

	IT UPGRADE Scope of Work	CONTRACT NUMBER _____ Technology
---	--	--

Title: Nelsonskop refurbishment project

Document Identifier:

Functional Location: **10-01GAD**

Area of Applicability: **Matimba Power Station**

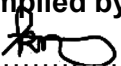
Functional Area of Applicability: **Engineering**

Revision: **0**

Total Pages: **65**

Report Date: **September 2024**

Disclosure Classification: **CONTROLLED DISCLOSURE**

Compiled by



M Losaba
System Engineer

Date: 06/02/2025

Functional Responsibility


G Nkuna
Auxiliary Manager

Date: 06/02/2025

Authorized by


J Mathobela
Engineering Manager

Date: 2025/02/06

Contents

1	Description of the works	5
1.1	Executive overview	5
1.2	<i>Employer's</i> objectives and purpose of the works	5
1.3	Interpretation and terminology	5
2	Engineering and the Contractor's design	7
2.1	<i>Employer's</i> design	7
2.1.1	Process Description	7
2.1.2	Process Data.....	7
2.1.3	New/Proposed Operational Philosophy	8
2.2	Parts of the works which the Contractor is to design	10
2.2.1	Detailed project specifications of works	10
2.2.2	Replacement of Asbestos pipes on the RAS/SAS system	15
2.3	Procedure for submission and acceptance of Contractor's design	16
2.4	Other requirements of the Contractor's design.....	17
2.5	Use of Contractor's design	17
2.6	Design of Equipment	18
2.7	Equipment required to be included in the works	18
2.8	As-built drawings, operating manuals and maintenance schedules	18
2.8.1	Drawings	19
2.8.2	Instruction Manuals	19
2.9	Plant and Materials	21
2.9.1	Quality	21
2.9.2	Plant & Materials provided "free issue" by the <i>Employer</i>	21
2.9.3	Contractor's procurement of Plant and Materials	21
2.9.4	Spares and consumables	22
2.10	Tests and inspections before delivery	23
2.11	Marking Plant and Materials outside the Working Areas.....	23
2.12	Contractor's Equipment (including temporary works).....	23
2.13	Completion, testing, commissioning and correction of Defects	24
2.13.1	Work to be done by the Completion Date	24
2.13.2	Commissioning	24
2.13.3	Start-up procedures required to put the works into operation	25
2.13.4	Take over procedures	25
2.13.5	Access given by the <i>Employer</i> for correction of Defects	26
2.13.6	Performance tests after Completion	26
2.13.7	Training and technology transfer	26
2.13.8	Operational maintenance after Completion	27

3	Plant and Materials standards and workmanship	28
3.1	Survey and Site clearance.....	28
3.2	Building works.....	28
3.3	Civil engineering and structural works.....	28
3.3.1	New structural design and engineering works	28
3.3.2	Structural inspection and reporting	28
3.3.3	Structural remedial works	30
3.3.4	Laboratory refurbishment.....	40
3.3.5	Guarantee on all structural repair work and coating systems.....	42
3.3.6	Drying Bed Sand Replacement.....	45
3.3.7	Additional Sewage Handling and Treatment	45
3.3.8	Standard Civil and Structural Specifications	46
3.4	Electrical & mechanical engineering works	47
3.4.1	Scope	47
3.4.2	General Information	47
3.4.3	Standards and Regulations.....	48
3.4.4	Standard Mechanical Specifications	48
3.4.5	Material	49
3.4.6	Power Supply	49
3.4.7	Manuals.....	49
3.4.8	Cabling Requirements	50
3.4.9	Electrical Distribution Panels.	52
3.5	Motor Control Centres (MCC).....	52
3.5.1	General	52
3.5.2	MCC Design Acceptance and Type Testing Requirements	55
3.5.3	LV MCC Design Requirements.....	56
3.5.4	Busbars	56
3.5.5	Lighting and small power	57
3.5.6	LV Motors.....	57
3.5.7	Inspection and Testing.....	58
3.5.8	Electrical Drawings Requirements.....	58
3.6	Control and Instrumentation engineering works	60
4	Technical scope of work for C&I	60
4.1.1	Fibre cable	60
4.1.2	Special tools.....	60
4.1.3	Redundancy	60
4.1.4	Automation system	60
4.1.5	Control room	60
4.1.6	Process Network Bus.....	61
4.1.7	Operator Station (OS) and Supervisory Control	61

5 Long-term data storage (VA) 62

6 Cabling 62

7 PLC 62

7.1 Instrumentation 63

7.2 Local Control Panels..... 63

7.2.1 General C&I Requirements..... 63

7.2.2 Installation requirements for the instrument, transducer, transmitter and junction box location and support 64

7.2.3 Interfacing remote signals onto Human Machine Interface Graphic..... 65

8 List of drawings..... 67

8.1 Drawings issued by the *Employer* 67

1 Description of the works

1.1 Executive overview

The Sewage Plant at Matimba Power Station (Nelsonkop Sewage Plant) started operating in the late 80's. The plant has deteriorated over the years and needs to be refurbished and upgraded. The plant has to be refurbished such that the output qualities obtained complies with Class C of the Water Quality Guideline of the Department of Water and Sanitation. The limits are also stated in the Water Use License (License No. 16/2/7/A400/B21/1) and non-compliance to these qualities may result in revocation of the WUL. Furthermore, the plant has to be upgraded with the latest technologies to ensure that it operates reliably for the next 25 years. The aim is to ensure that process integration is improved and more flexible. The plant was partially refurbished in 2013.

The works is inclusive of all activities necessary for the provision of a fully functional Sewage Treatment plant that meets Eskom and Department of Water and Sanitation requirements. The Contractor designs, manufactures, procures and installs all Mechanical, Civil, Electrical, Control & Instrumentation Plant, Equipment and Material required for the works as defined in this Works Information. This includes interfacing with and utilisation of existing plant and equipment.

The Contractor shall ensure that the complete design shall be performed by, or under the direction, control and supervision of an ECSA registered professional engineer for each discipline as required by the scope of the design. In instances where the design is performed under the direction, control and supervision of a professional engineer, the professional engineer will be responsible for signing off the design as applicable to his/her field of registration.

1.2 Employer's objectives and purpose of the works

The objective of the project is to refurbish the entire sewage treatment plant and its associated auxiliaries to comply with the regulations in terms of the Water Act of 1998 (Class C).

Furthermore the purpose of the project is to ensure that sewage plant is upgraded, using latest technological advances to an "as new condition", able to perform reliably for the next 25 plus years.

To ensure the structure life time expectancy is extended by another 25 years.

The purpose of this document is to describe in detail the scope of supply and services required from the potential Contractors and also describe the technical criteria to which the plant is designed

1.3 Interpretation and terminology

The following abbreviations are used in this Works Information:

Abbreviation	Meaning given to the abbreviation
AFC	Approved for construction
Abbreviation	Description
AC	Asbestos Cement
CAD	Computer Aided Design
CoE	Centre of Excellence
DB	Distribution Box

DFT	Dry Film Thickness
DI	Ductile Iron
DVD	Digital Versatile Disc
EPDM	Ethylene Propylene Diene Monomer
FAT	Factory Acceptance Testing
FRI	Forecast Rate of Invoicing
GRP	Glass fibre Reinforced Plastics
HDPE	High Density Polyethylene
HMI	Human Machine Interface
LDE	Lead Design Engineer
LED	Light-Emitting Diode
MCC	Motor Control Centres
mPVC	Modified Polyvinyl Chloride
NB	Nominal Bore
P&ID	Process and Instrumentation Diagram
PDF	Portable Document Format
PE	Polyethylene
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PVC	Polyvinyl Chloride
RAS	Return Activated Sludge
SACPCMP	South African Council for Project and Construction Management Professionals
SAS	Suspended Activated Sludge
SDR	Standard Dimension Ratio
SP	Set Point
STW	Sewage Treatment Plant
UPS	Uninterrupted Power Supply
OBL	Outside battery limits

2 Engineering and the Contractor's design

2.1 Employer's design

2.1.1 Process Description

The existing treatment works receives its influent from Marapong Township and pump station 3 situated next to Medupi housing village. The plant currently has a biological treatment capacity to accommodate a population of 10 000 persons and a hydraulic capacity of 1.2 MI/day. The purpose of this refurbishment is to maintain the capacity of the plant to receive 2.7 MI/day as per the original design.

The existing plant consists of an inlet works with a hand raked screen, an aerated balancing tank, an activated sludge reactor, a secondary settling tank and a chlorine contact tank. An inter-stage pump station forwards flows from the aerated balancing tank to the activated sludge reactor from where it flows via gravity through the remainder of the plant. Return Activated Sludge (RAS) is returned to the activated sludge reactor via a sludge pump station. Waste Activated Sludge is forwarded to a series of drying beds via the same sludge pump station. Disinfection is in the form of chlorine gas dosing. A Process flow diagram and P&ID (20.58-14933) of the existing Plant Process is included (Drawing No: 0.58/380).

The proposed upgrade to the works is focused on increasing biological performance of the plant. Biological capacity is increased by converting the aerated balancing tank into an activated sludge tank and by decreasing the pumping rate of the transfer pumps and also introducing DO and pH meter in the activated sludge tank. In order to convert the aerated balancing tank into an activated sludge reactor, the RAS needs to be returned to the aerated balancing tank.

2.1.2 Process Data

Design Raw sewage qualities

PARAMETER	Units	Design Value
Ammonia Nitrogen (NH ₃ -N)	ppm	30
COD	ppm	400-700
pH	N/A	>6.5
Settle able solids	MI/l	>5
Suspended Solids	ppm	>40
TKN	ppm	65
Total Phosphate		7

Hydraulic Capacity

The hydraulic capacity of the plant is to be increased to cater for an average dry weather flow of 2.7 MI/day.

Biological Load

The biological load capacity of the plant is to be increased to cater for a BOD load of 845 kg BOD /d and a nitrogen load of 185 kg/d.

Treatment Standard

The extended scheme has been designed to produce an effluent that complies with the General Limit Values as defined in the Water Act, the principal parameters of which are:

COD	75 mg/l (max.)
Ammonia as N	6 mg/l (max)

Nitrate as N	15 mg/l (max)
Suspended solids	25 mg/l (max)
pH	6.0 – 9.0
E Coli	0/100 ml

2.1.3 New/Proposed Operational Philosophy

The sewage treatment plant receives sewage from Pump Station 3 and Medupi housing village. The inlet chamber will be equipped with an automated screen. The screen consists of a vertical perforated screen basket and a shafted augur in a vertical tube. The sewage flows thorough an inflow connection and a chamber into the screen basket. Within the screen basket the flights of the screw are equipped with wear-resistant brushes for effective cleaning of the screen. As the screenings are gradually elevated by the augur, they are dewatered. The compacted screenings are discharged into a container/skip. The screened sewage flows off by gravity into the pump sumps. The top of the inflow chamber is open and serves as an emergency bypass so that the machine can be submerged without problems in case of power failure. The integrated bottom step prevents back-flooding into the sewer system and thus undesired deposits into the incoming sewer. The inlet chamber also has an overflow pipe into the pump sumps to prevent overflow of the inlet chamber. There will be two submerged pumps. The first pump will start 6m below ground level, second pump will start 5m below ground and pumps should stop 8m below ground level.

Raw sewage from Marapong and Pump station 3 is pumped to the inlet works at the Nelsonkop sewage treatment works via two rising mains. Two flow measuring devices are equipped on the two rising mains at the Nelsonkop Sewage Treatment plant inlet.

The raw sewage then flows through the inlet channel equipped with two electro-mechanical screens. One of electro-mechanical screens will be operational while the other one is on standby. While the raw sewage flows in through the open front end of the screen basket and through the screen bars, solids are retained by the screen basket, whereby the separation of floating, settling and suspended solids is dependent upon the screen bar size. Blinding of the screen surface generates an additional filtering effect so that solids can be retained that are smaller than the bar spacing. The machine starts to operate when a certain upstream water level is exceeded due to screen surface blinding. A robust stainless steel screw removes the screenings from the screen basket surface. Additional cleaning is achieved by wear-resistant brushes fitted to the screw flights. The screw conveyor transports the screenings through a closed and inclined pipe. While the screenings are transported, the screw conveyor dewateres and compacts to discharge them into a skip/container.

The raw sewage then flows through two constant velocity grit channels. Once raw sewage is screened and de-gritted it gravitates into the balancing pond. Pre-aeration and flow balancing takes place in the Balancing pond. Pre-aeration equipment comprises two free standing submerged aerators, free standing on the bottom of the pond, which provide sufficient oxygenation to reduce the estimated BOD (Biochemical oxygen demand) load by approximately 30%. The purpose of aeration is to suppress sewage odours and to maintain solids in suspension. The aerators are operated either individually, or simultaneously. The operation of the floating aerators is controlled automatically with a manual programmable timer with manual over-ride on the local stop/start control panel. The balancing pond is equipped with mercury float level controls to start the transfer pumps when the desired level is reached and stop when the desired low level is reached.

Once the balancing pond reaches a certain level one of two newly installed (2) Gorman Rupp pumps are activated by means of mercury float balls connected to the pumps. The raw sewage is then transferred to the aeration tank at a constant rate of 12 l/s. The pumps operate one duty/one standby on HAND/OFF/AUTO control in the local control panel. Mercury float level switches will be pre-set to allow the duty pump to run between low and high settings. The pumps are assembled on steel baseplate complete with 'V' belt drive and safety guard. The old pumps should also be connected to assist during high peak flow to avoid overflow of the balancing pond.

A manually raked screen angled at 45° is installed in the inlet chamber to the aeration tank. The pumped sewage from the transfer pump station is discharged just ahead of the screen to remove any additional solids. Collected solid matter on the screen must be raked up on to the drainage tray. The screen must be raked at least once per shift.

The mixed liquor level in the aeration tank varies over a pre-set range, providing a constant flow to the rest of the plant. If the level in the aeration tank reaches the lowest safe working operating level of the transfer pump, then the pump is switched off by level control device installed in the aeration tank to prevent overflow. Pump service resumes at the normal operating level.

The two vertical surface turbine aerators provide the means to aerate the sewage and keep the contents of the aeration tank completely mixed at all times. The strong turbulence, allows close contact of the raw sewage and the purifying bacteria. Dissolved oxygen level should be maintained at between 1, 0 and 2,0mg/l for optimum operation of the aeration system. This is normally done by making use of the aeration timing controls to match peak inflow periods.

The average hydraulic retention time at average dry weather flow is approximately 14 hours. The solids retention time at a mixed liquor suspended solids, concentration of 4000 mg/l is approx. 19 hours.

The aerators may be controlled manually or automatically by means of a 24 hour timer switch situated in the main control panel. The auto timer can be set for aerators to run independent of each other for any required period to within a half hour. The running periods for the aerators can be set on auto timer control to coincide with peak flow periods. The mixed liquor overflows into an outlet chamber from the aeration tank to the secondary settling tank by gravity. Mixed liquor from the aeration tank passes over the control weir and into the clarifier through the centre column and out through inlet ports to the main settlement area of the tank. Settled sludge is scraped to the centre-concentrating hopper in the floor of the tank by means of rotating scraper and is displaced through a pipe to the return sludge sump. The sludge discharge rate is variable by means of a series of discharge pipe rings fitted to the outlet end of the vertical sludge pipe. The rings which are self-locating will vary the height of the sludge pipe and will therefore vary the sludge draw off rate. The sludge discharge rate should be approximately 100% of the plant average dry weather flow rate (22l/sec.) Sludge from the sludge sump is returned to either the balancing pond or aeration tank by means of a submersible pump where it is used to maintain the necessary concentration. It will depend on the operational requirement at the time if the Return activated sludge flows into the balancing tank or if it will flow into the aeration tank. The selection between the two tanks is done manually with outlet valves to each tank. Excess sludge must be extracted at regular intervals approximately once a week during operation.

Surface floating matter is removed by the scum skimmer sweeping the scum to a scum outlet box, from where it is discharged to the return sludge sump by the automatic operation of a plug type valve operated by a striker bar on the rotating bridge every revolution of the tank. Clear water overflows the serrated weir plate into the outside launder and is discharged through a short pipe to the chlorine contact tank. A baffle plate prevents surface matter overflow. Weir and baffle plates must be kept clean by regular scrubbing and washing.

From the chlorination tank, the clarified water flows to the maturation pond for final polishing and storage prior to discharge from the treatment plant.

The rate of discharge of the activated sludge from the settling tank to the return activated sludge pump station is controlled manually, by means of a variable level outlet. The activated sludge pump station is equipped with two submersible pumps in a duty/standby configuration. The activated sludge pumps are operated by level controls (float switches) with manual over-ride on the local stop/start control panel. Submersible pumps are controlled float valves and have a low, high and high-high switch.

The activated sludge can be pumped to the sludge drying beds with the activated sludge pumps. This is controlled manually. The waste activated sludge is drained and air-dried on the duty sludge drying bed before manual removal and disposal off site.

An aqueous chlorine solution is mixed with the effluent at the influent of the contact tank. Potable water from the potable water head tank (located on site) is utilized for the aqueous chlorine solution and the chlorine is stored in chlorine gas cylinders in a chlorine building on site. Potable water is pumped through an injector and chlorine gasses are injected into the water, diluting it into a chlorine mixture and dosed into the chlorine contact tank. The effluent passes through the chlorine contact tank, flow over a weir where the flow is measured. Then effluent flows into the maturation pond 1 by means of gravity. It flows into the outlet chamber and gravity feeds to the maturation pond 2. At Maturation pond 2 the water is pumped to site for irrigation purposes or to the recovery dams when the required specification is not reached. The potable head tank is equipped with a float valve so that when full its shuts off the supply to the tank.

2.2 Parts of the works which the *Contractor* is to design

The Contractor is responsible for carrying out all activities and supplying everything necessary to provide the Works in accordance with the requirements of this Works Information. An organogram of the entire project team shall be submitted with the tender. The CVs of ECSA registered engineers per engineering discipline should be submitted and contain a copy of the ECSA certificate.

The short description of the scope of work for this project includes the design, construction, supply, delivery, installation, commissioning and decommissioning of the civil, mechanical, electrical, control & instrumentation for the refurbishment of STP. The works includes:

- a) Two automated screens on duty/stand-by operation for channel installation as well as the design and construction of these channels.
- b) Two inline magnetic flow meters for Marapong and Pump Station 3 inlet flows.
- c) Two submersible Aerators in the balancing pond
- d) Inter stage pumping station including all the pipes, valves and level regulators necessary.
- e) Two Mixers to be mounted on the existing structure of aeration tank during structural repairs.
- f) One DO analyser (aeration tank), two pH meter (balancing pond inlet and aeration tank) and one Chlorine residual analyser (outlet of contact tank).
- g) Inspection of the mechanical components of the settling tank and all worn out mechanical parts of to be supplied and installed.
- h) Replacement of all the existing asbestos pipes as well as the valves installed on those pipes.
- i) Two return activated sludge pumps and necessary valves and piping.
- j) Chlorine dosing system refurbishment to comply with SANS 10298:2009 (Indirect small to medium-sized gas chlorination systems for the disinfection of water)
- k) Inspection of Concrete structures with full technical report as well as the repairs of defective structures:: The balancing pond, aeration pond, settling tank, chlorine contact tank and drying beds show extensive concrete corrosion
- l) Replace the six (6) drying beds sand
- m) Laboratory refurbishment
- n) Pump Station 3 refurbishment
- o) Raw and treated sewage pipe line inspection and a full technical report
- p) All necessary control panels
- q) MCC
- r) Provision for an alternative raw sewage handling and treatment during Work execution (needed for the duration of the Works execution) period. The plant should be able to treat 1.5 Mega litres per day. The Contractor will provide the Client with a proposal for this for approval before commencement of the contract. This is to form part of the method statement package supplied in the tender.

2.2.1 Detailed project specifications of works

2.2.1.1 Installation of pump station screen at Pump Station 3

One new Pumping Station Automated Screen shall be supplied and installed under this contract. Civil and mechanical modification of the inlet chamber will be required to accommodate the new screen. The new screen must allow combination of screening, transport, compaction and dewatering in a single unit. The strainers will be manufactured from 316 stainless steel with frost protection and shall comply in general with the following:

- a) The screen is to be supplied complete with electrically driven motors, electrical cabling, and electrical control panel required.

- b) All the necessary control panels with minimum start stop buttons must be supplied. **The screen systems will be controlled from these local panels.** The replacement must conform to Corrosion Protection Standard for New Indoor and Outdoor Eskom Equipment, Components, Material and Structures Manufactured from Steel (240-75655504).
- c) The current sewer inlet pipe does not have a flanged end connection, it will need to be modified as screen connect to the sewer pipe by means of a flanged joint. The sewer inlet pipe is 300NB.
- d) The inlet chamber is 1750mm in diameter and 5 m deep. It will require a new lid as the current lid is different. The inlet chamber will also need to be cleaned and repaired before any installation can take place.
- e) Contractor to size the strainers for the flow rate of 85 l/s.
- f) The screen basket diameter 500 mm.
- g) The discharge shall be high enough to fit over a skip or waste bin to collect the discharged solid waste.

2.2.1.2 Pump Station 3 further scope

All the sumps at pump station 3 needs to be pressure washed to remove accumulated sludge in the sumps. Within this work package, the Contractor shall make allowances for replacement of pump guide rails of the following pump model:

The pump type FYLGT model CP3201.180 or equivalent as this model might be obsolete. The pumps must be upgraded with a guide-pin and flush valves (4901 model). Note Eskom will provide the flush valve
The submersible pump shall have the following features:

- a) Be installed in the existing sump after the sump are pressure cleaned.
- b) Be fitted with mercury float level control for level control between low and high.
- c) The sump should be fitted with guide bars and upper guide bar holders for three pumps. 3" Guide bars with a length of 7.75 m (double standard pipes)
- d) Be able to be operated manually on the current local control panel.
- e) Provision for alternative sewage handling during work execution. There should be a way to transport raw sewage from the pump station to STP during work execution at pump station 3.

2.2.1.3 Replacement flow meters

The flow meters at the inlet of the Sewage plant needs to be replaced. The tender unit shall be Sum and the rate shall be all-inclusive.

There are two Polyvinyl Chloride (PVC) pipes coming in from Marapong and another from Pump station 3. Currently the pipes ties into the manual screen at the plant with two mag flow meters connected on the lines. The flow meters needs to be replaced and installed on the existing pipelines.

Flow meter specification:

Type: magnetic flow meters

Flowrate: 160 l/s

Pipe material : PVC

Pipe sizes: 350 mm and 200mm

2.2.1.4 Installation of micro strainers (duty/stand-by operation)

A new automated micro strainers for channel installation shall be supplied and installed under this contract. Civil modification of the inlet channel will be required to accommodate the strainer. The new strainers must allow combination of screening, washing, transport, compaction and dewatering in a single unit. The tender unit shall be Sum and the rate shall be all-inclusive.

The strainers will be manufactured from 316 stainless steel with frost protection and shall comply in general with the following:

- a) The screen is to be supplied complete with electrically driven motors, electrical cabling, and electrical control panel required.
- b) All the necessary control panels with minimum start stop buttons must be supplied. The strainer systems will be controlled from these local panels. The replacement must conform to Corrosion Protection Standard for New Indoor and Outdoor Eskom Equipment, Components, Material and Structures Manufactured from Steel (240-75655504).
- c) The strainers must have an integrated screenings washing systems.
- d) Channels will need to be constructed for installation of the strainers, inlet pipes and outlet pipes to the grit channel. This modification will need to go through the approval process and all the required documents provided before any work can commence.
- e) The discharge shall be high enough to fit over a skip or waste bin to collect the discharged solid waste.
- f) Contractor to size the strainers for the flow rate of 160 l/s.
- g) Each strainer size 700 mm with 3 mm perforated plates. Inlet channels to be 700 mm wide and 900 mm deep as a minimum.

2.2.1.5 Installation of two floating aerators in the balancing tank

Two free standing submersible self-aspiration aerators shall be supplied and installed under this contract. The tender unit shall be Sum and the rate shall be all-inclusive. The balancing pond has a net volume of 1130m³ sized 16m x 32m at the bottom with 45° sloping sides.

The aerators shall be manufactured from proven designs and shall comply in general with the following:

- a) Each aerator is to be supplied complete with electrically driven motor, polyurethane filled Glass fibre Reinforced Plastics (GRP) float and mooring ropes.
- b) The electric motor is to be of the type specifically designed for aerator duty with non-hygroscopic windings and a one piece stainless steel shaft.
- c) The float shall be constructed of GRP and shall have an integral volute reinforced with encapsulated steel.
- d) The electrical motor shall be supported on a galvanized mild steel support ring.
- e) The aerator shall be fitted with a precision cast stainless steel impeller with 180-degree tailback blades designed to minimize clogging.
- f) The current aerators are moored by three-point tie-off shore point method. The selection of the mooring cables should be in accordance with the manufacturer's suggested standards. The length should be sufficient to allow for variation in vertical movement of the aerators with liquid level change. All mooring cables and hardware should be stainless steel.
- g) Local electrical control panel with minimum start stop button must be supplied. The aerators shall be able to be controlled manually or by means of a timer from the panel. The replacement must conform to Corrosion Protection Standard for New Indoor and Outdoor Eskom Equipment, Components, Material and Structures Manufactured from Steel (240-75655504).

Specification of existing aerators:

Air inlet bore = 80 mm

Air quantity= 260 Nm³/hr

Max Water depth = 4.7

2.2.1.6 Inter-Stage Pumps (Transfer Pumps)

Two inter-stage pump sets are required in a duty/standby configuration. The installation includes two suction and delivery pipework complete with non-return valves and shut off valves.

The contractor shall provide design calculations, construction drawings, P&ID's and further required drawings prior to commencing procurement and installation.

The pumps shall be mounted next to the existing inter-stage pumps and should be self-priming. The old pumps should be connected to the system such that when the level is very high in the balancing pond, one of the existing pumps should kick in to assist the two small pumps.

The pumps shall be "Gorman – Rupp T8A-B" or similar and shall have the following features:

- a) Horizontal Centrifugal pumps
- b) 1150 rpm, 5.5 Kw drive motors with belt drives
- c) 100mm galvanised suction and delivery pipework flanged
- d) Delivery single door swing non-return valves and shut-off (gate valve) valves 100mm flanged
- e) Be mounted on a common base plate with the motor
- f) The base plate will be bolted to a concrete plinth
- g) 3 mercury float switches for level control
- h) Be connected to the ultrasonic level indicator to achieve the control on flow rate required. The ultrasonic level indicator is connected to the aeration tank level to ensure that it does not overflow.
- i) Systems should be equipped with a local control panel with selection between manual and automatic operation. It should also be equipped with duty selector to select between pump 1 and pump 2. Automatic operation would be stop-start based on high-high and low level in balancing dam. The pre-set level of the balancing dam should allow for constant flow to the aeration tank without stop, start running of the pumps.
- j) Pump failure should be indicated by a highly visible flashing red light.
- k) The pumping facility should have the necessary rigging installations such as gantries or jib beam to be used for maintenance purposes.

The required delivery range is as follows:

- a) Maximum delivery 14l/s
- b) Minimum delivery 12l/s
- c) The static head will vary from 1.8 m to 2.0 m

The rising main is a 100 NB steel pipe, approximately 10 m in length on the discharge and 10 in length on the suction to the inter-stage pumps

Note: There are two suction mains (one per pump) and a single common rising main

2.2.1.7 Mixers in the aeration tank

Two high-speed fixed mixers shall be supplied and installed under this contract. The surface aerators the employer proposes will be mounted onto the existing concrete bridge which spans across the aeration tank. The mixers should be installed after the concrete repairs are done. The dimensions of the aeration tank are 25m x 16m x 3.6m.

The mixers shall be manufactured from proven designs and shall comply in general with the following:

- a) Each mixer is to be supplied complete with electrically driven motor.
- b) The electric motor is to be of the type specifically designed for mixer duty with non-hygroscopic windings and a one piece stainless steel shaft.
- c) The electrical motor shall be supported on a galvanized mild steel support ring.
- d) The aerator shall be fitted with a precision cast stainless steel impeller with 180-degree tailback blades designed to minimize clogging.
- e) The mixers shall be controlled manually and by means of a timer.
- f) The mixers shall be connected to a local electrical control panel as specified hereinafter with stop/start facility.

Specifications of Existing Mixers:

Electromotor: 22kw/1450 rpm/4 pole/380V/3 phrase

Driven motor coupling to gearbox flexible coupling in lantern housing assembly

Gearbox coupling to aerator shaft rigid spigoted flanged coupling

Hansen gearboxes type ND 36, shaft arrangement AN, reduction ratio 25:1

Rotation speed of aerator: 57 rpm

Immersion depth of aerator: +50mm

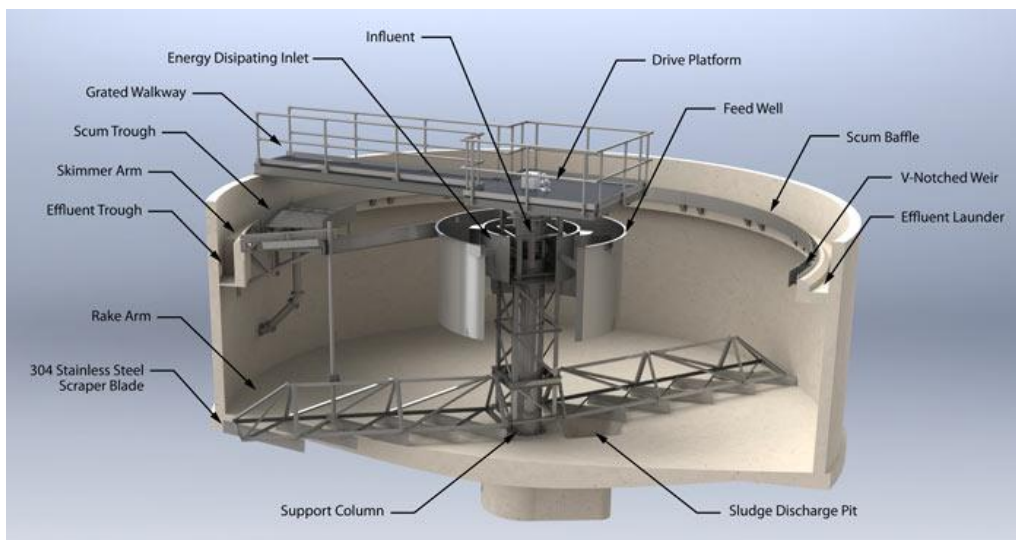
Power absorbed at shaft: 20kw

O₂ capacity: 2.05 kg O₂/Kwh

Nominal O₂ capacity: 82 kg O₂/hr

2.2.1.8 Settling tank mechanical refurbishment

The settling tank (also known as a clarifier) mechanical bridge is showing extensive wear and needs to be refurbished to as new condition. With a continuous flow of effluent water into the clarifier it is difficult to estimate the extent of the damage is on the bridge, supports, and civil structure. Thus the tendered price shall be for worst case scenario and needs include all mechanical works on the clarifier to be refurbished to a new condition. Pressure cleaning of the clarifier should also be included. The clarifier has a diameter of 14 meters with ppherical launders and water depth of approximately 5m.



2.2.2 Replacement of Asbestos pipes on the RAS/SAS system

The return activated sludge (RAS) pipework was replaced before commencement of the new contract. The old Asbestos pipe is still on site and needs to be removed in a safe manner. Only an approved dump site, for the removed material, may be used. Approval of the method statement and dump site is to be given by the contractor before any removal of material from site. The pipes of SAS system that delivers SAS to the drying beds are currently asbestos. These pipes need to be replaced with HDPE pipe, and asbestos need to be disposed of in a safe manner.

The specification for the new pipe to be installed is as follows:

- HDPE 100 SDR 17 (Class 10) – 100NB
- All old valves to be replaced with gate valves of 100NB

*The Contractor shall be responsible for the excavation, removal, and disposal of the old AC pipe on a licensed landfill site as well as the supply, installation and backfilling of the new HDPE pipe.

The pipe that transfers sewage from aeration tank to the clarifier as well as the pipe that transfers sewage from the clarifier to the sludge sump is asbestos. These pipes are encased in concrete and cannot be removed. The Contractor will be required to high-pressure clean the pipes and conduct a CCTV camera inspection of the pipes. The results of the inspection will be submitted to the Employer in the form of a technical report. If the pipes are found to be severely deteriorated the Contractor will repair the pipes by lining them with a suitable epoxy liner. Care shall be taken to ensure that the lining does not adversely affect/restrict the flow in the pipes.

All asbestos related work shall be done in accordance with Eskom Standard 32-303: *Requirements for safe processing, handling, storing, disposal and phase-out of asbestos and asbestos containing material, equipment and articles* and the *Asbestos Regulations, 2001*. Only registered asbestos contractors who are registered with the Chief Inspector will be allowed to conduct any asbestos related work.

2.2.2.1 Online Analyser Supply and Installation

Various online analysers are needed to ensure continues monitoring and operation at optimum conditions. In order for plant to operate under optimum conditions, various parameters like MLSS, oxygen level, BOD, pH, free chlorine are essential.

The Contractor will conduct a survey of the facility and submit a priced list of equipment needing.

An indicative list of online analyser equipment is as follows:

1. Oxygen analyser in the aeration tank.
2. pH meter in balancing dam and contact Tank
3. Residual chlorine analyser in contact pond

The analysers shall be online analysers and should also have a local display

2.2.2.2 Chlorine Dosing System Refurbishment

The complete chlorine dosing system shall be refurbished and upgraded under this contract and shall include a new chlorine detector and audible alarm to monitor for the presence of chlorine gas in the room. The chlorine dosing system needs to be refurbished so that it complies with SANS 10298:2009 (Indirect small to medium-sized gas chlorination systems for the disinfection of water) and also should be able to run on auto for effective and efficient chlorine dosing purposes. The chlorine system at the Water Treatment Plant for potable dosing can be used as reference for the sewage plant project. The water treatment plant chlorine dosing system drawings will be available for reference. The point of chlorination must be moved to the inlet of the contact tank to allow for longer contact time before discharge to maturation pond 1. The contractor shall provide design calculations, construction drawings, P&ID's and further required drawings prior to commencing procurement and installation.

Supply and install one outlet flow meter for chlorine contact tank.

As a minimum requirement the system should have the following:

- Chlorine detector
- Audible alarm
- Automatic switch from empty chlorine bank to full chlorine bank

2.2.2.3 Drying beds sand

The sand and gravel in the drying beds (x6) shall be removed, disposed of in an approved disposal facility, and replaced with new sand. Each drying bed is 100m².

The drying beds will be thoroughly cleaned, the bottom distribution system and laterals will be inspected, and a proposal shall be provided to Employer for any repairs needed.

The sand and gravel charge will be as follows:

- Graded gravel to be placed around the bottom drains in layers up to 30cm with a minimum of 15cm above the top of the bottom drains. At least 3 cm of top layer should consist gravel of 3 to 6mm size
- Clean sand of effective size of 0.5 to 0.75mm of uniform coefficient not greater than 4 to be used. The depth of sand may vary from 20 to 30cm.

The tender unit shall be m³ and the rate shall be all-inclusive of transport, removal, and replacing.

2.3 Procedure for submission and acceptance of *Contractor's* design

2.3.1 Design Review

The design documentation shall be submitted to the Project Manager four weeks after the Contract Date. The Project Manager approves or rejects six weeks after the design is submitted

All design work is signed and approved by the applicable Professional Engineer (Mechanical, Electrical, Chemical, and Civil) responsible for their preparation before being submitted to the Project Manager.

The Contractor submits detailed Technical Data Sheets of all mechanical equipment used for the works to the Project Manager as part of the design.

Approval of the design by the Project Manager does not relieve the Contractor of his liability for his design.

2.3.2 Documentation submission and recording

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

The Contractor submits to the Project Manager a schedule within one month of the starting date of all documents for acceptance. This schedule provides individual titles of drawings and calculations, and their proposed submittal dates, for submittals as requested in the Works Information and as necessary for the review by the Project Manager of the proposed means of compliance by the Contractor with all aspects of the requirements of the Contract. The scheduled date of first submittal, time allowed for acceptance and expected date of issue after acceptance will be shown for each drawing or document

The following documentation shall be supplied for the requirements of this Works Information from the Contractor in the final design package before any construction or commissioning commences.

- 1) Document submittal schedule indicating when all documents will be submitted
- 2) Drawing Register indicating when drawings will be submitted.
- 3) Complete detailed design file including all design calculations.
- 4) Functional Specifications
- 5) Line Sizing Calculations and Material Selection
- 6) Final isometric and general arrangements illustrating pipe dimensions, pipeline layouts and showing pipe supports
- 7) General Arrangement Drawing of System and boundaries (for the plant, control panel for trace heating and electrical panel)
- 8) Piping and Instrument Diagrams
- 9) Component material datasheets
- 10) Quality Control Procedures
- 11) Quality Control Plan and Inspection and Test Plan
- 12) Method Statements
- 13) Commissioning procedures

- 14) Assembly procedures
- 15) Technical, Operation and Maintenance Manuals of all plant equipment
- 16) Operating and Control Philosophies
- 17) Maintenance Philosophy
- 18) System curves and pump curves (for applicable motive water pumps)
- 19) Updated P&ID's with KKS coding
- 20) Loop Diagrams
- 21) Field termination drawings
- 22) Pipeline Schedule
- 23) Instrument schedule
- 24) Drive and Actuator Schedules
- 25) Mechanical Hook-up diagrams
- 26) Electrical Hook-up diagrams
- 27) I/O block diagrams
- 28) LOSS diagrams
- 29) Cubicle Internal Equipment Schedule
- 30) Functional Distribution (Allocation of field devices to I/O)
- 31) Detailed I/O List and Channel Assignments
- 32) Cable schedules
- 33) Termination schedules
- 34) Instrument calibration certificates
- 35) Valve datasheet
- 36) Schematics for the electrical design
- 37) Critical Spares List
- 38) Welding Procedure Specifications
- 39) Welding Procedure Qualification Record
- 40) Operating, Maintenance and Engineering Training Manuals

2.4 Other requirements of the *Contractor's* design

- a) In designing the works, the Contractor takes due cognisance of existing plant and equipment as well as safety and housekeeping constraints. It is the responsibility of the Contractor to overcome any issues that may arise due to space constraints with prior consent from project management and no extra payment or claim of any kind will be allowed on account of difficulties of access to the works or for the requirements of working adjacent to or in the same area as others. Adequate working space shall be provided by the Contractor for all new plant and existing plant for inspection, testing, operating and maintenance purposes.
- b) The Contractor is fully responsible for integrating his design with the existing installed plant and equipment. The works shall comply with professional engineering practice and standards. The works shall be designed for the environmental conditions prevailing at Matimba Power Station Site.
- c) The Contractor lists all the consumable components that forms part of the works, specifies each components life and includes it as part of the design package.
- d) All Plant and Materials used for process control are constructed of suitable material so that no corrosion or erosion by chemicals can occur, by virtue of its installation in the process.
- e) The Contractor provides all relevant welding procedures for acceptance by the Project Manager.

2.5 Use of *Contractor's* design

All designs, drawings, specifications, instructions, manuals and other documents created, produced by or on behalf of the *Contractor* for the purposes of Providing the *works* (collectively, the "Contractor's Copyright Documents") and copyright therein and all intellectual property rights relating thereto, are, will be, and will remain the property of the *Contractor*.

The *Contractor* hereby grants to the *Employer*, with effect from the Contract Date or in the case of documents or other matter not yet in existence, with the effect from the creation thereof (and notwithstanding the Completion or abandonment of the *works* or termination of this Agreement) an irrevocable, royalty-free, non-exclusive and perpetual licence to use those of the *Contractor's* documents and other matter supplied to the *Employer* under this contract, for any purpose whatsoever connected with the *works*, including for the purpose of maintenance, operation, construction, retrofit, refurbishment, upgrade, repair or demolition of the *works* or any parts thereof. The *Contractor* hereby shall procure that each *Subcontractor* shall execute all and any documents or other matter and take any other actions as may be required in order to give effect to this licence.

The *Employer* uses the *Contractor's* Copyright Documents and all intellectual property rights relating thereto for the sole purpose of all its needs at Matimba Power Station, which includes any *Employer* processes and procedures pertaining to use, maintenance, operation, construction, retrofit, refurbishment, upgrade, repair or demolition of the *works*.

The *Employer* may copy and submit, without restriction, all documentation to others employed or contracted by the *Employer* who has duly signed a confidentiality agreement with the *Employer*.

The *Contractor* may not use any Copyright Documents (and the copyright therein and all intellectual property rights relating thereto), which are owned by the *Employer* and/or *Others* and provided to the *Contractor*, for any other purpose than to Provide the *works*. The *Contractor* may not copy and therefore not retain copies of any such Copyright Documents.

At Completion of the whole of the *works*, or earlier termination, the *Contractor* returns to the *Employer* all such documentation provided to him by the *Employer* and/or *Others*.

2.6 Design of Equipment

The contractor shall provide a detailed proposal of the alternative treatment plant to be used. The treatment system should be able to handle 1.5 Mega litres per day. The dimensions shown on the tender drawings are intended for tendering purposes only. The Contractor is required to take the actual measurements onsite before proceeding with design & manufacture, as dimension accuracy remains the responsibility of the contractor.

Contractor's design or proposed design of alternative treatment plant are to be shared with the Project Manager, not necessarily for his acceptance but as an assurance that the plant will be able to allow the Contractor to Provides the Works efficiently and without delay. The liability of such design and use of the Equipment remains with the Contractor. Dimensions of every process unit to be submitted.

- Proof that the Alternative treatment plant/system can produce the required effluent quality. Supplier to provided 3 months analysis sheets of the effluent quality that a similar plant produced, the analysis sheets provided should show the company or owner of the plant and dates.

Refer to 6.3.7 of this works information for detailed requirements of the alternative treatment stream/system.

2.7 Equipment required to be included in the works

The contractor shall supply all the equipment mentioned in sections 3, 5&6 of this works information

The Contractor shall supply all of the equipment for the civil inspection and repair. This shall include as a minimum:

- 1) All mobile pumps and holding containers required to empty liquid containing structures for the purpose of inspection and repair.
- 2) All high-pressure washing and grit blasting equipment.
- 3) High definition cameras required for inspection.
- 4) Concrete core drilling equipment.
- 5) GPR GSS non-destructive testing equipment.
- 6) Phenolphthalein indicator testing kits.
- 7) All equipment required for structural repair works.

2.8 As-built drawings, operating manuals and maintenance schedules

2.8.1 Drawings

Drawings shall be submitted in hard copy and electronically in PDF and CAD (Microstation) format. The approval of Drawings shall not relieve the Contractor of this responsibility to supply the equipment according to the requirements on this Specification. All drawings shall be done in accordance with the Eskom Engineering Drawing Standard – Common Requirements (240-86973501). All drawings and documentation shall be submitted by the Contractor prior to installation work: The following procedure for the approval of Drawings shall be strictly followed

- a) Contractor prepares Drawings for approval
- b) Contractor checks Drawings for compliance with all requirements of the Specification and submits 3 copies, signed off as checked, to the Engineer for approval
- c) Engineer returns 2 copies, stamped as approved or returned for resubmission, to the Contractor
- d) Manufacture of equipment commences after approval of Drawings by the Engineer
- e) Contractor checks and inspects equipment during all stages
- f) Contractor presents Engineer with written confirmation that all equipment is in full compliance with the Specification and has been checked, inspected and fully tested. This confirmation, signed and dated by the Contractor, shall accompany a written request for the Engineer to witness re-inspection and re-testing of the equipment (e.g. distribution board)
- g) During the Engineer's inspections a fault list will be drawn up, if necessary, and handed to the Contractor
- h) Only after satisfactory rectification of the fault list and subsequent re-inspection, may the equipment be dispatched to site and
- i) The Contractor shall ensure that full copies of the Specification, as well as an approved, signed copy of the Drawings, are at hand during all inspections.

A complete set of Record ("As Built") Drawings, certified as accurate, shall be submitted to the Engineer immediately after completion of the Installation.

Layout Drawings, issued during tender stage, shall be marked up by the Contractor showing all dimensions to buildings, including the positions of underground cables.

2.8.2 Instruction Manuals

Three (3) copies of the operating and maintenance manuals shall be provided on delivery of the plant and equipment. These shall come in the form of plastic covered ring files with the following information indelibly printed on their covers.

MATIMBA POWER STATION OPERATING AND MAINTENANCE INSTRUCTIONS FOR THE NELSONSKOP STW (UPGRADE TO BIOLOGICAL AND HYDRAULIC CAPACITY) SUPPLIED BY:

(Name, address, telephone, e-mail and fax number of Contractor)

Each page, pamphlet, booklet, diagram, drawing etc. shall be separately bound into the manuals in a clear plastic pocket. Each pocket shall be numbered and indexed.

The first page of each set of manuals shall be an index, which shall include a list of the numbers and descriptions of all drawings and pamphlets included in the set as well as a list of the Engineer's drawings relating to the relevant sections of the Contract.

The instructions shall include the following:

- a) A list of spares, tools and testing equipment supplied under the Contract.

- b) A list of spare parts and testing equipment that is not supplied under the Contract but, which may be required for future major overhaul and/or testing of mechanical or electrical plant and equipment.
- c) For (a) and (b) above for spares, tools and testing equipment the Suppliers' names, addresses, telephone numbers, fax numbers and costs must be listed.
- d) List of "Name Plate Data" giving full particulars of serial numbers and other descriptive data pertaining to the plant and equipment installed.
- e) List of points requiring lubrication, stating for each point, the type and grade of lubricant recommended and full details as to quantity, timing, and renewing of lubrication. Before typing the manuals, the Contractor shall contact the Engineer to obtain the name and brand of lubricants generally in use by the *Employer*. Wherever possible, suitable grades of lubricant of that particular brand shall be nominated by the Sub-Contractor in the manuals.
- f) Particulars of bearings, contacts and other moving parts with instructions relating to any special attention, which may be required.
- g) Precautions to be taken in starting, running and stopping the plant or equipment by remote or manual control.
- h) Routine tests which the Contractor/Supplier(s) would suggest be carried out.

All information mentioned above shall be cross-referenced to the drawings.

Additionally the manuals shall provide the following electrical information that shall also be cross-referenced to the drawings:

- a) Equipment layout drawings
- b) Power single line diagrams
- c) Control schematic diagrams
- d) Narrative description of the control circuit operation
- e) Fault finding routines
- f) Routine maintenance instructions, procedures, and frequencies
- g) Equipment and component specification sheets
- h) List of equipment and components including manufacturer, catalogue number and suppliers address, fax and telephone numbers

Further one (1) set of drawings relevant to a particular motor control centre shall be placed in the motor control centre.

2.9 Plant and Materials

2.9.1 Quality

All equipment supplied by the contractor shall be in accordance to the standards mention in section 6 of this document. It is the responsibility of the Contractor to ascertain the condition of any used equipment or materials, transport to site, corrosion protection, as well as any spares compatibility issues that may present itself in the future.

The Contractor does not use Plant or Materials which are generally recognised as being unsuitable or otherwise to be avoided for the purpose for which they are intended.

Only components of high reliability are utilised, with a proven operating history, to enable the Plant to achieve required reliability and availability. Plant and Material design, engineering and manufacture accord with the best modern practice applicable to high-grade products of the type to be furnished, so as to ensure the efficiency and reliability of the works and the strength and suitability of the various parts for the works.

Plant and Materials withstand ambient conditions and the variations of temperature arising under working conditions without distortion, deterioration or undue strains in any part.

All parts are made accurately, and where practicable, to standard gauges so as to facilitate replacement and repairs. Like parts are interchangeable.

No repair of defective Plant and/or Materials is permitted without the Project Manager's acceptance and any such repair, if accepted, is carried out in accordance with the Employer's requirements.

The Contractor ensures that co-ordinated and formally documented management system is in place for the assurance of quality as specified in ISO 9001, Quality management Systems – Requirements.

The Project Manager is free to specify hold and witness points during the installation and on site testing stages of the project. The Contractor issues preliminary notification of such hold and witness points by four days advance notice to the Project Manager, and confirms such hold and witness points at least four days prior to the activity.

Documentation regarding quality procedures is submitted within thirty days of Contract Award. The Project Manager reviews and comments on the acceptability of these documents within the period for reply. If controlled copies of these documents have been submitted to the Employer, then the controlled copy numbers may be quoted in the submission

2.9.2 Plant & Materials provided “free issue” by the *Employer*

None

2.9.3 *Contractor's* procurement of Plant and Materials

- The Contractor supplies and uses suitable and sufficient construction plant, tools and equipment and materials as may be required to carry out the works efficiently.
- The Contractor at all times provides protection for all plant and materials from damage or loss due to weather, fire, theft, unexplained disappearance or similar.
- The Contractor at all times protects from damage, due to the Contractor's service to provide the Works, all plant and materials and equipment and all items on the site that are the property of the Employer or Others.
- The Contractor provides or manages, as part of works everything necessary for the receiving, inspection, safe keeping and storage, issuing, handling, management and administration of all plant and materials purchased by the Contractor.

- The Contractor provides through the Project Manager and relevant Construction Management personnel the documentation for the warranties from suppliers of all any relevant plant and material used in the execution of the works.
- The Contractor ensures to provide all guarantees and warranties of the plant & materials used in the works to the Project Manager and Employer when construction is completed.
- The Contractor supplies the labelling for the Plant that forms part of the works. The Contractor provides labels for the Plant according to the Matimba label specification. The Contractor makes use of the KKS codes and descriptions provided by the Employer.
- The labels shall be affixed in such a way that they are easily legible and not obstructed by the wiring or by other components.
- Clamping methods applied to the labels shall ensure that removal of the labels requires force. The Project Manager's acceptance should be sought for the proposed method of clamping prior to use.
- The Contractor supplies to the Project Manager, for verification and acceptance purposes, with a label list showing the text only. The Project Manager's acceptance should be sought for the positioning and designation of labels.
- The KKS codes are used accordingly on documentation (e.g. drawings, manuals, equipment lists, cable schedules etc.) as a unique identification means. References to plant are accompanied by the relevant KKS code for that item of plant.
- Abbreviations to descriptions on the labels are generally not acceptable. Where abbreviations are unavoidable, due to the limited number of characters that can be engraved/etched on labels, the abbreviations are submitted to the Project Manager for acceptance. The Contractor makes use of the Employer's "Eskom Plant Labelling Abbreviation Standard; 240-109607332.
- The Contractor arranges all shipments of Plant and Materials and consigns all such shipments to himself as consignee at the project shipping address, freight fully prepaid. The Contractor makes demurrage agreements and settlements with carriers for his shipments.

2.9.4 Spares and consumables

The Contractor submits, on completion of the design, a detailed listing of the recommended spares and prices for the Project Manager's acceptance to comply with the aforementioned requirement. The prices quoted shall include for packing, delivery to and off-loading at site, inspection and testing and adequate protection against corrosion, damage and weathering during transit and storage.

2.10 Tests and inspections before delivery

The Employer carries out quality inspections at his discretion without wavering the Employers right to conduct inspections at the Contractor's site prior to delivery.

All inspections and testing to be performed in accordance with the Quality Control Procedure (QCP) developed by the Contractor.

The Employer will be provided access to the Contractor's premises for the purpose of:

- Establishing compliance with the contractual requirements by means of inspections, surveillance and audits.
- Witnessing the performance of any tests.

The Employer will inspect equipment forming part of the Plant before they are released from the Contractor's premises at his discretion. This inspection entails a thorough check to ensure complete compliance with this specification including schedules, design drawings and other applicable standards.

The Contractor obtains clearance from the Employer or the Employer's agent before despatching of the equipment. This factory release inspection does not release the Contractor of any of his obligations under the contract.

2.11 Marking Plant and Materials outside the Working Areas

All Plant and Material paid for by the Employer must be clearly labelled as being the Employer's property

2.12 Contractor's Equipment (including temporary works).

The Contractor is liable for all plant & equipment in the designated area under his control. The Employer will not take any responsibility for any loss or damage to the equipment.

2.13 Completion, testing, commissioning and correction of Defects

2.13.1 Work to be done by the Completion Date

On or before the Completion Date the *Contractor* shall have done everything required to Provide the Works except for the work listed below which may be done after the Completion Date but in any case before the dates stated. The *Project Manager* cannot certify Completion until all the work except that listed below has been done and is also free of Defects which would have, in his opinion, prevented the *Employer* from using the works and Others from doing their work.

	Item of work	To be completed by
	As built drawings.	Within 30 days after Completion
	Performance testing of the works in use.	See performance testing requirements.

2.13.2 Commissioning

The Contractor shall issue a Completion Certificate in accordance with the NEC clause 35.

The Contractor commissions the works and ensures conformance to the Employer's performance requirements for the works. The Employer takes over sections of the system as required once the system performance requirements have been verified by the Contractor.

The Contractor submits a commissioning schedule and program for acceptance by the Project Manager. The schedule shall consist of cold commissioning and hot commissioning plan. Prior to the time when commissioning is to commence, the Project Manager will appoint a representative who will co-ordinate the commissioning of all Plant and Equipment forming an integral part of the system being commissioned.

The Contractor, at the time of commissioning, has the agreement, or alternatively, the attendance of the Project Manager involved in a particular phase, before proceeding with commissioning. Consequently, the Contractor must assure himself as to the safety of his own Plant and Equipment in respect of any particular commissioning test and in the event of damage accept responsibility for such Plant and Equipment. In the event of incorrect functioning, the Contractor determines the cause and he corrects the defect.

The Contractor shall provide a commissioning plan highlighting the requirements for commissioning (i.e. potable, demineralised water, air requirements, etc.) and the duration of commissioning. The plan shall also indicate how commissioning wastewater (if any) will be dealt with.

The Price includes all allowances for testing and commissioning whereby all sections of the works are made ready for full duty operation. Testing and commissioning shall include as a minimum:

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

The Contractor's preliminary trials and commissioning of the plants shall be carried out by the Contractor's representatives, who shall remain in attendance until such time as the plants are working to the Employer's satisfaction. A requirement of these trials is a 3 x 72 hour performance test to determine that all activities as laid down in the operating manuals are correct and are carried out in the correct sequence and to determine that all the plants have been provided as required in the scope of work.

Where the results of the performance tests performed don't correlate with expected results (concentration values, flow rates, pressures etc.) and/or the control functions as per the operating philosophy do not meet the specifications guaranteed, the Contractor, at his own expense, carries out all necessary adjustments and modifications to the works required to obtain the stated tolerances. Fully detailed proposals are submitted in

writing to the Project Manager for approval before any adjustments and modifications are made and work in this respect is carried out when convenient to the Project Manager.

The operating manuals should be submitted at least 4 weeks prior to the start of commissioning for acceptance by the Employer. Records and reports of all tests and inspections are prepared and submitted to the Employer.

2.13.3 Start-up procedures required to put the *works* into operation

The *Contractor* will be required to do plant checks to ensure that the material used and workmanship complies with the specified requirements. The *Engineer* will be attending whilst doing this. The results of those checks shall, if so ordered, be made available to the *Engineer*.

The plant will only be put in operation after relevant safety clearances for all plant and material has been issued by the Contractor and Signed by the Employer.

The contractor will be required to provide the Employer with the relevant start-up procedures.

2.13.4 Take over procedures

The maintenance and guarantee period will commence on the date of hand-over, which is the date of certification of completion of the works.

Hand-over will not occur until:

- a) Testing and commissioning report has been submitted and approved.
- b) Operating and maintenance manuals have been submitted and approved.
- c) The certificate of compliance (electrical) has been received.
- d) All "as-built" drawings (prints and electronic copies on DVD) have been submitted and approved.

As a minimum, the Contractor is required to supply:

- a) Two (2) sets of prints of each of the "as built" drawings and two sets of a drawing showing the construction of the major items with parts listed and reference numbers for ordering spares
- b) Two (2) sets of prints of each of the diagrams of electrical wiring connections
- c) DVD with PDF and CAD versions of above prints compatible with Employers CAD software (Microstation)

Additional requirements may be listed in the technical specifications.

2.13.4.1 Proving Period

After completion of the Contractor's preliminary trials and commissioning of the plant to the Employer's satisfaction, the plants will be taken over by the Employer and continue in normal service for a minimum period of 12 months.

During this proving period the Contractor shall optimise all aspects of the operation of the plant and shall be responsible for any defect resulting from faulty design, material and workmanship. The Contractor shall remedy such defects at his own expense and as soon as possible when called upon to do so by the Employer.

Any outage of sections of the plant required by the Contractor during this period shall, as far as practicable, be arranged to suit the convenience of the Employer. The duration of the outage must be supplied to the Employer in advance (at least 1 week) so that necessary arrangements can be made.

Acceptance tests to determine the efficiency, performance and other guarantees specified will be carried out at any time during the twelve months proving period by mutual agreement between the Employer and the Contractor.

2.13.4.2 Acceptance Tests

Acceptance tests shall be carried out to prove all the plant guarantee figures provided by the Contractor in the technical schedules.

For the acceptance tests the Contractor shall include:

- Four copies of the test programme and test sheets
- The services of a skilled testing Engineer that is fully experienced in the type of plant installed to assist the Employer in carrying-out of the acceptance tests throughout their duration.
- The provision of suitable testing equipment designed to impose simulated varying operating conditions on the plant. The design and use of such testing equipment shall be subject to the approval of the Employer.

When adjustments and modifications are completed, the Contractor advises the Project Manager in writing to this effect and applies for a further acceptance test. From the results obtained, and provided that the Employer is satisfied that it will be lasting, the works will be finally accepted by the Employer.

2.13.5 Access given by the *Employer* for correction of Defects

The equipment and installation included in this Contract shall be guaranteed and maintained in all respects for the duration of the Defects Notification Period.

The Contractor shall, for the full duration of the Defects Notification Period, be responsible for all work and equipment replacements required, including labour, travelling costs, the replacement of lamps and fuses, etc. Renewals or repairs resulting from misuse however, will not be made at the expense of the Contractor. The Contractor shall repair/replace faulty equipment within 48 hours of notification.

The Contractor shall submit full details of his maintenance and repair service facilities, including statutory holidays, weekends, after hours and normal hours.

The Contractor shall stock the accepted list of spares during the Defects Notification Period. All repairs to be made to the installation due to causes not covered by the guarantees shall be done utilising the above material.

2.13.6 Performance tests after Completion

On completion of the installation of all plant and equipment the Contractor will required to make appropriate arrangements and supply any instruments or apparatus etc. necessary for the testing of all plant and equipment supplied by the Contractor. Testing shall be in the presence of the Engineer's representative in order to demonstrate compliance with the requirements or the specification.

All tests as detailed in the SANS and Eskom Specifications are to be performed by the Manufacturer for the Contractor and shall be witnessed by the Engineer.

Site testing and Tests on Completion shall be in accordance with the Specifications.

2.13.7 Training and technology transfer

The Contractor provides training (classroom and hands-on) on the equipment and systems included as part of the works to the various categories of the Employer's technical staff (operators, maintenance and engineering personnel) for the duration of the works. Training provided by the Contractor is directly applicable to the actual equipment supplied for the works. Generalised training based on similar equipment is not acceptable. The local facilities for training provided by the Employer is a suitably sized air-conditioned room, as well as trainee and trainer desks, an overhead projector and flipchart or white board.

The course material is in English and includes all third party documentation. A copy of the training documentation is supplied for each trainee with an additional 3 master sets for the Employer's library and training department.

The training dates are included and shown in the Accepted Programme. The supply of drafts, pre-print proofs and printed copies of training documentation is planned by the Contractor in such a way that the required training is complete before commissioning of the Plant.

2.13.8 Operational maintenance after Completion

The Contractor shall be responsible for the maintenance of all equipment and provision of all lubricants, until the plant and equipment is successfully handed over.

Once the plant and equipment has been successfully commissioned and accepted, the Employer's site staff will undertake the operation of the plant and equipment and its routine maintenance in accordance with operating instructions and routine maintenance requirements to be furnished by the Contractor prior to acceptance.

3 Plant and Materials standards and workmanship

3.1 Survey and Site clearance

The Contractor will be required to do an underground scan of the entire working area to identify the position of existing underground services. Any damage caused to existing services shall be repaired by the Contractor at his own expense. The results of the underground scan shall be submitted to the Employer in a CAD (Microstation) and PDF format. The underground scan should indicate the type (Sewage, water, power etc) and depth of the identified service. The scan should also include coordinates and dimensions of existing benchmarks, to ensure that the exact position of the underground service can be identified prior to any excavation being done.

3.2 Building works

Any additional civil engineering and / or building work, or alterations, to that indicated on the drawings that may be required to accommodate the M & ECI plant in concrete/brickwork structures shall be the responsibility, and to the account, of the Contractor.

Such work shall include but not be limited to excavation, backfilling, the provision of plinths, provision of openings through concrete / brickwork, the concreting / bricking up of openings through concrete / brickwork and the making good of surfaces through which pipes pass.

Infill concrete and grout shall include an approved non-shrink additive.

The Contractor shall also be responsible for:

- a. The provision of all holding down bolts
- b. Supporting all pipework and plant temporarily until it has been fixed permanently
- c. Ensuring that pipework supplied under this Contract bears firmly against all anchor blocks provided by others.

The cost for such work, as detailed above shall not be measured separately but shall be deemed included in other rates and prices in the Schedule of Quantities.

3.3 Civil engineering and structural works

3.3.1 New structural design and engineering works

As part of the design package the appointed Contractor shall supply the following: detailed construction drawings, shop/manufacturing drawings, as built drawings and a detail design/calculation report all of which are signed off by a professionally registered engineer. The design of the new structures shall be done in accordance with the latest revision of the standards listed under section . 6.3.1 *Standard Civil and Structural Specifications*.

3.3.2 Structural inspection and reporting

All the Sewage Treatment Plant concrete structures, which have been identified below require inspection. The areas listed below have been identified through a visual assessment. Should there be additional areas identified when the plant is offline, and a thorough inspection can be conducted, these additional areas will be included in the inspection plan as agreed upon following discussions between the contractor and Eskom.

The concrete structures to be inspected and repaired are as follows:

- a) Balancing pond (20.6 x 36.6 x 2 m at bottom with 45° sloping sides plus 0.3 m freeboard)

- b) Aeration pond (25 x 16 x 3.6 m with 0.5 m freeboard and 45° sloping sides)
- c) Circular clarifier (14 m inside diameter, 3 m depth with peripheral launder and 7.5% floor slope with centre column)
- d) Chlorine contact tank (net volume of 33 m³), adjacent to the clarifiers complete with baffle walls. Including a discharge weir box and partitioned section to form a return sludge pump sump
- e) Drying beds (x6)

The appointed contractor will be required to do a comprehensive inspection of all the sewage plant and Pump Station 3 concrete and steel structures. The Contractor will be required to conduct a systematic assessment on all of the concrete and steel structures to determine the cause of the deterioration and the extent of the damage. The condition assessment will consist of a visual inspection conducted by an experienced Professional Engineer as well as on site testing and laboratory-based testing of samples removed from the structures. The condition assessment shall provide the basis from which the Contractor shall develop their method statement for repairs. During the condition assessment, the Contractor must distinguish between defects in the concrete itself and defects caused by the reinforcing. The assessment must be based on a sound understanding of mechanical, physical and chemical factors that result in the deterioration of concrete structures.

The inspection to be done shall be as follows:

- All water and sludge retaining structures shall be drained and the water/sludge shall be re-routed to the temporary sewage plant.
- All the surfaces of the concrete and steel structures need to be cleaned by means of high pressure water jetting
- All the loose aggregate and fine cement particles should be removed by means of steel brushing if the water jetting is not sufficient;
- Once each individual structure has been cleaned, visual inspections should be conducted on the inside and outside of all the structures;
- The inspections should include checklists and key indicators which will be inspected;
- High definition images should be taken of all the tanks on the inside and outside as well as all the major defects or areas of concern;
- Based on the findings of the visual inspection the Contractor shall develop a strategy for in-situ and laboratory-based testing.
- The results of the inspection should be presented in a report format with high quality images of the defects;
- The report shall highlight all the defects found including the extent and location of the defects with proposed methods of repair to restore the structural stability of the structures. The report shall be signed off by a professionally registered structural engineer (PrEng). No candidate engineers or professional technicians/technologists shall be accepted
- The report should also include a cost estimate in the form of a bill of quantities for the estimated cost to do the recommended repair if necessary; the cost should be market related cost. The bill of quantities shall be in accordance the latest edition of the "Model Preambles for Trades" as recommended and published by the Association of South African Quantity Surveyors.
- The submitted report should indicate whether the concrete structures are still safe to use and if there is possibly that leakage or collapse could occur and the time frame related to the modes of failure.
- If there are areas identified where the extent of deterioration seems severe, concrete core drilling should be done for laboratory testing. The concrete drilling should only be carried out if the engineer (contractor) has a concern that the structural integrity of the concrete structures have degraded to a critical point and it has been confirmed with the Eskom representative; Laboratory testing may include but is not limited to:
Strength and surface hardness.

Presence of chlorides.
Presence of sulphides.

- The capping of core samples taken should be done with epoxy/concrete mixture which is water proof and with no leaks;
- The results from the laboratory tests should also be detailed in the results report;
- The report should be submitted in the form of two hardcopies as well as a soft copy in PDF and/or Word document format, the images taken should also be submitted on a memory disc or CD.
- Non-destructive testing should be carried out on all the concrete structures using GPR GSSI to determine the cover on the rebar, the size of the rebar as well as the concrete strength.
- The carbonation of the concrete structures should be tested using a solution of phenolphthalein indicator to identify the PH of the cement. Both the results for the NDT and the PH should be presented in the report.

3.3.3 Structural remedial works

The contractor shall start with remedial concrete and steel work as soon as practically possible to ensure the timely completion of all repairs. The repair works can start in conjunction with the structural inspection if need be.

The Contractor provides the following to the Project Manager for review and acceptance before conducting any works:

- a) Comprehensive method statements detailing the following as a minimum, where required:
 - Construction methodology and sequence of construction for the repair or removal of various civil and structural components, taking into consideration access restrictions and safety requirements; All method statements to be signed off by *Contractor's* ECSA registered engineer.
 - Detailed report with all instances of defects to be repaired based on typical defects that were identified during the inspection conducted by the contractor.
 - Materials and machinery/equipment to be used;
 - Temporary works to be used including Project Manager's acceptance of such;
 - Manufacturer's literature/TDS for all materials used e.g. patching materials, anti-corrosion coating, bonding agents etc. including product description, composition, material and performance properties, installation and application procedures, use limitations and recommendations;
 - Plan for confining, collecting and disposing of broken concrete and other waste materials as a result of removal operations;
 - Works required to safeguard existing infrastructure and services including protection of all surface works and excavations against the ingress of surface water. The Contractor shall take whatever precautions may be required without impacting on plant operations.
 - Risk assessments, including taking into account shutdown of plant/ equipment where deemed necessary, in order to execute the works.
- b) Quality Control Plans/ Inspection and Test Plans;
- c) Rigging studies and design calculations where applicable;
- d) Contractor's Welding Procedure Specifications, Welder Qualification certificates, NDT testing procedure for all new welds which must align to the Standard for Welding Requirements on Eskom Plant (240-106628253);
- e) Fall Protection Plans and Working at Heights Plans;
- f) Detailed Level 3 Programme encompassing all works, showing float and logical links/ sequence/relationships that connect the various activities together;
- g) The Contractor's temporary works design calculations,

Existing infrastructure and services:

Any damages to existing infrastructure and services resulting from the works are repaired/ made good by the Contractor at his own expense. The Contractor supplies a method statement for the repair works to the Project Manager for review and acceptance prior to conducting the repair works. The Contractor may require removing existing undamaged civil and structural components or equipment/services to facilitate execution of the works stated herein. In such case, the Contractor submits a list of existing undamaged civil and structural components or equipment/services that require removal in a method statement for the Project Manager's review and acceptance, taking note that permits may be required for such. The cost of removal of undamaged components, preservation/storage and replacement to its original working state is the responsibility of the Contractor. In the case where existing drawings are not available, the Contractor is responsible for compiling drawings signed by a professionally registered engineer with ECSA that are adequate for reassembling of equipment/civil and structural components that require to be reinstated. The Contractor does everything possible to carry out the remedial actions without having the Employer decommission/shutdown any plant/ equipment to facilitate the repairs. Where all options have been exhausted, the Contractor performs a risk assessment to prove to the Project Manager the necessity of the required shutdown. These are formally documented in method statements to the Project Manager for review and acceptance.

Temporary works:

The Contractor designs all temporary works necessary to execute the works. The Contractor's appointed ECSA professionally registered engineer reviews and approves (by signature) the designs and drawings of all temporary works and additional supports and method statements produced by the Contractor; and supervises, inspects and approves the works as per such. All temporary works designs, where existing infrastructure are impacted by the works, are submitted to the Project Manager for review and acceptance, to prove that the existing infrastructure can withstand the induced load. The Contractor therefore submits all design calculations, in a design report which includes, but is not limited to, all inspection reports, survey data, design analysis models, assumptions, drawings/sketches, rigging studies etc. The Contractor takes full professional accountability and liability for all temporary items required for the execution of the works.

Concrete repair work

The scope includes the supply, testing, delivery and erection complete with grouting, holding down bolts, joints and sealants where applicable to ensure repairs and/ or member replacement as specified meets its original intent. The Contractor executes all concrete works in accordance with SANS 2001 – CC1 and Standard for Eskom Power Stations Concrete Remedial Work (240-144332407).

3.3.3.1 Substrate preparation prior to remedial action

All concrete substrates need to be prepared in accordance with the following guidelines:

- Areas to be repaired shall be clearly marked.
- All areas to be repaired shall be cleared and cleaned removing all loose material, dust and free water.
- Areas to be repaired shall be saw-cut and/or chipped to a minimum of depth of 10mm in a rectangular shape or until sound concrete is reached.
- Repair edges in water retaining structures shall be dove-tailed.
- A bonding agent shall be applied prior to applying repair products. The bonding agent shall be applied immediately prior to applying the repair product ensuring a wet on wet bond.
- Repair areas shall be protected from wet or windy conditions and direct sunlight.

Reinforcement preparation

All reinforcement to be prepared in accordance with the following guidelines:

- Prior to any remedial action where reinforcement is exposed, remove all tie wires, scour away corrosion mortar/concrete and any other loose material.

- Use a steel wire brush, air pressure, sand blasting or water jetting to clean reinforcement. If the structural integrity of the rebar has been compromised the affected bars should be removed and replaced.
- Prior to concrete repair, the steel reinforcement shall be covered by an approved corrosion inhibitor and bonding agent.

3.3.3.2 Concrete repair

Based on the investigation report done by the Contractor, he shall select the most suitable remedial method for a specific defect. Concrete repair methods that will be required are listed below:

Hand applied mortar

For smaller areas, not requiring formwork, mortar shall be applied by hand. A hand float shall be used to achieve the desired surface finish. Prior to applying the mortar, all deteriorated or defective concrete shall be removed and substrate prepared as follows:

- Carbonated concrete shall be removed to a depth of at least 20mm behind rebar and 50mm into non-carbonated concrete.
- Where concrete deteriorated due to chloride attack, concrete shall be removed to a depth of at least 30mm behind rebar and 100mm into sound concrete.
- Area to be repaired shall be marked clearly.
- Substrate must be damp but without standing/ponding water prior to application of the mortar.

Re-casting of concrete elements

Where concrete deteriorations extend to more than 100mm deep, replacement concrete needs to be used to repair the affected area. Concrete surfaces shall be prepared in accordance with section 3.3.3.1 and new concrete shall be cast onto sound substrate. A hand float shall be used to achieve the desired surface finish. For vertical surfaces formwork shall be installed in accordance with the formwork requirement of this document. The new concrete shall meet at least the minimum material specification for the parent concrete used in the structural element unless an updated design base supersedes the parent concrete specification. Where entire concrete elements have deteriorated, these elements should be recast. Deteriorated concrete elements shall be demolished and rubble cleaned. Elements shall be cast with concrete specifications in accordance with the current design.

Spray concrete or mortar

Spray concrete or mortar shall be used where large repairs are required. Prior to applying spray concrete or mortar, all deteriorated or defective concrete shall be removed and substrate prepared as follows:

- Carbonated concrete shall be removed to a depth of at least 20mm behind rebar and 50mm into non-carbonated concrete.
- Where concrete deteriorated due to chloride attack, concrete shall be removed to a depth of at least 30mm behind rebar and 100mm into sound concrete.
- Area to be repaired shall be marked clearly.
- Sprayed concrete shall not be used in temperatures below 2 degrees Celsius or on substrates exposed to windy conditions or rainfall.
- Substrate must be damp but without free water prior to application of sprayed concrete.

Increase cover by adding additional concrete or mortar

In areas with inadequate cover to reinforcement was provided during either the design phase or construction, the cover shall be increased in accordance with the following requirements:

- If reinforcement is visible remove concrete to at least 25mm behind the reinforcement.
- In cases where the reinforcement has corroded with insignificant effect to structural integrity, the reinforcement shall be cleaned using a steel brush and protected from further corrosion by applying a suitable corrosion inhibitor.
- In cases where the corrosion has affected the structural integrity of the reinforcement, the reinforcement shall be removed and replaced. Lap lengths of newly installed reinforcement shall be in accordance with the applicable SANS standard.
- Formwork shall be installed in accordance with the formwork requirements of this document,
- Concrete or mortar shall be applied to increase the concrete cover to at least 50mm, or as otherwise specified.

3.3.3.3 Concrete crack repair

All cracks with a width greater than 0.2mm need to be properly repaired.

Repair method for cracks where there is no more movement in the structure:

The following repair methodology should be followed for cracks in both vertical and horizontal structure where there is no movement in the structure.

Repair methodology:

- Prepare substrate in accordance with section 3.3.3.1.
- Ensure the area is free from free water.
- Cut a slot with a width of min 20 to 30mm to a depth of 50mm unless otherwise specified by the product TDS.
- Apply repair mortar using a trowel and finish with a render model to desired surface finish.
- Cure repair work for minimum 7 days or as specified in the manufacturer's material Technical Data Sheet.

Repair method for Cracks on horizontal surfaces where there is movement in the structure

Repair methodology:

- Prepare substrate in accordance with section 3.3.3.1 of this document.
- Widen the crack with a diamond blade about 10mm deep with a V-shape to contain crack injection resin, else build a retaining wall around the crack using neutral builders' silicone.
- Clean the surface and remove any loose material.
- Fill the crack by capillary action (place resin in reservoir created) using a low viscosity crack injection resin.
- Grind the excess product of and smooth the surface after resin has set.
- Allow to cure as indicated on the product TDS.

Repair method for cracks on vertical surfaces where there is movement in the structure.

Repair methodology:

- Wire brush the length of the crack to remove any loose material.
- In a staggered arrangement on either side of the crack, drill 10mm diameter holes, ranging from 70mm to 150mm deep into the crack at an angle between 30 and 45 degrees to the horizontal. Drill the holes at a distance centre to centre 300mm along the crack.
- Clean the drilled holes and crack with compressed air.
- Secure packers in the drilled holes by use of a hammer.
- Inject the resin using a manual or mechanical injection pump. Start injecting at the lowest point. Pump the resin into the packer until it exudes from the next. Then start at the next packer and repeat until it is completely filled.
- Allow to cure for 24 hours or as indicated in the product user manual. Grind down the packers and excess material and restore surface to the desired finish.

3.3.3.4 Concrete surface protection

Surface impregnation is the process of applying products to concrete surfaces which strengthens the surface. The pores and capillaries are filled blocking the concrete pores, thus preventing ingress of harmful substances. Surface coating is the process of improving the concrete surface resistance to external agents. Only approved surface coating and impregnation products may be used and applied in accordance with the repair material section in this document. The selection of coating products shall take into account structures subject to temperature fluctuations, vibration or inadequate joints. The coating material shall accommodate dynamic and thermal movement.

Surface impregnation and coatings shall be executed in accordance with the following methodology:

- Prepare substrate in accordance with section 3.3.3.1 of this document.
- Ensure the area is dry prior to applying surface impregnation products, unless otherwise specified on the product Technical Data Sheet (TDS).
- An approved concrete surface impregnation or coating product shall be used.
- All impregnation products should be based on an epoxy resin; ensure a good bond to smooth surfaces and achieve a penetration depth of >5mm.
- All surface impregnation products should be applied and cured in accordance with product application manual.

Hydrophobic impregnation

Hydrophobic impregnation is the treatment of concrete surfaces to produce a water repelling surface. All concrete structures subject to deterioration through water ingress shall be coated with a hydrophobic impregnation product.

Repair methodology:

- Prepare substrate in accordance with section 3.3.3.1 of this document.
- Clean and dry area prior to application of products;

- All products used shall not fill the surface pores and capillary network, but should line the entire concrete surface;
- All products shall be applied and allowed to cure according to the product Technical Data Sheet.

3.3.3.5 Remedial action for concrete expansion joints

Where concrete expansion joints are deteriorated, the following methodology should be used:

- Remove all dust, liquids and debris from area surrounding joint to be repaired.
- Remove all old material in the joint. Use pressurized water.
- Apply a bonding adhesive into the joints with a brush. Allow the adhesive to dry for a min of 10min or as specified in the product TDS. The adhesive should be sticky to touch and not completely dry.
- Insert a shock absorbing material.
- Apply a layer of self-levelling sealant to seal the joint.
- Barricade the area until sealant has cured as per the requirements of the product TDS.

3.3.3.6 Repair material requirements

All repair material shall meet the following requirements unless otherwise stated:

- Repair material shall be stored, prepared (mixed) and used in strict accordance with the manufactures instruction provided under the material safety and technical data sheets.
- Repair mortars should match or exceed the grade of the structural concrete they have to replace.
- Repair materials should be used as soon as possible after the preparation (mixing) and should never be used after the expiry of their pot life.
- It is not allowed to add water to lengthen the pot life of a mixed repair material.
- Only water which meets the requirements of the repair material manufacturers TDS and acceptance testing applicable in the normative criteria shall be used for construction and repairs.
- Different products used in conjunction (e.g. bonding agent & repair mortar) shall be from the same manufacturer to ensure full chemical compatibility.
- It is recommended that the Contractor have the material manufacturer on site for the first application of the said product to ensure that application is done correctly and that no warranties/guarantees are voided due to the incorrect application.

3.3.3.7 Formwork requirements

All formwork shall be according to the following requirements unless stated otherwise:

- Formwork shall be selected based on the required surface finish;
- If timber formwork is used, de-molding oil shall be applied to avoid water absorption;
- Foam strips to be used where necessary/practicable to prevent grout loss;
- Suitable openings to facilitate release of trapped air shall be provided where necessary;
- Adequate support shall be provided to prevent formwork from moving during casting.

3.3.3.8 Equipment requirements

All equipment shall be in accordance with the following requirements unless stated otherwise:

- Pneumatic chipping hammers should be hand-held unless noted otherwise, and capable of removing concrete beneath reinforcing bars;

- Sandblasting equipment should be capable of removing corrosion from the reinforcement and contaminants and laitance from newly exposed concrete surface;
- Compressed air equipment should be capable of removing dust and loose material from concrete and steel surfaces;
- Water blasting equipment should be capable of cleaning the reinforcement and roughened concrete;
- All equipment and cleaning material used shall not damage reinforcing steel or the concrete substrate in any way.

3.3.3.9 Concrete curing requirements

All repair works shall be cured for 7 days or as per the manufacture's repair material recommendations and TDS.

The scope includes for the supply, fabrication, shop detailing, galvanising/ painting as specified, delivery, erection complete with all necessary gusset plates, stiffeners, connections, cleats, brackets, base plates to ensure repairs and/ or member replacement as specified meets the original design intent. The Contractor executes all steel works in accordance with SANS 2001-CS1

3.3.3.10 Corrosion protection of steel elements

The Contractor applies adequate corrosion protection on all identified members in accordance with 240-106365693, Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings. Where there are any discrepancies between the above mentioned standard and this document, this document will get preference.

Equipment

Measuring and Test Equipment:

- The Contractor shall have a blast profile gauge, wet film comb, and a dry film thickness gauge at the shop/site at all times. The Contractor shall also have at the shop/site instrumentation to measure the psychrometric conditions and the substrate temperature.
- The electronic dry film thickness gauge shall conform to the requirements of ISO 2808 and shall be calibrated using the smooth calibration disc supplied by the instrument manufacturer.
- All test equipment and shims shall have current calibration certificates.

Spray Equipment:

- The spray equipment used shall be capable of properly atomising the material and shall be equipped with suitable pressure regulators and gauges. Air caps, needles and nozzles shall be of the type recommended by the coating manufacturer.
- All spray painting equipment shall be fitted with suitable oil and moisture traps.

Power Mixers

- All coatings shall be mixed with power mixers. Low speed mixers which do not induce air into the coating shall be utilised.

Coating materials:

- All materials, i.e. paint, solvents and cleaning agents for a specific paint system shall be supplied by the same manufacturer.
- The solvents used shall be those recommended and manufactured by the coating manufacturer. Where the recommended 'solvent' and 'clean-up thinners' for a material differ, the 'clean-up' solvent must not be added to the coating for dilution purposes.

- Excessive dilution of paints is not permitted. Solvent additions for application purposes shall be in strict accordance with the coating manufacturer's Product Data Sheet.
- The colours of the paints to be used shall be as specified by the Engineer. All paints and coatings shall be brought to site in new unopened containers. All containers shall be clearly marked with the manufacturer's material batch numbers and other relevant information.
- The Contractor shall ensure that the colour selection of the coat immediately prior to the finishing coat shall be suitable for complete obliteration by the finishing coat.

Surface preparation

General:

- Sharp edges shall be dressed to a radius of not less than 2 mm, but no more than half of the section thickness. All burrs, rags and weld spatter shall be removed as per the requirements of ISO 12944-3.
- Welds shall be free from imperfections (e.g. asperities, undercutting, blowholes, craters, and spatter) which are difficult to cover effectively with a protective paint system. The onus is on the Contractor to ensure that the surfaces are ready for coating.

Pre-cleaning:

- Oil and grease shall be removed by high pressure water washing with detergent solution and rinsing with clean water prior to wire brushing and application of coatings.
- Chemical and cleaning contamination shall be removed by means of neutralising or flushing or both. It is important that clean potable water is used for cleaning, or the surfaces will be left contaminated after washing. The surfaces shall thereafter be allowed to dry completely prior to coating or before continuing with the rest of the surface preparation process.

Wire brush cleaning and grit blasting

- Wire brush cleaning and grit blasting shall be used to remove all signs of corrosion and loose paint.

The following requirements shall apply prior to coating application:

- All surfaces shall be free from dust and debris.
- If the wire brushed/grit blasted surface changes colour, or rust bloom begins to form, the surface shall be re-brushed.

Coating application

Approval:

- No work shall be performed until the Quality Control Plan is approved by Eskom.

Mixing:

- The Contractor shall ensure that all paints are mixed in accordance with the manufacturer's instructions.
- In the case of two pack materials, the splitting of kits as supplied from the factory is not permitted.

Coating:

- The primer coat shall be applied as soon as possible after the surface preparation operation during the same shift as the blast cleaning operation, but under no circumstances may the primer be applied over rust bloom or over surfaces that have changed colour due to humidity or other contamination.
- Coating application and cleaning shall not take place when site conditions are likely to negatively affect these operations. The Contractor shall ensure that the necessary protective equipment is used to prevent contamination of the coatings and to minimise delays due to such site conditions.
- Successive coats shall be of distinctly different colour to the previous coat to ensure correct intercoat coverage. However, two finishing coats of the same colour may be applied to achieve complete colour uniformity. Special attention shall be given to cracks, crevices and edges to ensure complete coverage and paint thickness. All finishing colours shall be to the Eskom Engineer's approval.
- Concealed surfaces shall be completely coated. Suitable sponges may be used for application of coating to concealed surfaces or back to back angles. In the case where it is impractical to coat the concealed surface, the opening shall be sealed utilising an approved mastic material.
- All edges, corners, bolt holes, mouse holes, cut ends and weld beads shall be stripe coated by brush application, prior to the application of the intermediate coat. The stripe coating shall be an additional coat of the specified intermediate coat. In order to assist in its identification, the stripe coat shall be a different colour to both the specified intermediate coat and finishing coat. Under no circumstances shall stripe coating be carried out by roller or spray-application.

Application:

- Unless otherwise specified, all coatings shall be applied by airless spray techniques.
- In instances where spray application is considered not to be possible, practical or feasible, this must be brought to the attention of the Eskom Engineer at the time of tendering.
- Unless otherwise specified, all application work shall be carried out in strict accordance with the recommendations and instructions given in the signed Product Data Sheet supplied by the coating manufacturer.
- All coatings shall be evenly applied to form a smooth, continuous, unbroken coating free from tears, runs, sags, wrinkles, blisters, mud-cracking, change in colour or gloss, orange peel, visible pin-holes, dirt, dust or fluff occlusions or any other visible defects. Each coat shall provide complete coverage.

Fasteners

- All nuts and bolts shall be hot dip galvanized. All fasteners used shall be grade 8.8.

Inspection and testing

Visual inspection:

- Visual inspection for paint film defects shall be performed after each coat is applied. All defects including pinholes, runs, sags, dry spray etc. shall be corrected based on the requirements of ISO 12944 Part 4, before the next full coat is applied. Inspection and rectification shall be based on the requirements of ISO 12944 Part 4.

Dry Film Thickness (DFT):

- DFT shall be measured in accordance SABS ISO 2808 and instruments shall be calibrated using the smooth calibration disc supplied by the instrument manufacturer.
- The frequency of dry film thickness readings shall be a minimum of three reading per square metre of coated surface.
- The product data sheet shall indicate the required minimum and maximum DFT. The DFT is given in a range for each coat in the relevant coating system. These are the required minimum and acceptable maximum thicknesses. No individual thickness shall be less than 80% of the specified minimum

thickness and not more than 20% of thickness measurements taken shall be less than the specified thickness. No individual thickness shall be greater than 120% of the specified maximum thickness.

- The increase in thickness created by the application of the stripe coat shall not be used to justify recorded thicknesses that are in excess of the maximum specified thickness of the system.
- All deficient film thicknesses shall be rectified to the approval of the Eskom Engineer at the Contractor's expense.
- Actual readings and not averages shall be recorded.

Guarantees

- Eskom requires a guarantee of 15 years on all coating systems. Such guarantees shall be provided jointly by the Contractor in collaboration with the coating applicator/s and manufacturer's at the time of tender.
- Although visible coating defects such as blistering, cracking, flaking and peeling are not always associated with visible rusting, they indicate defects that could either lead to substrate corrosion or are shielding substrate corrosion that has already taken place beneath the coating. Any such defects noted during the guarantee period shall be the Contractor's responsibility and shall be repaired.

Specification for protective coatings (mild steel in aggressive external environment < 80 °C)

- Surface preparation shall be done in accordance with this document.
- Primer shall consist of a two component epoxy zinc prime (min 80% zinc in the dry film).
- Intermediate coat shall consist of a two component recoatable epoxy micaceous iron oxide
- Top coat shall consist of a two component polysiloxane finishing coat.

The following surfaces shall be coated in accordance with the above specification:

- Aeration tank steel structure.
- Sludge Pump Sump steel hoist frame.
- Pump Station 3 crawl beam

Specification for protective coatings (Hand railing/Stanchions)

- Surface preparation shall be by means of sweep blasting or a suitable galvanized iron cleaner as recommended by the coating manufacturer.
- Primer shall consist of a galvanising tie-coat/ primer.
- Top coat shall consist of a two component polyurethane acrylic finishing coat.

*All hand-railing on the STP shall be repainted in accordance with the above specification.

3.3.3.11 Sludge pump sump step iron replacement.

The Contractor shall be responsible to remove and replace the step irons in accordance with Eskom drawing 0.58/11611. The new step irons shall consist of 20mm diameter galvanised round bar.

3.3.3.12 Replacement of IBR roof sheeting

Roof sheeting to consist of IBR 890, 0.5mm Standard Chromadek sheeting (Z200 hot-dipped galvanized substrate pre-primed with a primer (Dry film thickness (DFT) of 5µm) and finished with a final paint coat (DFT

of 18 -22µm) on the top surface. A single backing coat (DFT of 8µm) is normally applied to the reverse side of the sheet).The Contractor shall supply a material certificate from the supplier with the delivery of the Chromadek sheeting. The colour of the roof sheeting shall be determined after contract placement

3.3.4 Laboratory refurbishment

Removal of existing infrastructure:

The following infrastructure needs to be removed by the *Contractor* and be disposed of into a skip provided by the *Employer*:

- Taking up and removal of exiting vinyl floor tiles (18m2).
- Hacking up and removing porcelain wall tiles (116m2).
- Built-in air-conditioning unit (1).
- Existing cabinets, frame and sink in laboratory.
- Vitreous china Washing Closet (WC) pan with cistern, including short lengths of piping (2).
- Vitreous china toilet roll holder; single roll holder (2).
- Stainless steel Wash Hand Basin including short lengths of piping (2).
- Remove and put aside hand-soap dispenser to be reinstalled at a later stage (2).
- Towel rails (2).
- Shower Heads and taps (2).
- Shower curtains (2).
- Mirrors (2).

Making good of doors:

External doors (2). The two external wooden doors shall be removed from their hinges and completely striped from any previous paint or varnish by sanding. The doors will then be coated by a suitable wood preservative that will provide protection and waterproofing in an external environment. The selected product shall provide protection against fungal attack and should not peel, crack or chip even after prolonged exposure. Each door shall be coated with three coats in accordance with the manufacturer's recommendation. Once the doors have been coated they shall be placed back into their original position.

Internal doors (6). The six internal wooden doors shall be removed from their hinges and completely striped from any previous paint or varnish by sanding. The doors will then be coated with a high quality solvent based enamel which is suitable for wooden doors and has a high gloss finish. The selected paint shall have a 7-year quality guarantee. Each door shall be coated with two coats in accordance with the manufacturer's recommendation. Once the doors have been coated, they shall be placed back into their original position. The *Contractor* shall supply the *Client* with three color samples. Each sample shall be painted onto the door.

Building up of old air-conditioning unit opening:

All walls shall be built in accordance with SANS 10400-K: 2015 (Walls) and SANS 2001-CM1: 2012 (Masonry walling). New bricks to match existing and will be placed in class II mortar. The opening will be plastered on the inside only (4m²). Type 1 joints will be used to connect new walls to existing.

New floor tiles

The new kitchen/lab and bathroom floor tiles shall consist of 350 x 350mm ceramic floor tiles or similarly approved. The *Contractor* shall submit three different samples of each of the tiles for the kitchen/lab and bathroom for selection.

New wall tiles

The new kitchen/lab and bathroom floor tiles shall consist of 600 x 300mm ceramic floor tiles or similarly approved. The *Contractor* shall submit three different samples of each of the tiles for the kitchen/lab and bathroom for selection.

New mosaic shower tiles

The new mosaic shower tiles shall consist of porcelain tiles in a herringbone pattern. The tiles shall be provided in sheets. The *Contractor* shall submit three different samples of the mosaic tiles to be used in the showers. Wall and floor tiles to be fixed with a suitable cement-based polymer modified tile adhesive designed for the installing of ceramic and porcelain tiles onto all types of cement based surfaces as well as other pre-primed

surfaces. Once set, a cement based polymer modified grouting compound designed to point tile joints up is to be used to grout all the wall and floor tiles. The selected grout should improve flexural strength, increase abrasion resistance, minimise shrinkage, reduce dirt pick-up and increase water resistance. The selected grout color should match that of the tiles.

For the installation of the mosaic tiles a cement based polymer modified adhesive that is suitable for wet areas as well as in underwater conditions is recommended. The selected product must protect against the growth of mildew and algae.

New laboratory cabinets

The new cabinets that are to be supplied must be similar to the existing cabinets with regards to the cupboard, drawer and shelving layout. The cabinets must be fit for purpose and must be manufactured to resist laboratory chemicals. Frames to be manufactured from epoxy coated steel and must be fitted with adjustable feet to accommodate for uneven floor surfaces. The color of the frame will be determined on site. The working surfaces of the cabinets shall consist of laboratory grade phenolic resin. The working surface must be chemical, wear and water-resistant and must be 900mm high. Cabinets shall consist of melamine with high impact resistant PVC edging on all doors and drawers. Hinges and drawer runners shall be of a high quality. Under bench units shall be 500mm deep and designed for a 900mm high work surface. Wall cupboards to be 300mm deep and 600mm high. Cabinet door and drawer handles to consist of full width aluminum extrusions that is covered with an epoxy coating. The handles must be wear resistant and easy to clean. The table below gives a summary of the new cabinets that need to be installed:

Cabinet description:	Quantity
1000mm Double door cabinet with two drawers.	7
500mm Four drawer unit.	2
500mm Waste bin unit.	2
1000mm Double door cabinet with blank for sink.	1
1000mm Sliding glass door cabinet (wall mounted).	5

New laboratory sink and tap

The new sink must be purposely fit for the above mention 1000mm double door cabinet that has a blank space for a sink. The sink must consist of a polypropylene injection molded sink that has a high chemical resistance. Dimensions: 552 x 400 x 231mm. The new tap must be polyester powder coated to ensure resistance against chemicals, UV fading and heat. The tap should comply with the following specifications:

- Handles: Metal polyester coated hot and cold handle with 180o opening function.
- Full swivel action spout.
- Ceramic headwork.
- 0-90oC Temperature range.
- Maximum working pressure of 10bar.
- Fixed metal nozzle.

New fridge

The *Contractor* shall supply and deliver a double door fridge for the storage of samples. The fridge will have the following specifications:

- Dimensions Height: 2020mm Width: 1140mm Depth: 635mm
- Clear glass doors.
- Gross capacity: 918 liters.
- Electronic temperature controller.
- Refrigerant type: R134a
- Number of shelves: 8 (minimum).
- Temperature range: 4 degrees Celsius.
- Voltage: 220-240.

Installation of new sanitary fittings:

The *Contractor* to supply and install two (2) Coral white front flush WC suites (or similar approved) comprising of WC pan, double flap heavy duty plastic seat and cistern. The WC suite to be SABS approved.

The *Contractor* to supply and install two (2) 570 x 465mm Coral Avocado Wall Mounted Basin & Floor Pedestal Sets or similar approved.

The *Contractor* to supply and install two (2) Cobra – Metsi MI-294 basin mixer with cast fixed outlet or similar approved. The mixer shall include chain, stay, mounting kit, and 2 x 1/2" female iron 400mm long flexible inlets. The *Contractor* to supply and install two (2) chrome Cobra Stella shower sets or similar approved which includes two under wall stop taps, flanged shower arm and shower rose. The shower set to be SABS approved, SANS 226 Type 2. The *Contractor* will be required to increase the height of the existing shower heads.

The *Contractor* to supply and install two (2) Portofino Cara Chrome, or similar approved Robe Hooks. The hooks to be manufactured from high quality brass with a chrome-plated finish and carry a 5-year manufacturing guarantee.

The *Contractor* to supply and install two (2) Portofino Cara Chrome, or similar approved shower soap holders. The soap holders to be manufactured from high quality brass with a chrome-plated finish and carry a 5-year manufacturing guarantee.

The *Contractor* to supply and install two (2) stainless steel lockable toilet roll holders. Each toilet roll holder shall be capable of holding three (3) toilet rolls.

The *Contractor* to supply and install two (2) shower curtains. The curtains must be 100% Polyester water resistant finish with drip dry technology. Curtain to include 8 hooks. Dimensions: to fit shower opening. Color: White. Warranty: 12 Months.

The *Contractor* to supply and install two (2) stainless steel restroom signs (150 x 150mm). One male and one female. The *Contractor* shall explain his preferred method of fixing the signs to the door in *his/her* method statement. Double-sided-tape or any other form of glue shall not be acceptable.

Plumbing and drainage

The *Contractor* shall remove and replace the existing drainage pipe going from the laboratory to the sludge sump (40m). The new drain shall consist of a solid wall Class 34 (Heavy duty) 110mm OD uPVC pipe that is laid with suitable flexible joints to allow for movement. Pipes shall comply with the requirements of SANS 791:2014. The pipe should not deteriorate in contact with water or sewage. The pipe trench shall be excavated to a minimum width of 700mm and to a depth that is equal to the base of the existing pipeline. Any hard rocks or boulders shall be removed from the trench. The pipe trench shall be backfilled with excavated material and compacted to 90% MOD AASHTO. Only solvent cements, lubricants and solvent cleaners recommended by the pipe or fitting manufacturer should be used in the jointing of pipes and pipe fittings.

Glazing

The *Contractor* to supply and install two (2) 600 x 900mm framed glass mirrors. The frame selection shall be subject to the *Client's* approval.

Paintwork

Previously painted plastered surfaces shall be washed down and allowed to dry before paint is applied. Blistered or peeling paint shall be completely removed and cracks shall be opened, filled with a suitable filler and smoothed. Walls shall be coated with one coat of low odour premium quality velvet sheen paint coating that is highly washable and stain resistant. The paint shall be applied to a suitable thickness that will ensure that the underlying paint layer is not visible. The selected paint shall carry a 15-year Manufacture Quality Guarantee. The *Contractor* shall provide three painted colour samples.

Ceilings shall be coated with one coat of low odour premium quality velvet sheen paint coating that is highly washable and stain resistant. The paint shall be applied to a suitable thickness that will ensure that the underlying paint layer is not visible. The selected paint shall carry a 15-year Manufacture Quality Guarantee. The *Contractor* shall provide three painted colour samples.

3.3.5 Guarantee on all structural repair work and coating systems

The Contractor shall provide a 10 year guarantee on all structural repair work and coating systems that were installed.

3.3.6 Construction monitoring and professional engineering certification of the works

The *Contractor's* ECSA Registered Professional Engineer responsible for the design of the structural remedial works is to provide construction monitoring on the works in accordance with the provision of normal and additional services as per "Guideline Scope of Services and Tariff of Fees for Persons Registered in terms of the Engineering Profession Act 2000", for construction monitoring of the execution of the works. Construction monitoring includes but not limited to:

- Review a sample of each important work procedure and construction material and other technical submissions such as construction method statements, inspection and test plans and quality control and quality assurance plans.
- Attending site meetings and maintain adequate presence on the construction site to review samples of works and important completed work prior to enclosure or on completion as appropriate.
- Provide the *Project Manager* with technical interpretation of the plans and specification when required.
- General inspection of materials and equipment for compliance with the design documentation for adherence to National and International standards.
- Provides the *Project Manager* with updated design documentation (drawings and specifications) where changes are required to ensure integration with existing works and where design changes are required due to unforeseen site conditions.
- Prepares and, on completion of the works, provides the *Project Manager* with As-Built drawings and a final (updated) design report signed by the *Contractor's* ECSA registered Professional Engineer.
- Conduct a final inspection of the completed works prior to commissioning.
- Certifies the works as complete, that design intent is achieved during construction, and the works are safe for commissioning and use in accordance with the design specifications by issuing a completion certificate i.e., Professional Engineering Certificate, in terms of the Construction Regulations, 2014, Occupational Health and Safety Act 1993.

3.3.7 Quality Requirements

- The *Contractor* shall supply individual product data sheets for all repair and coating products, comprising the system which shall contain the following as a minimum:
 - i. A description of the product.
 - ii. Confirmation that the product is suitable for the intended method of application.
 - iii. Recommended and non-recommended uses.
 - iv. The lining system product data sheets shall contain the maximum recommended service temperature which shall be a minimum of 30% greater than the maximum operating temperature of the structure. The lining rating shall consider the above temperatures as continuous service i.e. not intermittently.
 - v. Chemical resistance limits.
 - vi. Surface preparation.
 - vii. Application conditions and details including but not limited to: application temperatures, dilutions, pot-life, application techniques and DFT for the particular application method, over-coating intervals, and curing times required before immersion.
- Prior to the application of any of the corrosion protection systems, the Product Data Sheet/s shall be signed by the manufacturer and applicator. This is to ensure that the manufacturer is aware of this specification, the conditions under which it will be applied and to allow for technical back-up where required.

- The signed Product Data Sheet/s shall be deemed to be a binding reference document (as part of the QCP). It shall be specific to this project. Any further/other subsequent revisions of the Product Data Sheet/s shall be submitted to Eskom for reacceptance clearly stating the variations/deviations and no further use/application of the related product, for this project, is permitted until acceptance is granted by Eskom.
- A detailed Method Statement explaining all required steps for the execution of a visual inspection and condition assessment shall be provided at the time of tender. The method statement shall include details of the tests used to obtain the following information:
 - i. Strength and surface hardness.
 - ii. Concrete uniformity.
 - iii. Presence of reinforcement and depth of concrete cover.
 - iv. Depth of carbonation.
 - v. Presence of chlorides and chloride profile.
 - vi. Presence of sulphates.
 - vii. Rate of corrosion.
 - viii. Moisture content.
- A detailed Method Statement explaining how the concrete remedial works will be executed shall be submitted at the time of tender. The method statement must explain in detail the method selected by the *Contractor* to achieve the following:
 - i. Substrate preparation.
 - ii. Concrete repair by hand applied mortar.
 - iii. Concrete repair by recasting concrete elements.
 - iv. Concrete repair by spray concrete or mortar.
 - v. Concrete crack repair..
- A detailed Method Statement explaining all required steps for concrete protection, as specified in this scope of work shall be provided at the time of tender. The steps to be considered include but are not limited to:
 - i. The methods, steps, sequence, and equipment required for dust mitigation.
 - ii. Grease decontamination and washing.
 - iii. Soluble salt decontamination.
 - iv. The parameter setup for blasting and coating techniques i.e. conventional airless spray, dual/plural spray, flow coating, pigging etc. shall also be included in the Method Statement.
 - v. Methods for dust and debris removal, maintaining and ensuring cleanliness between coats shall be described.
 - vi. The Method Statement shall detail the precise sequence and breakdown of work areas/activities in order to apply the system with due consideration of dust contamination, possible overspray onto adjacent surfaces still requiring additional coats and curing periods.
 - vii. The Method Statement shall also consider the most efficient methods and sequencing to avoid unnecessary delays between coats that may have an impact i.e. time required for removal of spent abrasive grit and dust/debris, delay due to material handling, time required to handle, rig and move the component etc.
 - viii. All inspection interventions during and after completion of final coats shall be considered and included.
 - ix. The method statement shall describe all measures and details for establishing and maintaining the environmental conditions required for the application of the liner system. In addition, the method statement shall describe the ventilation techniques that will be implemented to prevent and/or manage fumes and dust.
- Detailed Method Statements shall be submitted to Eskom for review and acceptance/rejection prior to the commencement of any work. Eskom reserves the right to request further revision, clarification, or additions.
- The *Contractor* shall submit detailed, project specific Quality Control Plans (QCPs). The QCPs shall be based on the detailed Method Statements and shall contain all intervention points and relevant acceptance criteria as per the information as described in the Product Data Sheet/s and this scope of

work. Eskom reserves the right to request further revision, clarification or additions in accordance with or as required by this specification sheet.

- Under no circumstances shall any work be performed until the QCPs and Method Statements have been accepted by the *Eskom* engineer.
- The coating manufacturer shall provide technical surveys during the execution of the project. The applicator shall commit to this requirement in the Method Statement
- The applied lining system shall be guaranteed jointly by the coating manufacturer and applicator for a minimum period of ten years. This guarantee with proposed terms and conditions shall be submitted at the time of tender.
- The *Contractor* shall be certified and demonstrate compliance to the latest version of the ISO 9001: Quality Management Systems standard.
- The *Contractor* shall have the following documented information as a minimum:
 - i. Project Quality Policy
 - ii. Project Quality Strategy
 - iii. Project Quality Objectives
 - iv. Project Quality Management Plan
 - v. Project Organisation Chart.
 - vi. Project RACI Matrix.
 - vii. Job Descriptions including performance requirements and measurements.
 - viii. Equipment and Process Criticality Ratings.
 - ix. Project Quality Assurance Plans – per project phase:
 - Design.
 - Manufacturing, Inspection and Testing.
 - Construction, Inspection and Testing.
 - Commissioning and Taking-Over.
 - x. Project Quality Control Procedures.

3.3.8 Drying Bed Sand Replacement

The sand and gravel in the drying beds (x6) shall be removed, disposed of in an approved disposal facility, and replaced with new sand.

The drying beds will be thoroughly cleaned, the bottom distribution system and laterals will be inspected, and a proposal shall be provided to Employer for any repairs needed.

The sand and gravel change will be as follows:

- a) Graded gravel to be placed around the bottom drains in layers up to 30cm with a minimum of 15cm above the top of the bottom drains. At least 60 cm of top layer should consist of gravel of 7 to 15 mm size.
- b) Clean sand of effective size of 0.5 to 0.75mm of uniform coefficient not greater than 4 to be used. The depth of sand may vary from 50 to 60cm.
- c) Coarse gravel should be put back after the inspection of the drying beds and then graded gravel layer will follow.

3.3.9 Additional Sewage Handling and Treatment

The existing works is a single line installation and as such, it is necessary that process flow be maintained during the execution of the works.

It is possible to stop the forward flow on the plant for limited time (approximately 5 hours) at low-income flow periods however, the sewage handling plant will not be shut down and the incoming sewage will have to be treated while the inspections, testing and refurbishment is taking place.

A proposal on treating the influent to sewage plant, during execution the works, will form part of the tender package. The current layout of the sewage plant is shown in drawing – “20.58/14933 Sewage Treatment works Eskom Matimba” Power Station. The operation and control of the sewage treatment plant will remain under supervision of tenderer during the construction.

The proposal needs to have a cost breakdown and needs to cover all costs expected by the contractor. Tenderers shall allow for bypassing, diverting or maintaining forward flow during the execution of the whole works.

The alternative treatment plant shall meet the following requirements:

- Fit in the existing premises of the plant
- Effluent quality shall comply with general limits
- Plant shall be commissioned in no more than 12 months
- Shall be a proven technology that has been in operation for over 5 years. Technology that is in a research phase or piloting stage will not be accepted.

It is the sole responsibility of the contractor to select the treatment system. The contractor can choose to construct a new plant/module, retrofit the existing plant or supply a mobile/containerised system. A very detailed proposal shall be submitted with the tender.

In the event where the Contract decide to retrofit the system, it shall clearly state how the new streams will be interphase with the existing system. The contractor shall evaluate the capability of the existing infrastructure from the raw sewage screening to the settling tank (clarifier).

The selected alternative stream shall be able to treat raw sewage of the quality stated in section.. of this works information.

3.3.10 Standard Civil and Structural Specifications

The latest edition as at date of tender of the following specifications shall apply:

Number	Description
240-106365693	Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings
240-56364545	Structural Design and Engineering Standard
240-56364535	Architectural Design and Green Building Compliance Manual
240-57127953	Execution of Site Preparation and Earthworks Standard
240-106628253,	Standard for Welding Requirements on Eskom Plant
240-144332407	Guideline for Eskom Power Stations Concrete Remedial Work
SANS 1200	Standardized specification for civil engineering construction
SANS 10160 (1-8)	Basis of structural design and actions for buildings and industrial structures
SANS 10162 (1, 2 & 4)	The structural use of steel
SANS 10100 (1-2)	The structural use of concrete
SANS 2001 (All)	Construction works
SANS 2001 – CC1	Construction works Part CC1: Concrete works (structural)
SABS Method 865	Concrete tests - The drilling, preparation, and testing for compressive strength of cores taken from hardened concrete

Copies of the above listed SANS specifications are not bound into this document. They can be purchased from the SA Bureau of Standards directly.

For all Building Works, the latest edition of the “Model Preambles for Trades” as recommended and published by the Association of South African Quantity Surveyors shall apply. This Standard Specification in not bound into this document but may be purchased from the Master Builders Association directly.

In the event that there is a discrepancy between the SANS 1200 Specifications and the “Model Preambles for Trades”, the SANS 1200 Specifications shall take precedence.

3.4 Electrical & mechanical engineering works

3.4.1 Scope

This Specification covers the design, supply, delivery, installation, testing, commissioning, decommissioning and guarantee of the electrical, control and instrumentation installation as per the relevant Drawings and Specifications.

The Scope of work includes and not limited to:

- a) Removal of the existing main sewage plant MCC.
- b) Design and installation of new main sewage plant MCC.
- c) The main sewage plant MCC should be designed in such that the overall dimensions fit in the existing space or room. The newly designed MCC must fit on the existing cable trench.
- d) Low voltage and instrumentation cabling inclusive of cable racks.
- e) Replacement of all control panels (Main sewage plant and pump station 3) with newly designed ones.
- f) Replacement of all distribution panels (Main sewage plant and pump station 3) and junction boxes with newly designed ones.
- g) Replacement of all LV motors (Main sewage plant and pump station 3) with newly designed ones.
- h) Testing of all power, control and wiring cables, and replacement with newly designed ones if the existing cables are not in good condition. (Main Sewage plant and pump station 3).
- i) Addition of auxiliary contacts at the pump station 3 MCC panels for control and instrumentation remote monitoring (status) and data acquisition.
- j) Earthing of all electrical newly installed equipment to the earthmat.
- k) Detailed design drawings, including motor schematic diagrams and instrument and control termination diagrams.
- l) Earthing and lightning protection
- m) KKS labelling to all equipment.
- n) Any other installation materials stated or implied to provide for a complete installation in accordance with the Specifications, Drawings and Schedules supplied.
- o) Provide certificate of compliance for all small power installations.
- p) Install or modify lighting where needed.

The scope of work includes the provision for the design, manufacture, factory testing, supply, delivery, off-loading, move to position, erection, installation, site testing, commissioning, and handover for all electrical systems inclusive of all necessary accessories for the Sewage plant systems. All electrical equipment will be type tested in accordance with the relevant standards. The scope of work includes testing the existing supply cables, and terminating new supply cables to the MCC if the existing power cables are not in a good condition.

3.4.2 General Information

- a) Only equipment based on proven technology and of high reliability shall be considered for use.

- b) All schedules included in the Tender Document shall be completed in full and submitted with the Tender.
- c) All relevant technical information regarding each component or item offered shall be included either in the forms to be completed by the Tenderer or as an Appendix to the Tender, in order that the Engineer can make a proper evaluation of the offer.

3.4.3 Standards and Regulations

All materials and equipment shall be new and of the standard and quality specified.

Tenderers shall ensure that they are fully acquainted with the contents of the applicable Electrical Specifications.

The wiring installation shall comply fully with SANS 10142-1 as amended.

The design and manufacture of equipment and the complete installation shall be carried out and tested in accordance with the latest issue or amendments of the following Regulations, as applicable:

- a) SANS 10142-1 – The wiring of premises. Part 1: Low-voltage installations.;
- b) SANS 61439 - Low-voltage switchgear and control gear assemblies
- c) The Occupational, Health and Safety Act, (Act 85 of 1993);
- d) The local Municipal by-laws and Regulations and Regulations of the local supply authority;
- e) The Fire Brigade Services Act, 2000 (Act 14 of 2000);
- f) The Regulations of Telkom (S.A) Ltd;
- g) The National Building Regulations and Building Standards Act, (Act 29 of 1996); and
- h) 240-56536505 - Hazardous Locations Standard.
- i) 240-56227443 - Generation requirements for control and power cables for power stations Standard.
- j) 240-56227516 - LV Switchgear and Control gear Assemblies and Associated Equipment for Voltage up to and including 1000 V AC and 1500 V DC standard.
- k) 240-56357424 - MV and-LV switchgear protection standard.
- l) 240-56356396 – Earthing and Lightning protection Standard.
- m) 240-57617975 – New Low Voltage Motors procurement Standard.

3.4.4 Standard Mechanical Specifications

All the materials used in the Works shall be the best of their respective kinds and shall comply in all respects, in so far as this may be applicable, with the requirements of the latest South African Standard Specification, or British, American, or European Standard Specification where specified.

The following Standard Specifications apply to this Contract unless indicated otherwise:

Number	Description
SANS 62	Steel pipes and pipe fittings up to 150 mm nominal bore suitable for screwing to SABS 1109 pipe threads
SABS 136	ISO metric precision hexagon head bolts (coarse thread medium fit series), screws and hexagon nuts

SANS 460	Copper tubes for domestic plumbing services
SANS 664	Cast iron gate valves for water works
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SANS 763	Hot dip galvanised zinc coatings (other than on continuously zinc-coated sheet and wire)
SANS 965	Stainless Steel Pipes
SANS 1123	Steel pipe flanges
SANS 044	Welding
SANS 064	Preparation of steel surfaces for coating
SANS 0111	Engineering drawing
SANS 141	Dry film thickness of paints by means of magnetic flux type gauge
BS 1452	Specification for grey iron casting
BS 2035	Cast iron flanged pipes and flanged fittings
BS 2633	Class 1 welding of ferritin steel pipework
BS3605	Seamless and welded Austenitic stainless steel pipes and tubes for pressure purposes
BS 4999	General requirements for rotating electrical machines
BS 5080	Methods of testing for structural fixings in concrete and masonry
BS 5316	Acceptance tests for centrifugal, mixed flow and axial pumps.
API STD 1104	Standard for welding pipelines and related facilities

Reference to the above specifications shall be deemed to be referenced to the latest issue of the relevant specification at the time of tender.

3.4.5 Material

All switch boards, distribution boards, and control panels shall be manufactured as per Eskom latest approved standard.

All steelwork, cable trays, and cable ladders shall be hot-dipped galvanised.

All fixing bolts, nuts, washers, brackets, etc., shall be stainless steel.

3.4.6 Power Supply

The main sewage plant Power supply (380V) will be from the existing mini sub/transformer (315 KVA, 11kV/400 V, ONAN) on site. The *Contractor* shall ensure that all loads (New, Old or temporary sewage plant) do not exceed the transformer ratings or overload the transformer.

Pump Station 3 Power supply (380V) will be from the existing mini sub/transformer (500 KVA, 11 kV/400 V, ONAN). The *Contractor* shall ensure that all loads (New, Old or temporary plant) do not exceed the transformer ratings or overload the transformer.

3.4.7 Manuals

Before the Tests on Completion date, the Contractor shall submit a set of complete technical manuals to maintain, service and repair the installation. These manuals shall contain, as a minimum requirement, the following information:

3.4.7.1 Electrical Equipment

Drawings and manuals as specified in the Standard Specifications for the applicable equipment shall be provided. Documentation shall also include all the factory and site test certificates and final test set points.

3.4.7.2 Installation

- a) Included in this portion of documentation shall also be all cable test certificates of tests performed both by the manufacturer and after installation. All site test certificates including earth resistance measurements, loop testing, functional testing, etc., shall be included.
- b) Sets of the complete cable schedules shall be provided, showing the “as installed” status, sizes, quantities, cable and core numbering, core types and cable types of all cables installed, excluding cabling for single- and three-phase socket outlets. This shall include cabling installed for signals, pilots and for metering.

3.4.8 Cabling Requirements

The *Contractor* performs the scope detailed here-in pertaining to cabling works:

- a) Cable installation and termination complies with zone classifications of each location, where applicable also complies with 240-56536505: Hazardous Locations Standard and 240-56227443: Generation requirements for control and power cables for power stations Standard.
- b) Power cabling includes incoming power cables from 380V MCC board supplying the Electrical Distribution Panels and control panels feeding respective Sewage Plant equipment in different areas. The incoming power cable from the minisub to the temporary sewage plant is the responsibility of the contractor. The contractor is also responsible for designs, supplying, pulling and termination of any secondary cabling, therefore interfacing all cabling between contractor's provided equipment and the electrical panels.
- c) Cable route identification is the responsibility of the contractor. The contractor is to assess and make use of the existing cable routes and cable racks as far as possible, if cable racks are not in a good condition, it is the responsibility of the contractor to replace them. Provision for additional cable racks is to be made after assessments conducted by the *Contractor* and accepted by the *Employer*.
- d) The *Contractor* is to clearly specify the power requirements for the Sewage plant equipment to be provided and installed. The load schedule template provided is to be utilized to specify the power requirement 240-56227927. Provide the populated load list in Appendix 1 and load schedule as per Appendix 2.
- e) Cable schedules are to be developed to include the new circuit descriptions, cable sizes and lengths, cable numbers, cable types etc. as per Appendix 3. Electrical Cable Schedule template 240-56176097.
- f) The contractor is to carry out the necessary bonding and earthing requirements on all newly installed equipment, according to the requirements on the 240-56356396 – Earthing and Lightning protection Standard.
- g) Installation of durable cable numbering for all cables connected to the equipment, the cable labelling is to be installed such that it is visible for ease of identification during maintenance and is to comply with 240-56227443 Requirements for Control and power cables for power Stations standard. The cabling contractor is to apply to the *Employer* for the cable numbers using the developed cable schedules.
- h) A test certificate of compliance prior to commissioning is to be issued.
- i) The complete power and control cabling is to be designed, installed, and commissioned in accordance with the requirements of Eskom standard 240-56227443 – Requirements for control and Power Cables for Power Stations Standard.

- j) Handover of the plant is to be done, and to include all relevant documentation including but not limited to the following:
- Cable test certificates,
 - Cable routing and cable block diagrams,
 - 380V Sewage plant Electrical Distribution Panels single line diagrams, General Arrangements etc.
 - Cable schedules.
 - Cable diagrams.
- k) The contractor is to provide all the *Works* to the *Employer* as per the documents listed below, for review:
- Appendix 1: 240-56227927 – Electrical Load List Template.
 - Appendix 2: 240-77301384 – Electrical LV Load Schedule Template
 - Appendix 3: 240-56176097 – Electrical cable Schedule Template
 - Appendix 4: 240-56356421 – Electrical LV Switchgear Schedule Template.
 - Appendix 5: 240-56356465 – Electrical LV list of Switchboards Template.
 - Appendix 6: 240-77302094 – Electrical Termination Schedule Template.
- q) Verification of the allocated circuits for serviceability and operability shall be conducted; any defects on the circuits are to be reported to the Employer before any rectification is conducted.
- r) The Contractor is to verify the components ratings (i.e., fuse switches, fuses, and terminals) of the circuits, before the completion of designs.
- s) The Contractor to be responsible for all the connections to the earth mat.
- t) The Contractor is responsible for any modification and circuit components associated with Electrical Distribution Panels.
- u) Existing cables shall be tested before connecting to the new MCC. Existing cables shall be replaced with new cables if they did not pass the test. Cables are bottom entry.
- v) A continuous copper main earth bar shall be run for the full length of the Motor Control Centre.
- w) All equipment requiring earthing shall be effectively earthed to this main earth busbar.
- x) The Contractor shall ensure that all cable gland plates are effectively earthed via the steelwork of the panel or provided with individual bonded conductors.
- y) Existing electrical cables shall be tested before connecting to respective distribution panels, control panels and equipment. The Contractor shall ensure that new cables are installed should the existing cables not be within specifications.
- z) All steel structures shall be bonded to this common earthing electrode installation.

3.4.8.1. Qualification and experience

The key personnel should at minimum have the following:

For the installation, testing, jointing and termination of both LV and MV cables, a formally qualified Electric Cable Joints is a requirement. An Electric Cable Joints plans, prepares, installs, joints, and terminates low voltage (LV) (1000V) and medium voltage (MV) (up to and including 44kV) cables under dead (at zero potential) conditions. The candidate must be trained and qualify for SAQA Level 4. A qualified Electric Cable Joints must be able to:

- Plan and prepare for low voltage cable jointing equipment and operations and plan and conduct on-site preparation by setting up equipment for jointing procedures.
- Install, test, joint and terminate low voltage cables (dead) complying with statutory requirements and manufacturer specifications.

The Contractor must have successfully completed three projects in cable jointing and termination in the last 5 years. The summary of track record should indicate the following:

- Number of years' experience in the on cabling associated projects.
 - Summary of the nature of project and scope associated with cabling works (Design, installation, testing, jointing and termination).
 - Indicate the types of cables that have been jointed.
- 1-off Professional ECSA Registered Electrical Technologist/ Engineer with a track record of 4 completed projects in the last 5 years and have at least 5 years' relevant experience as a minimum, for design, construction, and commissioning of Electrical systems. 1-off Registered Electrician with Department of Labour (DoL) as Master Installation Electrician or Installation Electrician in terms of Electrical Installation Regulations. Proof of Registration certificate for an electrician or installation electrician to be submitted with reference to at least 3 completed projects for design, construction, and commissioning of Electrical systems in the last 5 years.

3.4.9 Electrical Distribution Panels.

The *Contractor* is to perform the scope detailed here-in pertaining to distribution panels:

- a) The scope of work includes the provision for the design, manufacture, factory testing, supply, delivery, off-loading, move to position, erection, installation, site testing, commissioning, and handover of LV MCC at main sewage plant and control gear Assemblies. Sewage Plant Electrical Distribution and control panels are to be supplied from the 380V MCC boards.
- b) The designs and installation of Sewage plant Electrical Distribution Panels are to be in accordance with the requirements of 240-56227516: LV Switchgear and Control gear Assemblies and Associated Equipment for Voltage up to and including 1000 V AC and 1500 V DC standard and 240-56357424: MV and-LV switchgear protection standard.
- c) The supply cables are to be terminated by the Contractor.
- d) All the Sewage plant equipment in the plant is to be supplied and controlled from the Sewage plant Electrical Distribution Panels, Junction and/or reduction boxes, the equipment includes, motors, pumps, etc.
- e) All the control sections in the panel are to have sufficient space for controllers which will:
 - Switch equipment on/off.
 - Interlock between running and standby equipment.
 - Drive and control all the motorized equipment.

3.5 Motor Control Centres (MCC)

3.5.1 General

The MCC includes but not limited to the following:

- MCC and control gear assemblies.
- Copper busbar connections.
- Protection schemes.

- The existing main MCC (main sewage plant) shall be replaced with a new MCC as shown on the drawings and as specified. The current MCC and the motor starter panels for Transfer Pumps shall be disconnected and removed by the contractor.
- The *Contractor* designs the MCC in accordance with the requirements of this works information, catering for all interfaces specified by the Employer.
- The *Contractor* designs MCC that complies with 240-56227516, SANS 61439. The Contractor completes LV Switchgear Technical Schedule A and B (240-115583001) in appendix 7 to provide guarantees on the offered plant concerned. The MCC must be of a type tested design as per SANS 61439-1 as a minimum.
- The Contractor performs the mounting of protection equipment, the wiring of the relays and control circuits on the LV MCC.
- The Contractor performs the detailed design of the protection and control circuits as well as interfacing.
- The Contractor's designs are submitted to the Employer for review and acceptance.
- The Contractor assesses the MCC room, and the solution required for ensuring that the floor level is even and within required tolerances.
- The Contractor provides training on the equipment regarding operating, maintenance, and engineering in accordance with the Acceptance Programme.
- Any special tool or keys that may be required for maintenance or for adjustments are provided by the Contractor.
- Disconnection and removal of the existing power and control cabling from the existing MCC and the removal of the existing MCC is carried out by the Contractor. The Contractor submits proposals for re-positioning of the power and control cables to suit the new MCC, for Employer's acceptance.
- The Contractor is responsible for re-connection of the power and control cables of the main supplies (incomers) once the MCC is in position.
- The Contractor ensures that the LV MCC earthing complies to Eskom's Lighting and Earthing protection standard 240-56356396.
- The Contractor ensures LV MCC comply with 240-56227516. All deviations are listed accordingly in the deviation schedule.
- The Contractor completes and submit the Compliance Schedule in Appendix 9 at the tender stage and describes any deviations from this technical specification in the comments section of the respective compliance schedules.
- Panel design and construction of the MCC is as per 240-56227516. The MCC is for indoor use, air insulated, metal-enclosed and internal arc classified in accordance with SANS 61439-1.
- The *Contractor* shall ensure that the new main sewage plant MCC is protected against under voltage and phase fail conditions as minimum.

- The *Contractor* shall ensure that the existing Pump Station 3 Motor Control Centre (MCC) and the diesel generator are equipped with alarm and operation indicators of all electrical equipment at pump station 3. The *Contractor* shall ensure that the alarms and operation indicators of all electrical equipment are configured and displayed on the Human Machine Interface (HMI) at the OPCR.
- The *Contractor* shall ensure that the new main sewage plant MCC to be installed and the existing diesel generator are equipped with alarm and operation indicators of all electrical equipment at the main sewage plant. The *Contractor* shall ensure that the alarms and operation indicators of all electrical equipment are configured and displayed on the Human Machine Interface (HMI) at the OPCR.
- Each functional unit is equipped with accessories to meet the design requirements and the accessories comply with 240-56227516.
- The Contractor is responsible for making sure that the positioning of the offered equipment makes it possible for maintenance personnel to perform maintenance with full access to the equipment. The existing MCC is 1830mm long as per drawing 0.59/711.. The contractor shall indicate at tender stage that their MCC will fit into the existing room. Variable speed drives and PLC cubicle can be mounted separately where applicable. The Contractor must do their own measurements of the existing MCC and the room.
- The MCC shall be vermin-proof type.
- Starters, incoming breakers, and local DB (Distribution Box) shall be housed in separate compartments. Each separate compartment shall be provided with a hinged door, which shall be arranged so that it cannot be opened while the apparatus contained therein is alive, unless this apparatus is fully shrouded or screened to prevent inadvertent contact. Where the apparatus contained in the compartment is provided with an isolating switch or MCB, the door shall be mechanically interlocked so that it cannot be opened unless the switch is in the "OFF" position.
- The *Contractor* shall install an Uninterrupted Power Supply (UPS) and a Charger for instrumentation and PLC power.
- The MCC shall be floor standing, front access, and bottom entry power cables with the gland plates as per the LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and including 1000V AC and 1500V DC Standard, 240-56227516.
- Each panel shall have auxiliary contacts for control and instrumentation interface.
- The Contractor shall equip the installed pump station 3 MCC with auxiliary contacts for control and instrumentation interface remote monitoring and data acquisition.
- Indicating lights shall be of the LED cluster type. They shall be provided with a lamp test push button to verify operation.
- Surge arrestors shall be complete with failure indication.
- Development of the Electrical Plant and Materials is not considered complete until the Contractor has provided a comprehensive list of spares to be held in stock which, at minimum, include one of each of the different controller modules, auxiliary relays, MCBs, switches, lamps as well as empty sub-racks, plugs and sockets and consumable items, if any.
- The Contractor designs a comprehensive protection scheme that defines the interfaces between all relays as well as the other related systems.
- The Contractor shall interface the new MCC with the existing diesel generator and the chop-over panel.

- Incomer feeders shall be provided with voltmeter, CTs, ammeter and indication lamps for breaker status.
- Motor status i.e, LOCAL/REMOTE/ON/OFF, etc are required for remote monitoring and data acquisition.
- Ammeter, push buttons, indication lamps for start/stop/trip shall be provided for all motors feeders. Local control panels shall be provided near the motors/pumps for START/STOP. Necessary logic for the implementation shall be incorporated. Relays, meters, and control switches shall be located at height which shall be convenient for monitoring.
- All equipment shall be rated for 15kA fault level, based on the transformer ratings.
- The duration of the maximum short circuit currents shall be deemed to be a minimum of one second.
- All removable covers/doors protecting live equipment shall be fitted with warning labels. Warning labels shall be engraved red characters on a white background.
- All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.
- All MCC equipment shall be inspected prior to delivery, to ensure compliance with the specification.
- The Contractor provides any special maintenance tools and equipment for the switchgear as per 240-56227516, the Contractor also supplies the necessary toolbox for the storage of the tools.

3.5.2 MCC Design Acceptance and Type Testing Requirements

The type testing requirements are as follows:

- a) The type tests and special tests are carried out on all types of functional units in accordance with 240-56227516 and SANS 61439-1.
- b) The Contractor provides relevant certificates and test reports to prove the compliance with 240-56227516. The minimum requirements for type tests applicable to MCC are provided in 240-56227516, section 3.
- c) The Contractor offers MCC that is similar to the type of the functional unit tested. If any functional component of the MCC differs from the one described in the type test certificates/reports, the components will be subject to re-testing before approval by the Employer. The conditions (i.e. panel configuration, number of tests to be done, etc.) under which the type tests are performed will be agreed between the test authority, Employer and Contractor.
- d) The Employer will accept the type testing before the Contractor starts with the manufacturing of the first switchboard incomer.
- e) Type test documentation represents the design of the functional unit with respect to the configuration, type, and rating. The information to be included in type test reports is in accordance with 240-56227516. The report of the type tested functional unit and associated components reflects the equipment under consideration. The type test report is provided in full, containing all records of the tests conducted as well as the drawings.

Routine test requirements are as follows:

- a) Routine tests are done by the accredited test authority in accordance with 240-56227516 and SANS 61439-1. The performance of the MCC as well as the associated protection schemes is proven to comply with the technical requirements stipulated in this specification.
- b) Two copies of the final routine test reports for each functional unit of the Plant are provided by the Contractor not later than the delivery date of the plant.

The components acceptance requirements are as follows:

- a) All active components of the Plant that do not form part of the OEM's original design are subject to acceptance by the Employer. The component complies with the relevant requirements of this technical specification as a minimum.
- b) Where required, the Contractor provides calculations to prove the component application, design, and compliance to the requirements. The relevant schematic drawings are used for the acceptance of component application. Should the requirements not meet the component application design requirement, the additional cost is borne by the Contractor.
- c) The Contractor provides original copies of the technical documentation of each component in a file complete with contents list as well as all calculations or justification per component. The Contractor submits two copies of files labelled Components Acceptance Application in this regard.

3.5.3 LV MCC Design Requirements

- a) After the contract is awarded, the Contractor performs Detail Design in accordance with Employer's requirements presented in this technical specification. The designs are agreed with the Employer to achieve Design Freeze status.
- b) The Contractor submits the following data in neat files for acceptance by the Employer before Design Freeze Status can be declared as a minimum:
 - Technical Schedule A and B.
 - Compliance Schedule.
 - Engineering Change Register.
 - Single Line Diagrams for switchboards.
 - General Arrangement Drawings.
 - Switchgear Schedule.
 - Protection Functional and Interface Block Diagrams.
 - Schematic Diagrams for Protection and Control Systems.
 - Component Schedules.
 - Technical Manuals.

The Employer will accept the following set of drawings, before any manufacturing can take place:

- a) General Arrangement drawings for the MCC.
- b) Switchgear Schedule for the MCC with reference to component schedule.
- c) Schematic diagrams for each circuit (this must include all wire numbers, termination numbers, termination strip numbers, fuse sizes and spare contacts).
- d) Component schedule for each circuit on the ASSEMBLY.

For non-standard circuits i.e., incomer, chop-over, the Contractor discusses the requirements with the Employer and work out a suitable design which the Contractor submits for acceptance.

3.5.4 Busbars

- a) Busbars design requirements are to be in accordance with 240-56227516 and SANS 61439-1.

- b) Horizontal power busbars and vertical busbar droppers shall be copper, of constant cross-sectional area throughout their length, and shall be mechanically braced for the short circuit current value as specified.
- c) Horizontal power busbars and vertical busbar droppers shall be copper, of constant cross-sectional area throughout their length, and shall be mechanically braced for the short circuit current value as specified.
- d) Contact surfaces of busbars at splices and bolted joints shall be silver plated.
- e) Busbars shall be colour coded.
- f) The busbars shall be rated for the full load capacity of the main switch and shall be capable of withstanding the fault level.
- g) The main horizontal busbars shall be completely isolated from the other zones. The vertical power busbar droppers on each panel shall be insulated or isolated so that with the compartment door open or the main cableway door open, access cannot be gained to live busbars.
- h) The contract shall ensure that horizontal and vertical busbars can withstand the dynamic forces under the full short circuit conditions. Bolted joints in busbars are to be joined using copper fishplates of equal section to the busbars and using high tensile bolts and lock-washers.
- i) The busbars shall be positioned in such a way to allow for easy extension to the sides by adding additional panels, and to allow for cable entry from the bottom and top. Their spacing shall be in such a way that the cables could be connected to them in a neat and safe configuration.
- j) Holes in busbars shall be jig-drilled or punched so that they are perfectly round and only with sufficient clearance to suit the correctly size of bolt. All busbar ends behind the blanking off covers shall be pre-drilled for fishplates.

3.5.5 Lighting and small power

All electrical low voltage installations must be done according to SANS 10142-1 as per amendments.

3.5.6 LV Motors

All motors supplied by the contractor are to comply with the requirements set out in the New Low Voltage Motors procurement standard 240-57617975, SANS 1804 and the new LV motor technical schedule A and B in Appendix 8.

The LV motor protection requirements are as follows:

- a) The motor protection scheme is to have the following functions as a minimum:
 - Undervoltage protection.
 - Thermal overload protection.
 - Overcurrent protection.
 - Surge protection.
 - Phase fail protection.
 - Earth fault protection, where relays are installed.

The *Contractor* is responsible for the design and provision of all necessary earthing material for the motors, the *Contractor* shall connect all earthing bars to the nearest earthmat bar. All motors shall have a minimum IP rating of IP65.

Motor Control

- a) An auto/manual selector switch shall be provided for each starter. The motors shall be controlled by PLC in auto mode and controlled locally with stop and start pushbuttons in manual mode. All the trip conditions must still be in place during manual operation.
- b) Duty and standby pumps (1 x duty and 1 x standby) shall be alternated with each start (flip-flop). The standby pump shall start in case of failure of the duty pump. An alarm indicating that a pump set is inoperable and that the pump set has been substituted by the standby pump set is to be activated when a duty pump fails.
- c) Motor control shall be as indicated on the Piping and Instrumentation diagrams and control philosophy. Audible and visual (flashing light) indication shall be provided for alarms and faults. The audible alarm shall be resettable by means of a reset pushbutton. The visual alarm (flashing light) shall remain activated until the fault has been cleared.
- d) Sufficient motor starters must be included to cater for the mechanical drive requirements.

3.5.7 Inspection and Testing

- a) The Engineer may carry out periodic inspections during various stages of manufacture. Final factory tests of the MCC shall be carried out before despatch from the works.
These tests shall include, but not be limited to, the following:
 - Tests to determine that the apparatus fully and strictly complies with the requirements of the specifications.
 - Comprehensive primary injection tests of all current transformers and associated circuitry.
 - Comprehensive pressure tests to prove insulation quality.
 - Functional tests of all control gear and the feeders.
- b) The Manufacturer shall make provision for all power supplies, testing equipment, simulating apparatus, and competent personnel to carry out the tests.
- c) At least two weeks' notice of the manufacturer's intention to carry out final tests shall be given to the Engineer. All test results shall be recorded on standard test sheets and three copies shall be provided to the Engineer within one week of satisfactory tests being completed.
- d) Once equipment has been erected on site, the following tests and field checkouts shall be performed:
 - Random primary and injection tests to check that the functioning of control current transformers and associated circuitry has not been disturbed.
 - Random checks on the functioning of control gear.
 - Comprehensive insulation resistance tests to prove that the quality of the insulation has not deteriorated during the erection of the MCC.
 - Particulars of the site tests and field checkouts and the results shall be recorded and incorporated on site reports.

3.5.8 Electrical Drawings Requirements

- a) The Contractor provides drawings for the required equipment as per the standards referenced within this technical specification.
- b) The Contractor develops the following minimum requirements for the drawings:

3.5.8.1 General Arrangement Drawings

The *Contractor* provides general arrangement drawings completely dimensioned, showing:

- a) Arrangement of equipment offered.

- b) Front view, and other elevation views of the equipment.
- c) Required clearances for opening doors.
- d) Conduit or cable entrance location for bottom entrance.
- e) Busbar locations and configurations.
- f) Incoming and outgoing cable termination positions.
- g) The height of all cable glands above floor level.
- h) Position of control panels and associated components.
- i) Terminal block locations.
- j) Mass of equipment.
- k) Details and positions of holding down bolts.
- l) Dimensions of holes required.

3.5.8.2 Schematic Drawings

The *Contractor* provides schematic diagrams that show the following:

- a) All protection and control devices and their contacts, each of which are labelled.
- b) All internal interconnections, bus wiring, inter-panel wiring, and connections to external equipment.
- c) All control and protection switches.
- d) Power supply connections.

3.5.8.3 Single-Line Functional Diagrams

The *Contractor* provides single line diagrams for each circuit to illustrate the functionality and interfaces between protection, control, and metering systems. Such a diagram will show the following:

- a) All power circuit equipment and their descriptions including type and specifications.
- b) Electrical connections of instrument transformers (i.e., VTs and CTs) with relation to the cabling of protected Plant.
- c) Electrical connections of instrument transformers (i.e., VTs and CTs) with relation to the cabling of protected Plant.
- d) Details of the instrument transformers
- e) Protection scheme
- f) Metering points.

3.5.8.4 Wiring Drawings

The *Contractor* provides detailed wiring diagrams to show the following:

- a) Approximate physical locations of all items in each control panel.
- b) All interconnecting wiring between control panels.
- c) Identification of all terminals, terminal blocks, and wires by numbers.
- d) Clear identification, by some distinguishing method, of all wiring which will be installed by the *Contractor*. This will include, but not limited to, trip circuits from remote devices, auxiliary contacts to remote devices, incoming control power, and separate incoming AC power. This also includes spare auxiliary contacts and relay contacts which are wired to terminal blocks for future use.

3.5.9 Circuit Breaker Trolleys and Access Ladders

- a) The *Contractor* provides circuit breaker trolley for the circuit breaker provided, as specified in Schedule A of Appendix 7. Circuit breaker trolley wheels do not damage any painted substation floors when the circuit breaker is moved away from the panel. Circuit breaker trolley wheels are lockable by hand. Wheel surface material is provided with the tender.

- b) The number of access ladders to be provided for the substation is as specified in Schedule A of Appendix 7.

3.6 Control and Instrumentation engineering works

- 1) Complete design.
- 2) Transporting of material to site.
- 3) Storage and handling of material on site.
- 4) Supply of equipment and tools.
- 5) Supply and installation of the interfaces.
- 6) Supply and installation of the VA interfaces for long term archiving on the Plant.
- 7) Supply and installation of all new cabling.
- 8) All de-commissioned equipment shall be removed from the plant
- 9) Proof of expandability of the control system shall be required.
- 10) Supply and installation of cable numbers and KKS numbers.
- 11) Supply and Installation of Engineering Station.
- 12) Supply and installation of one backup computer to make backups on of the plant.
- 13) ~~Software licences and original software packages with provision for upgrades.~~
- 14) Testing and quality control.
- 15) Training (Operating, Maintenance and Engineering).
- 16) Commissioning of total system.
- 17) Supply of Documentation.
- 18) As built drawings and documentation.
- 19) Maintenance, Engineering and Operating manuals.
- 20) Decommission and remove of existing equipment
- 21) Decommission of cables.
- 22) Making good of areas where equipment was removed (floors, lights and panels)
- 23) Supply of spear list after commissioning.

4 Technical scope of work for C&I

4.1.1 Fibre cable

Fibre communication cable shall run from the Sewage Handling and Treatment plant to OPCR

4.1.2 Special tools

The *Contractor* supplies all special tools required for maintenance and engineering of the *works* which become the *Employer's* property at *completion* of the project.

4.1.3 Redundancy

The control Bus shall function as a redundant Bus system and shall interface with the process LAN. Any failure on the process LAN may not influence the system.
The Bus or network shall follow different roots and shall be fibre.

4.1.4 Automation system

The functionality of the automation (Allen Bradley PLC Programming) systems shall remain as is.

4.1.5 Control room

The control and monitoring of the plant shall be available in the OPCR.
The existing HMI shall be used.

The control room and the computer room air conditioning is designed to operate within certain temperature and humidity specifications:

During the summer the air conditioning control system, controls the temperature at $22^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and the humidity at $30\% \pm 5\%$.

During the winter the air conditioning control system, controls the temperature at $22^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and the humidity at $40\% \pm 5\%$.

4.1.6 Process Network Bus

The *contractor* should give his proposed process Network Bus.

For the communication between the Allen Bradley PLC's is used. The Allen Bradley network is a proprietary network.

4.1.7 Operator Station (OS) and Supervisory Control

The OS shall be used for:

- Operating
- Monitoring
- Supervision
- Plant Control
- Diagnostics
- Historical Data from process server
- Alarming
- Real Time Data

Operating

Normal day to day operating.

Monitoring

Monitoring of specific plant layouts and conditions.

Supervision

Supervising and controlling specific plant areas.

Diagnostics

The system shall have an on-line diagnostic facility to identify and rectify problem areas with no down time or risks to the plant.

Alarming page

Improved alarm handling shall be implemented to ensure that problems are detected early enough to take corrective action.

Real Time Data

All the identified plant signals shall be displayed as a real time data.

All Analogue Points shall be displayed.

Historical Data

A facility for recording and accessing historical data shall be provided (data storage 6 months) on process server.

All Analogue Points shall be displayed. All other alarms, events, operator actions and C&I fault status alarms shall be logged as part of the new system's process storage facility to assist with incident investigations

Interface

An interface shall be installed to the prepose network

5 Long-term data storage (VA)

The current Visual Automation System (VA) shall be used for all current long-term data storage.

6 Cabling

- Communications bus per meter.
- Decommissioning of existing cabling.
- Supply and installation of new instrument cables. (UVG02ACV)
- Supply and installation of new cables from LCS I/O to MCC. (UVG12ACV)
- Supply and installation of new cables from MCC to LCS I/O. (UVG02ACV)
- Conduit where needed. Price per meter
- Glands. Per gland.
- Cable termination, including junction boxes and LCP's
- Documentation
 - Junction box drawings.
 - Cable schedules.
 - Termination diagrams.
- Cable numbers. Per number.
- Consumables.

7 PLC

- Supply and installation of all relevant hardware.
- Supply and installation of relevant PLC's
- Per PLC:
 - Function drawings.
 - Signal flow diagrams.
 - Cable and rack diagrams
 - Cable schedules.
 - Termination information.

- Commissioning of all newly installed equipment
- Commissioning of newly installed PLC's and the software for the PLC's
- Portable programming unit
- Software licenses

NOTE: The function drawings must be generated from the PLC. The price of the software (should additional software be needed to do this) must be included in the tender. There must be 24 input, 24 output and 8 analog in-and outputs spare.

7.1 Instrumentation

- P & ID drawing.
- Secondary process flow diagrams.
- KKS labelling per label.
- Commissioning of the new instrumentation and equipment
- Calibrations of Instrumentation

7.2 Local Control Panels

- Supply and Installation of Local Control Panels
- Termination drawings.
- Description of the plant instrument next to the indicator and push buttons per label.
- Supply and Installation of push buttons.
- Supply and Installation of all LED indicators bayonet type.
- Installation of 8 seven segment LCD indicators.
- KKS labelling

The C&I scope of work design provides monitoring of the Sewage plant at the existing Outside Plant control room (OPCR). The Employer's process control and operating philosophy describes the control and monitoring requirements.

7.2.1 General C&I Requirements

The following general design requirements are applicable to all aspects of the C&I design:

- (1) The *Contractor* shall ensure field equipment operates in an environment within the parameters stipulated by the manufacturer.
- (2) Where harsh environmental conditions are unavoidable, the field equipment shall be designed for operation in that environment.
- (3) All IP ratings are as per SANS 60529

- (4) All supplied field equipment, excluding Junction Boxes (JBs) and their electrical connections are rated IP 65 or better.
- (5) Field equipment situated outdoors, or in adverse environments, must be provided with additional protection hoods and enclosures.
- (6) All supplied field equipment operates over an ambient temperature range of: -10°C to 70°C.
- (7) The equipment layout shall be such that when mechanical work is performed, no C&I equipment shall be damaged.
- (8) The supplied field equipment provided shall be standardised to the maximum extent possible
- (9) The *Contractor* as part of the scope of work provides a detailed design report prior to execution of the works during the detail design scope freeze.
- (10) All the documents required to be submitted by the *Contractor* during the design freeze shall be supplied as part of design data pack.

7.2.2 Installation requirements for the instrument, transducer, transmitter and junction box location and support

7.2.2.1 Level transmitters installation requirements

All field equipment (level transmitters) shall be installed in accordance with the manufactures' instructions, the requirements of this specification and good practices.

All field equipment shall be installed with due regard for the following:

- Passageways and environment of people and equipment during maintenance activities
- Ergonomics and maintenance access to equipment
- Field equipment supports shall not be welded to vessels or handrail, but shall utilise self supported racks with integrated cable and tubing trunking.
- Junction boxes in close proximity of each other shall be installed on the same level with even spacing between instruments and transducers
- All instrument and transducers installation shall be free from vibrations
- The contractor shall design a panel that enhouse the 24VDC power supply, transmitter with local display and a radio and an antenna setup.
- The Contractor shall design brackets for transducers and antennas to ensure stability and accuracy in for measurements purposes
- The contractor shall ensure that the panel stand at no less 1.5 m level above ground such that no Eskom personal working on the panel will be required to bend. All indication instruments shall be orientated to permit viewing from walkways or platforms.
- All instruments shall be installed away from potential fire risks, hot environments and sources of radiation.
- Instruments shall normally be accessible for adjustment or maintenance from the permanent walkways or platforms without the need for any temporary access equipment such as ladders, platform or scaffolding.

7.2.2.2 Accessibility

All filed equipment including instrumentation, transducers, transmitters and junctions boxes shall be accessible for servicing from the floor level, walkways, permanent ladders or platforms

7.2.2.3 Instrument cable installation requirements

All instrument cabling shall conform to the requirements of Eskom Standard 240-56227433. Instrument cabling shall be installed with due respect for safety, reliability, access, maintenance, environmental conditions and best practices. All cabling shall be suitably protected against mechanical damage, chemical, dust build-up and heat.

- All instrument cables shall only be terminated on instruments or junction boxes
- All cables connected to instruments shall be installed with a loop of cable to provide sufficient slack for remaking the cable connection if the instrument is removed and to allow for removal of the instruments without electrical disconnection
- Instrument cables shall be routed separately from electrical power cables and crossovers that bring signal and power cables into close proximity shall be right at right angles.
- Trunk cabling between the field equipment transducers and the junction box/ panels shall run in trenches where above ground cable routes cannot be utilised.
- All power supply (220VAC) cables shall be buried/laid on a bed of sand 5000mm deep trenches
- The contractor shall identify the route for laying power cables after having performed underground scanning.
- The contractor shall provide the underground scanning report to the project manager before commencing with any trench digging.
- The contractor shall ensure that the surrounding areas where the trenches run are rehabilitated by levelling after completing the work.
- Contractor shall install permanent cable marker indications on the plant

7.2.2.4 Installation requirements for junction boxes and cables termination

1. All field equipment installations shall firstly comply with the Field Instrumentation installation standard 240- 56355754 and then all requirements of this standard
2. All cable connections at junction boxes and field instruments shall be made using compression crimp connectors when required.

7.2.2.5 Labelling

All Labelling:

1. Shall be permanent
2. Shall be according to the relevant labelling specification as dictated By Configuration Management for the project in question
3. Shall not be affected by maintenance activities and should facilitate the ease of maintenance
4. Shall be consistently and unambiguously used throughout the system
5. Shall be of such a nature as to be easily read and interpreted
6. Durable enough to with expected wear and environmental conditions
7. Coordinated and compatible with:
 - Codes and labels on related equipment
 - Other coding and labelling within the system

7.2.2.6 Earthling

1. All components of the enclosure i.e. door, terminal plate, gland plate enclosure and earth Bar shall be individually star terminated to earth stud
2. The earth stud shall have all the appropriate nuts, washers, lock washers for proper installation

7.2.3 Interfacing remote signals onto Human Machine Interface Graphic

The Contractor designs, supplies, installs, commissions and verifies all flowmeters, level meters, fibre, and additional PLC I/O modules PLC logic and HMI graphics which will interface with the existing HMI at Matimba Power Station to ensure accurate plant monitoring.

1. The contractor shall be responsible for all the configuration of the signals onto the Matimba Powers Station outside plant HMI system ABB 800xA HMI system.
2. The contractor shall perform all the installations, terminations and commissioning fibre communication system between the OPCR and Sewage plant.
3. The contractor shall be responsible for all the terminations on the PLC I/O's.
4. All terminations onto the PLC I/O modules shall be arranged with the project manager to avail C&I Engineer for supervision.

8 List of drawings

8.1 Drawings issued by the *Employer*

This is the list of drawings issued by the *Employer* at or before the Contract Date and which apply to this contract.

Note: Some drawings may contain both Works Information and Site Information.

Drawing number	Title
0.58/37664	Maturation Pond 1 Upgrade
20.58-14933	Sewage Treatment Plant P&ID
0.58/380	Sewage Treatment Works Layout
0.58/384	Land Acquisition for Escom Sewerage Plant Services Servitude
0.58/385	Piping and Cables to Escom Sewerage Plant
0.58/395	R.C. of Chlorination Tank and 14000 DIA. Clarifier
0.58/396	R.C. Details of Aeration Tank
0.58/397	Reinf. Detail of Central Base of 14000 DIA Clarifier
0.58/398	Reinf Schedule of Central Base of 14000 DIA Clarifier
0.58/399	Reinf Detail to central Column
0.58/400	Reinf Detail to Ring Footing of 14000 DIA Clarifier
0.58/401	Reinf Schedule to Ring Footing of 14000 DIA Clarifier
0.58/402	Reinf Detail of Floor Slab for 14000 DIA Clarifier
0.58/403	Reinf Schedule of floor slab and sleeper beam; 14000 DIA Clarifier
0.58/404	Reinf Detail for wall + Launder 14000 DIA Clarifier
0.58/405	Reinf Schedule of Wall + Launder 14000 DIA Clarifier
0.58/407	Chlorination Tank Reinf Detail of Bottom Slab
0.58/409	Chlorination Tank Reinf Detail of Walls 2 + 3
0.58/410	Chlorination Tank Reinf Detail of Walls 4 + 5
0.58/411	Chlorination Tank Reinf Detail of Walls 6 - 9
0.58/412	Chlorination Tank Reinf Detail to Wall 10 & Slabs A + B
0.58/413	General Arrangement of Structures and Pipes
0.58/439	R.C. Details of balancing Pond
0.58/441	Aeration Tank Layout Showing Sleeper Beam Numbers
0.58/442	Aeration Tank Sleeper Beams 1-6
0.58/443	Aeration Tank Sleeper Beams 7&8
0.58/444	Aeration Tank Sleeper Beam 9
0.58/445	Aeration Tank Floor Slab & Column Starters
0.58/446	Aeration Tank Columns
0.58/447	Aeration Tank 160THK Walkway Slab
0.58/448	Aeration Tank 160THK Walkway Slab
0.58/449	Aeration Tank Fixing of Sidewall Slab Reinforcement
0.58/450	Aeration Tank Sidewall Slabs
0.58/451	Aeration Tank Sidewall Slabs
0.58/452	Aeration Tank Sidewall Slabs
0.58/453	Aeration Tank Sidewall Slabs
0.58/457	Sludge Drying Beds: Sumps
0.58/458	Maturation Pond "Wier" Slab in Outlet Chamber
0.58/459	Maturation Pond Walkway Over Outlet Chamber
0.58/485	Raw Sewage Pump Station Arrangement
0.58/487	Balancing pond Additional Reinforcement Bars
0.58/571	R.C. Details of Pump Station
0.58/624	Pump Station Slabs at +868,162
0.58/625	Pump Station Sump Walls
0.58/626	Pump Station Reinf. Placement in Surface Bed
0.58/627	Pump Station Slab Reinforcement

0.58/628	Pump Station Slab Reinforcement
0.58/629	Aeration Tank Beams at +9300
0.58/705	Transfer Pump Station Plan, Sections & Elevations
0.58/807	Transfer Pump Station R.C. Details
0.58/11610	Raw Sewage Pump Station Details of Screening Bucket
0.58/11611	Arrangement of Sludge Pump Station
0.58/11612	Aerator Fixing Details
1063-03	Arrangement of Transfer Pumps
1063-11	Civil Detail of 14000DIA Clarifier, Chlorination Tank & Sludge Sump

