Eskom	Technical Specification	Technology

Title:	**Duvha Power Station Ikageng Sewage Treatment Plant Technical Specification**	Unique Identifier:	**382-ECM-AABZ28-SP0004-26**
		Alternative Reference Number:	**N/A**
		Area of Applicability:	**Engineering**
		Documentation Type:	**Specification**
		Revision:	**1**
		Total Pages:	**43**
		Next Review Date:	**N/A**
		Disclosure Classification:	**Controlled Disclosure**

Compiled by	Functional Responsibility	Authorised by
J Pillay	M.A. Naidoo	B. Cobo
EDWL	Engineer	Manager
Chemical CoE	Chemical CoE	Chemical CoE
Date: 2019/05/03	Date: 2019/05/03	Date: 2019/05/03

C3.1: EMPLOYER'S TECHNICAL SPECIFICATION

Contents

1 Description of the *Works*

1.1 Executive overview

The Ikageng Sewage Treatment Plant (STP) currently treats all sewage produced at Duvha Power Station (PS) and currently experiences poor performance.

The following issues are present at the plant:

- The plant is unable to produce water that fully complies with the National Water Act General Limits for discharge. Free chlorine, ammonia and suspended solids are examples of this non-conformance.
- The plant was designed to be run on automatic control. However, the current plant is run on manual.
- The current plant switchgear is outdated and does not comply with Eskom standards.
- There is also the issue of sludge settling in the aeration pond, resulting in more frequent cleaning of the pond.
- There are also issues surrounding structural damage due to the nearby mining activities.
- The current compressor does not comply with Eskom standards.
- The plant does not have proper flow metering on the inlet and final effluent lines.

The objective of this project is to refurbish the Duvha PS Ikageng STP such that it is returned to optimal performance and compliance with the National Water Act General Limits for Discharge. This involves performing a design that will ensure the above issues are resolved.

The requirements of the *Works* are as follows, but are not limited to:

- Design, supply, installation and commissioning of disinfectant dosing pumps and all associated piping and fittings
- Design, supply, installation and commissioning of a new programmable logic controller (PLC) to ensure that the plant is capable of operating in both manual and automatic modes
- Disconnect the existing power and control cables for all the existing equipment feeding from the existing 380V Distribution Panel and existing 380V Sewage Treatment Plant Board.
- Inspect and test the existing cables to indicate the condition of the cables and recommend which cables can be reused.
- Removal of the main existing decommissioned 380V Sewage Treatment Plant Board.
- Temporarily, reposition the existing 380V Distribution Panel to the proposed location within the substation room as depicted in Appendix D2, to allow for repairs of structural damage.
- Depending on the new location for the existing 380V Distribution Panel, it may be necessary to pull and extend the incomer cable and outgoing cables for the 380V Distribution Panel due to lack of cable slag and difficultly in termination thereof.
- Commission the existing 380V Distribution Panel on the temporary location to allow the operation of the plant while executing the entire *Works*.
- Design, supply, installation and commissioning of a permanent new 380V Sewage Plant Board and all associated equipment to ensure compliance with Eskom Standards
- Design, supply, installation and commissioning of a 380V Distribution Board for supplying electrical actuators.
- Manufacture/procurement, transport, supply, install, test and commission the new power cables between the new low voltage switchgear and the new electrical equipment i.e. low voltage motors and distribution board.
- Manufacture/procurement, transport, supply, install, test and commission the new power cables between the distribution board and electrical actuators.

- Manufacture/procurement, transport, supply, install, test and commission the new power cables between the new low voltage switchgear and the PLC.
- Reconnect the existing cables that are in good condition from the existing equipment to the new low voltage switchgear.
- Swing-over the supplies from the temporary 380V Distribution Panel to the new 380V Sewage Plant Board and decommission the existing 380V Distribution Panel.
- Bond existing and new electrical equipment to the existing earth mat,
- Test all electrical installation and provide certification.
- Design, supply, installation and commissioning of mechanical surface aerators for the aeration pond
- Removal of the current pneumatic system and replacement with electrical actuators
- Reparation of current structural damage
- Supply and installation of ultrasonic flow meters on the inlet and final effluent lines.
- Supply and installation of a 10 kg carbon dioxide fire extinguisher on the outside wall of the existing building
- Removal of all level switches at site with the installation and commissioning of level transmitters

Work To Be Performed By *Contractor*

The *Contractor* is responsible for the design, procurement, supply, manufacture, delivery to site, installation, and commissioning and testing of the entire Works to ensure a fully functional system. The *Contractor* shall ensure that any waste generated as part of the execution and commissioning processes shall be disposed of as per the Duvha PS waste management procedure.

1.2 *Employer*'s objectives and purpose of the *Works*

Duvha Power Station's objective is the refurbishment of the STP. The purpose of the refurbishment is aimed at achieving the following:

- Addition of disinfectant dosing pumps and all associated pipes and equipment for disinfectant control. This is to ensure that the free chlorine levels comply with the National Water Act General Limits for Discharge.
- Addition of a new programmable logic controller (PLC) to ensure that the plant is capable of operating in both manual and automatic.
- Addition of new plant switchgear complying with Eskom Standards.
- Addition of mechanical surface aerators for the aeration pond.
- Removal of the current pneumatic actuators and replacement with electrical actuators. This also includes the removal of the current air compressor and all associated equipment.
- Reparation of current structural damage.
- Addition of ultrasonic flow meters on the inlet and final effluent lines.

The *Contractor* should be aware that the above requirements cover the major changes to the plant. Additional requirements are located in the respective disciplines section in this Technical Specification.

1.3 Interpretation and terminology

System	An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective. These pieces include people, hardware, software, firmware, information, procedures, facilities, services and other support facets.
The *Works*	The *Works* is inclusive of the Duvha Power Station Ikageng Sewage Treatment Plant Refurbishment and all the activities necessary to ensure all requirements specified in discipline specific section of the Technical Specification are satisfied. The *Works* is to provide specifications to the *Contractor* for the design, supply, install and commissioning of all requirements in discipline specific sections of this Technical Specification.

Employer	This refers to the relevant Eskom employee as confirmed by the Project Manager.

The following abbreviations are used in this Technical Specification:

Abbreviation	Description
AI	Analogue Input
AO	Analogue Output
AWR	Ash Water Return
C&I	Control and Instrumentation
$Ca(OCl)_2$	Calcium hypochlorite (HTH)
Cl_2	Chlorine (liquid and/or gas)
COE	Centre of Excellence
DI	Digital Input
DMR	Department of Mineral Resources
DO	Digital Output
ECM	Engineering Change Management
EDWL	Engineering Design Work Lead
GTE	Group Technology Engineering
HDPE	High Density Polyetyhlene
LDE	Lead Design Engineer
LPS	Low Pressure Services
LV	Low Voltage
MLSS	Mixed liquor suspended solids
NaOCl	Sodium hypochlorite
NPV	Net Present Value
NWA	National Water Act
OPCR	Outside Plant Control Room
PLC	Programmable Logic Controller
ppm	Parts per million
PS	Power Station
SBR	Sequential batch reactor
STP	Sewage Treatment Plant
VDSS	Vendor Document Submission Schedule
WAS	Waste Activated Sludge

2 Management and start up.

2.1 Documentation control

Refer to the VDSS supplied for documentation submission requirements and Section 3.4.1.

2.2 Health and safety risk management

The *Contractor* acts in accordance with the health and safety requirements stated in the Technical Specification.

In carrying out its obligations to the *Employer* in terms of this contract; in providing the *Works*; in using Plant, Materials and Equipment; and while at the Site for any reason, the *Contractor* complies and procures and ensures the compliance by its employees, agents, Sub-*Contractors* and mandatories with:

- The provisions of the Occupational Health and Safety Act 85 of 1993 (as amended) and all regulations in force from time to time in terms of that Act ("the OHSA"); and
- All applicable Eskom Safety, Health and Environmental Requirements

2.3 Environmental constraints and management

The *Contractor* must ensure that the STP complies with the National Water Act, 1998 (Act No. 36 of 1998), Government Gazette No. 665 of 6 September 2013 General Limits for Discharge.

Refuse disposal

The *Contractor* is responsible to keep the work area clean of any rubble and liquid waste.

All waste introduced and/or produced on the *Employer*'s premises by the *Contractor* for this contract, is handled in accordance with the minimum requirements for the Handling and Disposal of Hazardous Waste in terms of Government Legislation as proclaimed by the NATIONAL ENVIRONMENTAL MANAGEMENT: WASTE ACT, 2008.

The removal of any hazardous waste is the responsibility of the *Contractor*. The *Contractor* must comply with the environmental criteria and constraints as per the Eskom Rules and Regulations.

2.4 Quality assurance requirements

The *Contractor* demonstrates compliance to ISO9001 quality standard.

The *Contractor* must be required to demonstrate by means of a Contract Quality Plan (CQP) that this organisation is so structured that all the requirements of the specification must be properly monitored and controlled. The Contract Quality Plan (CQP), which must include the Quality Control Plan (QCP), is to be drafted in accordance with QM-58 and the Supplier Contract Quality Requirement Specification (QM58). The Quality documents are to be submitted for approval to *the Quality Engineer* within thirty (30) days after a contract has been awarded to the *Contractor.*

No work may commence unless the Contract Quality Plan and Quality Control Plan documents have been approved in writing and a copy submitted to *the Quality Engineer/ Project Manager*. The *Contractor*, in conjunction with *the Quality Engineer* must sign off all Quality Control documents after completing all work as per the agreed scope. The *Contractor* to submit a copy of the final signed off documents/data packages to *the Project Manager* within one (1) week after completion of work.

The *Contractor* must be required to read and fully understand the contents of the Supplier Contract Quality Requirement Specification (QM58) and a copy is to be kept in possession or on premises.

The Supplier Contract Quality Requirement Specification (QM58) must remain applicable in the event of the contract being extended or modified for reasons permitted.

By signature and acceptance of this contract the *Contractor* acknowledges and agrees to comply with and adhere to Eskom's policies and procedures (current and/or latest revisions) including the Supplier Contract Quality Requirement Specification (QM58).

The *Contractor's* or Sub*Contractor*'s quality control plans cover inspection and test proposals for items or activities to be supplied as part of the *Works*.

The quality control plan indicates the following as appropriate:

- The identification of the item.
- A list of the sequence of operations including inspections and tests.
- The identification of the specification, drawings or procedures for each operation.
- The acceptance criteria with reference to the appropriate technical specification, in-house, national or international standard and relevant clause number.
- The inspections and tests the *Contractor* has nominated for hold and witness points.
- Provision for inspections and tests nominated by the Quality Engineer.
- Provision for inspection status indication.
- Inspection and test records which are generated by the *Contractor*.
- Competence of the people-Level II welding inspector, Coded welders, minimum N3 Fitters/Boiler makers
- Personnel qualifications from approved training and accredited institute
- ITPs and welding procedures
- Material certificates
- Organogram indicating the quality person and his/her duties
- Adhere to the QM58

- Follow the Eskom welding rule book

The quality control plans are reviewed by the *Quality Engineer and Project Manager* to allow for insertion of his specific requirements, including hold and witness points, prior to commencement of work. The *Contractor* does not commence work until the *Project Manager* accepts.

2.5 *Contractor*'s management, supervision and key people

The *Contractor* shall ensure that all designs, documentation and drawings/P&IDs presented shall be signed off by an ECSA registered Professional Engineer.

3 Engineering and the *Contractor*'s design

Duvha Power Station's objective is the refurbishment of the Ikageng Sewage Treatment Plant (STP). The plant has experienced deterioration in performance with regards to compliance to the National Water Act General limits for discharge, in that parameters such as free chlorine, ammonia and suspended solids are out of specification. The plant switchgear has never been refurbished or upgraded, and does not comply with the Eskom Switchgear Standards. The STP was designed to be operated with automatic control; however, it is currently being operated manually.

The *Contractor* is responsible to design, procure, supply, manufacture, and deliver to site, install, commission and optimization of the entire *Works* to ensure a fully functional plant.

3.1 *Employer*'s design

3.1.1 Current Plant Operations

The function of the Ikageng STP is to process raw sewage from Duvha PS to produce final effluent that conforms to the National Water Act general limits for discharge. The effluent produced at the STP is sent to the high level ash water return (AWR) dam to be reused for ashing.

Raw sewage flows into the plant via an inlet channel which is fitted with fine and coarse screens to remove coarse materials from the water. The fine and coarse screens each have a dedicated drip tray. Undesirable, non-biodegradable material that is caught on the screens is raked into the drip tray. The material is allowed to dry, and then disposed of appropriately. The screened effluent flows through the grit channel. The sewage then flows into the aeration pond. The sewage held into the aeration pond is gravity fed to the raw sewage sump.

Two raw sewage pumps are used to transfer the sewage from the raw sewage sump to the SBR and are controlled by level switches. One pump is on duty with the other on standby. Effluent is decanted from the SBR into the chlorine contact tank where it is dosed with calcium hypochlorite (HTH) before overflowing into maturation pond 1. Waste activated sludge is discharged from the SBR into the four sludge drying beds. The sludge is allowed to dry, and then disposed of at a landfill site.

Chlorinated effluent overflows from maturation pond 1, through to maturation pond 2 and finally into maturation pond 3, from which it is sent to a final effluent sump. There are two final effluent pumps, where one is on duty and the other is on standby. The pump operation is controlled by level switches in the final effluent sump, which starts and stops pumps based on the level in the final effluent sump. This is controlled by level switches placed in the final effluent sump.

The final effluent pumps transfer the final effluent to the high level ash water return dam to be reused for ashing.

3.1.2 Current Plant Process Design Parameters

The sewage treatment plant has the following design parameters:

3.1.2.1 Hydraulic Loading

Average Dry Weather Flow:	300 m^3/day
Peak Dry Weather Flow Factor:	2.5
Peak Wet Weather Factor:	1.15

3.1.2.2 Organic Loading

COD (Chemical Oxygen Demand) concentration of raw sewage:	700 mg/l
COD:BOD ratio (assumed):	50%
BOD (biological oxygen demand) concentration of raw sewage:	350 mg/l
Ammonia as N:	40 mg/l
Phosphate as P:	15 mg/l

3.1.2.3 SBR Reactor

Diameter:	14 m
Maximum water operating:	4.15 m
Minimum water operating depth:	3.5 m
Decant Depth:	0.65 m
Average Operating volume:	568 m^3

Average hydraulic retention:	45.4 hours
Volumetric loading:	185 g/BOD/m^3
Sludge loading per day:	0.047 kg BOD/kg MLSS
Number of decant cycles per day:	3
Decant volume:	100 m^3
Total decant volume per day:	300 m^3/day

3.1.2.4 Oxygen Requirements

Site Oxygen Requirements

Design sludge age:	20 days
O_2 demand for carbonaceous oxidation:	1.57 kg O_2/ kg BOD
O_2 demand for nitrification:	4.5 kg O_2/ kg NH_4
O_2 demand for carbonaceous oxidation:	126 kg O_2/day

Standard Oxygen Requirements

Temperature:	22°C
Cs:	8.743
Altitude at site:	1671 m
Atmospheric pressure:	0.83 bar
Alpha Factor:	0.85
Beta Factor:	1
Dissolved oxygen residual:	1 mg/l
Standard O_2 requirements:	372 kg/O_2/day
Total Aerator running time:	18.75 hours/day
Standard O_2 requirements per hour:	19.8 kg/hour

3.1.2.5 National Water Act General Limits for Discharge Parameters

Parameter	General Limit
Faecal Coliforms (per 100 ml)	1 000
Chemical Oxygen Demand (mg/l) (after algae removal)	75
pH	5,5-9,5
Ammonia (ionised and un-ionised) as Nitrogen (mg/l)	3
Nitrate/Nitrite as Nitrogen (mg/l)	15
Chlorine as Free Chlorine (mg/l)	0,25
Suspended Solids (mg/l)	25
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m
Ortho-Phosphate as phosphorous (mg/l)	10
Fluoride (mg/l)	1
Soap, oil or grease (mg/l)	2,5
Dissolved Arsenic (mg/l)	0,02
Dissolved Cadmium(mg/l)	0,005
Dissolved Chromium (VI) (mg/l)	0,05
Dissolved Copper (mg/l)	0,01
Dissolved Cyanide (mg/l)	0,02
Dissolved Iron (mg/l)	0,3
Dissolved Lead (mg/l)	0,01
Dissolved Manganese (mg/l)	0,1
Mercury and its compounds (mg/l)	0,005
Dissolved Selenium (mg/l)	0,02
Dissolved Zinc (mg/l)	0,1
Boron (mg/l)	1

3.1.3 Employer Responsibility

The Employer shall provide and maintain the required lighting luminaires within the substation room and area lighting outside the substation room. The employer shall maintain the existing Distribution Board inside the substation and ensure all the existing motors (raw sewage pump motors, effluent pump motors, SBR motor and existing sump pump inside the STP Pumphouse) that are not impacted by this project are functional.

3.1.4 Battery Limits

3.1.4.1 Process

The process battery limits start at inlet channel to the STP and terminates at the discharge of the final effluent sump, after the final effluent flow meter, inclusive of all associated components.

3.1.4.2 Mechanical

The mechanical battery limits start at the chlorine makeup tank, and terminate at the discharge into the chlorine contact tank. This includes all pumps, piping and fittings. The mechanical battery limits also start at the air compressor and end at the valves controlled by all pneumatic actuators, which includes all piping and fittings.

3.1.4.3 Electrical

The electrical battery limits starts from the incoming cable of the existing 380V Sewage Plant Board to the field equipment feeding from the 380V Sewage Plant Board, including bonding to the existing earth mat.

3.1.4.4 C&I

The control and instrumentation (C&I) battery limits include the field equipment, field cabling and Programmable Logic Controller (PLC).

3.1.4.5 Civil and Structural

Civil and structural battery limits include all plant structures starting at the inlet to the plant and terminates at the discharge of the final effluent sump, including all buildings, sumps and dams.

3.1.5 Process Design

3.1.5.1 New Chlorine Dosing System

The *Contractor* shall be responsible to procure, supply, install and commission two chemical dosing pumps that will take suction from a 100L chemical makeup tank. The pumps should be capable of supplying a flow up to 0.5 L/hr with a discharge pressure of up to 10 bar. The *Contractor* is also responsible for the removal the current chemical dosing pumps and piping and replacement with HDPE piping that will transfer the disinfectant solution from the makeup tank to the chlorine contact tank including all associated valves and fittings. The pumps should be capable of supplying disinfectant ranging from 1 ppm up to 10 ppm of chlorine in the form of calcium hypochlorite. The pumps and fitting shall be selected based on chemical compatibility with resistance to attack from chlorine and/or chlorine containing compounds.

3.1.5.1.1 Proposed System Architecture

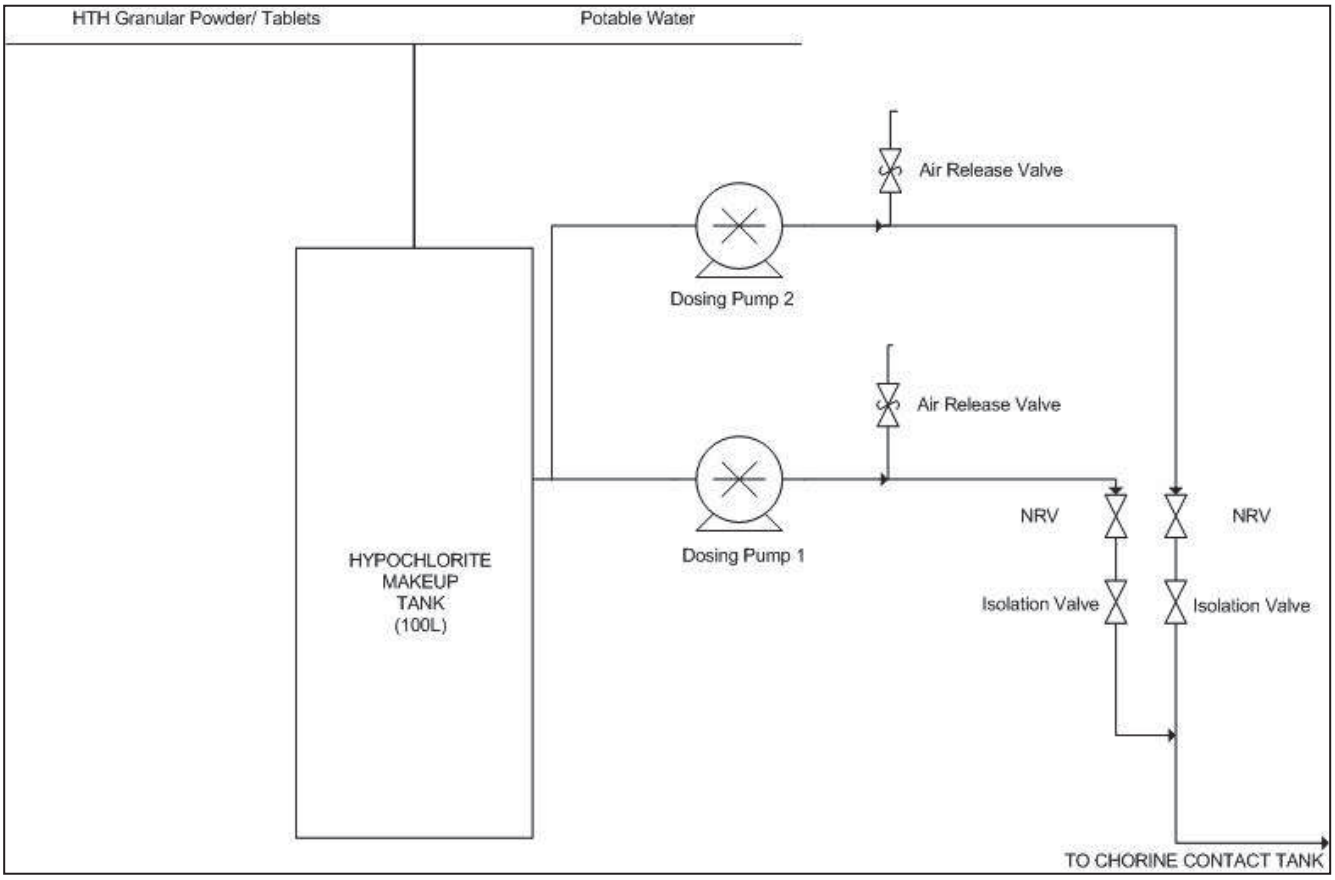

Figure 1: Proposed Configuration for Chlorine Dosage Process Design

3.1.5.2 Aeration Pond Aerators

The *Contractor* is responsible for the design, supply, installation, commissioning and testing of two mechanical surface aerators capable of agitating the aeration pond to a depth of 2.4 m and is able to adequately prevent solids from settling in the pond. The *Contractor* is also responsible for the removal of the current mechanical surface aerators at the aeration pond and all associated mechanical equipment. The *Contractor* shall ensure that the chosen mechanical surface aerators allow for the STP to operate producing a final effluent as per 3.1.2, and also satisfy the requirement of preventing the settling of solids. The *Contractor* shall ensure that the materials of construction for the mechanical surface aerators are resistant to corrosion due to contact with the screened sewage. The *Contractor* shall also supply and install a method to determine the level in the aeration pond to assist the operator with the operation of the aerators.

3.1.6 Proposed Operating and Control Philosophy

3.1.6.1 Aeration Pond Aerators

Start Up

The aerators are manually started up by the operator depending on the level of raw sewage in the pond. The operator should switch on the aerators via a button on a control panel located near the banks of the pond. If the *Contractor* is able to show that automating the operation of the aeration pond aerators is preferred, the *Contractor* shall include, in their tender, the additional cost for this change.

Normal Operation

- Only one aerator is run during normal operation, with the other on standby.
- During normal operation, one aerator operates continuously.
- The operator should monitor the level of sewage in the pond and switch off the aerators when the low level of 1 meter in depth is reached, to prevent damage to the aerators.

- The operator shall alternate the operation of the aerators: the aerator in operation should operate for a fixed length of time after which it is put into standby, with the aerator previously on standby now put into operation.

Abnormal Operation

- There is no situation currently perceived that will require both aerators to operate continuously. If the *Contractor* determines otherwise, the *Contractor* shall cater for this in their design.

Aerator shutdown

- If the dam level reaches low level, the operator shall switch the aerator off via a button located on a control panel near the banks of the pond.

3.1.6.2 Raw Sewage Sump and Pumps

Start Up - Automatic

- On the PLC, set the two raw sewage pumps to “auto” to enable automatic operation of the SBR process via the PLC programme without the operator’s intervention.
- Set one of the pumps to “duty” and the other pump to “standby”
- The pumps will start up as per the normal automatic start up below

Start Up - Manual

- During manual operation, the operator starts up and shuts down the pumps directly from the switchgear.
- Set one of the pumps to “duty” and the other pump to “standby”
- Switch the button for the “duty” pump to “on” to start the duty pump

Start Up – Abnormal Conditions

- Abnormal conditions for the STP require the PLC to have failed.
- During this mode, the operator shall start up and shut down the raw water and effluent pumps directly from the switchgear.

Normal Operation – Automatic

- During normal operation, one pump is on duty while the other pump is on standby
- The pump on duty shall run continuously, and shall abide by the controls below:
    - Low level – This level is set to a certain level above the pump suction pipe to prevent any cavitation in the pump. This switch will stop all pumps when the water level reaches the low level, depending on the number in operation at any time. This will stop the pumps regardless of whether the pumps are set to automatic or manual operation, and acts as an interlock.
    - High level – This level is set 150 mm below the level of the incoming raw sewage pipe and will start the selected duty pump.
    - High High level – This level is set approximately 100 mm below the incoming raw sewage pipe and will start the standby pump. Both pumps will operate at this level to reduce the level in the raw sewage sump.

Normal Operation – Manual

- During manual operation, the operator shall manually start and stop pumps using the PLC.

3.1.6.3 SBR

The aerator will complete 3 cycles in 24 hours, i.e. 3, 8 hour cycles per day.

There are 5 steps in the operation of the SBR:

- Fill
- React
- Settle

- Decant
- Idle

Fill

During this phase, the raw sewage pumps will start up and transfer raw sewage to the SBR. The tank desludging, tank dumping and tank outlet pneumatic valves will close. The aerator will switch on and the operator will be required to select the operation mode of the aerator according to “aerator operation” indicated below to aerate the raw sewage filling into the tank. This will continue to occur until the level in the tank reaches 4.25 m which is indicated by a high level alarm. This will then send a signal to the PLC to stop the raw sewage pumps and to start the next phase. This phase will occur for approximately 2 hours, and should be able to be changed.

React

During this phase, the raw sewage pumps will switch off and all other valves will remain closed. The PLC should send a signal to start up the aerator at Full (100%). This phase will occur for 4 hours and should be able to be changed.

Settle

During this phase the PLC sends a signal to the aerator to stop and the aerated sewage in the tank is allowed to settle. This should occur for approximately 1 hour and should be able to be changed.

Decant

During the decant phase, the PLC will send a signal to the tank dump valve to open and some of the decanted effluent will be sent to the sludge bed. This is done to ensure that no sludge is sent to the chlorine contact tank that may have accumulated on the flexible hose that is connected to the tank outlet valve and to also remove the top layer of fat and grease that is present in the liquid effluent. This will occur for approximately 5 minutes. Thereafter the PLC will send a signal to close the tank dump valve and open the tank outlet valve to the chlorine contact tank. The clear effluent will decant into this tank. This will continue for approximately 55 minutes until the tank reaches the low level of 3.6 meters and should be able to be changed. Once this level is reached, the PLC sends a signal to the tank outlet valve to close and the next step starts. This timing should be able to be changed.

Idle

During this step, all valves are closed except for the tank desludging valve to the sludge beds. This step will only occur if the mixed liquor suspended solids (MLSS) is too high in the tank and sludge needs to be wasted to the sludge drying beds. This step will be carried out manually. The operator will set the SBR to run in manual mode and open the tank desludging valve while keeping the tank outlet valve closed. The wasting will continue until the MLSS reaches that of the required sludge age (the design is for 20 days, of which an MLSS of 3900 mg/l is obtained).

In order to obtain the MLSS a sample of the bed must be taken and a settling test using an Imhoff cone will determine the MLSS of the tank. This test is done manually by the operator and should only be done when the aerator is operating, and the tank is almost full. The sample is allowed to settle for ±30 minutes and sludge level is read off as a percentage, which indicates the level of suspended solids in the tank. MLSS is measured in mg/l, and the Imhoff cone needs a 1 litre sample, therefore the percentage corresponds to the MLSS value in the tank.

Aerator operation

The aerator operation shall be controlled via the PLC. This will allow the operator to control the anaerobic/anoxic/aerobic phases of the effluent in the tank.

- Full – The aerator runs all the time
- ¾ - The aerator runs 90 minutes and stands 30 minutes
- ½ - The aerator runs 60 minutes and stands 60 minutes
- ¼ - The aerator runs 30 minutes and stands 90 minutes
- Off – The aerator is switched off

Manual Operation of the SBR

During manual operation, only the following are able to be controlled on the local control panel:

- Aerator
- Tank Outlet Valve
- Tank desludging valve
- Tank dumping valve

These items will be either set to “on” or “off”, “open” or “closed” based on the procedure below:

Filling

- Click on the “close” switch to close the tank outlet valve, the tank desludging valve, tank dumping valve
- Click on the “on” to switch on the aerator
- Fill while aerating for 2 hours and change the aeration switch to one of the settings mentioned in aerator operation depending on the screened sewage feed into the tank.

React

- Once the tank is full, set the aerator to run “Full”. Allow this to operate for approximately 4 hours.

Settle

- Once the 4 hour react step is completed, set the aerator to the “Off” setting
- The settling phase will occur for 1 hour

Decant

- When the 1 hour settling step is completed, click on “open” for the tank dumping valve
- Allow the effluent to exit the flexible hose through the tank dumping valve to the sludge beds for 5 minutes
- Click on “close” for the tank dumping valve
- Click on “open” for the tank outlet valve
- Allow the clear effluent to decant for 55 minutes to the chlorine contact tank.
- Thereafter click on “close” for the tank outlet valve and continue the sequence

The diagram below shows the sequencing of the SBR.

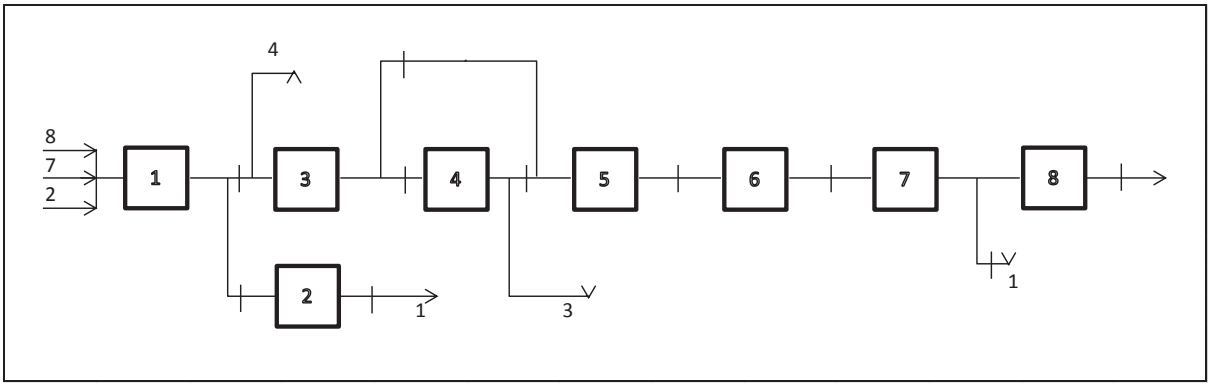

Figure 2: SBR Sequencing

1 – Initial

2 – Off duty

3 – Aerator running

4 – Aerator Standing

5 – Aerator runs 100%

6 – Settling

7 – Decanting

8 – Sludge Discharge

3.1.6.4 Chlorine Dosing

There are two chlorine dosing pumps, 1 on duty and 1 on standby. During automatic mode, the pump on duty and the pump on standby must be selected from the PLC. When the tank outlet valve opens, the PLC must send a signal to the chlorine dosing pump on duty to start up, pumping a 5ppm solution of calcium hypochlorite (from the HTH granular tablets) into the chlorine dosing tank. When the tank outlet valve is closed (at the end of the decanting cycle), the PLC sends a stop signal to the running duty pump.

During abnormal/manual operation, the dosing pumps shall be manually started and stopped via the switchgear.

3.1.6.5 Final Effluent Sump and Pumps

Start Up - Automatic

- On the PLC, set both final effluent pumps to “auto” to enable automatic operation of the final effluent pumps via the PLC
- Set one of the pumps to “duty” and the other pump to “standby”
- The pumps will start up as per the normal automatic start up below

Start Up - Manual

- During manual operation, the operator starts up and shuts down the pumps directly from the PLC
- Set one of the pumps to “duty” and the other pump to “standby”
- Switch the button for the “duty” pump to “on” to start the duty pump

Start Up – Abnormal Conditions

- Abnormal conditions for the STP require the PLC to have failed.
- During this mode, the operator shall start up and shut down the final effluent pumps directly from the switchgear.

Normal Operation – Automatic

- During normal operation, one pump is on duty while the other pump is on standby
- The pump on duty shall run continuously, and shall abide by the controls below:
    - Low level – This switch is set 100 mm above the pump suction pipe to prevent any cavitation in the pump. This switch will stop all pumps when the water level reaches the low level, depending on the number in operation at any time. This will stop the pumps regardless of whether the pumps are set to automatic or manual operation, and acts as an interlock.
    - High level – This level is set 150 mm below the level of the incoming final effluent pipe and will start the selected duty pump.
    - High High level – This level is set approximately 100 mm below the final effluent pipe and will start the standby pump. Both pumps will operate at this level to reduce the level in the raw sewage sump.

Normal Operation – Manual

During manual operation, the operator shall manually start and stop pumps using the PLC

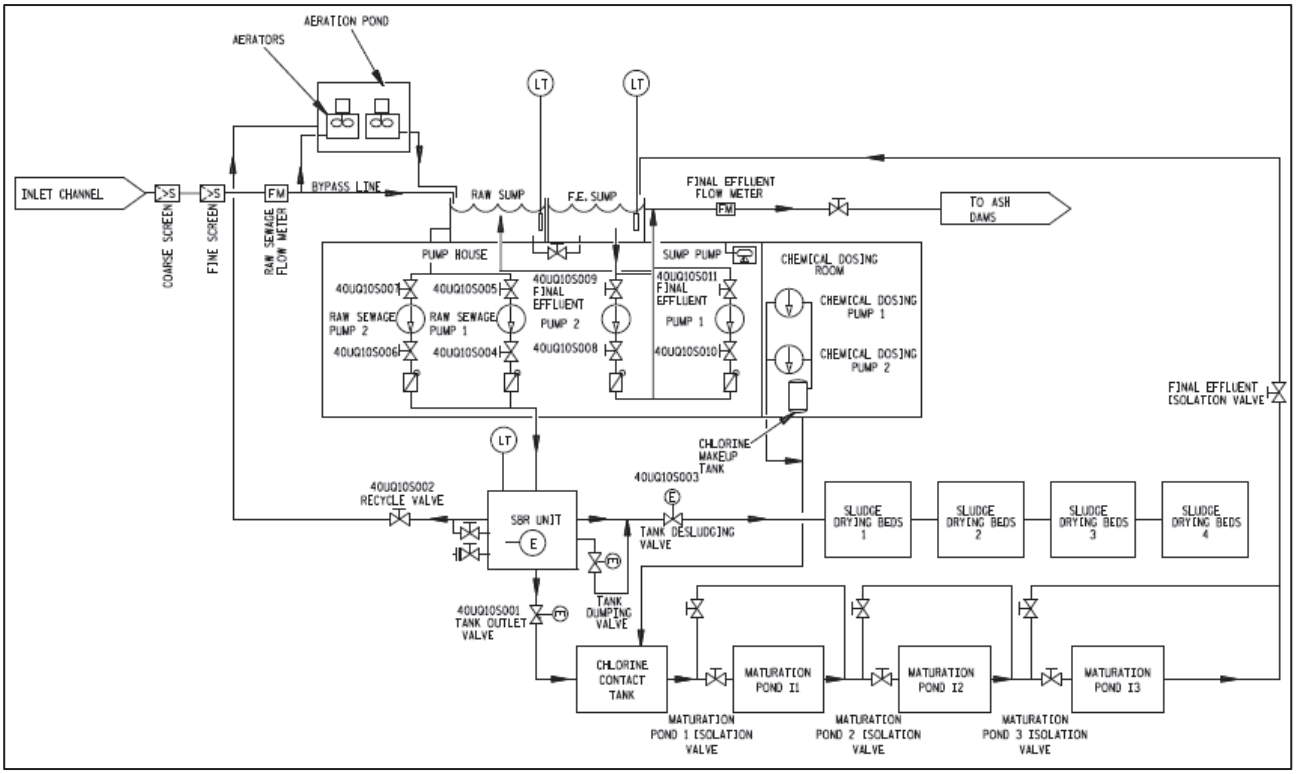

Figure 3: P&ID for the Sewage Treatment Plant with proposed changes

3.1.7 General Remarks

- The *Contractor* is fully responsible for integrating the operation, monitoring, control and process management of the *Works* with existing installed plant and equipment. This will include the *Works* for mechanical, civil, electrical and C&I requirements.
- The *Contractor* shall submit all design calculations and information when required to do so by the Project Manager.
- The *Contractor* shall supply test results for all applicable tests to the Project Manager
- In providing the *Works*, the *Contractor* is fully responsible for the delivery to and offloading at the Site of all Plant, Equipment and Materials required for the *Works*. The Project Manager reserves the right to carry out any checks of his own on any Plant, Equipment and Materials that has been delivered to Site for the *Works*.
- In providing the *Works*, the Contractor takes note of and complies with the following general requirements with regards to documentation:
  - All drawings and reports compiled for the *Works* are to become property of the Employer on completion of the *Works*.
  - The *Contractor* must provide a comprehensive reference list of installed Plant, not more than 5 years old, and includes contact names, telephone numbers and email addresses. The Employer reserves the right to visit or communicate with the users of one or more of the referenced plants in order to assess and verify the accuracy of the information supplied by the *Contractor*.
  - Material safety data sheets shall be submitted.
- The *Contractor* shall supply any items, components or services to render the equipment complete and serviceable on the starting date of cold commissioning.
- The tenderer shall submit a list indicating all items that require frequent maintenance, cleaning, inspection etc. relative to other plant items. The frequency of high maintenance and/or inspection and/or cleaning and a description of the work involved shall be included with the tender.

- Tenderers shall submit a list indicating expected life of all components and ensure spares availability for the next 40 years, or specify the period that spares will be available. Life cycle costing will be taken into consideration during tender evaluation.
- The *Contractor* must provide a Diphoterine® solution as a necessary form of safety as eyewash.
- The *Contractor* shall procure and supply safety buoys for use at the STP.
- The *Contractor* shall procure and supply life jackets for use at the STP.

3.2 Parts of the *Works* which the *Contractor* is to design

3.2.1 Mechanical Design

The *Contractor* is responsible for the replacement of the existing pneumatic actuators with electrical actuators. The *Contractor* shall also remove the existing control air compressor and associated piping.

The *Contractor* shall select the electrical actuators from the list of actuators specified in the valve manufacturer's documentation. The *Contractor* must perform an evaluation to confirm that the valve and actuator combination is fit for purpose.

3.2.1.1 Fire protection

The *Contractor* shall procure, supply and install a 10 kg carbon dioxide fire extinguisher against the outside wall of the existing building.

3.2.2 Electrical Design

With reference to the electrical LOSS diagram (Appendix D5), the electrical scope for this project is the replacement of the existing 380V Sewage Treatment Plant Board with new Low Voltage Switchgear. The existing 380V Sewage Treatment Plant Board is fed from the 11kV Station Board 1 via 11/0.4 kV, 500kVA Oil filed Sewage Plant Transformer or alternatively fed from 11kV Station Board 2 as depicted in Appendix D6. The scope of work also includes temporarily relocate the existing 380V Distribution Panel and also provision of a distribution board to supply electrical actuators and procurement of new low voltage electrical motors (aeration pond motors and dosing pump motors). The *Contractor* shall further supply new power and control cables for all the new equipment to be supplied as part of this project. All new equipment shall be bonded to the existing earth mat and tested for quality purpose. All electrical equipment and the electrical installation must have a certificate of conformity provided to the *Employer*. Should there be any conflicts with any requirements in this specification and standards that the *Contractor* needs to comply to, the *Contractor* records any discrepancies and presents it to the *Employer* for decision making.

3.2.2.1 Low Voltage Switchgear requirements

For the Low Voltage Switchgear *Works*, *the Contractor* shall:

- Decommission the existing 380V Sewage Treatment Plant Board
- Perform detailed designs, manufacture/procure, transport, supply, install, test and commission the new low voltage switchgear assembly required to supply all the equipment for Ikageng Sewage Plant in accordance with the LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard (240-56227516).
- Populate and finalise the switchgear load schedules as per design.
- Populate list of switchgear signals required by the modes of operation together with interposing relays for C&I requirements.
- Provide all equipment and components required for the *works.*The *Contractor* to populate and update the below mentioned schedules, electrical load list and provide the general arrangement drawings, as per design and submit to the *Employer* for acceptance. Templates to be completed by the *Contractor* are:
    - 240-56227927, Electrical Load List Template as depicted in Appendix D4
    - 240-56356421, Electrical LV Switchgear Schedule Template
    - 240-77301384, Electrical Load schedule Template
    - 240-56176097, Electrical Cable Schedule Template

- Special Requirements
    - Protection relays comply with “List of Approved Electronic Devices to be used on Employer’s Power Stations Standard (240-56227589)”. The protection relays must be on the Employer’s approved protection relay list which is contained in the standard (240-56227589).
    - For all group MCB feeders fed from CFS, Fuse Switch Disconnector, MCB’s and fuse protection curves are provided by the *Contractor*. The *Contractor* shall ensure that CFS is cascaded with MCBs. The *Contractor* provides these curves to the Employer in a hard copy format (as part of the technical manual).

The General Arrangement drawing for the existing 380V Sewage Treatment Plant Board is as depicted in Appendix D3

3.2.2.2 Relocation of the existing 380V Distribution Panel

For the existing 380V Distribution Panel, *the Contractor* shall:

- Decommission the existing 380V Distribution Panel and temporarily, reposition the existing 380V Distribution Panel to the proposed location within the substation room as depicted in Appendix D2, to allow for repairs of structural damage.
- Extend the incomer cable and provide cable joints for outgoing cables where necessary due to lack of cable slag and difficultly in termination thereof.
- Commission the existing 380V Distribution Panel on the temporary location to allow the operation of the plant while executing the entire Works.
- Swingover the outgoing supplies from the 380V Distribution Panel to the new 380V Low Voltage Switchgear and decommissioning the 380V Distribution Panel after commissioning the new 380V Low Voltage Switchgear.

The General Arrangement drawing for the existing 380V Distribution Panel is as depicted in Appendix D3

3.2.2.3 Distribution Board requirements

For the Distribution Board *Works*, *the Contractor* shall:

- Perform detailed designs, manufacture/procure, transport, supply, install, test and commission the Distribution Board assembly that is required for supply the electrical actuators.
- The circuit breakers shall comply with SANS 556-1
- Earth Leakage relays shall be single equipped with sensitivity of 30mA with associated circuit breaker or on-load switch for use on 220V/250V single phase, 50Hz supply.
- The fault current rating of the unit shall be 2.5kA or 5kA as required, when tested in accordance with SANS 556-1
- Surge arrestors shall comply with the requirements of the relevant part of SANS 61643.
- Surge arrestors shall be suitable for installation at altitude of up to 1800m above sea level.
- The colour of distribution board and equipment enclosure shall be “Light Orange”, colour B26 of SANS 1091 as recommended in SANS 10140, Part 2 unless specified on the contrary.
- The Distribution Board shall be IP 65 and mounted on the support structure, and bonded to the existing earth mat.

The Distribution Board shall be done in accordance with the latest standard for Coal Fired Power Stations Lighting and Small Power Installation (240-55714363) as well as SANS 10142-1 (The wiring of premises part 1: Low voltage installations).

3.2.2.4 Motors requirements

For the motors *Works,* the *Contractor* shall:

- Perform detailed designs, manufacture/procurement, transport, supply, install, test and commission the new low voltage motors (dosing motors and aeration pump motors) to comply with the requirements of the LV Motor Procurement Standard (240-57617975)
- Decommission the existing old motors (effluent pump motors, raw sewage pump motors, SBR motor and dosing motors).

- Provide the new motors including base plates required as per the employer specification. specified in Technical Schedule AB (Appendix D).

3.2.2.5 LV Cabling and Cable Racking requirements

For the cabling and cable racking *Works,* the *Contractor* shall:

- Inspect and test the existing cables to indicate the condition of the cables and recommend which cables can be reused.
- Disconnect the existing power and control cables for all the existing equipment feeding from the existing 380V Sewage Treatment Plant Board and 380V Distribution Panel.
- Extend the incomer cable and provide cable joints for outgoing cables for the 380V Distribution Panel where necessary due to lack of cable slag and difficultly in termination thereof after relocation of the 380V Distribution Panel.
- Manufacture/procurement, transport, supply, install, test and commission the new power cables between the low voltage switchgear and the new electrical equipment i.e. motors and distribution boards.
- Manufacture/procurement, transport, supply, install, test and commission the new power cables between the distribution board and electrical actuators.
- Manufacture/procurement, transport, supply, install, test and commission the new power cables between the low voltage switchgear and the PLC.
- Reconnect the existing cables that are in good condition to the new low voltage switchgear.
- Ensure interfacing with all the other system requirements of the plant/installation.
- Test all cables and provide a test report.
- Develop, finalise and implement the optimised cable routing.
- Produce exact cable routing designs of all the cables.
- Cater for cable servitudes and cable racking.
- Implement all cable routing designs as approved.
- Implement all cable terminations.

Produce all documentation and drawings. The power cables and cable racks shall be done in accordance with 240-56227443 (Requirements for Control and Power Cables for Power Stations Standard.

3.2.2.6 Protection

The *Contractor* to design the protection for the scope of this project such that it complies with the requirements of: 240-56357424 – MV and LV Switchgear Protection Standard.

3.2.2.7 Earthing and lightning protection requirements

For the earthing and lightning protection Works, the Contractor shall:

- Ensure all new electrical equipment to be installed by the Contractor are earthed and properly bonded to the existing earth mat.
- Conduct an earth continuity tests and provide certification for quality controls.
- Ensure that new equipment is interfacing with all the other system requirements of the plant/installation.
- Produce all documentation and drawings for the design.

Earthing and lightning protection shall be done in accordance with the Earthing and Lightning Protection Standard (240-56356396).

3.2.2.8 Testing of Electrical Equipment

Prior to delivery of electrical Plant, the *Employer* witnesses the Factory Acceptance Tests and carries out Quality Assurance inspections at the *Contractor's* site for:

- LV Switchgear
- LV Motors

- Distribution Board
- Functional unit testing of motor control starters

All the electrical test certificates and reports will be supplied to the *Employer* prior to delivery of electrical equipment.

The *Contractor* is responsible to test electrical equipment in accordance with the requirements of the relevant specification.

- Material
    - All material supplied shall be in accordance with SANS 62262.
- Installation, Operating and Maintenance Manuals
    - The *Contractor* to supply three (3) hardcopies and an electronic copy of the installation, operating and maintenance manuals for the LV motors, LV Swichgear and Distribution Board that form part of the scope of this project.

3.2.2.9 Documentation

- The type test certificates and reports must be for the appropriate equipment offered. The certificates and reports must be referenced to the components and combination of the components. All type test reports and certificates must be accepted by the Employer prior to delivery to site.
- During design phase, the *Contractor* submits prints of all drawings for each revision to the Employer for acceptance. All drawings to be signed by the *Contractor's* ECSA registered Professional Electrical Engineer/Technologist.
- The Contractor provides full sets of drawings for the switchgear, low voltagae motors and distribution board to the Employer for acceptance prior to manufacture. All drawings to be signed by the Contractor's ECSA registered Professional Electrical Engineer/Technologist.
- All drawings provided after installation are signed "As Built" by the *Contractor's* ECSA registered Professional Electrical Engineer/Technologist. The *Contractor* submits prints of all "As Built" drawings to the Employer for acceptance. After the handover, all drawings become the property of the Employer.

3.2.2.10 Contract Deliverables Documents

- *Contractor* produces drawings showing all the cable routes, compiles the cable schedules and cable block diagrams and submits to Employer for acceptance before any equipment procured.
- *Contractor* to produce drawings for the switchgear, distribution boards including low voltage motors and updates all existing drawings (i.e. switchgear load schedules, general arrangement drawings) that are affected by the scope of this project and submits to the Employer for acceptance before any equipment is procured.
- *Contractor to produce redline earthing and lightning protection designs drawings indicating where the new equipment will be bonded to the existing earth mat to the Employer for acceptance before any equipment is procured*.
- Where necessary, manufacturers shall outline drawings showing required clearance for maintenance.
- *Contractor* to submit all equipment schedules at the end of their detailed design phase for acceptance of the Employer before any equipment is procured.
- All drawings to be submitted for Employer acceptance before procurement, manufacture, installation, testing and commissioning of any equipment or system.
- The *Contractor* to produce a design report that indicates the design basis of the entire electrical reticulation that forms part of the scope of this project for acceptance to the Employer before any equipment can be procured.
- Acceptance will be by letter listing the drawings and the allocated numbers. If a drawing is not accepted, a mark-up print showing the required revisions may be returned to the *Contractor*.

- No drawing which has been submitted may be cancelled by the *Contractor* without prior agreement and, once issued, no alterations, additions or omission may be made to or from any drawing without re-issuing it under a new revision number.
- The *Contractor* will cost for all new cables for the scope of this project. In addition, the *Contractor* to indicate the cost to test, inspect and write a report on all cables that will be decommissioned in the plant as a result of this project. The report to indicate the condition of the cables and will recommend which cables can be reused.

3.2.2.11 Tender Returnable for Electrical *Contractor*

The *Contractor* to produce a letter indicating that they will comply with the requirements of this specification, the below stated *Employer's* standards, SANS and IEC standards for the electrical scope of this Project. Should there be any deviations, the *Contractor* to clearly state all deviations in the letter.

- 240-56227516, LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard.
- 240-55714363, Lighting and Small Power Installation Standard.
- 240-56227443, Requirements for Control and Power Cables for Power Stations Standard.
- 240-56356396, Earthing and Lightning Protection Standard
- 240-57617975, New LV Motor Procurement Standard
- 240-56361435, Transport of Power Station Electric Motors Standard
- 240-56360387, Storage of Power Station Electric Motors Standard
- 240-56357424, MV and LV Switchgear Protection Standard
- 240-56227589, List of Approved Electronic Devices to be used on Employer's Power Stations Standard
- SANS 10142-1, The wiring of premises part 1: Low voltage installations.

3.2.3 C&I Design

3.2.3.1 System Overview

The Ikageng STP is currently controlled, operated and monitored locally via the Siemens S7 300 modular PLC as a standalone system. Currently there is no interface for remote monitoring from the OPCR and for the project there is no requirement for remote monitoring. The PLC is currently housed within the LV switchgear panel.

3.2.3.2 Scope of Work

The scope of the *Works* includes the following:

- Detail design, supply, installation, commissioning and testing of the control system and field equipment for the Ikageng STP system, to meet the control philosophy specified in Section 3.1.6.
- Relocation of the Siemens PLC from the electrical panel to a dedicated PLC cabinet.
- Removal of existing pneumatic actuated valves signal cabling from the Ikageng STP stand-alone control system.
- Interface of the new electrical actuated valves to the Ikageng STP stand-alone control system.
- New cabling for the newly installed instrumentation, including termination in junction boxes to the PLC.
- All software and licences for the *Works* (demo licenses are not allowed).
- Documentation as specified.
- All equipment and control components are supported and maintainable for a minimum of 15 years from installation.

3.2.3.3 Control System Requirements

- Upgrade existing CPU 313 to 315-2DP.
- Additional analogue input and output modules.
- PLC programming.

- The PLC to be housed in a panel which is suitable for the environment. To comply with the Eskom Standard: 240-56355815: Control & Instrumentation Field Enclosures and Cable Termination Standard.
- Analogue input measurements from the field based on four-wire 24 V DC, 4 - 20 mA signals.
- 10 % spare I/O capacity is provided.
- All analogue and digital signals used for operator information, control, protection interlocking, calculations or plant histories are continuously monitored for validity.
- Figure 4 below shows a proposed pumps I/O modules.
- Figure5 shows proposed analog I/O modules for electric actuators, level and flow signals.
- Figure 6 shows a typical network.

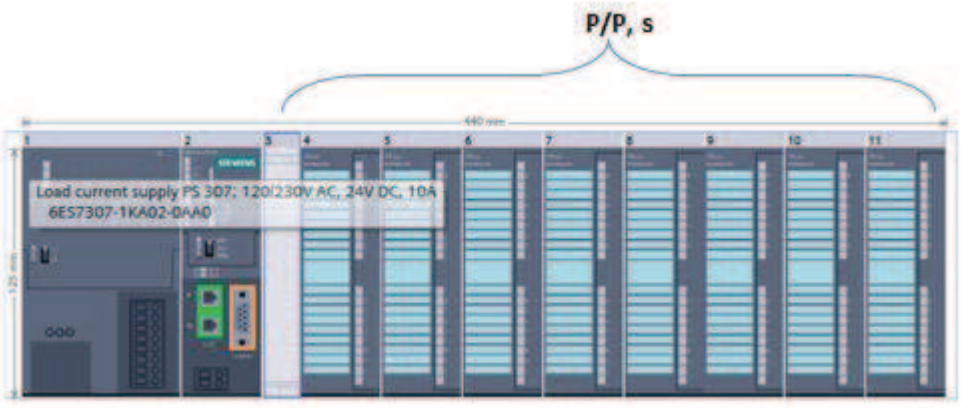

Figure 4: Pumps signals I/O modules

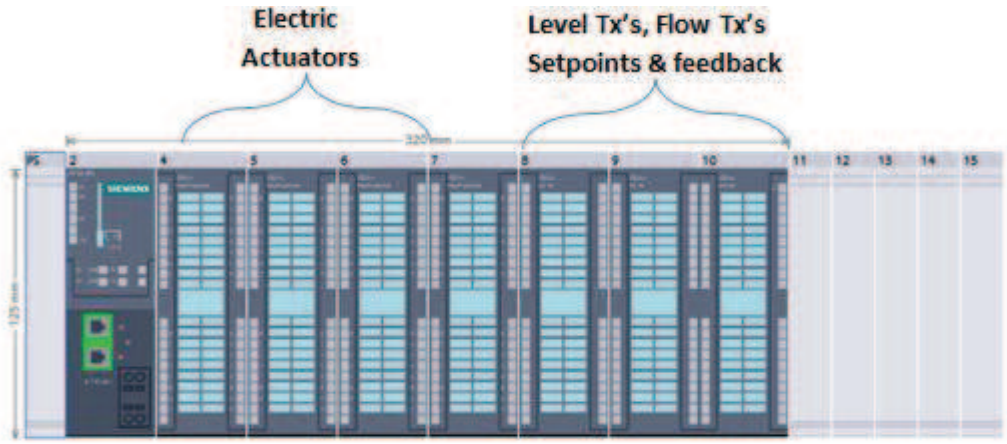

Figure 5: Proposed Analog I/O modules for electric actuators, level and flow signals

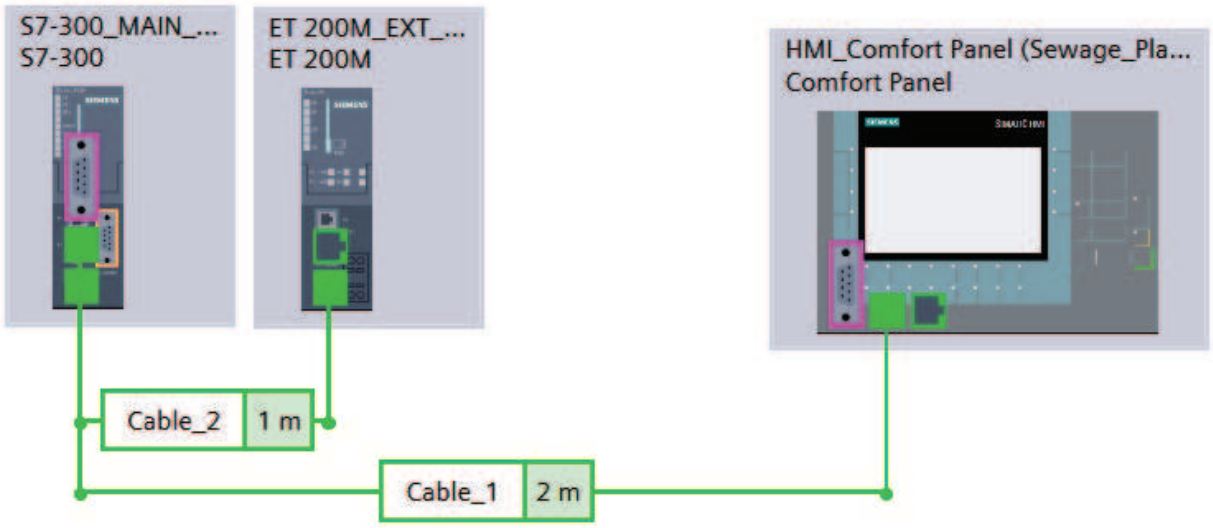

Figure 6: Proposed Network

3.2.3.4 OP Panel Requirements

- New OP panel for operation and monitoring of the plant.
- Panel to be connected to the PLC via a Profibus protocol.
- Panel to be in a touch screen format. To comply with the Eskom Standard: 240-56355815: Control & Instrumentation Field Enclosures and Cable Termination Standard.

3.2.3.5 Field Equipment Requirements

- All instrumentation shall be provided with a nametag/plate.
- Existing pear ball level measurement for the raw sewage sump to be replaced with an ultrasonic level transmitter.
- Existing pear ball level measurement for the final effluent sump to be replaced with an ultrasonic level transmitter.
- Existing pear ball level measurement for the SBR tank to be replaced with an ultrasonic level transmitter.
- Existing inlet raw sewage flow measurement to be replaced with a new ultrasonic flow measurement with a local indicator conforming to the requirements specified in Water Accounting and Management Framework Standard (240-105200800).
- New final effluent discharge flow measurement (ultrasonic flow measurement) conforming to the requirements specified in Water Accounting and Management Framework Standard (240-105200800) with a local indicator to be installed.
- Existing pear ball level measurements for the sump pump pit will be retained.
- New PLC panel.
- The panel wiring is as per the requirements specified in the Control & Instrumentation Field Enclosures and Cable Termination Standard (240-56355815).
- All instrumentation must use either 24V for binary feedback or 4-20mA for analogue feedback.
- New cabling from the newly installed instrumentation, including termination in the junction boxes to the PLC. To comply with the Eskom Standard: Requirements for control and power cables for power station 240-56227443.
- Cabling (including termination) from the PLC to electrical switchgear.

- Cable routing and racking.
- Field equipment to be IP 65 rated.
- Listing of all the instruments in the Control & Instrumentation Instrument Schedule (240-61379718) template and completing all the information required by the template.
- Listing of all drives and actuators in the Drive and Actuator Schedule (240-61379755) templates and completing all the information required by the template.

3.2.3.6 PLC Power Supply Requirements

- Power supply 24V DC.
- Permissible range 20.4 V to 28.8 V.
- Current consumption 1A.
- Figure 7 shows proposed power supplies.

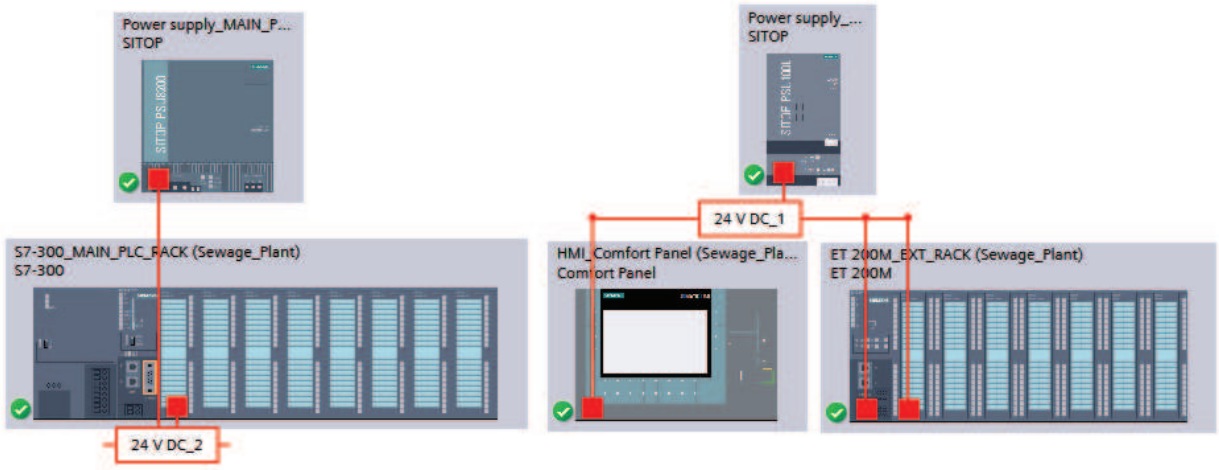

Figure 7: Power supply

3.2.3.7 General Requirements for the *Works* (C&I design)

All field equipment & installations shall comply with the requirements of the following:

- 240-56355754 - Field Instrument Installation Standard.
- 240-89147446, Impulse Piping Standard.
- 240-56355815, Control & Instrumentation Field Enclosures and Cable Termination Standard.
- 240-56227443, Requirements for Control and Power Cables for Power Stations Standard.
- 240-56355789, Flow Measurement System Installation Standard.

At project completion the As-Built package is issued to the Project Manager for review. The documentation package includes the following documents:

- Instrument schedule as per the Control & Instrumentation Schedule 240-61379718 template
- Drive schedule as per the Drive & Actuator Schedule 240-61379755 template
- Equipment schedule
- Cable and termination schedule
- Cable routing
- Loop wiring diagrams
- Mechanical hook-up diagrams
- Alarm and signal lists

- Panel general arrangement & internal layout drawing (including internal wiring)
- Power distribution diagram
- PLC programme (software), licenses and warrantees
- PLC diagram and P&ID of the upgraded system
- Equipment data sheets
- Operating, maintenance, training manuals

3.2.3.8 Requirements for Engineering, Installation, Commissioning and Testing

During the engineering phase the *Contractor* performs plant investigation to verify and clarify scope, documentation provided by the Employer and the location of equipment.

The installation of the relevant equipment does not begin until the design documentation has been accepted by the Project Manager. Quality inspections and tests are carried out by the *Contractor* and Employer's representative after installation to prove the compliance of the installation with the technical specification and the detailed engineering design documentation. The installation is only considered complete once the quality inspections and tests for the installation concerned have been accepted by the Project Manager.

The *Contractor* is required to perform cold commissioning activities that include field equipment loop checks, drives and testing of the PLC functionality. The PLC functionality checks include system checks, interlocks/protection checks and sequence control checks. The electrical drives are local and auto operated and checked for correct operation.

Site Acceptance Test (SAT) is performed by the *Contractor* to demonstrate that the control system meets the requirements of the technical specification and design documentation. The test includes full testing of the logic/program, mechanical and visual inspection of the equipment (including wiring in the panel, plant coding, signal descriptions, OP graphics, etc.

3.2.3.9 Instrumentation Free Issue List

The following instrumentation shall be a free issue to the *Contractor*:

- Final effluent discharge flow measurement
- Final effluent sump level measurement
- Inlet raw sewage channel inlet flow measurement
- Raw sewage sump level measurement
- Sequential batch reactor tank level measurement
- OP panel
- CPU-315-2DP

3.2.4 Civil and Structural

3.2.4.1 Overview of Civil and Structural work

Structural damages to the existing pumphouse structure are to be repaired; no new structure will be constructed.

The following items need to be repaired, and will be discussed in more detail below:

- A section of the floor has subsided (behind the electrical control panel)
- Cracks in the walls and floor
- The pump trench waterproofing
- Damaged ceiling tile
- Cat ladder (doesn't have a man cage)

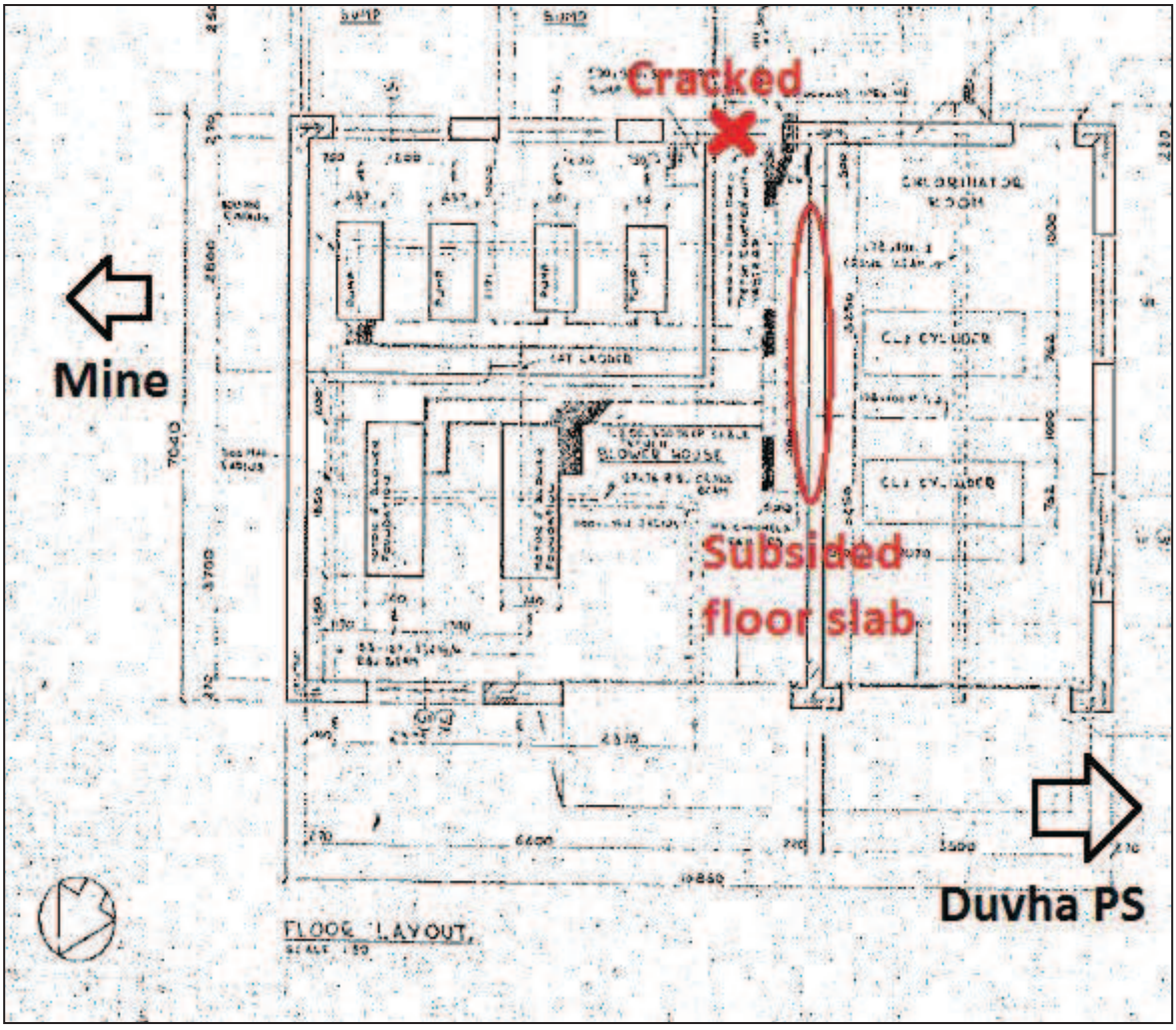

Figure 8: Floorplan of pumphouse structure showing major damage

The above Figure 8: Floorplan of pumphouse structure showing major damage shows major structural damages noted, however all cracks and other damages need to be repaired. The major damages will be discussed below; complete method statements of all civil work must be submitted by the *Contractor*, as the below discussion is only for guidance purposes.

3.2.4.2 Subsided section of floor

The electrical control panel will need to be removed to allow access to this section of the floor that has subsided. The electrical panel will be removed as part of the electrical scope; the solution for the temporary supply will thus be unaffected. The section of the floor where the temporary supply will be located must be tested by non-destructive testing methods to proof that the floor will not be damaged by the new imposed loadings.

The work will include the following activities as a minimum:

- Removal of the subsided floor slab
- Testing of geotechnical conditions
- Filling cavity with approved material
- Compacting of backfilled material
- Construction of new floor slab (to be tied to the existing floor and wall) that is capable of supporting the imposed loading from the new electrical panel.

3.2.4.3 Cracks in structure

There are some large cracks in the structure affecting both the walls and the floor. All cracks need to be checked and repaired by use of an approved epoxy or grout product. Were it is determined that the brickwork is damaged, the affected bricks must be removed and replaced, or the parts of the affected bricks must be bonded together using a class 2 mortar mix.

3.2.4.4 Waterproofing of pump trench/pit

The existing pump pit/trench floor and walls up a height of 1m must be waterproofed to prevent the ingress of groundwater and the egress of any effluent that might leak from the system. The product used for waterproofing must be able to withstand the harsh chemical conditions present in the effluent.

3.2.4.5 Installation of new equipment

The imposed loading from all new equipment that will be installed must be checked and the floor tested (non-destructive testing) to prove that the floor will be able to support the imposed loadings and any vibrations that might be caused by the equipment.

Should the floor not be able to support the new imposed loadings the structure will need to be strengthened, or the loading must be spread out over a larger floor area. The preferred solution in such a case will only be determined if it is confirmed that such action will be necessary.

Routing and installation of new cable racks must be done in a way that will not damage any existing services or reinforcing in reinforced concrete.

3.2.4.6 Damaged ceilings tiles

Damaged ceiling tiles to be removed and tested to ensure that no asbestos are present. Should no asbestos be present the damaged ceiling tiles must be replaced with tiles similar to the ones installed currently. Should asbestos be present, all ceiling tiles must be removed and disposed of by a suitably qualified contractor and then replaced with ceiling tiles that are asbestos free.

3.2.4.7 Cat ladder

The cat ladder at the pump pit/trench must be equipped with a cage since the height of the cat ladder is approximately 2.8m.

3.2.4.8 Detail Design Report

Detailed design report relating to the civil and structural *Works* including all accompanying drawings for construction and all design calculations. The civil and structural *Works* design report is to be signed by an ECSA registered professional civil engineer. Calculations that form part of the design report are arranged in a logical sequence and include such sketches and annotations as may be required to make them self-explanatory.
Calculations clearly identify the subject of the calculations and include, but are not limited to the following information:

- Project name
- *Contractor's* name
- Contract No.
- Date of calculation
- Revision No.
- Name of the item
- Page No.
- Assumptions used for design purposes
- Specifications, codes and standards used
- Computer programmes used
- Loading imposed by structures, plant and equipment during the erection, commissioning, operation and maintenance
- Safety factors and combinations of loads used
- Calculations and results of all components (including detailed design calculations)

- Design models
- Settlement of plant and equipment foundations
- Sources of information and any record of other information associated with the completed *Works*
- Reference sources (including text books and design manuals used)
- Reference to the appropriate drawings
- Selected materials and finishes
- Manufacturer's technical specifications

3.2.4.9 Drawings

Drawings prepared by the *Contractor* include complete construction details including:

- General arrangement layouts
- Layouts and sections of the different components
- Reinforcement drawings and bending schedules
- Construction joint details
- Details of embedded parts
- Structural steel detailing and corrosion protection
- Details of all plinths, openings, box-outs, holding down arrangements, grouting, connections etc. required for plant and equipment.

All submitted drawings to be signed by a Professional Civil Engineer with ECSA registration number stated on drawing.
Drawings are also to be submitted in .dwg or .dgn Microstation compatible formats.
The Employer reserves the right to use the drawings and design calculations of the *Contractor* submitted to the Employer at his own discretion.

3.2.4.10 Construction Monitoring during Execution

- The *Contractor* is mandated in terms of Construction Regulations 2014: Duties of Designer, 6(1) g to fulfil the duties described therein for the detailed designs done by the *Contractor*. The required level of construction monitoring is provided in order to certify that the works are constructed in accordance with the *Contractor's* design.
- Any risk associated with the *Contractor's* design is highlighted to the Employer together with mitigation measures.

The *Contractor's* Designer is responsible for any technical queries that may arise during the works and conducts the necessary level of construction monitoring required to certify that the works are constructed in accordance with the design and provides a Certificate signed by a Professional Engineer in this regard.

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

The *Contractor* is required to tender an offer, as his main offer, including any additional processes which may, in the *Contractor*'s opinion, be required for the correct intended functioning and operation of the *Contractor*'s design.

Inclusion or exclusion of any process is required to be accompanied by a full technical and financial justification for acceptance by the relevant Eskom engineer.

The tender is required to include a full cost breakdown for each of the processes, with major items of equipment being accounted separately. Minor items of equipment may be bundled together under a single cost allocation; however, an inventory of items thus bundled is required to be provided.

The *Contractor* is required to provide detailed capital and life-cycle costing (including labour, maintenance and operational costs) for the main and any alternative offers, with a breakdown for the processes included

The *Contractor* submits detail design reports and associated drawings for the following:

- Process design
- Arrangement design
- Mechanical detail design
- Electrical detail design
- Control and Instrumentation detail design
- Civil and Structural detail design

The *Employer*'s governance procedures require the *Employer* to perform End-of-Phase design reviews. The *Employer* requires a period of four (4) weeks for each design review. The documents that are required for design submissions can be found in the respective appendix for each discipline VDSS.

3.4 Other requirements of the *Contractor*'s design

3.4.1 Configuration Management

3.4.1.1 Document Management

All documents supplied by the *Contractor* shall be subject to Eskom's approval. The language of all documentation shall be in English. The *Contractor* shall include the *Employer*'s drawing number in the drawing title block. This requirement only applies to design drawings developed by the *Contractor* and his *Subcontractor's*. Drawing numbers will be assigned by the Employer as drawings are developed. All documentation shall be controlled and managed in accordance with Documents and Records Management Procedure (32-6).

3.4.1.2 Drawings Format and Layout

The creation, issuing and control of all Engineering Drawings will be in accordance to the latest revision of Engineering drawing Standard (240-86973501). Drawings issued to Eskom will be a minimum of one hardcopy and an electronic copy. All *Contractors* are required to submit electronic drawings in Micro Station (DGN) format, must be editable, and scanned drawings in pdf format. No drawings in TIFF, AUTOCAD or any other electronic format will be accepted. Drawings issued to Eskom may not be "Right Protected" or encrypted. The Employer reserves the right to use these drawings to meet other contractual obligations.

3.4.1.3 Document Identification

Eskom to provide a Vendor Document Submission Schedule (VDSS) during enquiry to ensure Eskom's requirements are met. The *Employer* is required to submit the VDSS as per agreed dates to the *Contractor*. Eskom will pre-allocate document numbers on the VDSS and send back to the *Contractor* through the delegated Eskom Representative. The VDSS is revisable and changes must be discussed and agreed upon by all parties. Changes in the VDSS can be additional documentation to be submitted, changes in submission dates or corrections in documentation descriptions, document numbers, etc. The *Contractor*'s VDSS shall indicate the format of documents to be submitted.

3.4.1.4 Document Submission

All project documents must be submitted to the delegated Eskom Representative with transmittal note according to Project / Plant Specific Technical Documents and Records Management Work Instruction (240-76992014). In order to portray a consistent image it is important that all documents used within the project follow the same standards of layout, style and formatting as described in the Work Instruction. The *Contractor* is required to submit documents electronically along with a transmittal note. Final Hard copies must be delivered to the *Eskom site Representative* at handover.
In addition, the *Contractor* shall be provided with the following standards which must be adhered to:

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

3.4.1.5 Email Subject

Electronic copies shall be submitted to the *Eskom Representative* through email, email subject***; Project Name_Discipline_Subject***. Electronic copies that are too large for email will be delivered on large file

transfer protocol and/or hard drives to the Project Documentation Centre. A notification email, with the transmittal note attached, shall be sent to the *Eskom Representative*.

3.4.1.6 Engineering Change Management

All Design change management shall be performed in accordance to the latest revision of the Eskom Project Engineering Change Management Procedure (240-53114026) and the Employer shall ensure that *Contractor* is provided with latest revisions of this procedure. Any uncertainty regarding this procedure should be clarified with the Employer. All design reviews will be conducted according to the Design Review Procedure (240-53113685).

3.4.2 PLANT CODING AND LABELLING

3.4.2.1 Plant Coding

Coding of the design shall be based on the AKZ coding system and the *Contractor* shall undertake the coding in line with the Duvha Information Manual. Plant Coding shall be undertaken by the employer (CoE Coding Technician in cooperation with the Site base Coding Technician) and as such the service provider shall make available the following documentation to code:

Mechanical:

- Piping and Instrumentation Diagrams (P&IDs)
- Interface list (new added plant components list)
- Process flow diagrams (PFDs)

Electrical:

- Single line diagrams
- Electrical board general arrangements (GA)
- Cable schedule

C&I:

- C&I architecture drawings
- C&I Cubicle GA
- Cable block diagrams
- Remote control station lists
- Cable schedules

Civil:

- Site layouts
- Building layouts
- Building sectional layouts
- Building floor plans per level
- Underground services layouts
- Cable rack & support
- Building lists (including room equipment lists)

Employer will only code the AKZ code defining Documentation listed above. The *Employer* will assign a coding practitioner who will interact with the Service Provider in coding the plant as listed above. The Service Provider will then be required to include allocated codes to all other designs and related documentation. It is also the responsibility of the Service Provider to consistently apply the AKZ codes throughout the rest of the technical documentation which shall include, but not limited to:

- Load schedules
- Board parts lists

- Cable block diagram
- Termination diagram
- Drive & actuator schedules
- Instrument schedules
- Alarm lists, loop diagrams
- Signal lists
- Schematic diagrams
- Termination diagrams
- Logic diagrams, etc.

The Service provider shall ensure that all documentation is coded (as per the codes assigned by the Practitioner) prior submission to Employer for review.

3.4.2.2 Plant Labelling

It is the responsibility of the *Contractor* to manufacture and install labels according to station based labelling standard called Duvha Information Manual and Plant Labelling Standard (240-71432150).

The Coding Technician shall facilitate base-lining of all equipment lists from the *Contractor*, and only baselined equipment lists shall be used as a basis for the production of labels. The Eskom Plant Labelling Abbreviation Standard (240-109607332) shall be provided to the Service provider as a reference for the creation of equipment lists.

Labelling of components inside electrical and C&I panels shall be done by the Service provider.

3.4.2.3 As-built drawings, operating manuals and maintenance schedules

The *Contractor* provides the following three weeks before commissioning:

- As-built revision of all the design documents and must be editable;
- Operating and maintenance manuals.
- Certificate of Compliance issued in terms of SANS 10142-1

3.5 Use of *Contractor*'s design

Detail design calculations, simulations and drawings to be submitted to the *Employer* for acceptance before any construction work must commence. The calculations and simulations must be submitted in a Microsoft Excel Spreadsheet. The drawings must be submitted in a CAD format (version to be confirmed during negotiations and approved by *Employer*). After approval the calculations & simulations must be the property of the *Employer*. All documents listed on the VDSS need to be submitted accordingly.

3.6 Design of Equipment

Should any other equipment require design in order to perform the design for the *Works*, the liability for this design will remain with the *Contractor*.

3.7 As-built drawings, operating manuals and maintenance schedules

Refer to the VDSS for the requirements.

4 Procurement

4.1 People

4.1.1 Minimum requirements of people employed on the Site

The following key people perform designs for the *Works*:

- The professionally registered engineers/technologists responsible for the approval of the designs, and shall provide the qualifications and experience of all engineering personnel

The professionally registered structural engineer/technologist has a minimum of 5 years post registration experience.

The person carrying out and signing off the electrical scope of work needs to be accredited and registration with the Electrical Contracting Association of South Africa (ECA) and Department of Labour.

4.2 Plant and Materials

4.2.1 Quality

Refer to 2.4.

4.2.2 Plant & Materials provided "free issue" by the *Employer*

Refer to 3.2.3.9 for the list of equipment provided as "free issue".

4.2.3 *Contractor*'s procurement of Plant and Materials

All plant and materials for this project must be included in the price

4.2.4 Spares and consumables

The *Contractor* is required to provide a complete list of recommended spares. This list should include the prices of the item and its availability over the life of the system. The prices quoted is required to 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

4.3 Tests and inspections before delivery

Refer to the discipline specific sections for this information.

5 Construction

5.1 Temporary works, Site services & construction constraints

5.1.1 Site services and facilities

Based on plant design, the plant is capable of being out of service for a maximum of 7 days. Should the *Contractor* require additional time for the plant to be out of service, the *Contractor* shall supply their own temporary power supply to the plant. The plant currently has access to potable water, and there are facilities for waste disposal. However, should the current facilities available for waste disposal be insufficient, the *Contractor* must dispose of the waste at their own cost.

5.1.2 Control of noise, dust, water and waste

The *Contractor* shall ensure that no excessive noise, dust, water and waste are generated as part of construction activities.

5.1.3 Training and technology transfer

The *Contractor* is required to provide training to the plant operators to ensure reliable operation of the refurbished plant.

6 Plant and Materials standards and workmanship

6.1 Civil engineering and structural *Works*

During the construction of the *Works* there are numerous standards and specifications to which the *Contractor* must adhere to. The documents listed below, including normative references within, are not bound in this document but are obtained by the *Contractor* at his own expense and must be adhered to during the implementation of the *Works*.
Where a SANS standard referenced has been replaced by a newer standard, the *Contractor* is required to adhere to the latest revision of the newer standard. Where a SANS standard referenced is composed of several parts, all applicable parts are to be adhered to.
The following specifications are required to be complied to:

Table 1: Table of Civil Standards

240-56364535	Architectural Design and Green Building Compliance Manual
240-56364545	Structural Design and Engineering Standard
240-57127951	Standard for the Execution of Site Investigations
240-57127953	Execution of Site Preparation and Earthworks Standard
240-57127955	Geotechnical and Foundation Engineering Standard
240-84418186	Road Specification Manual
240-85549846	Standard for Design of Drainage and Sewerage Infrastructure
SANS 10400	The Application of the National Building Regulations
SANS 2001-BE1	Construction works Part BE1: Earthworks (general)
SANS 2001-BS1	Construction works Part BS1: Site clearance
SANS 2001-CC1	Construction works Part CC1: Concrete works (structural)
SANS 2001-CC2	Construction works Part CC2: Concrete works (minor works)
SANS 2001-CG1	Construction works Part CG1: Installation of glazing in window and door frames
SANS 2001-CM1	Construction works Part CM1: Masonry walling
SANS 2001-CM2	Construction works Part CM2: Strip footings, pad footings and slab-on-the-ground foundations for masonry walling
SANS 2001-CS1	Construction works Part CS1: Structural steelwork
SANS 2001-CT2	Construction works Part CT2: Structural timberwork (roofing)
SANS 2001-DP1	Construction works Part DP1: Earthworks for buried pipelines and prefabricated culverts
SANS 2001-DP2	Construction works Part DP2: Medium pressure pipelines
SANS 2001-DP3	Construction works Part DP3: Cable ducts
SANS 2001-DP4	Construction works Part DP4: Sewers
SANS 2001-DP5	Construction works Part DP5: Stormwater drainage
SANS 2001-DP6	Construction works Part DP6: Below-ground water installations
SANS 2001-DP8	Construction works Part DP8: Pipe jacking
SANS 2001-EM1	Construction works Part EM1: Cement plaster
SANS 1200 A	Standardized specification for civil engineering construction Section A: General
SANS 1200 D	Standardized specification for civil engineering construction Section D: Earthworks
SANS 1200 DK	Standardized specification for civil engineering construction Section DK: Gabions and pitching
SANS 1200 F	Standardized specification for civil engineering construction Section F: Piling
SANS 1200 HA	Standardized specification for civil engineering construction Section HA: Structural steelwork (sundry items)
SANS 1200 HB	Standardized specification for civil engineering construction Section HB: Cladding and sheeting
SANS 1200 HC	Standardized specification for civil engineering construction Section HC: Corrosion protection of structural steelwork
SANS 1200 M	Standardized specification for civil engineering construction Section M: Roads (general)

SANS 1200 ME	Standardized specification for civil engineering construction Section ME: Subbase
SANS 1200 MF	Standardized specification for civil engineering construction Section MF: Base
SANS 1200 MG	Civil engineering construction Section MG: Bituminous surface treatment
SANS 1200 MH	Civil engineering construction Section MH: Asphalt base and surfacing
SANS 1200 MJ	Standardized specification for civil engineering construction Section MJ: Segmented paving
SANS 1200 MK	Standardized specification for civil engineering construction Section MK: Kerbing and channelling
SANS 1200 MM	Standardized specification for civil engineering construction Section MM: Ancillary roadworks
SANS 10109-1	Concrete floors Part 1: Bases to concrete floors
SANS 10109-2	Concrete floors Part 2: Finishes to concrete floors
SANS 10064	The preparation of steel surfaces for coating
SABS 471/ SANS 50413 & SANS 50196	Portland cement (ordinary, rapid hardening and sulphate resisting)
SANS 50196-1	Methods of testing cement Part 1: Determination of strength (EN 196-1:2005, IDT, Ed. 2)
SANS 50196-2	Methods of testing cement Part 2: Chemical analysis of cement
SANS 50196-3	Methods of testing cement Part 3: Determination of setting times and soundness
SANS 50196-4	Methods of testing cement Part 4: Quantitative determination of constituents
SANS 50196-5	Methods of testing cement Part 5: Pozzolanicity test for pozzolanic cement
SANS 50196-6	Methods of testing cement Part 6: Determination of fineness
SANS 50196-7	Methods of testing cement Part 7: Methods of taking and preparing samples of cement
SANS 50197-1	Cement Part 1: Composition, specifications and conformity criteria for common cements
SANS 50197-2	Cement Part 2: Conformity evaluation
SANS 1083	Aggregates from natural sources - Aggregates for concrete
SANS 50025 series	Hot rolled products of structural steels Parts 1-6
SANS 5831	Presence of chlorides in aggregates
SANS 5861-2	Concrete tests - Sampling of freshly mixed concrete
SANS 5862-1	Concrete tests - Consistence of freshly mixed concrete - Slump test
SANS 5863	Concrete tests - Compressive strength of hardened concrete
SANS 5864	Concrete tests - Compressive strength of hardened concrete

6.2 Electrical & mechanical engineering works

6.2.1 General Requirements

Fabrication, Installation, Inspection and testing in accordance with:

- EN 13480, Metallic industrial piping
- EN 13445, Unfired pressure vessels
- SANS 2001-DP2, Construction works Part DP2: Medium pressure pipelines

Pumps in accordance with:

- 240-56030537, Eskom Specification for centrifugal Pumps

Valves in accordance with:

- 240-105020315, Standard for Low Pressure Valves

Piping in accordance with:

- 240-123801640, Standard for Low Pressure Pipelines
- 240-89147446, Instrument Piping for Fossil, Hydro, Renewable and Aero-Derivative Power Plants Standard

- EN 1092, “Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated” or “SANS 1123, Pipe flanges”

Welding in accordance with:

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

Corrosion protection in accordance with:

- 240-101712128, Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings
- 240-106365693, Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings

Fire Protection in accordance with:

- 240-54937450, Fire Protection & Life Safety Design Standard

6.3 Process control and IT *Works*

The *Works* complies with the following codes and standards:

- 240-56356396, Earthing and Lightning Protection Standard
- SANS 60529:2013, Degrees of protection provided by enclosures (IP Code)
- 240-56737448, Fire Detection and Life Safety Design Standard

6.4 Other requirements

The *Contractor* performs the following site acceptance tests:

- Due to the plant not requiring changes to the process, the plant shall operate at the parameters listed in 3.1.2 for at least a 3 month period
- Pump and motor vibration tests according to BS ISO 10816-7 category I
- Confirm pump duty point
- System performance at minimum and maximum system flow rate
- System performance at minimum and maximum supply water level
- Confirm that all control valves are operated within the valve's control range
- 1 month system reliability run

The *Contractor* includes the following on his ITP:

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

List of drawings

6.5 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 Technical Specification and Site Information.

Drawing number	Revision	Title
24.57/51239	**1**	**Ikageng Sewage Plant Layout**

Appendix A: VDSS

The VDSS and all Appendices can be found on the supplied website:

http://eng.eskom.co.za/sites/fs/pem/gxr/dps/duvhaecmproject/Duvha%20Ikageng%20Sewage%20Plant%20Refurb/Forms/AllItems.aspx?RootFolder=%2Fsites%2Ffs%2Fpem%2Fgxr%2Fdps%2Fduvhaecmproject%2FDuvha%20Ikageng%20Sewage%20Plant%20Refurb%2F8%2E%20Technical%20Specification%2FAppendices

Appendix B: MECHANICAL APPENDICES

Mechanical Appendices include:

B1. Mechanical Eskom Standards

B2. Orbinox Knife Gate Valve Specifications

Appendix C: C&I APPENDICES

C&I Appendices include:

C1. C&I Eskom Standards
C2. List of free issued items (Parts List)
C3. Drive and Actuator template
C4. Instrument Schedule template
C5. Limit of Supply Services (LOSS) Diagrams

Appendix D: ELECTRICAL APPENDICES

Electrical Appendices include:

D1. Electrical Eskom Standards
D2. Ikageng Sewage Treatment Plant Substation Electrical Equipment Layout
D3. General Arrangement Drawing for existing 380V Switchgear Boards
D4. 380V Sewage Treatment Plant Load Schedule
D5. Electrical LOSS Diagram
D6. Station MV & LV Electrical Diagram

Appendix E: CIVIL AND STRUCTURAL APPENDICES

Civil and Structural Appendices include:

E1. Civil and Structural Eskom Standards

Appendix F: PROCESS APPENDICES

Process Appendices include:

F1. Process Eskom Standards
F2. Plant Design Manual
F3. Sewage Treatment Plant Layout