worn Personnel to stand clear as materials are being tipped Use stop blocks and signs to warn vehicles of excavations, where applicable Stand clear of plant whilst materials are being compacted Establish position of underground services and protect services from damage	6	3	18	H
Ground/soil conditions	Saturated soil Unstable soil Contaminated soil Collapse of trench/ excavation walls/trapping Falling into excavation Collapse of adjacent structures	Serious injury/Fatal. Lost time injury. Personnel injury. Property damage. Suffocation Cuts Bruises Fractures	Survey to be done to determine soil conditions and location of underground services Beware of undermining of other structures (e.g.: buildings, scaffolds) Safety shoes, visible vests, dust masks, hard hats and gloves to be used Where any uncertainty pertaining to the stability of the soil still exists, the decision from a professional engineer or a professional technologist competent in excavations shall be decisive and such a decision shall be noted in writing and signed by both the excavation supervisor and the professional engineer or technologist, as the case may be.	6	3	18	H
Underground Services	No surveys done to establsih existing services. No way-leaves available Striking of buried services	Injury to employees Disruption of services to community. Fines and claims for damage	Make all necessary enquiries to establish what services are in the area. Consult drawings and advice from service provider (e.g.: Municipality or ESKOM) when planning work. Assume all service to be live (Unless confirmation is received to confirm that services are isolated or otherwise made safe). Do not work near live services without authorisation from site management. Comply with the requirements of the safe system of work for underground services. Where available, locate services with a locator Hand dig around services	6	2	12	M

Bulk earthworks	Large plant not able to stop in time. Operator not seeing other employees Unsafe act or condition not being rectified in time. Employees crossing the haulage roads.	Loss time injury Property damages Serious injury/fatalities.	Supervisor to make sure bulk earthworks area is out of bounds to unauthorized persons All employees to be inducted Correct PPE. to be used and all workers to be clearly visible Pre use inspections to be done daily Operator certificates must be on site	6	3	18	H
9) Building of structure							
Bricklaying	Working with tools, bricks and mortar	Foot, hand and body injuries	Provision of proper PPE, Induction training and safety talks and planning	6	1	6	L
	Working at height on scaffold and trestles	fatality, major fractures, cuts and bruises	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	3	18	H
	Working at unprotected edges	fatality, major fractures, cuts and bruises	Planning, barricade, training and toolbox talks	6	3	18	H
Plastering	Faulty hand tools Faulty spirit level Rubble and material. (tripping and falling) Working at heights (different level falls)	Poor quality work Lost time injury. Serious injury/fatal.	Good quality tools Tools in good condition Clean area Training on correct use of tools Fall protection plan to be in place	6	3	18	H
Finishing.	Hand tools used incorrectly Exposure to hazardous materials, Dust, paint and other materials. Poor Housekeeping Trip hasards hazards. Working in eevated possition.	Loss time injuries Severe injuries Loss in production.	Correct PPE.use. Correct training received. Use eye protection.	6	2	12	M
Partition installation	Unsafe use of PPE. Obstacles on ground may cause tripping and falling Material may dislodge causing employee to fall down Untrained employees working with portable electrical equipment Unsafe electrical tools Unsafe extension cords (electrocution) Unsafe ladders Incompetent workers	Loss time injuries Severe injuries Property damage Loss in production Fatalities Electrocution	All employees to be trained on safe use of PPE. Good housekeeping All equipment and tools to be checked daily Provide safe access at all times Lift all cables off ground where possible All workers to be trained for the task at hand Only competent workers to use electrical tools Provide a valid fall protection plan	6	3	18	H

Paving	Truck colliding with workers/vehicles/plant while delivery of material Lack of supervision Unstable foundations or pallets can cause collapsing of brick stack Struck by falling loads Incorrect use of PPE. Scattered and protruding objects Exposure to noise and dust Loss time injuries Fatalities Hazardous chemicals (petrol) Faulty hand tools Incorrect level and positioning of paving	Severe injuries Property damage Loss in production	Truck driver to be trained and competent All workers to be trained and inducted Correct use of PPE. (dust masks) Level area and all load bearing equipment in satisfactory condition Supervisor to safely space workers from each other MSDS, use gloves when refueling Always use correct lifting techniques	6	2	12	M
	Repetative bending. Exposure to noise and dust	Impact injuries Ergonomic injuries Cuts Injury to knees Hearing and eye damage	Impervious gloves to be worn/ barrier cream to be used Kneelers or similar to be available Personal protective equipment to be worn – for example if saw used to cut pavers	6	2	12	M
Glazing	Cutting and working with glass and aluminium	Major cuts and amputations	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	2	12	M
Fitting and fixing door and window frames	Faulty equipment and tools Working with electric power tools Unprotected openings and doorways Loss time injury	Serious injuries Property damage	All tools and equipment to be according to SABS standards and weekly tools inspections to be done Only trained and competent employees to work with power	6	2	12	M
Plumbing	Working with open flame	Fire and burn wounds, proporty damage	Fire prevention training, safety talks, adequate fire equipment	6	2	12	M
	Working at height	Fatality, major fractures, cuts and bruises	Induction training and safety talks and planning and supervision, Provision of proper PPE	6	3	18	H
	Improper use of tools Use of untrained employees Use of open flames Struck by materials falling	Injury to persont Fire Burns Exposure to lead fumes	Ensure standard safety procedures are followed at all times Only used trained and competent personnel Ensure there is a safe working area at all times Ensure materials are stored neatly Ensure there is safe access and egress at all times Ensure all personnel wear suitable and sufficient personal	6	2	12	M

Tiling	Carrying tiles	Back injuries	Induction training and safety talks and planning	6	2	12	M
	Exposure to tile chippings, dust	Exposure to dust, eye injuries	Provision of proper PPE, Induction training and safety talks and planning	6	1	6	L
	Working with grinder	Fire, inhalation of dust, eye injuries	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	1	6	L
Painting	Working at height and exposure to paint	Fatality, major fractures, cuts and bruises, alergy to	Induction training and safety talks and planning and supervision, Provision of proper PPE	6	3	18	H
Placing of pre-stress slabs	Placement of heavy concrete slabs	Fatality, major fractures, cuts and bruises	Planning, barricade, training and supervision	6	3	18	H
Installation of ceilings	Working on unsafe scaffolding and ladders Objects falling on workers below Incorrect use of PPE. Incorrect use of equipment and tools Unsafe use of tools and equipment.	Severe injuries to employees Loss time injuries Property damage	Supervisors to make sure ladders and scaffolding is up to standard at all times All workers to be trained in correct use of PPE. and safe use of hand tools Good housekeeping	6	2	12	M
10) Steelwork							
Steelwork	Carrying heavy material	Back, hand and foot	Induction training and safety talks and planning	6	1	6	L
	Working with grinder, abrasives and cutting flame	Fire, inhalation of dust, eye injuries and burns	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	2	12	M
	Exposure to welding arch and fumes	Long term respiratory disease	Good ventilation and Provision of proper PPE, Induction training and safety talks and planning	6	2	12	M
Steel Erection	Lack of knowledge on safe work procedure Incompetent erectors, crane operators, rigger Workers harnass not secured or no lifeline. Work area not barricaded Lifting equipment not in good working condition.	Cuts, bruises and fractures Possible fatalities Damage to property	Adhere to all general precautions for working at height Barrier off / exclude area below work All lifting appliances to be examined and inspected Inspection register in place and up to date All personnel to be trained and competent and wear clipped on safety harnessed when working at height Ensure that lifting equipment (slings, chains, shackles) test certificates are current and on site Competent persons only to connect loads and direct plant	6	3	18	H
Installation of balustrade fencing	Transfer of material to assembly area Use of portable electric tools Use of welding machines Working on ladders or unsafe working platforms Fire	Severe injuries Loss time injuries Property damage	Workers to be trained on safe use of hand tolls and safe lifting methods All ladders to be according to standard Fire extinguishers available on site Only trained workers to use with portable electric equipment	6	2	12	M

11) Temporary work							
Temporary work	Working with tools, bricks and mortar	Foot, hand and body injuries	Provision of proper PPE, Induction training and safety talks and planning	6	1	6	L
	Working at height on scaffold and trestles	fatality, major fractures, cuts and bruises	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	3	18	H
	Working at unprotected edges	fatality, major fractures, cuts and bruises	Planning, barricade, training and toolbox talks	6	3	18	H
Form Work	Untrained erectors. No temporary work design. No competent supervision Poor quality or inadequate material	Serious injury/Fatal. Lost time injury. Personnel injury. Property damage.	Formwork must be assembled by competent workers under supervision of an experienced supervisor. Formork must be assembled in accordence with the design that was developed by a competent person. The formwork must be signed off by the designer before concrete pour.	6	3	18	H
Tower Scaffold	Scaffold not built to standard Lifting of heavy unit into ceiling Un-authorised access Overlaoding of scaffold Weather conditions Medical condition of worker	Injury to employees, possible fatal and damage to property.	Tower to be on firm level ground with wheels or feet properly supported. Height not to exceed 3 times the base dimension. i.e. 2x3m Erection by competent person Inspection before first use Weekly record of inspection required Guard rails and Toe boards as per normal scaffolds Beware when moving of overhead obstructions, such as power lines Never move in strong winds	6	3	18	H
Shuttering	Lack of planning. Incorrect equipment No pre use inspection of equipment Incorrect PPE. Designated areas and structures not in clean and orderly fashion	Serious injury. Loss time injuries. Property damage.	Equipment to be checked, identified and entered in a prior to use All employees to be trained Good housekeeping at all times Ensure proper/safe off loading	6	2	12	M
12) Plant and equipment							

Plant or Vehicles Operation	Equipment failing Workers injured by passing traffic Road users and pedestrians at risk from operation of moving plant Noise	Hearing Loss Injury to employees Damage to property	Implement traffic protection measures Trained and competent operators must be used Check plant and vehicles on daily basis before use and record inspections. Maintain vehicles in safe condition Medical certificates of fitness required for construction plant Crossing of road by construction vehicles or machines must be limited to the practical minimum Plant and vehicles must be fitted with amber rotating beacons and reverse alarms/hooters Wear appropriate protective clothing/equipment, e.g.: goggles, gloves, ear defenders, etc as appropriate	6	2	12	M
Compactors	High noise levels	Hearing loss	Provision of proper PPE, Induction training and safety talks	6	2	12	M
	Heavy moving machine	Foot injury		6	1	6	L
Operation of machinery and vehicles.	Employees not trained or licensed can cause incorrect operation of equipment resulting in collision. Poor visibility can cause collision. ` Checklist not properly visually done.	Lost time injury. Serious/fatality. Damage to property.	Formal training on the use of equipment. Correct type of license used by the operators. Medical certificates available. Proper checklist system to be implemented. Defects logged and repair prior to use.	6	3	18	H
Parking of machinery and vehicles.	Uneven surfaces can cause machinery/vehicle to run away. If park brake is not applied, machinery/vehicle can run away. If stop block is not put behind wheels machinery/vehicle can move. If machinery/vehicle is not locked it can cause the use of unauthorised person.	Serious injury/ fatality. Lost time injury. Property damage.	Draft safe work procedures for parking of machinery/ vehicles. Train employees on the procedures. All machinery/vehicles to be equipped & Cd with stop blocks. Ensure park brake in working condition at all time.	6	3	18	H
Use of generators	Chemical vapors. Noise. Fire Back injuries when lifting Electric shock	Lost time injury. Personnel injuries Noise induced hearing loss	Correct PPE. to be used Prevent spillages and leaks Fire extinguisher available Generator to be properly earthed and in good condition.	6	2	12	M

Grader	Employee being injured by standing on, under or too close to engine or tamping drum Grader engine failure Grader colliding into other plant or LDV Employees being run over by grader.	Severe injuries Lost time injuries Fatalities Property damage Environmental damage	All protective guards must be in place before start of engine. Operator should be competent and trained with competency certificate in file Grader must be well maintained inspected. Correct PPE must be used	6	3	18	H
Transporting and tipping of soil by using tipper trucks	Tipper colliding into other LDV Tipper overturning Material tipped onto employees Tipper reversing over employees Employees exposed to noise and dust Tipper tipping in incorrect area	Severe injuries Loss time injuries Damage to property Fatalities Loss in production.	Operator must be trained and competent Tipper to be used at safe angle Employees to stay clear of tipper when dropping of soil Tipper truck must be well maintained with records on file	6	3	18	H
Use of Pneumatic drill/Jackhammers	Damaged machine could cause injury and or damage Not using PPE while working with machine Incompetent employees working with machine can cause injury Employees exposed to dust and noise Unsafe use of power tools	Loss time injuries. Severe injuries. Property damage.	Machines need to be serviced and well maintained Pre use checklist to be done Competent and trained employees to use machine only Always use the correct PPE. (respirators, eye protection) Only trained and competent people to work with power tools	6	2	12	M
Operating the whacker.	Incompetent operator Hazardous chemicals (petrol) Employees exposed to dust, noise and vibration	Loss time injury Property damage	Use correct PPE. Operator needs to be competent and trained MSDS, use hand gloves when refueling	6	2	12	M

Excavator.	Machine overturning. Materials or equipment falling from Machine. Workers being endangered by machine operation. Machine arcing with or coming into contact with overhead cables or underground services.	Loss time injuries Severe injuries Property damage Loss in production Fatalities Damage to existing services could cause financial claims	Operator to be trained and competent. The operator will be responsible for ensuring machine is not misused and that it is maintained accordingly. Excavator must not be operated within 6m of overhead power cables when the boom is fully extended, unless suitable precautions are taken. Before excavation ground survey will be made to locate any underground services and prevent damage or injury.	6	3	18	H
Dumper.	Machine overturning. Falling of dumper. Collision with other plant or pedestrians.	Loss time injuries Severe injuries Property damage Loss in production	Driver to be trained, certified and have a valid driver's license. No unauthorised persons will be permitted to use the dumper. No overloading the dumper. Dumper not to be within 1.5m of any excavation. When tipping the dumper must be on level ground and suitable measures must be taken to prevent "overturning".	6	2	12	M
TLB	Workers can fall under wheels. Struck by boom or bucket. Falling material on workers or equipment. Collision with other plant or pedestrians.	Loss time injuries Severe injuries Property damage Loss in production Fatalities	Driver to be trained, certified and have a valid driver's license. No unauthorised persons will be permitted to use the TLB. No overloading the TLB. TLB not to be within 1.5m of any excavation. No extra worker or persons in cab except operator.	6	3	18	H
Water Tanker.	Fall under wheels. Collision with other plant or pedestrians. Water Tanker overturn.	Loss time injuries Severe injuries Property damage Loss in production Fatalities	Driver to be trained, certified and have a valid driver's license. No unauthorised persons will be permitted to use the Water Tanker. No worker allowed on the back of moving Water Tanker.	6	3	18	H
Concrete Mixer.	Loose clothing can get caught in machine. Limbs trapped or severed. Inhalation of cement dust. Eye injuries.	Loss time injuries Severe injuries Property damage Loss in production.	Operator to be trained and competent in using a concrete mixer. Proper PPE. to be worn. Correctly moving and handling the chutes. Stay always a clear distance from concrete mixer.	6	2	12	M

12 Ton flat drum roller.	Fall under drum. Collision with other plant or pedestrians. Workers can fall under drum.	Loss time injuries Severe injuries Loss in production. Fatality	Operator to be trained and competent in using a flat drum roller. Proper PPE. to be worn. Always aware of workers around the roller.	6	3	18	H
Pad foot roller.	Fall under drum. Collision with other plant or pedestrians. Workers can fall under drum. Not wear always a kidney belt for vibration it can cause carpal tunnel syndrome and kidney problems.	Loss time injuries Severe injuries Loss in production. Damage to proporty. Fatality	Operator to be trained and competent in using a pad foot roller. Proper PPE. to be worn. Always aware of workers around the roller.	6	3	18	H

13) Hotwork							
Welding & Flame Cutting Equipment Inspection & Use	Sparks being created in a vapour zone Possible explosion Injury to employees Fire hazard Untrained persons Unsafe equipment Incorrect connection to welding machine Poor welding operation Exposure of others in work area to sparks Exposure of poisonous gases	Damage to property Injury to employees Electrocution Fire Burns, injury to employees Electrical shock Arc' eyes injury	Only trained employees may operate the machine Train employees and keep copy of training certificate Keep a copy of certificate Keep machine in good condition Keep register up to date and inspect equipment monthly Operator must be in visual contact with the welding equipment at all times Ensure welding machine is positioned away from access route and is visible to the operator at all times. Only approved welding cables may be used. Operator and supervisor must ensure only approved connections are used. Clamp ground or earth cable into position Use correct clamps; Connect only by means of approved clamps Do not weld ground or earth cable into position Secure work area and good ventilation Always clamp the earth cable into position Use a screen, or work In an area away from other employees Work in an area with good ventilation	6	2	12	M
Flame cutting.	Unsafe flame cutting equipment used. Employees not competent to perform flame cutting. Flame cutting equipment not maintained and inspected.	Fatality. A lost time injury. Property damage.	Flame cutting equipment to be fitted with flashback arrestors. Flame cutting equipment to be inspected daily and deviations rectified. Safe storage or pressure equipment after use. Only competent employees to perform flame cutting. Ensure the correct PPE.	6	3	18	H
Arc welding.	Employees not competent to perform arc welding. Faulty equipment. Chemical/ flammable material next to welding activities. Inspections not frequently performed on equipment.	Serious injury/fatal. Lost time injury. Property damage. Environmental.	Only competent employees perform arc welding. Frequently inspections. No welding to be done near flammable liquids. Ensure the correct PPE.	6	3	18	H

Oxy acetylene equipment	Using unsafe and faulty equipment Fire and smoke inhalation from burning steel Incompetent workers The use of gas equipment has a high potential for fire and or explosions Flammable liquids close to working area Unauthorised persons in work area.	Loss time injuries Severe injuries Explosions Fatalities Property damage	NEVER use oil or grease on any gas fittings Correct use of PPE. Fire equipment to be in close proximity Only trained and competent workers to use equipment Store in a safe way No unauthorized persons in work area. Make sure area of work is clear of unauthorized persons.	6	3	18	H
14) Stacking, storage and houseekeeping							
Stacking and storage	Storage and work areas not kept clean and safe	Damage to proporty, injuries	Job specific training, Induction training and safety talks and planning and supervision	6	1	6	L
Stacking of material.	Employees not trained on safe work procedures. The crane operator incompetent. The slings are not tested as prescribed. Equipment not inspected and maintained frequently. Lifting equipment not maintained & inspected frequently can cause injury or damage to property.	Serious injury/fatal. Lost time injury. Personnel injury. Property damage.	Adhere to lifting and rigging procedures. Only competent employees to use lifting equipment. Only certified lifting equipment to be used. All lifting equipment to be fitted with SWL identifying tags. Area where to be stacked is level area. Barricading to be done around stacking material.	6	3	18	H
Stacking of Structural Steel	Employees not trained. Not wearing the correct PPE. Steel is not placed on wood poles not direct on ground to prevent rust.	Serious injuries Lost time injury. Personnel injury.	Train employees on the procedures. Use correct PPE.	6	2	12	M
Housekeeping	Poor housekeeping on construction sites. Trips and falls Creating dust Fire hazards	Serious injury. Lost time injury. Personnel injury. Property damage.	Ensure the area below where any elevated work is being performed is free of any rubble, spikes, tools or equipment Ensure that all areas have been checked by competent persons on a daily basis Ensure that all site agents have certified their work area as safe by the end of each shift Good housekeeping principles.	6	2	12	M

15) Handling and storage of hsardous chemicals							
Hazardous Substances, Use and Storage	Exposure to vapours Direct contact with substances Use untrained employees	Injuries to workers through use of hazardous substances, e.g.: injuries to eyes, skin, inhalation, etc Damage to environment	Use substances in accordance with data sheet, particularly reference protective clothing required (example: gloves, goggles, etc) Know what First Aid measures are Have welfare facilities available for washing of hands, etc Train employees in usage of substances	6	2	12	M
Use and storage of flammable liquids	Improper storage of flammable substances Possible fire Unmarked containers Employees smoking in vapour zones Untrained employees	Serious injury to employees Burns Property damage Explosions Fire	Flammable substances to be stored in an appropriate flammable store which is well ventilated and a reasonably fire resistant container, cage or room and kept locked with proper access control measures in place Material Safety Data Sheets to be in safety file No smoking, and no heat/ignition close to or at sources Employees to be made aware of dangers Signage to be brought on to indicate dangers	6	2	12	M
Diesel Storage	Theft of fuel Fire at storage area Spillage due to leak in tank Inhalation of hazardous vapors.	Property damage Serious injuries/fatal Lost time injury	Ensure that security guards is on duty and that there are sufficient lighting during the night Employees should be trained in firefighting and fire extinguishers available in all areas on site Fuel tank to be properly secured and well ventilated. Bund wall to be in place to contain all spillage. Display no smoking and open flame signage. Provide adequate fire equipment with signage.	6	3	18	H
Hazardous chemicals and storage	Inhaling Handling Untrained employees Insufficient ventilation	Severe injuries Loss time injuries. Fatal.	Use the SABS 0228 code of practice Correct PPE. to be used by employees Sufficient ventilation in storage areas	6	3	18	H

16) Confined space							
Confined Spaces	Lack of oxygen Explosive gasses Not being able to communicate with each other Restricted movement Not using correct PPE. Ensure all sources of energy (steam, electricity, water) to confined space is isolated and locked out. Unlit area	Suffocation Serious injuries Fatalities Property damage	Ensure that correct PPE. is issued Trained competent person to ensure that locking out of energy sources has been completed. (water, compressed air) All employees to have completed induction training. All employees must have valid medical certificate Ensuring that communication is maintained at all times with “hole watch” tested using a dosimeter to ensure atmosphere is safe to work in. Install sufficient lighting.	6	3	18	H
17) Working at heights							
Working at Height Elevated Work	Unsafe access(Ladders, scaffold) to work area Objects falling from above. Falling debris, tools and equipment. Incliment weather.	Serious injury/Fatal. Lost time injury. Personnel injury. Property damage.	All access equipment is properly constructed (inspections record must be maintained) Only trained personnel construct, dismantle or control the access equipment All access equipment must have full toe boards and guardrails - comply with SANS 10085 on erection/use and dismantling of scaffolding No access equipment may be loaded above the level of the guardrail No access equipment to be loaded above its safe working load Where work involves leaning out on an open leading edge, then all personnel are to be fitted with full body harness. The harness must be connected at all times All fall arrest equipment to be correctly maintained Ensure if ladders are being used for access, they are either footed or tied. Also the ladder must be set at the correct level of 1 in 4 or approximately 75 PPE to be used: harnesses, hardhats, safety shoes, overalls. Ensure staff at height all has medical and psychological certificates. Harnesses to be inspected daily.	6	3	18	H

Open edges	Un-authorised removal of edge protection and signage No edge barricading done.	Fatalities. Serious injury. Loss time injuries. Property damage.	Use barricades in such a manner to prevent any person from falling. Always ensure that barricading is done in a manner that is safe Barricading must be of high standard. Barricading must be able to prevent a person from falling from open edges.	6	3	18	H
Working at elevated positions	Slipping and falling, persons not fit to work at heights i.e. vertigo, epilepsy. Objects falling down from above. Working unsecured and falling down. Trying to carry material or tools up a ladder/ scaffolding while climbing up. Areas not barricaded.	Loss time injuries. Fatalities. Property damage.	Adequate secure ladders/platforms and scaffolding to be used All employees working at heights to have valid medical certificate Fall prevention systems to be	6	3	18	H
Edge Protection.	Solid Edge Protection not installed on all open edges of Buildings including Excavations 1.5 meters or deeper. No warning signs posted.	Fatalities Loss time injuries Severe injuries Property damage Loss in production.	Barricading must be strong enough to prevent a person from falling from height. Fall risk signs can be posted. Induction training must cover working in close proximity to open edges. Regular toolbox talks on the topic must be conducted. Daily task risk assessments must be conducted and recorded.	6	3	18	H
18) Roofwork							
Roof work	Working at height	fatality, major fractures, cuts and bruises	Provision of proper PPE, Induction training and safety talks and planning and supervision	6	3	18	H
	Carrying heavy material on roof	fatality, major fractures, cuts and bruises of worker and others	Induction training and safety talks and planning	6	3	18	H
Roof truss erection	Unsafe access to work area Incorrect PPE used Objects falling from heights and injuring workers below Workers falling down due to non-use of fall restraint systems Rainy or wet conditions Lifting and transporting roof trusses to assembly area Trusses not properly secured. Workers not medical fit.	Loss time injuries Serious injury/fatalities Property damage	Only trained workers to work on heights Ladders to be fastened at all times Safety harnesses must be used at all time while working on heights Correct PPE. to be used No work to commence in wet conditions Properly secure and brace trusses to prevent falling down. Erect 1 truss at a time	6	3	18	H

Roof sheeting and cladding	Un-authorised access to roof Working on sloped angle with roof sheeting. Bad weather conditions Dropping of roof sheeting Tools and equipment dropping down Unsafe use of portable electric tools Workers not tied to anchor point or lifeline Workers not wearing fall protection harnassess No fall protection plan	Loss time injuries Severe injuries Property damage Loss in production Fatalities	Supervisors to ensure that there is safe access to roof area, by providing safe access ladders or scaffolding All employees to use safety harnesses while working on roof with life lines running parallel with roof No work to be done in bad or wet weather conditions Sheeting to be placed from one side to the other to prevent open spaces All employees to be trained in working at height and inducted Correct use of PPE.	6	3	18	H
19) Conrete work							
Foundations (excavating and pouring)	Inclement weather, rain can cause collapsing of excavation. Open excavations Underground services The truck is not road worthy.	Loss time injuries Severe injuries Property damage Loss in production Fatalities	Make sure ground is from a stable formation before workers get into excavation. Always barricade off the open excavations Approved engineer's drawings to identify all underground services Stockpiling of soil to be a safe distance away from excavation edge Formal training on the use of equipment. Licensing of operators. Medical certificates available. Checklist system to be completed before work commences.	6	3	18	H
Steel Fixing	Injuries to hands, fingers, limbs,feet due to handling of steel Tripping , falling ,slipping on steel Steel falling from above can injjure workers. Eye injuries due to flying fragments of wires. Workers falling from elevated heights	Back injuries caused by manual handling Eye injuries from tie wire Trips / falls Falling form height	PPE must include safety boots and goggles Manual handling training may be required Use only trained personnel Cap starter bars to prevent injuries where feasible Use of safety equipment e.g. safety gloves safety shoes hard hats and eye protection No unaurthrised persons allowed in area Steel area to be barricaded off. Ensure that workers have proper safety	6	2	12	M

Pouring concrete with cement truck.	The driver of truck is incompetent to off load cement. The cement truck is not road worthy.	Serious injury/fatal. Lost time injury. Personnel injury. Property damage.	Formal training on the use of equipment and operators. Licensing of operators. Medical certificates available. Checklist system to be implemented. Defects logged and repair prior to use. Make sure the cement is not the correct MPA. Make sure the cement truck is not bump against the load off area.	6	3	18	H
Pouring concrete with cement pump.	The driver of cement pump is competent to off load cement. The cement pump is road worthy. The cement pump jib is not bump against off load area. The cement is not the correct MPA.	Serious injury/Fatal. Lost time injury. Personnel injury. Property damage.	Formal training on the use of equipment operators. Licensing of operators. Medical certificates available. Checklist system to be implemented. Defects logged and repair prior to use. Make sure the cement pump is not bump against the load off area.	6	3	18	H
20) Civils							
Cutting Kerbs	Unsafe machinery Lack of knowledge on safe work procedure Damage to property and injury to employees Unexpected disruption in work	Injury, cuts, bruises and amputation	Only trained operators to use saw and change blades. Personal Protective Equipment must be worn. Gloves, goggles, dust mask and hearing protection. People to be kept away from the work area. Work to cease if people have to pass. Sparks etc. to be directed away from people and any flammable material.	6	2	12	M
Laying of storm water and sewer lines	Inclement weather, rain can cause collapsing of excavation. Shoring/battering is not done in deep excavations. Training of employees in excavation safe work procedures. Open excavations Underground services Confined space No safe access or egress	Loss time injuries Severe injuries Property damage Loss in production Fatalities Damage to existing services could cause financial claims	Make sure all workers are trained to work in deep excavations. Use the correct material to do shoring. Make sure shoring/battering is done in deep excavations. Make sure ground is from a stable formation before workers get into excavation. Formal training on the use of equipment. Ensure there is safe access/egress at leasever 12 meters	6	3	18	H
21) Explosive actuated tools							

Use of explosive actuated fasting devices	Pointing tools carelessly in any direction Employees not trained in the use of explosive powered tools Machines not cleaned or oiled Miss fires Unsafe disposal of empty cartridges	Serious injury. Lost time injuries Property damage	Competent workers to be trained Daily checklists to be done Correct PPE. must be used at all times	6	2	12	M
22) Fire protection							
Fire fighting and prevention	Fire can occur Fire alarm not functional, therefore people not hearing the sound of alarm Non availability of fire equipment Untrained personnel using wrong type of equipment or extinguishers to distinguish fire	Property damage Serious injuries Fatality	Fire escape routes to be determined and clearly marked Formal training on the emergency evacuation plan and to be reviewed. Monthly checklist of all fire equipment Formal training on basic firefighting	6	3	18	H

23) Demolition							
Demolition work	Demolishing the wrong structure Substandard/dangerous equipment Exposure to dust, noise & vibration Not wearing correct PPE. Rubble overloading floors Hidden services (electrical, water) Possible collapsing of structures	Damage to equipment plant Serious injuries/fatality. Property damage Lost time injuries.	Correct drawings and permits need to be obtained Adjacent property, building or part of building to be demolished will be surveyed and a report, in writing, prepared as to the findings. All equipment and tools in good working order Only trained workers to perform work of this nature Rubble to be removed on a regular basis All services to be disconnected. Demarcate demolition area and display warning signage. Temporary supports to be installed according to engineer's drawings.	6	3	18	H
Breaking concrete slab	Employees exposed to dust and noise Unsafe use of power tools (jack hammer). Workers not using the applicable PPE.	Loss time injuries Serious injuries Property damage	Always use the correct PPE. (respirators, eye protection) Only trained and competent people to work with power tools	6	2	12	M
24) Transport and traffic management							
Transporting people.	Road worthy vehicle to be used. Vehicle used for transporting people not properly equipped with necessary safety requirements. Workers not seated.	Injuries to workers Lost time due to injury. Property damage.	Ensure that where people are transported together with material and tools that vehicle is equiped as per road safety act requirements. Ensure employees are properly seated. LDV's used for transporting people must comply with standard regulations. No standing is allowed.	6	2	12	M
Exit/Entry into the Public Roads.	Heavy vehicles entering high traffic areas No construction traffic signs posted No flagman	Motor vehicle collusion. Fatalities Loss time injuries Severe injuries Property damage Loss in production.	Driver to be trained, certified and have a valid driver's license permitted to use a vehicle. Traffic management plan must be developed. Flagman must be posted and correct signs posted.	6	3	18	H

25) Health and Ergonomics							
Construction work creating Dust	Exposure to dust	Breathing in dust can cause long term health problems. Eye damage. Property damage.	Wear respiratory protection Dampen down and minimise dust where possible Make use of environmentally friendly methods to minimize dust kick-up, use bale straw and spread over area to prevent wind kick-up	6	2	12	M
Construction equipment creating excessive noise	Exposure to Noise	Noise can damage hearing permanently	Wear hearing protection Have machinery tested to establish the exposure to noise levels so that proper protection can be issued Induct employees on hearing loss before they are exposed to high levels of noise	6	2	12	M
Construction equipment creating vibration	Exposure to Vibration	Ergonomic injury to employees	Medical surveilence. Resticting exposure times Employees exposed to vibration must receive induction on using their PPE	6	2	12	M
26) Effect on public							
Working in built up or residential areas	Adjacent Land Use Boundary and access control/public liability exposure. Increased foot traffic across or next to site Children playing on site Members of public entering site	Members of public getting injured. Loss of property Civil claims against contractor	Proper segregation of construction works from other land users Signage indicating dangers of entering site The construction site must be suitably and sufficiently fenced off Provide a controlled access point to prevent the unauthorised entry of persons	6	2	12	M

	A	B	C	D	E	F	G	H	I
1	**BASELINE RISK ASSESSMENT**								
2	**Site: BOSPOORT AT RUSTENBURG, NORTH – WEST**			**Risk Assessment Team:**		**Pieter Herbst (Pr. CHSA/057/2017)**			
3	**Date: 13 July 2020**								
4	**EXPOSURE AND INFECTION WITH CORONA VIRUS**								
5	**Frequency** 2 < 15% chance of exposure - 3 ><15 and 50% chance of exposure 4 ><50 and 75% chance of exposure 5 > 75% chance of exposure	**Probability of injury /loss /damage** Unlikely = 1 Possible = 2 Almost certain = 3 Certain to happen = 4 Has happened before = 5	**Severity of inj/damage** Minor/no inj/damage = 2 Serious inj/damage = 3 fatality/major damage = 4 multiple fatalities/damage = 5 catastrophic = 6	**Rating** Up to 13 = Low risk. ><14 and 36 = Moderate risk. 36> = High risk					
6	**Description of Area/Activities/Task**	**Hazards**	**Risk , Unwanted Event & Consequences**	Frequency of exposure to hazard	Probability of injury loss / damage	Severity of injury/ loss/damage	Score	Rating L, M, H	**Recommended controls**
7	**Infection with Corona virus**	**Exposure to Corona virus through:**	Infected employees could die, become very ill, infect many other persons including public. Loss of production. Delay in project. Finacial loss. Total disaster.	4	3	6	72	H	Company must develop an infection prevention, infection management and after care contingincy plan which must include; a. Training of staff b. Precautionary measures c. Workers reporting system d. What procedures will be followed by company when a person reports possible infection e. Procedures when person has been confirmed as infected(support) Re-entry of persons who have recovered f. training of site management and workers inthese procedures g. Provision of appropriate PPE Provision of washing fascilities and sanitiser.
8		Working in close proximity to other workers							
9		Travel to work in taxi, bus and train							
10		Physical contact with infected person							
11		Contact with contaninated tools, equipment, surfaces							
12		Infected person couching or sneezing onto those in close proximity							
13		Not being issued or wearing appropriate PPE							
14		Not having adequate washing fascilities with appropriate sanitiser available							
15		Management not developing a contingency plan and communicating it with employees							
16		Workers not adequatelly informed about the threat and protection methods							
17		Mass gatherings and meetings							
18		Workers not adequatelly washing hands							
19		Travel history not declared by persons accessing the site							

	A	B	C	D	E	F	G	H	I
1	**BASELINE RISK ASSESSMENT**								
2	**Site: BOSPOORT AT RUSTENBURG, NORTH – WEST**			**Risk Assessment Team:**	**Pieter Herbst (Pr. CHSA/057/2017)**				
3	**Date: 13 July 2020**								
4	**EXPOSURE AND INFECTION WITH CORONA VIRUS**								
5	**Frequency** 2 < 15% chance of exposure - 3 ><15 and 50% chance of exposure 4 ><50 and 75% chance of exposure 5 > 75% chance of exposure	**Probability of injury /loss /damage** Unlikely = 1 Possible = 2 Almost certain = 3 Certain to happen = 4 Has happened before = 5	**Severity of inj/damage** Minor/no inj/damage = 2 Serious inj/damage = 3 fatality/major damage = 4 multiple fatalities/damage = 5 catastrophic = 6	**Rating** Up to 13 = Low risk. ><14 and 36 = Moderate risk. 36> = High risk					
6	**Description of Area/Activities/Task**	**Hazards**	**Risk , Unwanted Event & Consequences**	Frequency of exposure to hazard	Probability of injury loss / damage	Severity of injury/ loss/damage	Score	Rating L, M, H	**Recommended controls**
20 21	**Communication and awareness**	Potentially infected / exposed employees not identifed and monitored due to a lack of awareness communication and hygiene measures	Inadequate communication channels will not reinforce health and hygiene measures in the workplaces such as hand hygiene, respiratory etiquette, and staying home when ill in order to limit transmission. It may also help with compliance with public / community health advice.	4	3	5	60	H	Provide awareness posters / signage and include access to handwashing facilities and place hand sanitizing dispensers in prominent locations throughout the workplace.
22	**Medical management**	Occupational health practitioner services not available i.e. rural areas	Although screening may not identify all individuals infected with COVID-19 in the workplace, occupational health and safety professionals may be able to quickly and safely identify and isolate symptomatic individuals in the workplace.	4	3	5	60	H	Plan for rapid isolation of a symptomatic employee and identify an area where employees/clients can be isolated if they become ill at the workplace; Ensure that contact details of care professionals and relevant information is available and communicated health.
23		Records of COVID 19 Exposure Medical Questionnaire not retained	Relevant information required for effective monitoring and identification purposes not available						Questionnaires must be discussed with employees and records must be retained.
24		Inadequate workplace cleaning and disinfection protocols	The frequency (i.e. one contact versus multiple contacts) and duration (i.e., transient contact versus prolonged contact) of exposure to high-touch surfaces and objects could potentially increase the risk of contamination.						Enhance environmental cleaning procedures and protocols with a special attention to high-touch surfaces and object (e.g., phones, computers and toilet facilities

	A	B	C	D	E	F	G	H	I
1	**BASELINE RISK ASSESSMENT**								
2	**Site: BOSPOORT AT RUSTENBURG, NORTH – WEST**			**Risk Assessment Team:**	**Pieter Herbst (Pr. CHSA/057/2017)**				
3	**Date: 13 July 2020**								
4	**EXPOSURE AND INFECTION WITH CORONA VIRUS**								
5	**Frequency** 2 < 15% chance of exposure - 3 ><15 and 50% chance of exposure 4 ><50 and 75% chance of exposure 5 > 75% chance of exposure	**Probability of injury /loss /damage** Unlikely = 1 Possible = 2 Almost certain = 3 Certain to happen = 4 Has happened before = 5	**Severity of inj/damage** Minor/no inj/damage = 2 Serious inj/damage = 3 fatality/major damage = 4 multiple fatalities/damage = 5 catastrophic = 6	**Rating** Up to 13 = Low risk. ><14 and 36 = Moderate risk. 36> = High risk					
6	**Description of Area/Activities/Task**	**Hazards**	**Risk , Unwanted Event & Consequences**	Frequency of exposure to hazard	Probability of injury loss / damage	Severity of injury/ loss/damage	Score	Rating L, M, H	**Recommended controls**
25	**Safety and security**	Public / community interaction with employees during work hours	Mass gathering outside the site including employees and local community looking for employment.	4	4	5	80	H	Appointed CLO to be made aware of and trained on Covid-19 control measures
26		Access control not effective	Perimeter fencing and area demarcation of work areas inadequate to prevent public / community from entering the workplace.						The principal contractor must enforce strict access control and no person may enter the site except those who have undergone induction training and who is listed on the employee list.
27		Use of stationary i.e. pen and paper when recording acccess at the entrancemof the site							
28		Incidental touching while perfoming duties							The only exceptions are persons who have pre-arranged official appointment which has been approved by the project construction
29	**Mental health issues in the workplace**	Employer not providing sufficient information and referrals with regard to counselling services	Employees may experience increased stress associated with COVID-19, that can bring up historical traumas, trauma of past	3	3	4	36	H	Ensure that contact details and related information for the support provided by the Department of Health in various provinces are communicated and available.
30									
31									
32	**Control of hazardous chemical substances**	HCS decanted and not labelled with its contents	Legal non-comopliance with regard to the HCS regulations and municipal by-laws.	5	4	3	60	H	a.The type of sanitiser used for COVID 19 must have a minimum of 60% alcohol and it is important that adequate stock is held onsite b.Due to its high alcohol content it poses a fire risk as well as a possible risk of being used by workers for intoxicating purposes which can lead to poisoning c.It is therefore very important to include these risks into account when the risk assessments is updated
33		Inadequate MSDS information and communication of HCS i.e. hand sanitizers							
34		Flammable liquids i.e. hand sanitizer's alcohol level							
35	**Compensation - Reporting of occupational deseases by employer**	Inadequate reporting procedures and associated records	Inadequate incident / emergency preparedness and response in case of an emergency and exposure to the virus.	4	4	4	64	H	Good standing with the compensation commissioner must be verified and relevant records must be available on site to present to inspectors. Records must be retained as part of the incident management process.
36		Contractor not in good standing with compensation fund							
37									

	A	B	C	D	E	F	G	H	I
1	**BASELINE RISK ASSESSMENT**								
2	**Site: BOSPOORT AT RUSTENBURG, NORTH – WEST**			**Risk Assessment Team:**	**Pieter Herbst (Pr. CHSA/057/2017)**				
3	**Date: 13 July 2020**								
4	**EXPOSURE AND INFECTION WITH CORONA VIRUS**								
5	**Frequency** 2 < 15% chance of exposure - 3 ><15 and 50% chance of exposure 4 ><50 and 75% chance of exposure 5 > 75% chance of exposure	**Probability of injury /loss /damage** Unlikely = 1 Possible = 2 Almost certain = 3 Certain to happen = 4 Has happened before = 5	**Severity of inj/damage** Minor/no inj/damage = 2 Serious inj/damage = 3 fatality/major damage = 4 multiple fatalities/damage = 5 catastrophic = 6	**Rating** Up to 13 = Low risk. ><14 and 36 = Moderate risk. 36> = High risk					
6	**Description of Area/Activities/Task**	**Hazards**	**Risk , Unwanted Event & Consequences**	Frequency of exposure to hazard	Probability of injury loss / damage	Severity of injury/ loss/damage	Score	Rating L, M, H	**Recommended controls**
38	**Personal protective equipment (PPE)**	PPE purchased not in accordance with standards and specifications	Increase of infectinon due to non-compliance. Lack of resources to purchase adequate stock of relevant PPE	5	5	4	100	H	Workers who are exposed to people who are ill with respiratory symptoms, such as coughing and sneezing, may use face masks and eye protection if the nature of their work warrants it. Gloves are only recommended when workers will be in direct contact with an ill person, or a contaminated object or environment. PPE must be used correctly; training on their use should be provided and records Shall be retained.
39		Not selecting appropriate PPE in relation to the hazard route of transmission							
40		Incorrect fitting of PPE							
41		Inadequate information and training communication and / or material							
42		Limitation of PPE not identified and / or communicated							
43		Shortage of stock							
44		PPE not safely disposed							
45		Cross contamination due to incorrect storage of PPE							

C3.5C EMPLOYER'S ENVIRONMENTAL MANAGEMENT PLAN

RLM/RWST/OMM/0101/2024/25 - RE-ADVERT: APPOINTMENT OF A CONTRACTOR FOR CONSTRUCTION OF BOSPOORT NORTH RESERVOIR AND ACCESS ROAD

ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPr)

File Reference Number:
NWP/EIA/97/2018

Project Title:
The proposed construction of a 500mm diameter rising- and an 800mm diameter gravity potable water pipelines from the Bospoort WTW to tie into the existing pipeline to Rustenburg town, a reservoir and associated access roads currently under the jurisdiction of the Rustenburg Local Municipality, North West Province.

Prepared for:

Applicant:
Rustenburg Water Services Trust (Mr. Pet Maas)
701 Missionary Mpheni House
Corner Nelson Mandela & Beyers Naude Road
Rustenburg
0300

Cell: +27 (0)83 445 7287
Fax: +27 (0)86 645 8844
Email: pet.maas@tigros.co.za

Compiled by:
Ecoleges Environmental Consultants cc
Tel: +27 (0)83 644-7179
Fax: 086 697 9316
P.O. Box 9005, Nelspruit, 1200
P.O. Box 516, Machadodorp, 1170
Email: justin@ecoleges.co.za

Submission Date: 7 June 2019

Report Status: Final 00

DOCUMENT CONTROL

Table 1. Document Control.

COMPILED BY	STATUS	REVISION	SIGNATURE	DISTRIBUTED ON
Hlengile Mtsweni	Draft	00		29 April 2019
Justin Bowers	Final	00		06 June 2019

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

EXECUTIVE SUMMARY

The project proponent, Rustenburg Water Services Trust, has appointed Ecoleges Environmental Consultants as the Environmental Assessment Practitioner (EAP) to undertake an application for an Environmental Authorisation (EA) through a Basic Assessment (BA) process, as the proposed pipeline and reservoir construction trigger listed activities in terms of the EIA Regulations (2014) as amended (GG No. 40772, GN No. 326 & 327, 7 April 2017) in terms of Section 24 of the National Environmental Management Act (NEMA, Act 107 of 1998). The application was submitted on the 18th March 2019 to the North West Department of Rural, Environment and Agricultural Development (DREAD) as the designated Competent Authority.

Following the upgrading of the 12Mℓ/d Bospoort Water Treatment Works (WTW) to 24Mℓ/d, a new 500mm diameter rising main is required to convey potable water, from an existing pipeline from the WTW to the new reservoir. An 800mm diameter pipe will supply the water from the reservoir at approximately 300ℓ per second to augment the current Vaalkop supply system and provide much needed potable water to the communities in the area as well as Rustenburg Town.

This Environmental Management Programme (EMPr) is developed in compliance with section 24N of the NEMA, 1998, as amended and contains those requirements prescribed in the EIA Regulations, 2014, as amended, including section 23 and Appendix 4 of GN No. R. 326 of 7 April 2017.

The EMPr is to be read in conjunction with the BA Report (BAR) and Environmental Authorisation (EA) providing detail on the affected environment as well as the impact assessment for the anticipated environmental impacts.

Activities to be undertaken during the construction, operational and decommissioning phases include:

<u>Construction Phase</u>

- Site preparation;
  - Clearly delineate the construction footprint to avoid construction creep outside the approved development footprint;
  - Complete search and rescue for fauna/flora of conservation concern or protected status ahead of any construction activities;
- Establish access roads (access roads largely pre-existing);
- Transport plant and equipment to site;
- Establishment of laydown areas;
- Establishment of ancillary infrastructure;
- Construction and establishment of the pipeline/reservoir;
- Site rehabilitation; and
- Environmental management and monitoring throughout the construction process, inclusive of:

- Continuous monitoring and removal of alien or invasive plant species;
- Dust monitoring and management;
- Storm water monitoring and management;
- Erosion monitoring and remediation;
- Fire management;
- Vegetation and habitat management;
- Hazardous substance monitoring and management, including detecting any leakage or spillage; and
- Monitoring and management measures to protect hydrological features.

Operational Phase

- Maintenance, repairs of the pipeline/reservoir and associated infrastructure inclusive of:
  - Cleaning, maintaining the pipeline and reservoir permanent servitude, including associated infrastructure;
  - Removal of alien invasive vegetation; and
  - Maintain and repair fencing (where applicable).
- Environmental management and monitoring throughout the operational process, inclusive of:
  - Continuous monitoring and removal of alien or invasive plant species;
  - Storm water monitoring and management;
  - Erosion monitoring and remediation;
  - Fire management;
  - Vegetation and habitat management;
  - Monitoring and management measures to protect hydrological features; and
  - Scour chamber discharges and water quality monitoring;
- Waste management; and
- Health and safety implementations.

Decommissioning

Complete decommissioning can occur should it no longer be economically feasible to continue the pipeline & reservoir operation; activities will include:

- Apply for environmental authorisation;
- Site reparation;
- Disassembly and recycling of existing components; and
- Rehabilitation of the site.

The implementation of the EMPr within the project is not an optional additional or "add on" requirement. The EMPr is legally binding, integral to the contract and is as important as the engineering aspects of the contract. The EMPr is a working document to be used throughout the life of the project, until such time that closure is achieved.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

TABLE OF CONTENTS

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

TABLE OF FIGURES

TABLE OF TABLES

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

CHECKLIST

An environmental management programme (EMPr) must comply with section 24N of the NEMA, 1998, as amended and contain those requirements prescribed in the EIA Regulations, 2014, as amended, including Regulation 23 and Appendix 4. Additional requirements relating to content of the EMPr specified in the any comments and responses received from I&AP's including the competent authority are also included as well as referencing relevant guideline documents. Table 2 indicates the requirements stipulated in the EIA Regulations which have dictated the layout and content of this EMPr.

Table 2. Environmental Management Programme Checklist.

Content of Environmental Management Programme (EMPr)	Page/Section
1. (1) An EMPr must comply with section 24N of the Act and include-	☑
(a) details of	
(i) the EAP who prepared the EMPr; and	Page 12
(ii) the expertise of that EAP to prepare an EMPr, including a curriculum vitae;	Page 13
(b) a detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description;	**Section 3** Page 15-29
(c) a map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that should be avoided, including buffers;	**Section 4** Page 31 & 32
(d) a description of the impact management outcomes, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development including-	**Section D** Page 33-95
(i) planning and design;	☑
(ii) pre-construction activities;	☑
(iii) construction activities;	☑
(iv) rehabilitation of the environment after construction and where applicable post closure; and	☑
(v) where relevant, operation activities;	☑
(f) a description of proposed impact management actions, identifying the manner in which the impact management outcomes contemplated in paragraph (d) will be achieved, and must, where applicable, include actions to -	**Section D** Page 33-95
(i) avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;	☑
(ii) comply with any prescribed environmental management standards or practices;	☑
(iii) comply with any applicable provisions of the Act regarding closure, where	N/A

applicable; and	
(iv) comply with any provisions of the Act regarding financial provisions for rehabilitation, where applicable;	N/A
(g) the method of monitoring the implementation of the impact management actions contemplated in paragraph (f);	**Section D** Page 33-95
(h) the frequency of monitoring the implementation of the impact management actions contemplated in paragraph (f);	**Section D** Page 33-95
(i) an indication of the persons who will be responsible for the implementation of the impact management actions;	☑
(j) the time periods within which the impact management actions contemplated in paragraph (f) must be implemented;	☑
(k) the mechanism for monitoring compliance with the impact management actions contemplated in paragraph (f);	**Section D** Page 33-95
(l) a program for reporting on compliance, taking into account the requirements as prescribed by the Regulations;	☑
(m) an environmental awareness plan describing the manner in which-	**Section 6** Page 59
(i) the applicant intends to inform his or her employees of any environmental risk which may result from their work; and	**Section 6** Page 59
(ii) risks must be dealt with to avoid pollution or the degradation of the environment; and	**Section 9** Page 66
(n) any specific information that may be required by the competent authority.	☑
(2) Where a government notice gazetted by the Minister provides for a generic EMPr, such generic EMPr as indicated in such notice will apply.	N/A

ABBREVIATIONS / ACRONYMS AND DEFINITIONS

Table 3. List of terms for abbreviations used in this document.

Abbreviation / Acronym	Term
BA	Basic Assessment as per Regulation 19 of the EIA Regulations (2014), as amended.
BPDM	Bojanala Platinum District Municipality
CA	Competent Authority
CAR	Corrective Action Reports
CLO	Community Liaison Officer
CRE	Chief Resident Engineer
DEA	Department of Environmental Affairs (National)
DMR	Department of Mineral Resources
DREAD	Department of Rural, Environment and Agricultural Development (North West)
DWS	Department of Water & Sanitation
EA	Environmental Authorisation
EAPASA	Environmental Assessment Practitioners Association of South Africa
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment as provided for in Section 24 of NEMA (Act 107 of 1998) and EIA Regulations (2014), as amended.
EIAr	Environmental Impact Assessment Report
ELU	Existing Lawful Use as per Part 3 of the National Water Act (Act 36 of 1998)
EM	Environmental Manager
EMPr	Environmental Management Programme
GA	General Authorisation as per Section 39 of the National Water Act (Act 36 of 1998)
HSO	Health & Safety Officer
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IEA	Independent Environmental Auditor
LA	Listed Activity (EIA Regulations, 2014)
LN1	Listing Notice 1: GN. No. R. 983, 4 December 2014, as amended in GN. No. R. 327, 7 April 2017.
LN2	Listing Notice 2: GN R. 984, 4 December 2014, as amended in GN. No. R. 325, 7 April

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

	2017.
LN3	Listing Notice 3: GN R. 985, 4 December 2014, as amended in GN. No. R. 324, 7 April 2017.
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NHRA	National Heritage Resources Act, 1999 (Act No. 25 of 1999)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
SACNASP	South African Council for Natural Scientific Professions
SAHRA	South African Heritage Resources Agency
SDF	Spatial Development Framework
SEO	Site Environmental Officer
SO	Social Officer
WUL	Water Use License
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works

Table 4. Definitions of some terms used in this document.

Term	Source	Definition
Aspect (environmental)	ISO 14001: 2015	Element of an organisation's activities or products or services that interacts or can interact with the environment. An environmental aspect can cause (an) environmental impact(s). A significant environmental aspect is one that has or can have one or more significant environmental impact(s).
Corrective Action	ISO 14001: 2015	Action to eliminate the cause of a non-conformity (or non-compliance in the case of an EMPr) and prevent recurrence.
Development	EIA Regulations (2014)	Means the building, erection, construction or establishment of a facility, structure or infrastructure, including associated earthworks or borrow pits, that is necessary for the undertaking of a listed or specified

		activity, but excludes any modification, alteration or expansion of such a facility, structure or infrastructure, including associated earthworks or borrow pits, and excluding the redevelopment of the same facility in the same location, with the same capacity and footprint.
Development footprint	EIA Regulations, 2014 as amended	Any evidence of physical alteration because of the undertaking of any activity.
Environment	ISO 14001:2015	Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their relationships.
Environment	National Environmental Management Act (Act 107 of 1998)	The surroundings within which humans exist and that are made up of— (i) the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and (iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.
Environmental Impact	ISO 14001: 2015	Change to the environment, whether adverse or beneficial, wholly or partially resulting an organisation's environmental aspects.
Maintenance	EIA Regulations (2014)	Means actions performed to keep a structure or system functioning or in service on the same location, capacity and footprint.
Performance	ISO 14001: 2015	Measurable unit. Performance can relate either to quantitative or qualitative findings.
Significant impact	EIA Regulations (2014)	Means an impact that may have a notable effect on one or more aspects of the environment or may result in

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

		non-compliance with accepted environmental quality standards, thresholds or targets and is determined through rating the positive and negative effects of an impact on the environment based on criteria such as duration, magnitude, intensity and probability of occurrence.
Sustainable development	National Environmental Management Act (Act 107 of 1998)	The integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations.
Watercourse	EIA Regulations, 2014 as amended	(a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, pan, lake or dam into which, or from which, water flows; and any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined in the National Water Act, 1998 (Act No. 36 of 1998); and a reference to a watercourse includes, where relevant, its bed and banks.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SECTION 1: DETAILS & EXPERTISE OF THE EAP AND APPLICANT

Details of –

(i) The EAP who prepared the report; and applicant details

Environmental Assessment Practitioner	Ecoleges Environmental Consultants
Contact Person	Justin Aragon Bowers
Postal Address	PO Box 9005, Nelspruit, 1200
Telephone	+27(0)83 644 7179
E-mail	justin@ecoleges.co.za

Project Applicant	Rustenburg Water Services Trust
Trading Name (if any)	
Contact Person	Pet Maas
Physical Address	701 Missionary Mpheni House Cnr Nelson Mandela & Beyers Naude Road Rustenburg 0300
Postal Address	N/A
Postal Code	0300
Telephone	N/A
Cell	083 445 7287
Fax	086 645-8844
Email	pet.maas@tigros.co.za

(i) The expertise of the EAP to prepare the EMPr, including a curriculum vitae;

Abbreviated Curriculum Vitae of Justin Aragon Bowers

Name	Justin Bowers
Date of birth / ID No.	15 October 1972 7210155074089
Nationality	South African
Marital Status	Married with four children
Current Address	P O Box 516, Machadodorp, 1170. ● Redwing Farm, erf. Kaalbooi 368JT, Waterval Boven District, 1195, Mpumalanga, South Africa ● Cell: 082 451-5608 ● e-mail: justin@ecoleges.co.za
Languages	English, Afrikaans and Basic Zulu
Driver's Licence	Code EB, A & C1
Specialisations	Key Fields: Compliance monitoring, vegetation ecology, rehabilitation plans, environmental / ecological management plans, environmental auditing, Environmental Impact & Basic Assessment.
Qualifications & Courses Attended	**1998 – 2000** NATIONAL DIPLOMA: NATURE CONSERVATION, Technikon Pretoria **2001 – 2002** BACCALAUREUS TECHNOLOGIAE: NATURE CONSERVATION, Technikon Pretoria **2003 – 2007** MAGISTER TECHNOLOGIAE: NATURE CONSERVATION (CUM LAUDE), Tshwane University of Technology, Pretoria **2008** Environmental Law elective (MBA Programme), Rhodes University, Grahamstown. **2010 – Present** Certificate in Aquaculture, Department of Genetics & Aquaculture, University of Stellenbosch **2014** Implementing Environmental Management Systems, Centre for Environmental Management, North-West University, Potchefstroom. **2017** Transition ISO 14001 course, Centre for Environmental Management, North-West University, Pretoria locale. **2018** EMS: Lead Auditor, CEM, North-West University, Potchefstroom.
Latest Publication	Sadie J. Ryan, Paul C. Cross, John Winnie, Craig Hay, Justin Bowers, Wayne M. Getz. 2012. The utility of normalized difference vegetation index for predicting African buffalo forage quality. *Journal of Wildlife Management* DOI: 10.1002/jwmg.407.
Professional affiliations	IAIA^{sa}, GSSA, SACNASP.

SECTION 2: INTRODUCTION & BACKGROUND

Following the upgrading of the 12Mℓ/d Bospoort Water Treatment Works to 24Mℓ/d, a new 500mm diameter rising main is required to convey potable water from the Treatment Works to the new reservoir. An 800mm diameter pipe will supply the water from the reservoir to Rustenburg town. Both these lines will be steel pipelines and will convey approximately 300ℓ per second between the Treatment Works and Rustenburg Municipality. The pipelines will augment the current Vaalkop supply system and provide much needed potable water to the communities in the area as well as Rustenburg Town.

SECTION 3: DESCRIPTION OF THE ACTIVITY

(b) a detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description.

Table 5 describes all the activities that will be undertaken during the lifespan of this project including the identified listed activities and other associated activities (that do not require environmental authorization in their own right), but are needed to achieve the desired objective, that is the upgrading of the Bospoort Water Treatment Works via:

Construction of a new 500mm diameter rising main to convey potable water from the Treatment Works to the new reservoir. An 800mm diameter pipe will supply the water from the reservoir to Rustenburg town.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Table 5. A detailed description of the activities (including Listed Activities as per the EIA Regulations, 2014 as amended) and resultant aspects of the project that are covered by the EMPr.

Phase	Activity	Sub-activities	Aspects
Planning & Design (including pre-construction)	Compliance with legal requirements by acquiring authorisations, permits and/or licenses for activities/uses undertaken during construction and operation The development of- (ii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs- (a) within a watercourse; (c) if no development setback has been adopted within 32 metres of a watercourse, measures from the edge of a watercourse; h. North West iv. Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority.	Protected Species	Impacting protected species prior to obtaining the required licenses / permits.
		Water Use (21a)	Taking water from a watercourse prior to obtaining the required licences / permits.
		Water Use (21f)	Discharging waste or water containing waste into a water resource prior to obtaining the required licences / permits.
		Water Use (21g)	Impacting the watercourse through disposal of waste prior to obtaining the required licences / permits.
		Water Use (21c & i)	Impeding or diverting the flow of water & altering the bed, banks, course or characteristics of a watercourse
		Access Roads (not exceed threshold & layout to have minimal impacts)	Poor alignment & extent of linear activities like roads, fences, pipelines or other cleared servitudes can increase runoff, cause erosion and sedimentation of aquatic habitats and result in regulatory non-compliance.
		Servitudes & wayleaves	Commencement without authorisation / permit from relevant authorities.
		Compliance monitoring	Commencement without appointment of an Environmental Control Officer (ECO) to monitor compliance with the EA & EMPr.
		Municipal bylaws	Non-compliance with the municipal bylaws.
		Protection of archaeological findings	Destruction of graves and other sites of archaeological value and need for relevant permits where necessary.
	Socio-economic considerations	Employment of local labour	Insufficient employment of local labour.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Phase	Activity	Sub-activities	Aspects
			Presence of construction workforce.
			Influx of job seekers.
			Loss of farm labour to construction work.
			Job seekers may begin enquiring prior to commencement of construction as awareness of the project grows.
		Economic benefits from professionals	If the appointed professionals are unreasonably expensive, the funds to head the projects might be exhausted.
		Expectations	Job seekers may begin enquiring prior to commencement of construction as awareness of the project grows.
		Uncertainty	Community confusion, frustration & lack of information.
		Construction and use of Temporary Access Roads	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Increase in vehicle movement in area.
		Provision of sanitation systems	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Ground water contamination.
		Demarcation, fencing and gates	Loss of vegetation and habitat.
			Impede faunal movement.
			Impeded human movement and disrupted daily activities.
		Working near or on the watercourse	Decline in water availability of water resource.
		Water Use, abstraction and Management	

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Phase	Activity	Sub-activities	Aspects
Construction	Site establishment (construction camp, sanitation, temporary accommodation) *LN3: Listed Activity 12* *The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.* *h. North West* *iv. Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority;* *vi. Areas within a watercourse or wetland, or within 100 metres from the edge of a watercourse or wetland*	Clear & grub (fence line, pipeline, reservoir footprint, access roads and associated infrastructure)	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Noise Generation.
		Construction and use of Temporary Access Roads	Loss of Vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Increased level of noise generation.
			Increase in vehicle movement in area.
			Dust generation.
		Sanitation	Ground water contamination.
		Fencing & gates	Loss of vegetation and habitat.
			Impede faunal movement.
			Impeded human movement and disrupted daily activities.
		Lighting	Visual intrusion in remote areas.
	Access control including fencing of perimeter	Construction and use of Temporary Access Roads	Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Increased level of noise generation.
			Increase in vehicle movement in area.

Phase	Activity	Sub-activities	Aspects
			Dust generation.
		Fencing & gates	Loss of vegetation and habitat.
			Impede faunal movement
			Impeded human movement and disrupted daily activities.
	Contractor's employees (staff conduct, movement)	Water use and management	Water contamination.
			Misuse of available water.
		Cooking of food	Harvesting & fire control.
		Sanitation	Unpleasant odours.
			Mismanagement of sewerage.
		Employment of local labour	Insufficient employment of local labour.
			Presence of construction workforce.
			Influx of job seekers.
			Loss of farm labour to construction work.
	Construction of permanent & temporary access roads	Vegetation Clearing & Soil Hardening	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased level of noise generation.
		Impact on the existing road conditions	The development of potholes.
			Damage to vehicles.
			Potential increase in vehicle accidents.
	Transport on site & accommodation of traffic (parking areas)	Parking	Increase in vehicle movement in area.
			Impact on the existing road conditions.
			Increase human safety risk.
			Increase in the level of noise generation.
			Greenhouse gas emissions.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Phase	Activity	Sub-activities	Aspects
		Impact on the existing road conditions	The development of potholes.
			Damage to vehicles.
			Potential increase in vehicle accidents.
	Sourcing & management of water (for drinking, sanitation & construction activities)	Drinking, dust suppression & sanitation	Water contamination.
			Misuse of available water.
	Sourcing & management of building material	Excavation of suitable bedding and backfill material	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
		Topsoil stripping and storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Soil contamination.
			Encroachment and establishment of alien vegetation.
		Slopes and slope stabilisation	Dust generation.
			Increased potential for erosion.
			Water contamination.
			Decline in aesthetic quality of the environment.
			Increase human safety risk.
	Stockpiling and material laydown areas (spoil, mulch, building sand, topsoil, windrows, material & equipment)	Topsoil stripping storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Soil contamination.
			Encroachment and establishment of alien vegetation.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Phase	Activity	Sub-activities	Aspects
			Reduced productivity of subsistence farmland.
		Slopes and slope stabilisation	Dust generation.
			Increased potential for erosion.
			Water contamination.
			Decline in the aesthetic quality of the environment.
			Increase human safety risk.
	Earthworks & excavations	Trenching	Dust generation.
			Increased potential for erosion.
			Increase human safety risk.
			Entrapment of small fauna
		Importing of suitable bedding and backfill material	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Reduced productivity of subsistence farmland.
			Increased potential for erosion.
		Topsoil stripping and storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Soil contamination.
			Reduced productivity of subsistence farmland.
			Encroachment and establishment of alien vegetation.
		Slopes and slope stabilisation	Dust generation.
			Increased potential for erosion.
			Water contamination.
			Decline in aesthetic quality of the environment.

Phase	Activity	Sub-activities	Aspects
			Increase human safety risk.
		Crushing of material	Dust generation.
			Loss of vegetation, habitat and soil fertility.
	Construction of a pipeline and reservoir LN1: Listed Activity 9 The development of infrastructure exceeding 1000 metres in length for the bulk transportation of water or storm water- (i) with an internal diameter of 0.36 metres or more; or (ii) with a peak throughput of 120 litres or more; excluding where – (a) such infrastructure is for the bulk transportation of water or storm water or storm water drainage inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area. LN3: Listed Activity 2 The development of reservoirs,	Spoil material generation and management	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Decline in the aesthetic quality of the environment.
		Transportation and storage of the cement and associated materials	Increase in vehicle movement in area.
			Impact on the existing road conditions.
			Increase human safety risk.
			Increase in the level of noise generation.
			Greenhouse gas emissions.
		Protection of archaeological findings	Destruction of graves and other sites of archaeological value.

Phase	Activity	Sub-activities	Aspects
	excluding dams, with a capacity of more than 250 cubic metres. **h. North West** iii. Outside urban areas; (dd) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;		
	Pipeline Watercourse Crossings	Effects from pipeline trenching	Increased potential for erosion.
		Excavation stockpiles	Increased potential for water pollution
		Mixing of soil horizons	Encroachment and establishment of alien vegetation.
		Clearing of riparian zone	Loss of vegetation, habitat and soil fertility.
	Handling of waste & generation (solid waste including 'spoil', liquid waste, separation, storage and disposal)	Domestic and construction waste collection, storage, handling and disposal	Unpleasant odours.
			Increase in waste generation.
			Decline in the aesthetic quality of the environment.
		Spoil material generation and management	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Decline in the aesthetic quality of the environment.
	Handling of hazardous substances (fuel/oil, cement, bitumen, sewage/grey water) & management (including storage) at sanitation sites, kitchens, batching sites, refuelling areas and on site.	Maintenance of sanitation systems	Unpleasant odours.
			Soil contamination.
			Water contamination.
			Mismanagement of sewerage.
		Bund area for fuel storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.

Phase	Activity	Sub-activities	Aspects
			Soil contamination.
		Use of flammable material and other material stores	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Soil contamination.
		Refuelling of construction vehicles and plant	Soil contamination.
			Water contamination.
		Handling, storage, disposal of hazardous waste	Unpleasant odours.
			Soil contamination.
			Water contamination
		Transportation of hazardous waste	Potential spillages of hazardous waste.
			Increase human safety risk.
			Greenhouse gas emission.
	Plant management (parking, driving, repair and maintenance, and refuelling)	Refuelling of construction vehicles and plant	Soil contamination.
			Water contamination.
		Bund area for fuel storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Soil contamination.
		Operation and movement of construction vehicles and plant	Dust generation.
			Increase in level of noise generation.
			Soil contamination.
			Increase human safety risk.
			Vibration.
			Greenhouse gas emissions.
	Building work (concrete work)	Water use and management	Water contamination.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Phase	Activity	Sub-activities	Aspects
			Misuse of available water.
		Spoil material generation and management	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Decline in the aesthetic quality of the environment.
		Excavation of suitable bedding and backfill material	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
	Disturbing natural areas	Slopes and slope stabilisation	Dust generation.
			Increased potential for erosion.
			Water contamination.
			Decline in aesthetic quality of the environment.
			Increase human safety risk.
		Topsoil stripping and storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Soil contamination.
			Reduced productivity of subsistence farmland.
			Encroachment and establishment of alien vegetation.
	Site closure & rehabilitation	Removal of structures and infrastructures	Increase in waste generation.
		Removal of inert waste and rubble	
		Hazardous waste and pollution control	

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Phase	Activity	Sub-activities	Aspects
		Final shaping of disturbed areas	Increased potential for erosion.
		Topsoil replacement and soil amelioration	
		Ripping and scarifying	
		Planting	Reduced productivity of subsistence farmland.
		Grassing	
		Maintenance	Encroachment and establishment of alien vegetation.
		Management of alien vegetation	Loss of vegetation, habitat and soil fertility.
Operation (including maintenance)	Operation employment	Consultation with affected parties	Insufficient consultation.
		Employment of local labour	Insufficient employment of local labour.
			Presence of construction workforce.
			Influx of job seekers.
	Pipeline & Reservoir Infrastructure	Maintenance and Repair	Increase in waste generation
	Operation of Scour Chamber	Discharging from Scour Outlets	Increased potential for erosion.
			Increased potential for water pollution
	Consumption (energy, water, and other resources)	Water use and management	Water contamination.
			Misuse of available water.
		Cooking of food	Fire hazard.
			Illegal wood harvesting.
	Maintenance	Refuelling of construction vehicles and plant	Soil contamination.
			Water contamination.
		Handling, storage & disposal of	Unpleasant odours.

Phase	Activity	Sub-activities	Aspects
		waste	Soil contamination.
			Water contamination.
		Maintenance of sanitation systems	Unpleasant odours.
			Mismanagement of sewerage.
	Lighting to create visibility at night	Use of generators	Increase in level of noise generation.
			Soil contamination.
		Security	Trespassing.
	Terrestrial and aquatic ecological management	Use of herbicides	Loss of vegetation, habitat and soil fertility.
			Soil contamination.
		Harvesting of indigenous plants	Loss of local biodiversity
		Overgrazing	Increased potential for erosion.
			Reduced productivity of subsistence farmland.
			Dust generation.
	Social & community changes	Security	Trespassing.
		Fire Control	Loss of vegetation, habitat and soil fertility.
		Employment of local labour	Insufficient employment of local labour.
			Presence of construction workforce.
			Influx of job seekers.
			Loss of farm labour to construction work.
		Visual aspects	Visual Intrusiveness.
Decommissioning (including rehabilitation)	Disposal of infrastructure, residual of all types of waste	Demolition activities	Dust generation.
			Increased level of noise generation.
			Vibration.
			Increase in waste generation.

Phase	Activity	Sub-activities	Aspects
			Increase human safety risk.
		Removal of inert waste and rubble	Decline in the aesthetic quality of the environment.
			Soil contamination.
	Human influence (staff conduct, movement)	Harvesting of indigenous plants	Loss of vegetation, habitat and soil fertility.
			Decline in the aesthetic quality of the environment.
		Fires for heat & cooking	Fire hazard.
			Loss of vegetation, habitat and soil fertility.
			Illegal wood harvesting.
		Littering	Decline in the aesthetic quality of the environment.
			Unpleasant odours.
			Increase in waste generation.
			Decline in the aesthetic quality of the environment.
		Noise	Increase human safety risk.
			Increase in the level of noise generation.
	Roads and access routes	Topsoil stripping and storage	Dust generation.
			Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
			Encroachment and establishment of alien vegetation.
		Road decommissioning & rehabilitation	Dust generation.
			Increased level of noise generation.
			Soil contamination.
	Rehabilitation of affected footprint	Removal & transportation of structures and infrastructures;	Increase in vehicle movement in area.
			Impact on the existing road conditions.
			Increase human safety risk.

Phase	Activity	Sub-activities	Aspects
			Increase in the level of noise generation.
			Greenhouse gas emissions.
			Increased potential for erosion.
		Maintenance & management of alien vegetation	Loss of vegetation, habitat and soil fertility.
			Increased potential for erosion.
		Planting & grassing	Reduced productivity of subsistence farmland.
		Topsoil replacement and soil improvement	Loss of vegetation, habitat and soil fertility.
		Final Shaping of disturbed areas	Increased potential for erosion through lack of conformance to surrounding landscape.

SECTION 4: LAYOUT MAP OF PROPOSED ACTIVITY

(c) a map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that any areas that should be avoided, including buffers.

"The Environmental Management Programme (EMPr) to be submitted as part of the EIAr must include the following:
ii. The final site layout map.
iv. An environmental sensitivity map indicating environmental sensitive areas and features identified during the EIA process.
v. A map combining the final layout map superimposed (overlain) on the environmental sensitivity map."

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

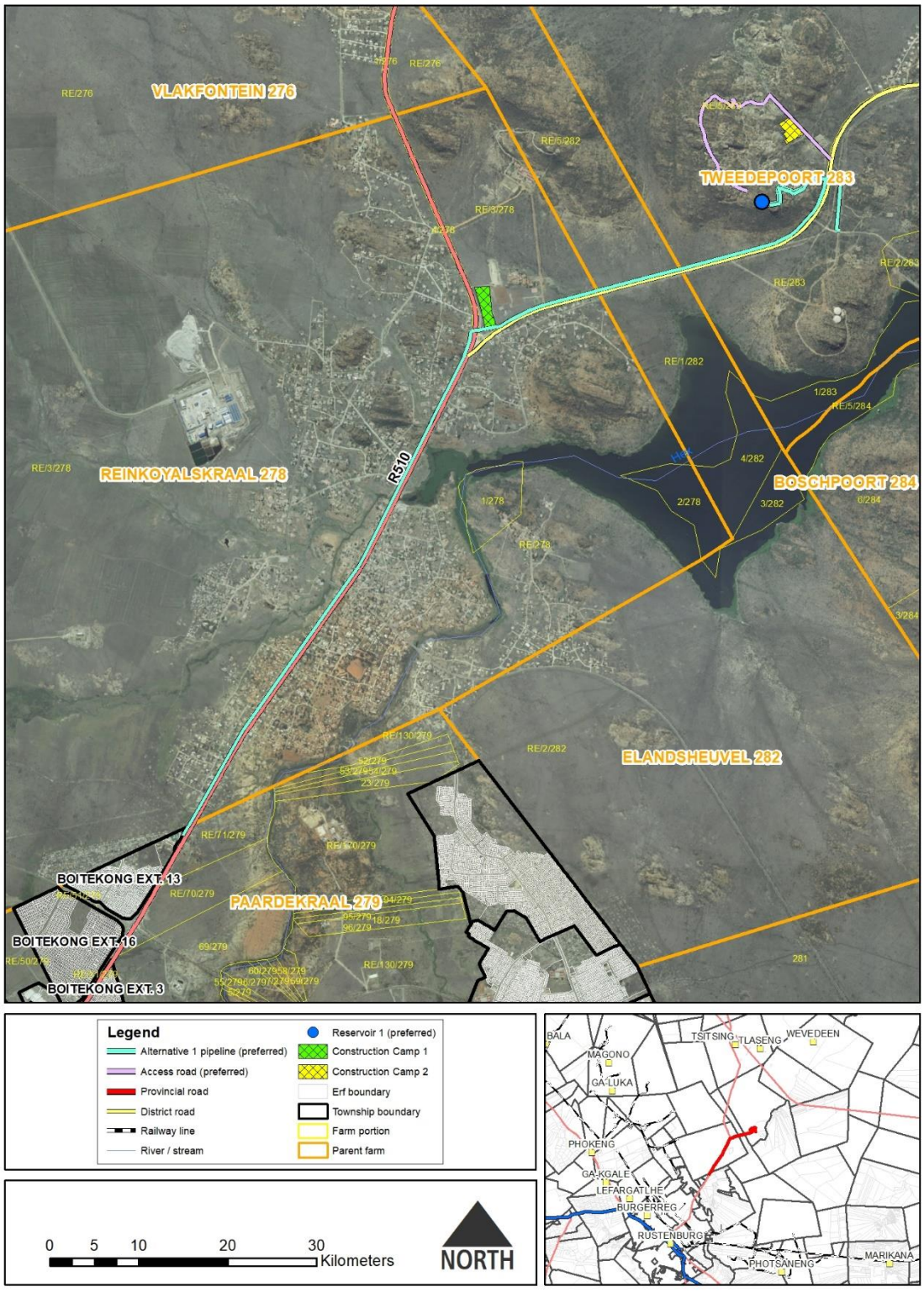


Figure 1. Site layout map of the pipeline route and the reservoir.

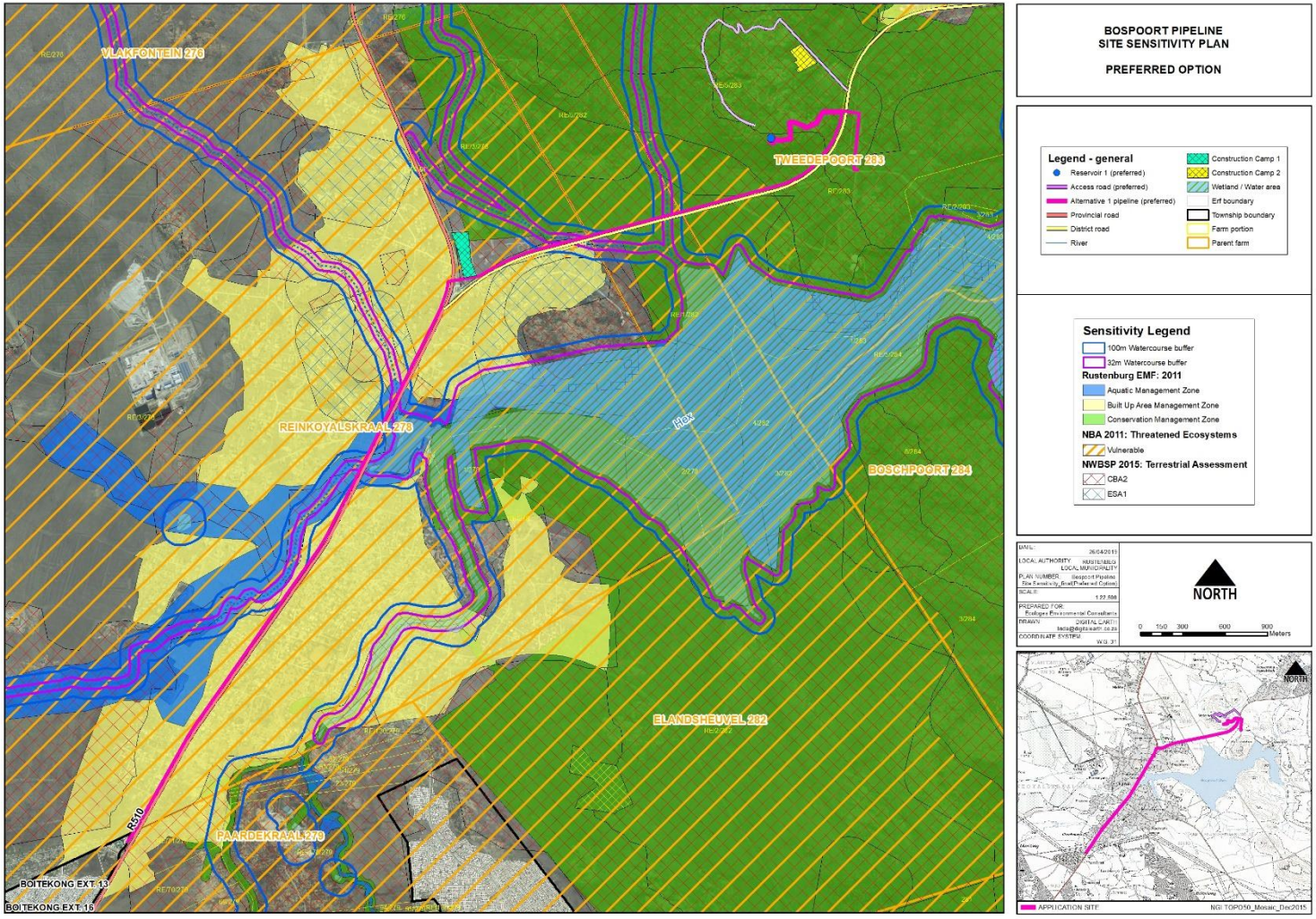


Figure 2. Site sensitivity map of the pipeline route and the reservoir.

SECTION 5: ACTIVITIES, ASPECTS AND IMPACTS AND THEIR MANAGEMENT, MITIGATION & DESIRED OUTCOMES

1.(1)(d) a description of the impact management outcomes, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development including-
(i) planning and design;
(ii) pre-construction activities;
(iii) construction activities;
(iv) rehabilitation of the environment after construction and where applicable post closure; and
(v) where relevant, operation activities;

1.(1)(f) a description of proposed impact management actions, identifying the manner in which the impact management outcomes contemplated in paragraph (d) will be achieved, and must, where applicable, include actions to -
(i) avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;
(ii) comply with any prescribed environmental management standards or practices;
(iii) comply with any applicable provisions of the Act regarding closure, where applicable; and
(iv) comply with any provisions of the Act regarding financial provisions for rehabilitation, where applicable;

1.(1)(g) the method of monitoring the implementation of the impact management actions contemplated in paragraph (f);
(h) the frequency of monitoring the implementation of the impact management actions contemplated in paragraph (f);
(i) an indication of the persons who will be responsible for the implementation of the impact management actions;
(j) the time periods within which the impact management actions contemplated in paragraph (f) must be implemented;
(k) the mechanism for monitoring compliance with the impact management actions contemplated in paragraph (f);
(l) a program for reporting on compliance, taking into account the requirements as prescribed by the Regulations;
(m) an environmental awareness plan describing the manner in which-
(i) the applicant intends to inform his or her employees of any environmental risk which may result from their work; and
(ii) risks must be dealt with in order to avoid pollution or the degradation of the environment; and
(n) any specific information that may be required by the competent authority.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

The impacts are considered within the scope of the project, including but not limited to the Listed Activities. The relevant impacts resulting from Listed Activities and associated activities, including environmental, socio-economic and cultural heritage, are informed by a predetermined list of potential environmental impacts, comments received from Interested and Affected Parties and the findings contained in specialist studies.

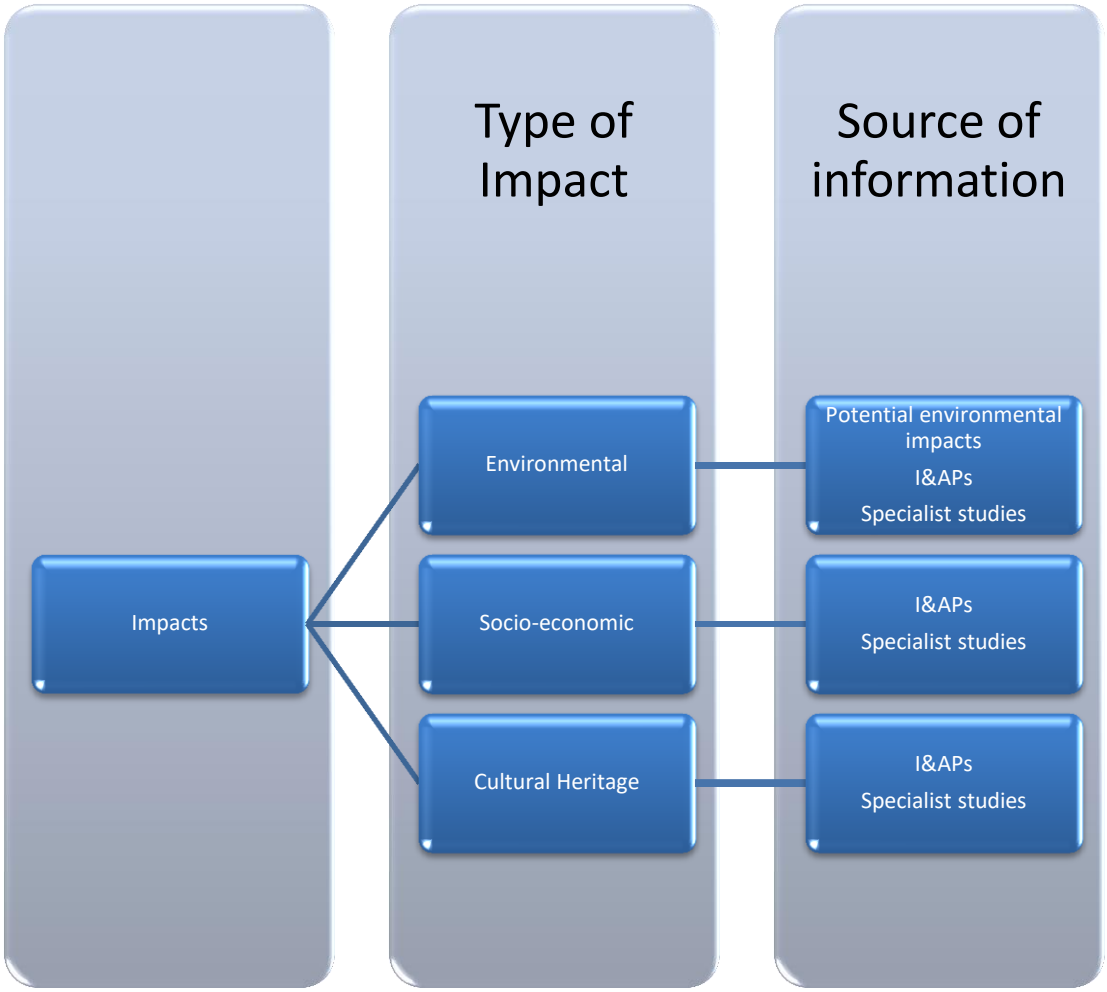


Figure 3: A breakdown of the different types of impacts including the resources used to identify them.

As stipulated in regulation 1(1)(d) of Appendix 4 of the EIA regulation (2104), as amended; the setting of desired impact management outcomes forms the principle objective of an EMPr. Outcomes are driven by impact management actions including measures and mitigations to avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation; to comply with any prescribed environmental management standards or practices, including legal requirements and in some cases, “best practices” that the Implementer aspires to fulfil (e.g. Equator Principles). The outcomes are achieved by implementing and achieving measurable Targets (both quantitative & qualitative). Management and mitigation measures are set to afford guidance and parameters to the implementer to achieve the set outcomes. The following section describes management programmes for the different environmental attributes pertaining to the Project. As part of the Management

Programmes, the section describes the potential environmental impacts which may result from the identified aspects / activities, the desired outcomes of mitigating these impacts as well as the targets used to measure the level of environmental compliance and performance.

The following legislation, guidelines, departmental policies, environmental management instruments and / or other decision-making instruments that have been developed or adopted by a competent authority in respect of activities associated with a development of this nature, were identified and considered in the preparation of this EMPr:

1. Bojanala Platinum District Municipality IDP (Final) 2017/18;
2. Conservation of Agricultural Resources Act, 1993 (No 43 of 1983) and the regulations dealing with declared weeds and invader plants;
3. Constitution of the Republic of South Africa Act, 1996 (No. 108 of 1996), including section 24;
4. DAFF (1970) Sub-Division of Agricultural Land Act, 1970 (No. 70 of 1970),
5. DEA (2011), National list of ecosystems that are threatened and in need of protection. GN 1002, GG 34809, 9 December 2011.
6. DEAT (2004) Environmental Management Plans, Integrated Environmental Management, Information Series 12, Department of Environmental Affairs and Tourism (DEAT), Pretoria.
7. DWA (2007), Guideline for Developments within a Flood line (Edition 1), Department of Water Affairs and Forestry, Pretoria, South Africa;
8. DWAS (2016), General Authorisation in GN No. 509 published in Government Gazette No. 40229 dated 26 August 2016;
9. DWAS (2016), General Authorisation in GN No. 538 published in Government Gazette No. 40243 dated 2 September 2016;
10. Environment Conservation Act, 1989 (No 73 of 1989), including Schedules 4 and 5 of the National Regulations regarding Noise Control made under Section 25 of the Environment Conservation Act, 1989 (Act 73 of 1989) in GN No. R 154 of Government Gazette No. 13717 dated 10 January 1992. (Note that this particular section of the Environment Conservation Act is not repealed by NEMA (107 of 1998)). Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983);
11. Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947);
12. Government Municipal Systems Act (Act 32 of 2000);
13. Hazardous Substances Act, 1973 (Act No. 15 of 1973);
14. Health Act, 2003 (Act No. 61 of 2003);
15. Local Government: Municipal Systems Act (Act 32 of 2000);
16. Lochner, P. 2005. Guideline for Environmental Management Plans. CSIR Report No ENV-S-C 2005-053 H. Republic of South Africa, Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning, Cape Town.
17. Minerals and Petroleum Resources Development Act, 2002 (No 28 of 2002);
18. National Environmental Management Act, 1998 (No 107 of 1998) including EIA Regulations, 2014 published in Government Notice No. R. 982, R. 983, R. 984 and R.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

985 in Government Gazette No. 38282 dated 04 December 2014, as amended in Government Notice No. R. 324, R. 325, R. 327 and R. 328 in Government Gazette No. 40772 dated 07 April 2017;

19. National Environmental Management: Air Quality Act, 2003 (No 57 of 2003) including the list of activities which result in atmospheric emissions published in GN No. 248 of Government Gazette No. 33064 dated 31 March 2010;
20. National Environmental Management: Biodiversity Act, 2004 (No 10 of 2004);
21. National Environmental Management: Waste Act, 2009 (Act No. 59 of 2009) ("NEM: WA");
22. National Forest Act, 1998 (No 84 of 1998);
23. National Heritage Resources Act, 1999 (No 25 of 1999);
24. National Veld and Forest Fire Act, 1998 (No 101 of 1998);
25. National Water Act, 1998 (Act No. 36 of 1998), Sections 27, 28, 29 ,30 ,31 and 39 (Sections dealing with General Authorisations and Water Use Licenses).
26. North West Biodiversity Management Act (NWBMA -Act 4 of 2016), Provincial Gazette no. 7721, Provincial Notice 3, 3 January 2017, as amended (not in force at time of report).
27. Rustenburg Local Municipality Bylaws, especially fire brigade services by laws no. 2 of 2015.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

The following management programme aims to set management actions to achieve stated desired outcomes for each environmental aspect, including quantifying the measurable targets. While the impacts and management & mitigations have been addressed under the various project development phases, they are not intended to be mutually exclusive, and impacts from one phase are likely to occur in subsequent phases; but in the interest of reducing redundancy they have not been repeated for each phase.

TABLE 6. COMPLIANCE MANAGEMENT.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
6.1	**All Phases with special emphasis on Planning & Design Phase (including Pre-Construction)**						
6.1.1	**PROTECTED SPECIES**						
6.1.1.1	Impacts on protected plants. Appointed Ecologist identified *Sclerocarya birrea* (Marula) at Ch 1000.	Comply with the relevant sections of the National Forest Act (NFA) (Act 84 of 1984), the National Environmental Management: Biodiversity Act, 2004 (NEM:BA) (Act No. 10 of 2004) and North West Biodiversity Management Act (NWBMA, Act 4 of 2016),	Obtain and provide proof of issuance of necessary permits for any listed species under NFA, NEMBA and NWBMA (if relevant).	The applicant shall apply for and obtain the relevant licenses / permits from the appropriate authorities (DAFF, DEA, and Provincial Authority) prior to disturbing or destroying any protected species.	Applicant / Contractor to appoint botanist.	Prior to commencement of construction.	Compliance to be verified by SEO, ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
		Provincial Gazette no. 7721, Provincial Notice 3, 3 January 2017, as amended (not in force at time of report).					
6.1.2	**WATER USE AUTHORISATION FOR TREATED EFFLUENT**						
6.1.2.1	Contravention of section 21 (f) & (g) of the NWA.	The commencement of water uses that are authorised in terms of the NWA, 1998 (Act No. 36 of 1998).	Issuance of a Water Use License.	The applicant shall apply for a water use entitlement, i.e. a WUL for section 21 (f) & (g) water uses for the discharge and disposal of the effluent.	Applicant / EAP.	Prior to commencement of construction.	Compliance to be verified by ECO & IEA.
6.1.3	**WATER USE AUTHORISATION FOR ABSTRACTION**						
6.1.3.1	Contravention of section 21 (a) of the NWA.	Utilisation of surface water within volume stipulated in the Water Use License.	Records demonstrating abstraction volumes in compliance with WUL limits.	Abstraction must not exceed the limits prescribed in the WUL, factoring in the amount abstracted by the Bospoort WTW.	Applicant / Contractor.	Applicant.	Compliance to be verified by ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
6.1.4	**WATER USE AUTHORISATION FOR PIPELINE CROSSINGS**						
6.1.4.1	Contravention of section 21 (c) & (i) of the NWA.	The commencement of water uses that are authorised in terms of the NWA, 1998 (Act No. 36 of 1998).	Issuance of a Water Use License.	The applicant shall apply for a water use entitlement, i.e. a WUL for section 21 (c) & (i) water uses for impeding or diverting the flow of water & altering the bed, banks, course or characteristics of a watercourse	Applicant / EAP.	Prior to commencement of construction.	Compliance to be verified by ECO & IEA.
6.1.5	**Compliance Monitoring**						
6.1.5.1	Commencement of construction prior to the appointment of an ECO.	Monitor compliance with the EMPr from the onset of construction and until the rehabilitated development is handed over to the Applicant for operation.	Proof of ECO appointment prior to commencement of construction.	A qualified, suitably experienced & accredited independent ECO must be appointed (registered with SACNASP & EAPASA (if applicable)) to monitor and report to the competent authority on compliance with the EA and EMPr, and where necessary oversee or facilitate the identification and permitting / licensing of protected species prior to clearing of any vegetation.	Applicant.	Prior to commencement of construction and until the rehabilitated development is handed over to the applicant for operation. The minimum frequency for ECO inspections is monthly, unless specified	To be verified by IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
						otherwise in the Environmental Authorisation.	
6.1.5.2	Ignorance of duty of care and remediation of environmental damage in accordance with Section 28 of the National Environmental Management Act, 1998	Ensure compliance with Section 28 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended.	Records demonstrating when the incident occurred and how it was remediated.	The applicant must be responsible for compliance with the provisions for duty of care and remediation of environmental damage in accordance with Section 28 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended.	Applicant	As and when the incident occurs.	Compliance to be verified by SEO, ECO & IEA
6.1.6	**Municipal By-laws**						
6.1.6.1	Commencement of construction prior to submission and approval of building plans by the Rustenburg Local Municipality.	Local municipality approval of building plans.	Issuance of a certificate referred to in section 118(1) of the Local Government: Municipal Systems Act (Act 32 of	The plans and specifications for any building, whether of a temporary or permanent nature, to be erected on the land must be submitted to the Rustenburg Local Municipality for approval in terms of the Local Government: Municipal	Applicant.	Prior to commencement of construction.	Compliance to be verified by SEO, ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			2000).	Systems Act, 2000 (Act No. 32 of 2000).			

TABLE 7. CONSTRUCTION CAMP, LAYDOWN AREAS, STOCKPILES, STORES & EQUIPMENT.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
7.1	**Planning & Design Phase (including Pre-Construction)**						
7.1.1	Land surface pollution.	Reduce risk of pollution or harm to sensitive environments from the inappropriate location of construction related sites within or within proximity to those sensitive environments.	Approved and effectively implemented layout plan indicating designated construction-related sites, servitude (temporary & permanent) and location of sensitive areas.	A construction site layout plan must be developed by the contractor and approved by the SEO / ECO to ensure that all construction related sites are located outside sensitive environments, including no-go areas and buffer zones. Furthermore, those construction related sites or activities with the greater risk or potential for causing pollution or harm to the receiving environment, including but not necessarily limited to laydown areas, material stockpiles, toilets, waste skips and stores, must not be within close proximity to the aforesaid sensitive environments, i.e. these construction related sites	Applicant / Contractor	Prior to commencement of construction.	ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				or activities must not, as far as is practical, be located on the watercourse-side of any construction camp or area demarcated for construction activities.			
7.1.2	Degradation of the environment outside of the development footprint.	Zero construction creep into and subsequent degradation of areas outside the preferred or approved development footprints.	Approved and effectively implemented (demarcated on site) layout plan indicating all environmental sensitivities, especially no-go areas.	Permanent and temporary construction footprints must be designated, and sensitive terrestrial & aquatic habitats demarcated as no-go areas during construction, including required buffer zones. The project footprint must be clearly demarcated on the ground to ensure that no construction creep results toward any watercourses or defined sensitive areas. Placement of infrastructure and laydown & stockpile areas must be	Applicant / Contractor	Prior to and ongoing enforcement during construction.	ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				done so as not to negatively affect surface water runoff in a way that leads to erosion and export of material to be deposited in any watercourses.			
7.2	**Construction Phase**						
7.2.1	Land contamination.	To avoid and reduce anthropogenically induced environmental pollution. To ensure compliance with Rustenburg Municipality Bylaws.	Incident registers that indicate pollution events, from the operation of construction plant, equipment or other vehicles, over time. Compliance with section 24 of fire brigade services by laws no. 2 of 2015 published in terms of Section 12 and	Emergency breakdowns must be addressed with immediate and adequate pollution containment measures including but not limited to drip trays and spill kits. No washing of plant and equipment within the construction camp, and no repairs or servicing of construction plant, equipment or other vehicles, except for emergency breakdowns, are permitted within the preferred or approved development footprint, construction-related areas, no-go areas and on neighbouring properties.	Applicant / Contractor	Throughout construction.	ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			13 of the Local Government: Municipal System Act, 2000 (Act 32 of 2000) as amended.	The contractor(s) and any sub-contractors, including their employees, are prohibited from entering the designated no-go areas for whatever reason and without the prior written consent of the SEO. Refuelling of vehicles and plant may only take place at a designated and permitted (from local Fire Chief) fuel storage tank or mobile fuel bowser, under the guidance of a Specific Operating Procedure (SOP) that limits spillage and addresses remedial actions in the event of a spillage. The contractor shall restrict the following activities to the construction camp: - Bulk waste storage,			

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				- Parking, - Storing hazardous materials, - Emergency vehicle & plant repair & maintenance as far as practicable, - Designated concrete mixing area - Material stockpiles, and - Lay down areas. Use chemical toilets that contain the sewerage in a closed and removable 'tank', i.e. do not use open drums. Environmentally friendly toilets should also be considered e.g. E-loos. Toilets must track the construction front. Use drip trays for refuelling, emergency repair / maintenance work and all stationary construction plant and equipment that can leak, such as TLBs,			

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				compressors and generators. Washing of equipment including brushes shall not occur on site or in a watercourse but shall be restricted to the main construction camp where adequate containment measures are in place.			
7.2.2	Noise pollution.	To avoid nuisance noise to affected landowners & occupiers and reduce noise impacts to the environment and implement active monitoring in the event of noise-related complaints received.	Noise must fall within the parameters set by: **1.**(SANS) Standard 10103:2008: The measurement and rating of environmental noise with respect to annoyance and	Noise generation must be managed, including the use of radios and other music playing appliances. Vehicles and plant must be in a good state of repair to limit noisy operations.	Applicant / Contractor.	Frequency of monitoring as stipulated in relevant regulation and standard, as amended from time to time following any noise-related complaints.	SEO or appointed specialist service provider. Verification to be done by ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			speech communication. **2.**DEA Regulations No. R.154. Noise Control Regulations promulgated in terms of Section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989). GG No. 13717, 10 January 1992.				
7.2.3	Degradation of the environment outside of the development footprint.	To avoid impacts to the biodiversity integrity and ecological function of areas outside the	No impacts outside the development footprint. All contraventions to be recorded in	No residues of stockpiled material must be left on site, that can impede restoration of ecological function and remain a visual intrusion on the landscape.	Applicant / Contractor.	Update to incident register following each contravention.	ECO & IEA.

No.	Potential Impacts	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
		development footprint.	incident register.	Disturbed habitats resulting from construction-related activities must be rehabilitated immediately after the cessation of those activities on or near the disturbed habitats. The alignment of fences or roads and the placement of potential impediments, such as walls, laydown & material stockpile areas must not alter surface water runoff patterns (i.e. impede or increase surface water runoff) in a way that will cause ponding or erosion and sedimentation of a watercourse.			

TABLE 8. WASTE MANAGEMENT (generation, handling, storage and disposal, including hazardous waste).

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
8.1	**Planning & Design Phase (including Pre-Construction)**						
8.1.1	Shortening the lifespan of the local waste disposal sites.	To minimise the generation of project-specific waste by implementing an effective waste management strategy based on the waste hierarchy.	Keep accurate records of waste volumes (litres, kg and / or m^3) generated by type.	Establish and implement an Integrated Waste Management Strategy including avoidance, reduction, re-using, recycling and disposal, i.e. the production of hazardous waste can be **avoided** by providing drip trays, **reduce** waste by using the correct quantities, **re-use** concrete rubble as back fill or **recycle** steel off-cuts and **dispose** of non-hazardous solid waste at a registered municipal dump site. Induct all labourers on the waste management strategy and enforce it through regular (at least	Applicant / Contractor (SEO).	Prior to commencement of construction with ongoing maintenance and updates to Strategy.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				weekly) toolbox talks. Keep accurate records of waste generated by type. All hazardous and solid waste must be removed to a licensed waste disposal site for the type of waste produced. No solid waste may be disposed of on site. The storage of solid waste on site, until such time as it may be disposed of, must be in a manner acceptable to the Local Authority and the Department of Water and Sanitation (DWS) or the Department of Environmental Affairs (DEA).			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
8.2	**Construction Phase**						
8.2.1	Removal of inert waste and rubble. Loss of ecological function and agricultural potential.	Maintain ecological function and agricultural potential.	Zero concrete hard pan layers observed on the ground. All waste waybills & certificates of safe disposal and landfill licenses in register and on file.	In the event of concrete hard pan layers, break up all concrete hard pan layers and dispose of appropriately (at a registered landfill site) or re-use the concrete in legitimate construction works.	Applicant / Contractor (SEO).	For each disposal event.	ECO & IEA.
8.2.2	The high economic cost of disposing hazardous waste at authorised landfills, and potential contamination of land by illegal dumping.	The reduced generation of hazardous waste and the avoidance of environmental (land and water) contamination.	Indicators and trends in hazardous waste generation and management over time while considering amount of active construction to contextualise	The contractor shall contain contaminated water from washing brushes and other tools as well as the dirty water (possibly hazardous) in a conservancy tank until sufficient volume warrants disposal by a registered hazardous waste	Applicant / Contractor (SEO).	Throughout construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			efforts. All waste waybills & certificates of safe disposal and landfill licenses in register and on file.	management company. The contractor shall return used oil to the supplier or an oil recycling company.			
8.2.3	Solid and liquid waste can be harmful to fauna if swallowed / ingested or if the creature becomes entangled or impaled.	Healthy animals (wild and domesticated).	Zero incidence (in the incident register) of waste induced harm to wildlife or livestock. No litter observed in the development footprint and no-go areas.	Designate a temporary bulk waste storage area, ensure it is "predator-proof", and provide sufficient scavenger proof dust bins during construction. Provision must be made for the adequate storage of used and contaminated substances such as oil, lubricants and other petroleum products during the construction and operational phases of the	Applicant / Contractor (SEO).	Throughout construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				development. The substances must be stored in such a way that it would not pose threat to the environment. Do not litter and ensure sound housekeeping.			
8.2.4	Improper handling, storage or disposal of waste can cause toxicity – the introduction of toxic or hazardous substances into a watercourse - spills can be washed into the watercourse by storm water run-off.	To ensure sound waste management practices that do not affect any aquatic environments.	Zero incidence (in the incidence register) of waste induced impacts on aquatic environments.	Hard-surfaces and parking areas with storm water outlets should not channel litter, oil and fuel spills into a watercourse, causing water pollution. The contractor is prohibited from discharging untreated waste water, including domestic water from sanitation facilities, into a watercourse. The contractor shall store & contain hazardous	Applicant / Contractor (SEO).	Throughout construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				chemicals within a secure, safe and adequately bunded facility at the construction camp, to ensure spillages do not enter any aquatic environments.			
8.2.5	Construction activities will produce solid and liquid waste, which can contaminate the ground (litter, spillage) if improperly handled, stored or disposed.	To reduce contamination of the soil through improper management of waste.	Low incidence of waste induced ground contamination, with a trend indicating constant improvement over time (not just quantities but procedural. improvements too). Suitable close-out documentation and reviews of SOPs & MS	Do not mix concrete on open ground. Mix in a wheel barrow, a mixing tray or on a concavely shaped and supported liner. In the event of a leak or spill onto the ground, immediately remove contaminated soil to the depth of penetration and temporarily store in a designated solid waste container until sufficient volume warrants disposal at a registered waste site.	Applicant / Contractor (SEO).	Throughout construction.	ECO & IEA.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			following significant contamination events.	Alternatively, onsite treatment of contaminated soil should be considered to be facilitated by a registered hazardous waste management company. The burning, burying or illegal dumping of waste is prohibited. When handling hazardous materials, such as when refuelling vehicles or generators, the contractor shall implement appropriate precautionary measures, such as a ground cover or drip trays, to prevent spills from contaminating the ground.			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				The contractor shall prevent the run-off of slurry or cement contaminated water from concrete / plaster mixing sites. Adequate waste receptacles must be available, including those that track with the active work fronts, to ensure effective waste management. Remove ineffective danger tape / netting that has begun to litter the site or surrounding areas. Follow housekeeping rules to avoid littering (littering is			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				likely to be more prevalent at designated eating / rest areas).			
8.2.6	The contamination of soil.	To reduce the amount of hazardous waste, specifically contaminated soil, that is generated during construction.	Sound management & disposal of contents of drip trays and / or utilisation of alternative hydrocarbon absorbents in drip trays. Zero sand observed in drip trays and bunds. Zero spills or leaks observed under or near stationary construction plant and equipment.	Use drip trays for refuelling, emergency repair work and all stationary construction plant and equipment that can leak, such as TLBs, compressors and generators. Drip trays must be regularly emptied, or they can be filled with hydrophobic hydrocarbon absorbent material to avoid the content from overflowing during rainfall events.	Applicant / Contractor (SEO & Plant Operators).	Throughout construction.	ECO & IEA.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
8.2.7	The contamination of soil (and generation of waste) by undesirable practices.	To reduce the amount of hazardous waste, specifically contaminated soil, that is generated during construction.	Zero observations of spills covered with soil.	Do not cover spills with virgin soil. It merely increases the disposal cost for a greater volume of hazardous waste. Utilise as an alternative, hydrocarbon absorbents, for spillages.	Applicant / Contractor.	Throughout construction.	ECO & IEA.
8.2.8	Illegal dumping will result in the loss of certain land uses like agriculture and conservation and remove natural habitat.	Continued self-sustainability of the site's ecological and agricultural integrity.	Waybills and/or safe disposal certificates from the service provider. No evidence of illegal dumping of project-specific waste within the development footprint, no-go areas or neighbouring	The contractor shall dispose of general waste, that cannot be recycled, at a registered municipal landfill site. All waste to be removed to a suitable waste disposal facility by a registered service provider, where relevant.	Applicant / Operator.	Throughout operation,	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			properties.				
8.3	**Operational Phase**						
8.3.1	Solid waste can be blown away and into the landscape.	A pristine environment, devoid of wind-blown litter.	No litter or other open sources of project generated waste observed within the fenced premises.	The site will be kept tidy always. All waste shall be picked up daily. Maintain good housekeeping tendencies.	Applicant / Operator.	Throughout operation.	IEA.
8.4	**Decommissioning Phase**						
8.4.1	The generation of potentially harmful waste that has the potential of contaminating the environment if not disposed at a licensed landfill or, if disposed at an appropriate landfill, reduces the capacity and lifespan of that site.	To minimize waste and ensure suitable disposal at the end of project life.	No evidence of residual structures relating to the project, unless specifically retained at landowner's request.	Properly dispose of all waste & residual structures.	Applicant.	At decommissioning phase.	IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
8.4.2	Illegal dumping sites cannot retain the ecological functions and land use required to generate ecosystem goods and services and tangible economic benefits including income from conservation or farming.	To ensure that no illegal waste dumps are left in situ following decommissioning.	Restoration of the footprint to a functional ecological and agricultural state.	The illegal dumping or disposal of waste generated from the decommissioning of the pipeline & reservoir within the development footprint, no-go areas or on adjacent properties is strictly prohibited.	Applicant.	At decommissioning phase.	IEA.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

TABLE 9. FAUNA & FLORA MANAGEMENT.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
9.1	**Planning & Design Phase (including Pre-Construction)**						
9.1.1	The construction of new service tracks can destroy plants of conservation concern.	To reduce the impacts of roads on fauna & flora.	The successful relocation of plants of conservation concern into suitable habitats.	Prior to the construction of any new roads, a search & rescue must be conducted by a suitably qualified specialist for protected fauna & flora and that of conservation concern; which must then be transplanted outside the works area in a comparative habitat type. Ascertaining similar habitat types may require soil sampling and analysis over and above above-ground similarities.	Applicant / Contractor.	Prior to & during construction.	SEO, ECO & IEA.
9.2	**Construction Phase**						
9.2.1	Increased risk of alien plant invasion to the detriment of the local ecology and agricultural potential.	To effectively control the invasion of any alien plants.	No new alien plant recruitment (directly or indirectly resulting from construction	Alien invasive vegetation recruitment must be controlled within and along the construction footprint and fence lines. Manual control measures are preferred, but where herbicides are used	Applicant / Contractor.	Throughout construction.	SEO, ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			activities) within the development footprint and neighbouring no-go areas or properties.	they must be those endorsed & selective for the target species with the lowest environmental toxicity. Applicant shall collect and destroy all seeds of weed, invader and alien plant species occurring within disturbed and /or rehabilitated areas. Applicant shall immediately uproot, cut or debark weed, invader and alien plant species upon being identified. Areas disturbed during construction shall be monitored for the recruitment of weed, invader and alien			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				plant species and controlled immediately upon being found to occur. Recruitment of alien and invasive plants must be controlled to ensure they do not seed and propagate (both declared weeds and those that are outside of their natural distribution).			
9.2.2	Construction activities (i.e. clearing and grading) have the potential to directly impact, that is damage / injure and destroy / kill, local fauna and flora. (The impacts are exacerbated when the species	To reduce in situ losses of protected and conservation important flora & fauna.	Spatially explicit "Search & Rescue" register indicating the nature & position of all translocated flora & fauna.	A search and rescue must be undertaken of all footprints that will be temporarily or permanently affected during construction of the development footprint. All fauna and flora that are protected or of conservation importance must either be cordoned off and protected or translocated outside of the	Applicant / Contractor. All search & rescue & translocation activities must be carried out by suitably qualified specialists.	Pre-Construction.	SEO, ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
	affected are classified as protected, sensitive, rare, or threatened and endangered).			site establishment and pipeline and reservoir footprint, into habitats of a similar nature. Avoid direct contact with fauna, through clearing and grading as it can cause injury or death.			
9.2.3	Harvesting of: - indigenous plants for muthi; - firewood; and - poaching of animals.	To ensure no harvesting of natural resources within and adjacent to the development footprint.	Zero incidence of harvesting. All incidences recorded in the incident register including close-out actions. Compliance with the North West Biodiversity Management Act (NWBMA, Act 4 of 2016),	The harvesting or collection of any natural product(s) from the environment is strictly forbidden. Do not poach or hunt animals within development footprint, no-go areas and neighbouring properties. "Problem" animals must be handled with assistance from the provincial conservation authority.	Applicant / Contractor.	Throughout construction & operation.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			Provincial Gazette no. 7721, Provincial Notice 3, 3 January 2017, as amended (not in force at time of report).	Except for search and rescue operations authorized by the ECO and the Provincial Conservation Authority, no mammal, bird, reptile, invertebrate or fish shall be intentionally caught, hunted or poached, within the development footprint and no-go areas.			
9.4	**Decommissioning Phase**						
9.4.1	Impacts on biological functioning and productivity of vegetation.	To ensure restoration of ecological function following decommissioning.	No degraded areas within the decommissioned footprint.	Reinstate ecological function by recreating an open system by removing all project related fencing.	Applicant / Landowner.	At completion of decommissioning activities	IEA.
9.4.2	Alien Plant Invasion Risk.	To ensure no residual alien plants at cessation of operations.	Zero incidence of alien plants within the decommissioned footprint.	The rehabilitated servitudes shall be monitored following the completion of decommissioning of the pipeline and reservoir footprints for the recruitment	Applicant / Landowner.	At completion of decommissioning activities, within the growth season, as well as the following	IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				and subsequent control of weed, invader and alien plant species.		growth season following decommissioning.	

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

TABLE 10. WATER USE & MANAGEMENT (INCLUDING WATERCOURSES).

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
10.1	**Planning & Design Phase (including Pre-Construction)**						
10.1.1	Decrease in water quality of watercourses.	To minimise the risk of impacts to water resources in and around the project footprint.	No high-risk activities located within close proximity to water resources.	Avoid placing high risk (pollution generating) activities within close proximity to a watercourse as they can cause water pollution.	Applicant / Contractor.	During site establishment & throughout construction.	SECO, ECO & IEA.
10.1.2	Uncontrolled and unsustainable abstraction from a watercourse or aquifer (borehole) and depletion of already constrained groundwater resource.	Utilisation of surface water within the allocation stipulated in the Water Use License for the Bospoort WTW.	Implementation of a register recording abstraction volumes. Provision of adequate storage of water allowing for abstraction rates within Water Use License conditions.	Abstraction volumes must comply to the conditions of the Water Use License. Adequate storage of water must be provided, to allow for suitable abstraction rates that will not exceed the rate stipulated in the WUL throughout the construction process. Water meters must be	Applicant / Contractor / Land owner	Prior to and monthly throughout construction.	SECO, ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				installed on all abstraction pipelines/equipment to ensure that utilisation rates are measured and monitored and do not exceed the permissible limits.			
10.2	**Construction Phase**						
10.2.1	Excessive abstraction from a watercourse or aquifer.	To reduce water usage for construction activities.	Evidence of dust control additives used to minimise water usage for dust suppression activities, including completed logbooks and no evidence of over wetting, i.e. erosion or pools of water (puddles).	An environmentally friendly water-soluble dust control additive / binder must be added as an additive to any water used for dust suppression. The additives generally assist with surface stabilization thereby significantly reducing water usage.	Applicant / Contractor.	Throughout construction.	SECO, ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				All water bowsers must maintain logbooks in which quantities used for construction and dust suppression are recorded. Water bowsers implementing dust suppression, must determine optimal rates of application to ensure over-wetting does not occur.			
10.2.2	Decrease in water quality of water resources.	To minimise the risk of water contamination and activities that impact negatively on water quality.	All high-risk activities to be located at least 35m away (specified buffer zone) from any water resource (surface or ground).	Chemical toilets shall be in the shade, at least 35m from any watercourse. Re-fuelling with a mobile fuel bowser shall take place outside any watercourse.	Applicant / Contractor.	Throughout construction.	SECO, ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
10.3	**Operational Phase**						
10.3.1	Impediments to surface water runoff.	To retain as far as possible surface water hydrology.	Limited signs of erosion along or resulting from the fence line.	Fence lines must be regularly cleared of accumulating debris (accumulating debris does not refer to living plants, otherwise the removal of plants will cause more erosion), to allow surface water to flow uninhibited across the development footprint.	Applicant / Operator.	Throughout operation.	IEA.
10.3.2	The excessive and / or wasteful use of water has the potential to reduce the ecological reserve required for sustaining the local ecosystem.'	To use water in a manner that is ecologically sustainable and not wasteful.	No drips, leaks or other evidence of wasteful water use.	Water leaks shall be repaired immediately upon being found. Water-saving showerheads shall be used, where relevant. Consider placing a cistern displacement device in the toilet	Applicant / Operator.	Throughout operation.	IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				cistern. Educate employees on the importance and practices of water efficiency. If practical, consider harvesting rainwater from drainpipes. Use an aerator and / or a water flow-reducing spout on the taps and shower heads.			
10.3.3	Poor water quality can be a health risk or harmful to humans.	To ensure safe potable water for employees.	Compliance of potable water to SANS 241 standard.	Water used for potable (drinking) purposes must be tested to ensure compliance with the minimum standards. Should elements of the water not comply, the water must be treated to ensure no acute or	Applicant / Operator.	Quarterly.	IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				chronic health risks.			

TABLE 11. AIR QUALITY MANAGEMENT.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
11.1	**Planning & Design Phase (including Pre-Construction)**						
No pre-construction impacts associated with this phase.							
11.2	**Construction Phase**						
11.2.1	Old and poorly maintained vehicles cause the most air pollution from cars, specifically GHG emissions that are released to the atmosphere, contributing to global warming and acid rain.	To reduce the level of car or other combustion-related pollutants entering the atmosphere (by keeping well-maintained plant and equipment).	Evidence of servicing at required intervals. No visible evidence of excessive emissions.	Construction plant and equipment shall be kept in a good state of repair to reduce combustion-related emissions.	Applicant / Contractor.	During construction.	Plant Manager, SEO, ECO & IEA.
11.2.2	Negative effects on floral photosynthetic functioning and potential increase in breathing ailments of site staff, surrounding landowners, communities and	To manage dust entrainment on access roads which may not exceed the thresholds stipulated in the National Dust Control	Full compliance with National Dust Regulations. Acceptable Dust fallout rate	Effective implementation of the National Dust Control Regulations. Excessive vehicle movement, and the transport and off-loading of dispersive materials shall be avoided during windy conditions, unless additional dust suppression	Applicant / Contractor.	During construction, monthly.	Following complaints and / or obvious signs of significant dust fallout. Monitoring of dust fallout to be undertaken

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
	fauna.	Regulations.	($mg/m^2/day$): Residential area < 600 Non-residential area < 1200 Exceedance not more than twice in a year, not sequential months.	methods will ensure that the dust fallout does not exceed the acceptable limits. The contractor is to take into consideration predicted wind speeds from the local weather station when planning construction-related activities with a high risk of generating dust. Dust suppressant must be prioritised for any drilling activities.			by a professional service provider and compliance to be verified by ECO & IEA.
11.2.3	Safety risks and road accidents due to reduced visibility.	To reduce vehicular accidents due to poor dust-induced visibility.	Full compliance with National Dust Regulations.	Dust suppression must be carried out on access roads where high dust entrainment is evident. Dust generated by construction activities must be minimized by dust suppression techniques such as the use of water sprinklers.	Applicant / Contractor.	During construction. Dust fallout evaluation monthly and dust suppression as conditions dictate.	Following complaints and / or obvious signs of significant dust fallout affecting visibility of traffic. Monitoring of dust fallout to

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
							be undertaken by a professional service provider and compliance to be verified by ECO & IEA.
11.2.4	Unpleasant odours.	To reduce unpleasant odours often associated with ablution facilities.	Records of regular servicing, and daily cleaning log.	Chemical toilets shall be kept hygienic and cleaned daily to avoid unpleasant odours.	Applicant / Contractor.	During construction.	SEO, HSO, ECO & IEA.
11.3	**Operational Phase**						
11.3.1	Decrease in air quality.	To manage dust entrainment on access roads which may not exceed the thresholds stipulated in the National Dust Control Regulations.	Full compliance with National Dust Regulations.	Effective implementation of Dust Control Regulations. Dust suppression must be carried out on access roads to minimise operational dust emissions.	Applicant / Operator.	As required to minimise dust emissions.	IEA.

TABLE 12. SOIL MANAGEMENT.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
12.1	**Planning & Design Phase**						
12.1.1	Loss of valuable topsoil.	To minimise disturbance & contamination of topsoil.	Compliance with site layout plans.	Clearing, and the location of topsoil stockpiles and / or windrows, shall take place in pre-authorised and clearly defined areas only.	Applicant / Contractor.	Prior to and during construction.	ECO & IEA.
12.2	**Construction Phase**						
12.2.1	Decline in soil organisms.	To maintain the biological integrity of disturbed soil.	The list of plant species, and their relative abundancies, chosen for rehabilitation reflects the natural plant communities that need to be rehabilitated.'	Re-seed disturbed areas after construction with grass seeds of the naturally occurring plant species to encourage soil invertebrate species richness.	Applicant / Contractor (SEO).	Following construction or construction induced disturbance.	ECO & IEA.
12.2.2	Loss of valuable topsoil.	To retain all disturbed and cleared topsoil.	Comparative quantification of cleared and reinstated topsoil	Any topsoil removed during the establishment of parking areas, temporary roads, or any other cleared areas, must be protected from vehicular and construction	Applicant / Contractor (SEO).	During initial clearing and prior to reinstatement of topsoil.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			volumes.	impacts. Do not mix topsoil with cement and / or subsoil or let it be pulverised by trucks.			
12.2.3	Potential sterilisation of the soil.	To maintain soil viability.	Use of only selective, environmentally friendly herbicides.	Where possible, refrain from using non-selective herbicides to control vegetation, depending on the active ingredient, it can sterilise the soil. Application of herbicides may only be applied by or under the supervision of a Certified Pest Control Officer as stipulated by the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947).	Applicant / Contractor (SEO).	Every treatment episode.	ECO & IEA.
12.2.4	Soil contamination.	To reduce and avoid soil contamination.	No evidence of contaminating activities on unprotected ground, or in	Construction plant and equipment shall be kept in a good state of repair to reduce hydrocarbon leakages.	Applicant / Contractor (SEO).	During construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			the case of accidental spills, documented evidence of rapid remediation.	Immediately remove contaminated soil to the depth of penetration and temporarily store in a designated solid (separate hazardous) waste container until sufficient volume warrants disposal at a registered (separate hazardous) waste dump site. Alternatively, onsite treatment of contaminated soil should be considered with and / or in consultation with a registered hazardous waste management company. Soil horizons must be stockpiled or windrowed separately during excavation to ensure they can be reinstated in reverse order and ensure restored soil structure.			
12.2.5	Soil erosion, soil loss & associated	To reduce erosion induced soil	To record all areas prone	Areas disturbed and rehabilitated during construction shall be	Applicant / Contractor	During construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
	degradation of ecosystems.	losses and consequential ecosystem degradation.	and affected by erosion and implement suitable pre-emptive and remedial measures.	monitored for signs of erosion and if found to occur, immediately corrected ('source') and repaired ('symptom'). Bulk shape the areas where material is introduced to mimic or blend in with the surrounding, natural topography. Do not fine shape or rake because an uneven surface will impede surface water run-off and facilitate infiltration. Correct any cause of erosion at the onset thereof by controlling / diverting storm water run-off, immediately repairing and stabilizing / rehabilitating impacted areas in the most appropriate manner. Ensure a quick and adequate cover with indigenous and local grass species.	(SEO).		

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				Ensure storm water run-off is adequately controlled on disturbed sites before rehabilitating them (ripping, replacing the topsoil and mulching/brush packing), i.e. cut-off berms. Grading of existing farm roads must not be promoted, but farm tracks must be utilised as far as possible. Sediment traps may be necessary to prevent erosion and soil movement if there are topsoil or subsoil stockpiles or windrows present during the wet season. The Contractor shall monitor the rehabilitated servitudes for the duration of the contract defects and liability period for signs of			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				erosion.			

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

TABLE 13. SOCIAL-ECONOMIC MANAGEMENT (HEALTH, SAFETY & SECURITY & COMMUNICATION).

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
13.1	**Planning & Design Phase (including Pre-Construction)**						
13.1.1	Concerns about social disturbance and community safety (including loitering at construction site).	To reduce human induced impacts and nuisance factors.	No complaints from affected parties in the on-site complaints register. Where complaints are lodged effective and timeous close-out must be demonstrated.	Adequate accommodation and transport must be provided for all staff to reduce impact on the property owner and adjacent farms as well as relieving pressure off road networks. A complaints register must be maintained and be accessible on site, in which complaints linked directly to the project can be lodged, and addressed in a proactive manner.	Applicant / Contractor (via CLO and SO).	Prior to and during construction and operation.	ECO & IEA
13.1.2	Community confusion, frustration & lack of information.	To avoid creating false hope where job creation opportunities are concerned.	Development of an effective job seeker database.	Implementation of a community relations strategy until all activities on site cease and rehabilitation is completed. Develop a job seeker database or integrate with an existing service provider in the adjacent towns, to	Applicant / Contractor / Operator	Prior to and during construction and operation.	ECO & IEA

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				ensure job seekers' details are captured. As positions become available, this database can be searched for suitable skills within the local populous before positions are outsourced. These measures will reduce the potential nuisance factor to the land owner, caused by job seekers reverting to visiting the proposed site of development.			
13.2	**Construction & Operation Phase**						
13.2.1	Increase in crime including damage to property infrastructure and vandalism.	Reduce impacts associated with crime.	No perpetuating criminal activity. Improvements to security must be demonstrated following an incident.	Adequate security measures must be in place throughout construction & operation phases to discourage criminal elements from site.	Applicant / Contractor / Operator.	At commencement of construction, especially site establishment and during operation.	ECO & IEA.
13.2.2	Potential social pathologies (social	Reduce impacts associated with	No strike & community	Ensure effective communication and engagement with staff and	Applicant / Contractor /	At commencement	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
	unrest).	disgruntled staff.	actions by staff. Improvements to engagement with staff & community must be demonstrated following an incident.	surrounding community via inter alia the appointment of a suitably qualified CLO. Transparent communication through the right channels to communicate with the community as to when and how their contracts will come to an end.	Operator (CLO).	of construction, and during operation.	
13.2.3	Injury to site staff from construction, demolition and blasting activities.	To ensure effective Health & Safety implementation.	Appointment of a suitably qualified HSO and compliance monitoring against the OHSA (Act 85 of 1993).	Implement a safety plan, access protocols, grievance mechanism and compensation policy. All staff must undergo a site induction that outlines the socio-environmental constraints of the site.	Applicant / Contractor (HSO) / Operator.	Throughout Construction & Operation.	Health & Safety Audits biannually or otherwise stipulated in the OHS or construction regulations.
13.2.4	Injury to trespassers resulting in possible lawsuits.	To avoid inadvertent injuries to trespassers.	No recorded injuries to trespassers.	Increase security to protect trespassers from being electrocuted if and where electric fences are installed. Adequate signage must be placed	Applicant / Contractor.	Throughout construction	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				around the development warning uninformed people of the potential hazards and dangers associated with the project.			
13.2.5	Negative effects on the wellbeing of the local inhabitants and site staff as well as the potential outbreak of disease (including HIV/AIDS).	To avoid negative impacts on the health of the residents and occupiers.	Effective implementation of awareness training including measures to assess effectiveness of training.	AIDS / HIV awareness training must be undertaken to ensure that the labour force is well informed on the matter. Dangerous fumes, noise, dust and water impacts must be avoided that may affect both the labour force and surrounding landowners and users.	Applicant / Contractor / Operator	Ongoing	ECO & IEA.
13.2.6	Potential increase in pedestrian and livestock accidents.	To reduce impacts and injuries to pedestrian and livestock.	No injuries recorded in incident register. Close-out Reports must demonstrate improvements to avert a	An awareness must be fostered to drive carefully to avoid killing or injuring people or animals and damage to property. Open excavations must be secure and cordoned off to avoid accidental injury to humans and animals alike.	Applicant / Contractor / Operator.	Ongoing awareness and following cessation of use of borrow pits.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			recurrence.	Any complaint from the public during the construction and operation of this project must be attended to by the person involved as soon as possible to the satisfaction of the parties concerned. A complaint register must be kept to address issues and complaints raised by concerned parties. A complaints register should be kept during construction and operational phase of this project to address issues and complaints raised by concerned parties.			
13.3	**Decommissioning Phase**						
13.3.1	Increased unemployment after construction & operation ends.	To minimize the negative social impacts at the end of each phase of the project.	Develop an effective implementation of an Exit Strategy.	Develop and implement a holistic Exit Strategy that adequately and timeously communicates and buffers staff lay-offs. Clearly make the terms and conditions of employment known to	Applicant.	Prior to commencement of construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				all employees (temporary & permanent) including anticipated duration of each phase.			

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

TABLE 14. CULTURAL, HERITAGE, ARCHAEOLOGICAL & PALEONTOLOGICAL MANAGEMENT.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
14.1	**Planning & Design Phase (including Pre-Construction)**						
14.1.1	Surveying and pegging of temporary footprints can disturb sites of historical significance, i.e. Graves.	To ensure initial survey & clearing activities do not disturb know heritage sites.	All graves and know heritage sites are secure (fenced or cordoned-off).	Ensure that none of the layout & designs of permanent footprints will disturb sites of historical significance, including graves. All formal and informal cemeteries and burials must be left in situ and not be disturbed. If this is not possible, a permit must be applied for in terms of Section 36 of the NHRA (Act 25 of 1999) and is subject to mandatory public consultation.	Applicant.	Prior to surveying.	ECO & IEA.
14.1.2	Lack of awareness of heritage resources.	To promote awareness about heritage resources and their presence within the development area.	Heritage content in site induction, toolbox and awareness talks.	Include an awareness of heritage resources in the environmental induction. Categories of heritage resources include, inter alia: • Evidence of archaeological sites or remains include remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell	Applicant / Contractor.	Throughout construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				fragments, marine shell and charcoal / ash concentrations. • Archaeological or paleontological sites over 100 years old, • Sites of cultural significance associated with oral histories, • Significant cultural landscapes or viewscapes, • Burial grounds, unmarked human burials, graves of victims of conflict, and/or graves older than 60 years, • Structures older than 60 years, • Fossils, etc.			
14.2	**Construction Phase**						
14.2.1	Loss of archaeological & palaeontological valuable artefacts.	To ensure construction activities do not disturb know or incidental heritage sites.	No loss of archaeological valuable artefacts. All known "heritage" sites within the	All areas of heritage value must be demarcated and avoided. Incidental discoveries during clearing and grubbing, and archaeological artefacts unearthed during excavations must, be disclosed to site management with immediate	Applicant / Contractor.	Throughout construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			development footprint is suitably cordoned off.	cessation of activities until their significance can be assessed by a qualified heritage specialist.			
14.2.2	Loss of cultural and heritage value to society.	To ensure correct procedures are followed following chance finds to preserve the heritage resource.	Adherence to protocols specified in management actions following a chance find.	Contact a professional archaeologist, depending on the nature of the finds, as soon as possible to inspect the findings. In the event that fossils are uncovered during construction then the Fossil Chance Finds Procedure under the PIA report must be implemented. If there are any new heritage resources discovered during construction and operation phases of the proposed development, then construction must cease within the immediate vicinity and a buffer zone of 30 m must be established.	Applicant / Contractor.	Throughout construction.	ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				A professional archaeologist or palaeontologist, depending on the nature of the finds, must be contracted as soon as possible to inspect the findings at the expense of the developer. If any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils or other categories of heritage resources are found during the proposed development, SAHRA APM Unit (Natasha Higgitt/Phillip Hine 021 462 5402) must be alerted as per section 35(3) of the NHRA. If unmarked human burials are uncovered, the SAHRA Burial Grounds and Graves (BGG) Unit (Thingahangwi Tshivhase/Mimi			

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				Seetelo 012 320 8490), must be alerted immediately as per section 36(6) of the NHRA. A professional archaeologist or palaeontologist, depending on the nature of the finds, must be contracted as soon as possible to inspect the findings. If the newly discovered heritage resources prove to be of archaeological or palaeontological significance, a Phase 2 rescue operation may be required subject to permits issued by SAHRA; If any unmarked human burials are uncovered and the archaeologist called in to inspect the finds and/or the police find them to be heritage graves, then mitigation may be necessary and the SAHRA Burial Grounds and Graves (BGG) Unit must be contacted for processes to follow			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				(Mimi Seetelo 012 320 8490). The contractors and workers should be notified that archaeological sites might be exposed during the construction work. Contractors and workers shall be advised of the penalties associated with the unlawful removal of cultural, historical, archaeological or palaeontological artefacts, as set out in the National Heritage Resources Act (Act No. 25 of 1999). Sites BP3 – 13 must be mitigated by a qualified archaeologist. All impacted sites must be mapped in detail and where archaeological deposit is present (such as the midden at BP9), this deposit must be sampled by means of archaeological excavations. A permit in terms of section 35 of			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				the NHRA and Chapter II and IV of the NHRA Regulations must be applied for from SAHRA via SAHRIS for this purpose;			
14.3	**Operational & Decommissioning Phases**						
Significant heritage impacts are mostly expected to occur during the construction phase.							

TABLE 15. INFRASTRUCTURAL & TRAFFIC MANAGEMENT (INCLUDING PARKING ON SITE).

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
15.1	**Planning & Design Phase (including Pre-Construction)**						
15.1.1	No impacts expected during these phases.						
15.2	**Construction & Operation Phase**						
15.2.1	Dust entrainment from unsurfaced roads can result in unacceptably high dust fallout.	To manage dust entrainment on access roads which may not exceed the thresholds stipulated in the National Dust Control Regulations.	Full compliance with National Dust Regulations. Acceptable Dust fallout rate ($mg/m^2/day$): Residential area < 600 Non-residential area < 1200 Exceedance not more than twice in a year, not sequential months.	Dust suppression must be carried out on access roads where high dust entrainment is evident. To reduce water usage, a suitable soil binder must be used in dust suppression activities. Excessive water usage to control dust on dirt roads can cause erosion and lead to hazardous conditions for road users.	Applicant / Contractor.	During construction, monthly.	Following complaints and / or obvious visible signs of excessive dust fallout, monitoring of dust fallout must be undertaken by a professional service provider and compliance to be verified by ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
15.2.2	Parking and driving carelessly can increase collisions with mammals, birds, reptiles, amphibians and insects – collectively referred to as "roadkills".	To avoid and minimise impacts from traffic on animals residing on and around the property.	Compliance to speed limits. No recorded project vehicle associated animal mortalities.	Drivers shall always adhere to the relevant speed limit(s) (on the existing road network) and restrict their movements to the existing and / or approved roadway or servitude. The speed limit on the property shall be 40 km/h and 30km/h within the development footprint. A register must be maintained of all animal mortalities recorded on the property and localised access roads.	Applicant / Contractor.	During construction.	Compliance to be verified by ECO & IEA.
15.2.3	Contamination from spills when refuelling, parking, driving, emergency repairing, operating plant or equipment to soil or nearby or within the watercourse.	To reduce contamination of soil from leaking plant and vehicles and upon occurrence is remediated promptly.	Spills are removed within 48 hours of event. Records of servicing by off-site workshop. Drip tray issued	Oil & fuel spills on roadways and parking areas must be removed to depth of penetration following their discovery and placed in a designated hazardous container for safe disposal. Drip trays must be placed under all plant that is parked overnight and extended periods not in	Applicant / Contractor.	During construction.	Compliance to be verified by ECO & IEA.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
			to all plant and recorded in a register.	operation. Drip trays can be filled with hydrophobic hydrocarbon absorbent material to avoid content being leached out during rainfall events. No servicing or washing of vehicles or plant may take place in parking bays, and all servicing must be done off-site, no service or wash-bays are to be constructed on site. Emergency breakdowns in the parking areas or along roads, must be addressed after adequate pollution containment measures have been implemented including but not limited to drip trays and spill kits. Refuelling of vehicles and plant			

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
				may only take place at a designated and permitted (from local Fire Chief) fuel storage tank or mobile fuel bowser, under the guidance of a Specific Operating Procedure (SOP) that limits spillage and addresses remedial actions in the event of a spillage.			
15.3	**Decommissioning Phase**						
There are no significant impacts expected during this phase.							

TABLE 16. VISUAL ASPECT MANAGEMENT.

No.	Potential Impact	Desired Outcomes	Targets & Indicators	Management Actions & Mitigation Measures	Responsibility	Timeframe / Frequency	Monitoring
16.1	**Planning & Design Phase (including Pre-Construction)**						
There are no significant impacts expected during this phase, as footprint location has already mitigated the planning and design requirements.							
16.2	**Construction & Operational Phase**						
16.2.1	Impact of construction on visual receptors, including road users and local homesteads.	To manage the facility in a way that minimised its visual impacts on the surrounding environment.	Demonstration of effects to minimise visual impacts.	Use visual screens to minimise the visual impact on the scenic resources of this region. Have minimal placements that can be visually intrusive to sensitive receptors. Utilise fencing options that do not create a significant visual barrier.	Applicant.	Throughout the project lifecycle.	ECO & IEA.
There are no significant impacts expected during the decommissioning phase.							

SECTION 6: ENVIRONMENTAL AWARENESS PLAN

This section of the report is included in compliance with Section 24N(3)(c) of the NEMA and the EIA Regulations (2014) as amended.

The EMPr needs to include, inter alia:
An environmental awareness plan describing the manner in which-
(i) The applicant intends to inform his or her employees of any environmental risk which may result from their work; and
(ii) Risks must be dealt with to avoid pollution or the degradation of the environment;

Throughout the construction & operational phases environmental as well as health and safety awareness training should be provided to all employees to promote the effective implementation of the EMPr actions.

This section of the report focusses on the environmental awareness training. It provides a guideline as to the possible environmental risks that may be experienced as part of the project as well as way to avoid the risks and subsequent environmental degradation. The aim is to provide a guide to developing a comprehensive yet easily understandable awareness plan to present to employees of all education and skill levels which should be presented to the employees at least one week prior to commencement of construction. The following pointers are given for the environmental awareness training course:

- Environmental awareness training should be undertaken by the environmental and / or health and safety representative of the developer / contractor with the input of an EAP or ECO if required;
- Environmental awareness reminders should be undertaken at least bi-annually to ensure that employees and Contractors are kept aware of the risks and management thereof;
- It is recommended that awareness posters be developed and placed on site in highly visible areas to provide the required information when it needs to be referred to as well as reminding employees of their obligations regarding environmental protection;
- A slideshow can also be developed for initial awareness induction and for use as a reminder of the environmental risks and responsibilities at the site or induction of future Contractors; and
- Throughout the presentations (posters, meetings, slideshows, etc.), it is recommended that visual aids be used to explain the potential risks and management thereof as thoroughly as possible.

Should any new personnel be contracted or arrive on site during the construction period, they should attend the environmental awareness course. The environmental awareness training should be provided to all labourers, technical staff and any other Contractor appointed.

The awareness training forms part of this EMPr and should be implemented as part of the conditions of environmental management and risk prevention. Refer to the management

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

measures in Tables 6 through 16 above for proposed management and mitigation actions to be undertaken to prevent or minimise the risks described below. Attention should be focussed on the following areas of sensitivity during the construction phase:

- Removal of vegetation during site clearance;
- Animal habitat disturbance due to vegetation clearance;
- Soil erosion and pollution;
- Soil compaction;
- Health and safety;
- Degradation of roads; and
- Fire risks.

Other elements to be taken into consideration by the employees during both the construction and operational phases include:

- The presence of animals on site;
- Disturbances to neighbours due to noise and traffic;
- The positive impacts, of the greener technology being implemented, on the biophysical and socio-economic environments; and
- Awareness should be raised regarding the possible occurrence of sensitive plant and animal species and heritage features.

The awareness training for this project should aim to prevent, and where prevention is not possible, mitigate detrimental environmental impacts. It should promote awareness of environmental risks and management thereof. It should furthermore promote green thinking and provide information on alternative energy sources and energy consumption reduction.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SECTION 7: RESPONSIBILITIES OF ROLE PLAYERS

The approved EMPr shall be printed, completed and kept in an on-site file designated for all matters pertaining to environmental management. Co-operation is required between the applicant, contractor, and ECO to ensure that activities are managed in an amicable and responsible manner and in accordance with the philosophies of environmental legislation and principles of the EMPr.

This EMPr is predominantly compiled for the management of construction & operations associated with the development of a solar PV facility, once the Planning and Authorisation phases are complete. The tabulated management programmes assign responsibilities to one or more role player, the below descriptions identify responsibilities and accountabilities in the case of any uncertainty.

Applicant

The applicant remains ultimately accountable for ensuring that the development is implemented according to the requirements of the EMPr. Although the applicant delegates specific responsibilities to role players to perform functions on his / her behalf, the ultimate accountability cannot be delegated. The developer is responsible for ensuring that sufficient resources (time, financial, man-power, equipment, etc.) are available to the other role players (e.g. the contractor, SECO, etc) to efficiently perform their tasks in terms of the EMPr. The responsibility of restoring the environment in the event of any negligence, which leads to damage of the environment, also falls to the applicant.

The applicant must ensure that the EMPr is included in any documents (tender, appointment etc.) so that any contractor who is appointed is bound to the conditions of the EMPr. The applicant must appoint an independent Environmental Control Officer (ECO) prior to commencement of construction, to help identify pre-construction & construction criteria that need to be fulfilled timeously, to avoid non-compliance with the overarching authorisation conditions and / or legislation.

Contractor

The contractor, as the developer's agent on site, is bound to the EMPr conditions through his / her contract with the developer and is responsible for ensuring that she / he adheres to all the conditions of the EMPr. The contractor shall be responsible for the actions undertaken by all their employees including sub-contractors. The contractor must thoroughly familiarise him / herself with the EMPr requirements before coming onto site and must request clarification on any aspect of these documents, should they be unclear. The contractor must ensure that he / she has provided sufficient budget for complying with all EMPr conditions at the tender / appointment stage.

The contractor must comply with all instruction (whether verbal or written) given by the environmental manager, project manager or site engineer in terms of the EMPr.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Site Environmental Officer (SEO)

The Site Environmental Officer (SECO) shall be appointed by the contractor to implement the EMPr daily. The SEO shall ensure that all construction activities are carried out in accordance with the relevant conditions of the EMPr, Environmental Authorisation (EA), General Authorisation (GA) or Water Use License (WUL) (under the National Water Act), wayleaves, provincial ordinances & provincial bylaws.

Environmental Control Officer (ECO)

The Environmental Control Officer (ECO) is appointed by the applicant as an independent monitor of the implementation of the EMPr, EA & GA / WUL. He / she must form part of the project team and be involved in all aspects of the project planning that can influence environmental conditions on the site.

The ECO must attend relevant project meetings, conduct inspections to assess compliance with the EMPr, EA & GA / WUL and be responsible for providing feedback on potential environmental problems associated with the development. In addition, the ECO is responsible for:

- Liaising with relevant authorities;
- Liaising with contractors regarding environmental management; and
- Undertaking routine monitoring and appointing a competent person / institution to be responsible for any specialist monitoring (if required).

The ECO has the right to enter the site and undertake monitoring and auditing at any time, subject to compliance with health and safety requirements applicable to the site (wearing safety boots, head gear, mouth mask etc.).

Independent Environmental Auditor (IEA)

An IEA shall be appointed by the Applicant to undertake EMPr, EA & GA / WUL compliance audits at 6-monthly intervals during construction. The purpose of conducting a periodic compliance audit would be to systematically check and evaluate progress on EMPr, EA & GA / WUL implementation. The environmental audit will serve as a 'snapshot' of the environmental situation and progress at a given point in time. The purpose of the audit is to illustrate whether there has been any improvement or change over time.

The IEA will fulfil the auditing requirements by systematically auditing the Project's performance & compliance against the requirements of the EA, EMPr & GA / WUL in a process that is carefully planned, structured and organised. The audit process must, on a sampled basis, track past actions, activities, events, and procedures through using existing documentation, conducting interviews with managers and personnel, and observing practices on site.

Following construction, the IEA will undertake operational audits in accordance with the EIA Regulations (2014) as amended, which at the time of compilation of this report was every 5

years but may change with future amendments. Additional auditing requirements may be needed to fulfil the requirements of any Norms & Standards.

SECTION 8. COMMUNICATION

At least monthly construction site meetings should be held where feedback can be given, and any potential problems identified and remedied. If they cannot be remedied then construction in that area should be stopped, until a suitable remedy is identified.

Monitoring Compliance

Pre-construction, Construction and Post-construction:

The ECO will be responsible for monitoring and reporting on compliance of the activity from pre- to post-construction.

Inspections and resulting compliance reports shall be a systematic, independent and documented process for obtaining compliance evidence and evaluating it objectively to determine the extent to which the compliance criteria are fulfilled. The compliance criteria (or reference) against which the compliance evidence is compared shall include this EMPr, the Environmental Authorisation & General Authorisations or a Water Use License (under the National Water Act).

The ECO must undertake monthly inspections of the site and submit monthly environmental compliance reports to the Department of Environmental Affairs (DEA) as the competent authority for this project, unless otherwise prescribed in the EA. The compliance reports must identify the actual and potential transgressions, describe the impacts, provide verifiable evidence (photographs, records or statements) and recommend corrective and preventive actions (including completion dates). The compliance reports must measure the applicant / contractor's level of compliance against the aforesaid criteria. Performance scoring / reporting is optional.

The SECO shall maintain an on-site diary to record environmental aspects (elements of the construction activities that can interact with the environment) and environmental impacts (any change to the environment, whether adverse or beneficial, wholly or partially resulting construction activities), daily.

The EMPr is a legally binding document and should form part of the contract. Should there be failure to comply with the EMPr the following steps are envisaged:

Step 1

The ECO meets with the contractor and points out the deviation from the EMPr. The ECO and Contractor agree on a solution and this non-compliance is recorded by the ECO as well as the solution put forward to rectify it.

Step 2

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Should there still be non-compliance or there is a more serious infringement of the EMPr the contractor is informed in writing with a deadline by which the problem must be rectified. Any extra costs that may be accrued must be borne by the contractor.

Step 3
If non-compliance persists, the Chief Resident Engineer (CRE) or Project Manager (PM) shall order the contractor to suspend construction in that specific area or the project as a whole until the activity at variance with the EMPr is corrected and or remedial actions taken. Any cost that occurs as a result of such action shall be for the account of the contractor.

Step4
Where there is non-compliance with the EMPr and no evidence that the contractor intends complying even though the above 3 steps have been taken the applicant may terminate the contract due to non-compliance (breach of contract). Such measures do not replace any legal proceedings that may occur as a result of such non-compliance.

Environmental Awareness Plan

The applicant shall ensure that his project team, contractor and labourers are adequately trained with regard to the implementation of the EMPr, EA & GA / WUL throughout construction.

Time Periods and Failure to Comply with the EMPr

The time periods within which the measures prescribed in this EMPr must be implemented shall be applicable to the full duration of the activity that is being undertaken and mitigated. The time periods within which corrective and preventive actions need to be implemented shall be determined by the nature and severity of the finding. In the absence of a prescribed deadline or completion date, findings shall be corrected or prevented immediately upon being found to occur, if practical.

Pre-construction

Environmental Awareness Inductions shall be targeted at two distinct levels of employment: management (applicant, architect, engineer, contractor / site agent) and labourers (including the site foreman). The SEO shall be responsible for preparing and presenting inductions appropriate to the audience. Inductions shall be undertaken prior to the commencement of construction. Where possible the presentation will be conducted in the language of the employees.

The Environmental induction for management shall include mitigations that are relevant to or require management's involvement prior to implementation including, but not limited to, the following:

- Measures required during the Planning and Design, and Pre-construction phase, and
- Site establishment.

The Environmental induction for the contractor's labourers and foreman shall, as a minimum, include the following:

- A description of the actual and potential environmental impacts,
- Standard operating procedures for undertaking construction activities (i.e. mixing concrete, driving, etc.) that can have an environmental impact,
- Staff conduct including sanitation and movement,
- The integrated waste management strategy,
- The steps to be taken should any item of perceived environmental importance including archaeological artefacts be located or unearthed, and
- The environmental emergency plans.

Construction

The SEO and ECO shall undertake an informal training needs analysis throughout construction to identify appropriate environmental topics and the appropriate labourers to target. The analysis shall be informed by the findings contained in the site diary and compliance reports. Training shall be given during toolbox talks.

The SEO and ECO shall keep records of the environmental inductions and subsequent toolbox talks in an on-site file designated for all matters pertaining to environmental management.

Operation:

The operator & relevant authorities should be responsible for monitoring compliance with aspects of the activity that fall within their jurisdiction.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SECTION 9: ENVIRONMENTAL EMERGENCY PLAN FOR THE CONTROL OF ENVIRONMENTAL INCIDENTS

Definition of an 'Environmental Incident'

Section 30 (1) (a) of NEMA 'incident' means an unexpected, sudden and uncontrolled release of a hazardous substance, including from a major emission, fire or explosion, that causes, has caused or may cause significant harm to the environment, human life or property"

Procedure

The contractor shall ensure that emergencies are reported and controlled in accordance with the sequence of events prescribed for spillages in a watercourse, on land and fire, including:

- Action to be taken
- Removal and remediation measures to be implemented
- Internal and external communication plan
- Prescribed reporting procedure

The contractor shall ensure that their employees are adequately trained to react to environmental emergencies in accordance with this procedure.

The SECO shall complete the table of contact numbers, erect them in a conspicuous place within the construction camp and make its whereabouts known to all of the contractor's staff.

Equipment

The following equipment is required to successfully implement this procedure. It must be ensured that the equipment is supplied to or is readily available for all living quarters, site offices, kitchen areas, workshop areas, stores and on site.

1. A spill kit including absorbent fibres, mats and booms
2. A net
3. A whistle
4. Adequate lighting for night shifts
5. Spades
6. Sand bags
7. Designated hazardous waste drums
8. (Trained personnel with) protective clothing for extinguishing fires
9. Fire extinguishers
10. Fire beaters
11. Water carts/tankers with pumps and hoses
12. Water pumps and pipes (for fires started at the watercourse crossings)

Contact Numbers

Organisation	Name	Telephone/cell Number
Project Personnel		
Applicant		
Engineer		
Contractor		
HSO		
SEO		
ECO		
Interested and Affected Parties		
Land Owner		
Adjacent Land Owner		
Adjacent Land Owner		
Emergency Services		
Spill Clean-up Service Provider		
Fire Department		
Chief Fire Officer (Fire Chief)		
SA Police Services		
Disaster Management Centre		
Local Municipality		
District Municipality		
Irrigation Board		
Water Catchment Management Agency		
Water Treatment Works		
DWS (Regional Head of Department /		

Chief Director)		
DWS (Regional Director: Water sector Regulation & Use)		
DEA (Provincial Head of Department)		
DEA (Director: Environmental Impact Management)		
DEA (Director General)		
DEA (Director: Environmental Impact Evaluation)		

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE IN A WATERCOURSE

ACTION TO BE TAKEN		
Personnel	**Responsibility**	**Action**
Employee	Reporting	The person responsible for, or who discovers, a hazardous substance spill must report the incident to their immediate Supervisor.
Supervisor	Reporting	Report the incident to the SEO, HSO and Resident Engineer. ● Note that the SEO will take control of all relevant actions once he/she arrives on the scene.
HSO	Reporting	Report the incident to an Inspector (designated under section 28 of the Occupational Health & Safety Act, 1993) within the prescribed period and manner.
Supervisor / SEO	Initial investigation	Determine the extent of the spill, i.e. its boundaries, by observing for the following: 1. Any visual indication of pollution, 2. Any odours or emissions detected, 3. Any indication of the source of pollution, 4. Any sign of damage to the natural system. ● The Supervisor / SEO should provide lighting if working at night.
Supervisor / SEO	Co-ordination	Sound an alarm/whistle. ● The designated response team consisting of area specific personnel and including the environmental leader, will congregate at the spill kit. ● All other employees who do not have specific duties to perform are to evacuate the affected area to a location designated by the Supervisor / SEO.
Supervisor / SEO	Co-ordination	Minimise the effects of the incident on the environment and persons by removing the source of the spill at least 100m away from the watercourse or cut-off the supply of the spill if the source is not moveable.
Supervisor / SEO	Co-ordination	Contain the spill by laying an absorbent sock or boom across the width of the watercourse AT A PRE-DETERMINED LOCATION downstream of the construction area (spill). ● A series of parallel booms may be required.
Supervisor / ECO	Co-ordination	Secure the affected area with danger tape.

HSO	Co-ordination	The site shall not be disturbed and no article or substance may be removed (without the consent of the inspector) if there is or likely to be a death, or if there is a loss of limb or part of a limb. However, action can be taken to prevent a further accident, to remove the injured or dead or rescue persons from danger.
Engineer / SEO / HSO	Decision-making	The Engineer will assess the situation in consultation with the SEO and HSO and act as required. ● The risk involved shall be assessed before anyone approaches the scene of the incident. ● The HSO will consult the MSDSs. ● The scale of the spill will dictate whether the spill will be cleaned up by using the on-site spill kit and in the prescribed manner, or by contacting a Spill Clean-Up Service Provider for assistance. ● The SEO will take photographs of the affected area. ● No person shall be allowed to approach a spill unless he/she is equipped with the personal protective clothing.
SEO	Directions	If a Spill Clean-Up Service Provider is used, assist the emergency services by clearly marking the route to be taken to the spill site.
SEO	Co-ordination	Take such measures as the Catchment Management Agency may either verbally or in writing direct within the time specified by such institution.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE IN A WATERCOURSE

REMOVAL AND REMEDIATION MEASURES TO BE IMPLEMENTED		
Personnel	**Responsibility**	**Action**
SEO	Co-ordination	Remove the contaminated sock or boom from the surface of the water. If lose fibres were scattered on the surface to capture hydrocarbons in shallow (still) pools, 'fish' it out with a net.
SEO	Co-ordination	Remove the contaminated soil from the banks of the watercourse, to the depth of penetration using a spade or shovel.
SEO	Co-ordination	Temporarily store the contaminant in the designated hazardous waste facility at the construction camp.
SEO	Co-ordination	Contact a licensed hazardous waste service provider to collect and transport the waste to a licensed hazardous waste landfill site.
SEO	Co-ordination	Rehabilitate the banks of the watercourse by replacing the topsoil and planting indigenous plants.
SEO	Monitoring	Immediately follow any known spillage of toxic substances into a stream or river with monitoring of the receiving streams or rivers and public health.
SEO	Co-ordination	Should water downstream of the spill be polluted, and fauna and flora show signs of deterioration or death, specialist hydrological or ecological advice must be sought for appropriate treatment and remedial procedures to be followed.
SEO	Monitoring	Take photographs of the affected area during rehabilitation.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE IN A WATERCOURSE

INTERNAL & EXTERNAL COMMUNICATION PLAN		
Personnel	**Responsibility**	**Action**
Employee	Reporting	The person responsible for, or who discovers, a hazardous waste spill must report the incident to their immediate Supervisor.
Supervisor	Reporting	Report the incident to the SEO, HSO and Resident Engineer.
HSO	Reporting	Report the incident to an Inspector (designated under section 28 of the Occupational Health & Safety Act, 1993) within the prescribed period and manner.
SEO	Reporting	Report the incident to the Site Agent and / or Manager and the ECO.
SEO	Reporting	If the spill is too big for the spill kit, contact a Spill Clean-Up Service Provider.
SEO	Reporting	If the spill is going to affect downstream users, inform the Land Owner, the Irrigation Board and water treatment works (if applicable). ● Provide the following information to the water treatment works: 1. The exact location of the spillage, 2. The time of the spillage, 3. As much information about the nature of the pollution, 4. The name and telephone number of the person contacting them. ● Irrigation Boards control river structures and may be able to divert/or impound the river to protect 'water supply intakes'.
SEO	Reporting	Report the incident to the following authorities within 24 hours. 1. DEA (Director General), 2. DWS (Director General and Chief Director), 3. SA Police Services, 4. Fire Department, 5. Catchment Management Agency, 6. DEA (provincial Head of Department) or Local Municipality, and 7. Any persons whose health may be affected by the incident.

SEO	Reporting	Provide the following information: 1. The nature of the incident, 2. Any risks posed by the incident to public health, safety & property, 3. the toxicity of substances or by-products released by the incident, and 4. any steps that should be taken in order to avoid or minimise the effects of the incident on public health and the environment.
ECO / Applicant / Site Agent / CRE	Reporting	If the nature of the impact constitutes a gross violation of the EA or any legislation: ● The ECO must report the incident to the applicant. ● The applicant must report the incident to the Local Municipality, DEA, and DWS. ● The Site Agent and / or Manager must report the incident to their Environmental Group Manager, Divisional MD and CEO. ● The Resident Engineer must report the incident to his Superiors.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE IN A WATERCOURSE

PRESCRIBED REPORTING PROCEDURE		
Incident recording		
Personnel	**Responsibility**	**Action**
SEO	Investigation	Conduct an investigation, including interviews, and record all details of the incident. ● The cause must be investigated.
SEO	Reporting	Complete an Environmental Incident Report and forward it to all key project personnel, with the exception of the Emergency Services.
SEO	Reporting	Within 14 days of the incident, report the incident to the following authorities. 1. DEA (Director General), 2. DEA (Provincial Head of Department), 3. Local Municipality, 4. DWS (Regional Director).
SEO	Reporting	Provide the following information: 1. The nature of the incident, 2. The substances involved and an estimation of the quantity released and their possible acute effect on persons & the environment & data needed to assess these effects, 3. Initial measures to minimise impacts, 4. Causes of the incident, whether direct or indirect including equipment, technology, system or management failure, and 5. Measures taken & to be taken to avoid a recurrence of such incident.
SEO	Reporting	Submit an action plan within 14 days, or a shorter period of time, if specified by the Regional Director (DWS).
SEO	Reporting	The action plan must include the following information: 1. A detailed time schedule of measures taken to: 1.1 Correct the impacts resulting from the incident; 1.2 Prevent the incident from causing any further impact; and 1.3 Prevent a recurrence of a similar incident.
Progress reporting		
SEO	Revising	Identify methods for preventing the incident from

	Procedures	re-occurring and revise method statements and/or procedures for implementing as early as possible.
SEO	Training	Conduct either a toolbox talk or environmental awareness training/re-induction to the all employees and include additional mitigations to avoid a re-occurrence. ● Keep the program, including a signed attendance register, in the on-site environmental file.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE ON LAND

ACTION TO BE TAKEN		
Personnel	**Responsibility**	**Action**
Employee	Reporting	The person responsible for, or who discovers, a hazardous substance spill must report the incident to their immediate Supervisor.
Supervisor	Reporting	Report the incident to the SEO, HSO and Resident Engineer. ● Note that the SEO will take control of all relevant actions once he/she arrives on the scene.
HSO	Reporting	Report the incident to an Inspector (designated under section 28 of the Occupational Health & Safety Act, 1993) within the prescribed period and manner.
Supervisor / SEO	Initial investigation	Determine the extent of the spill, i.e. its boundaries, by observing for the following: ● Any visual indication of pollution, ● Any odours or emissions detected, ● Any indication of the source of pollution, ● Any sign of damage to the natural system. The Supervisor / SEO should provide lighting if working at night.
Supervisor / SEO	Co-ordination	Sound an alarm/whistle. ● The designated response team consisting of area specific personal and including the environmental leader, will congregate at the spill kit. ● All other employees who do not have specific duties to perform are to evacuate the affected area to a location designated by the Supervisor / SEO.
Supervisor / SEO	Co-ordination	Minimise the effects of the incident on the environment and persons by removing the source of the spill at least 100m away from the watercourse or cut-off the supply of the spill if the source is not moveable.
Supervisor / ECO	Co-ordination	Contain the spill to a confined area to prevent the spreading of the spilled chemical or substance. ● Use sand bags or construct earth berms. ● If relevant, close off all storm water drains with absorbent mats. ● Do not wash the spill with water as it will cause

		the spill to spread.
Supervisor / ECO	Co-ordination	Secure the affected area with danger tape.
HSO	Co-ordination	The site shall not be disturbed and no article or substance may be removed (without the consent of the inspector) if there is or likely to be a death, or if there is a loss of limb or part of a limb. However, action can be taken to prevent a further accident, to remove the injured or dead or rescue persons from danger.
Engineer / SEO / HSO	Decision-making	The Engineer will assess the situation in consultation with the SEO and HSO and act as required. ● The risk involved shall be assessed before anyone approaches the scene of the incident. ● The HSO will consult the MSDSs. ● The scale of the spill will dictate whether the spill will be cleaned up by using the on-site spill kit and in the prescribed manner, or by contacting a Spill Clean-Up Service Provider for assistance. ● The SEO will take photographs of the affected area. ● No person shall be allowed to approach a spill unless he/she is equipped with the personal protective clothing.
SEO	Directions	If a Spill Clean-Up Service Provider is used, assist the emergency services by clearly marking the route to be taken to the spill site.

SPILLAGE ON LAND

REMOVAL AND REMEDIATION MEASURES TO BE IMPLEMENTED		
Personnel	**Responsibility**	**Action**
SEO	Co-ordination	Remove the contaminated soil to the depth of penetration using a spade or shovel.
SEO	Co-ordination	Temporarily store the contaminant in the designated hazardous waste facility at the construction camp.
SEO	Co-ordination	Contact a licensed hazardous waste service provider to collect and transport the waste to a licensed hazardous waste landfill site.
SEO	Co-ordination	Rehabilitate the area cleared of hazardous waste by replacing the topsoil and planting indigenous plants.
SEO	Monitoring	Immediately follow any known spillage of toxic substances with monitoring of the receiving environment, and public health if necessary.
SEO	Monitoring	Take photographs of the affected area during rehabilitation.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE ON LAND

INTERNAL & EXTERNAL COMMUNICATION PLAN		
Personnel	**Responsibility**	**Action**
Employee	Reporting	The person responsible for, or who discovers, a hazardous waste spill must report the incident to their immediate Supervisor.
Supervisor	Reporting	Report the incident to the SEO, HSO and Resident Engineer.
HSO	Reporting	Report the incident to an Inspector (designated under section 28 of the Occupational Health & Safety Act, 1993) within the prescribed period and manner.
SEO	Reporting	Report the incident to the Site Agent and/or Manager and the ECO.
SEO	Reporting	If the spill is too big for the spill kit, contact a Spill Clean-Up Service Provider.
SEO	Reporting	Report the incident to the following authorities. 1. DEA (Director General), 2. SA Police Services, 3. Fire Department, 4. DEA (Provincial Head of Department) or Local Municipality, and 5. Any persons whose health may be affected by the incident.
SEO	Reporting	Provide the following information: 1. The nature of the incident, 2. Any risks posed by the incident to public health, safety & property, 3. the toxicity of substances or by-products released by the incident, and 4. Any steps that should be taken in order to avoid or minimise the effects of the incident on public health and the environment.
ECO / Applicant / Site Agent / RE	Reporting	If the nature of the impact constitutes a gross violation of the EA or any legislation: ● The ECO must report the incident to the applicant. ● The applicant must report the incident to the Local Municipality, DEA, and DWS. ● The Site Agent and/or Manager must report the incident to their Environmental Group Manager, Divisional MD and CEO.

		● The Resident Engineer must report the incident to his Superiors.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

SPILLAGE ON LAND

PRESCRIBED REPORTING PROCEDURE		
Incident recording		
Personnel	**Responsibility**	**Action**
SEO	Investigation	Conduct an investigation, including interviews, and record all details of the incident. ● The cause must be investigated.
SEO	Reporting	Complete an Environmental Incident Report and forward it to all key project personnel, with the exception of the Emergency Services.
SEO	Reporting	Within 14 days of the incident, report the incident to the following authorities. 1. DEA (Director General) 2. DEA (Provincial Head of Department), and 3. Local Municipality.
SEO	Reporting	Provide the following information: 1. The nature of the incident, 2. The substances involved and an estimation of the quantity released and their possible acute effect on persons & the environment & data needed to assess these effects, 3. Initial measures to minimise impacts, 4. Causes of the incident, whether direct or indirect including equipment, technology, system or management failure, and 5. Measures taken & to be taken to avoid a recurrence of such incident.
Progress reporting		
SEO	Revising Procedures	Identify methods for preventing the incident from re-occurring and revise method statements and/or procedures for implementing as early as possible.
SEO	Training	Conduct either a toolbox talk or environmental awareness training/re-induction to the employee(s) responsible for the spill and include additional mitigations to avoid a re-occurrence. ● Keep the program, including a signed attendance register, in the on-site environmental file.

FIRE

ACTION TO BE TAKEN		
Personnel	**Responsibility**	**Action**
Employee	Reporting	The person who starts or discovers a fire must report the incident to their immediate Supervisor.
Supervisor	Reporting	Report the incident to the SEO, HSO and Resident Engineer. ● Note that the SEO will take over co-ordination of all relevant actions once he/she arrives on the scene.
SEO	Reporting	If there is potential for a fire to spread and endanger life, property or the environment, alert the landowner and Fire Department.
Land Owner	Reporting	Alert the owners of adjacent land.
HSO	Reporting	Report the incident to an Inspector (designated under section 28 of the Occupational Health & Safety Act, 1993) within the prescribed period and manner.
Supervisor / SEO	Co-ordination	Sound an alarm/whistle. ● The designated response team consisting of area specific personnel and including the environmental leader, will congregate at the fire-fighting equipment. ● All other employees who do not have specific duties to perform are to evacuate the affected area to a location designated by the Supervisor / SEO.
SEO	Directions	Assist the Fire Department by clearly marking the route to be taken to the fire.
SEO	Co-ordination	Extinguish the fire or assist in doing so.
SEO	Co-ordination	Stop the spread of the fire.
SEO	Co-ordination	Provide assistance to a fire protection officer or forest officer in the event that they take control over the fighting of a fire.
HSO	Co-ordination	The site shall not be disturbed and no article or substance may be removed (without the consent of the inspector) if there is or likely to be a death, or if there is a loss of limb or part of a limb. However, action can be taken to prevent a further accident, to remove the injured or dead or rescue persons from danger.

FIRE

REMEDIATION MEASURES TO BE IMPLEMENTED		
Personnel	**Responsibility**	**Action**
SEO	Assessment	Immediately follow any fire with an assessment of the effects on the environment, public health, safety and property.
SEO	Search	Search the scorched earth for reptiles and other creatures that can be rehabilitated and saved. ● Use only a licensed rehabilitation facility.
SEO	Monitoring	Monitor for signs of erosion after the first few rains and new flush. ● Manage erosion resulting from a loss in plant basal or aerial cover. ● Ensure that the control measures are not destructive.
SEO	Managing	No Vehicles or plant are permitted to drive through burnt areas.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

FIRE

INTERNAL & EXTERNAL COMMUNICATION PLAN		
Personnel	**Responsibility**	**Action**
Employee	Reporting	The person who starts or discovers a fire must report the incident to their immediate Supervisor.
Supervisor	Reporting	Report the incident to the SEO, HSO and Resident Engineer. ● Note that the SEO will take control over all relevant actions once he/she arrives on the scene.
SEO	Reporting	Report the incident to the Site Agent and/or Manager and the ECO.
SEO	Reporting	If there is potential for a fire to spread and endanger life, property or the environment, alert the landowner and Fire Department.
Land Owner	Reporting	Alert the owners of adjacent land.
HSO	Reporting	Report the incident to an Inspector (designated under section 28 of the Occupational Health & Safety Act, 1993) within the prescribed period and manner.
SEO	Reporting	Report the incident to the following authorities. 1. DEA (Director General), 2. SA Police Services, 3. Fire Department, 4. DEA (Provincial Head of Department) or Local Municipality, and 5. Any persons whose health may be affected by the incident.
SEO	Reporting	Provide the following information: 1. The nature of the incident, 2. Any risks posed by the incident to public health, safety & property, 3. the toxicity of substances or by-products released by the incident, and 4. any steps that should be taken in order to avoid or minimise the effects of the incident on public health and the environment.
ECO / Applicant / Site Agent / RE	Reporting	If the nature of the impact constitutes a gross violation of the EA or any legislation: ● The ECO must report the incident to the applicant. ● The applicant must report the incident to the Local Municipality, DEA, and DWS. ● The Site Agent and / or Manager must report the incident to their Environmental Group Manager,

		Divisional MD and CEO. ● The Resident Engineer must report the incident to his Superiors.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat., MGSSA) & S.D. MacGregor (MSc., Pr.Sci.Nat.)
Reg: 2006/023163/23

FIRE

PRESCRIBED REPORTING PROCEDURE		
Incident recording		
Personnel	**Responsibility**	**Action**
SEO	Investigation	Conduct an investigation, including interviews, and record all details of the incident. ● The cause must be investigated.
SEO	Reporting	Complete an Environmental Incident Report and forward it to all key project personnel, with the exception of the Emergency Services.
SEO	Reporting	Within 14 days of the incident, report the incident to the following authorities. 1. DEA (Director General), 2. DEA (Provincial Head of Department), and 3. Local Municipality.
SEO	Reporting	Provide the following information: 1. The nature of the incident, 2. The substances involved and an estimation of the quantity released and their possible acute effect on persons & the environment & data needed to assess these effects, 3. Initial measures to minimise impacts, 4. Causes of the incident, whether direct or indirect including equipment, technology, system or management failure, and 5. Measures taken & to be taken to avoid a recurrence of such incident.
Progress reporting		
SEO	Revising Procedures	Identify methods for preventing the incident from re-occurring and revise method statements and/or procedures for implementing as early as possible.
SEO	Training	Conduct either a toolbox talk or environmental awareness training/re-induction to the employee(s) responsible for the spill and include additional mitigations to avoid a re-occurrence. ● Keep the program, including a signed attendance register, in the on-site environmental file.

C4.1 GEOTECHNICAL INFORMATION

RLM/RWST/OMM/0101/2024/25 - RE-ADVERT:

APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF BOSPOORT NORTH RESERVOIR AND ACCESS ROAD