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## PART 3: SCOPE OF WORK

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# 1 Description of the works

## 1.1 Executive overview

Duvha Power Station (PS) is in the process of upgrading the Cooling Water Treatment Plants (CWTPs) which are used for alkalinity control of the Cooling Water (CW). There are currently two CWTPs on the station, one serving the North CW system and one serving the South CW system.

Each CWTP is currently fitted with two operational silo systems (the South side CWTP has three silo's but only two are operational) with each silo system fitted with a silo cone, knife gate valves, aeration pads, lime mixing tank, slurry transfer pumps and all required pipework from the silo to the mixing tank and from the mixing tank to the clarifiers.

Post Upgrade, Each plant will consist of the two existing storage silos (one for hydrated lime and one for soda ash) as well as two slurry makeup and transfer systems. These makeup and transfer systems each consist of a vibrating bin unit connected to the storage silo fitted with a feeder setup. The chemicals are fed to a slurry dilution tank fitted with a mechanical stirrer. From the slurry dilution tank the slurry is supplied to the clarifiers' centre wells via piping. The upgrade will include all electrical, mechanical, civil and structural as well as control and instrumentation equipment.

The Technical Specification includes the following engineering design information:

- Design Assumptions
- Requirements for the CWTP system
- Process Flow Diagrams
- Process and Instrumentation Diagrams
- Interface Requirements

This Scope is inclusive of all activities necessary to address the upgrade of the CWTPs. The *Contractor* designs, manufactures, procures, installs and commissions all Mechanical, Structural and Civil, Electrical and Control & Instrumentation (C&I) plant required for the *works* as defined in this *Technical Specification*. This includes interfacing with and utilisation of existing Plant and Material as well as decommissioning and removal of existing Plant and Material that are no longer required for the functioning of the CWTPs. The *Contractor* is also responsible for skills transfer with regards to operation and maintenance of the upgraded CWTPs. It is important to note that the silos are already in existence however the *Contractor* shall ensure that they are suitably lined and structurally sound for their intended purpose.

## 1.2 Employer's objectives and purpose of the works

The Employer's objective is to minimise the volume of raw water added to the CW system by maximising the cycles of concentration in the CW system by ensuring adequate and reliable CW treatment. The purpose of the works is to improve the availability and reliability of the CWTPs at Duvha Power Station. This will be achieved through this plant modification.

## 1.3 Interpretation and terminology

The following abbreviations are used in this Technical Specification:

Abbreviation	Meaning given to the abbreviation
AC	Alternating Current

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AKZ	Analagen kennzeichnung system
C&I	Control and Instrumentation
CCW	Concentrated Cooling Water
COC	Certificate of Compliance
CW	Cooling Water
CWTP	Cooling Water Treatment Plant
DC	Direct Current
DCS	Distributed Control System
ECSA	Engineering Council of South Africa
FAT	Factory Acceptance Test
HAZOP	Hazard and operability
HMI	Human Machine Interface
I/O	Input/ Output
IEEE	Institute for Electrical and Electronic Engineers
IP	Ingress Protection
ISO	International Standards Organisation
ITP	Inspection and Test Plan
LV	Low Voltage
MCB	Mini Circuit Breaker
NDT	Non Destructive Testing
OEM	Originally Equipment Manufacturer
OPC	Ordinary Portland Cement
OSH ACT	Occupational Health and Safety Act
P&ID	Piping and Instrumentation Diagram
PLC	Programmable Logic Controller
PQR	Procedure Qualification Record
Pr. Eng.	Professional Engineer
PS	Power Station
PVC	Poly Vinyl Chloride
QA	Quality Assurance
QCP	Quality Control Plan
QMS	Quality Management System
SANS	South African National Standard

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SIT	Site Integration testing
UPS	Uninterrupted Power Supply
VSD	Variable Speed Drive
WPQR	Welding Procedure Qualification Record
WPS	Welding Procedure Specification
WTP	Water Treatment Plant

## 2 Management and start up.

### 2.1 Documentation control

The *Contractor* implements a comprehensive document control of all documents, their revision status and of the document status in relation to the 'as built' and 'as designed' or commonly known as "Approved for Construction" plant status. Procedures, document control, flow diagrams and indexes are included in this system. The drawing register contains the following information and is submitted monthly in a Microsoft Excel format to the Employer:

- Drawing number (*Employer* and *Contractor's* number)
- Revision
- Approval status
- Location of drawing at that stage
- Drawing AKZ number
- Drawing description
- Sheet number
- Transmittal number
- Date of submission

The *Contractor* adheres to the *Employer's* Documents and Record Management Procedure (32-6) for all documents submitted.

The *Contractor* provides the following procedures for maintenance activities:

- Calibration and checking of instrumentation, pneumatic positioners, and electrical actuators including frequency of maintenance interventions.
- Trouble shooting and replacement of faulty equipment.

### 2.2 Training workshops and technology transfer

#### 2.2.1 General

The *Contractor* provides training on the equipment and systems included as part of the *Works* to the various categories of the *Employer's* technical staff 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. All training will consist of both theoretical and practical training. The training is to be structured such that competency tests are done at the end of the training sessions on all the training participants.

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At design freeze, the *Contractor* submits to the *Project Manager* for acceptance a detailed training programme as well as a prospectus for each course. The training schedule is incorporated in the Accepted Programme.

A certificate of satisfactory completion to be issued to employees who successfully completed the training.

**2.2.2 Training Documentation**

The *Contractor* provides all course material including manuals. All course material is in English and includes all third party documentation. A copy of the training documentation is supplied to each trainee with an additional 3 master sets for the *Employer's* library and training department. All training material is also supplied in an electronic format for easy reference.

Training manuals are continuously updated by the *Contractor* up to the date of issue of the Defects Certificate for the whole of the *works*.

**2.2.3 Operating, Maintenance and Engineering Training Manuals**

The *Contractor* provides Operating, Maintenance and Engineering Training Manuals. The quantity of manuals to be supplied is as follows:

- Synopsis (Manual) - 1 copy
- First Draft - 1 copy
- Final Draft/Pre Print Proof - 1 copy
- Final Manual - 5 copies

All documentation is also to be handed over in an electronic format for easy reference.

**2.2.4 Participation of Employer's Staff**

The *Employer* intends to second staff, both engineering and maintenance, part-time or full-time to the *Contractor's* team during the engineering, installation and commissioning stages of the contract, without affecting the Prices. The aim is that the *Employer's* personnel receive "on-job" training in order to become familiar with the equipment forming part of the *works*.

The *Employer's* training requirements are as follows:

- The Provision of detailed training manuals incorporating all aspects of the training that will be provided to the Project Manager for acceptance.
- Initial training of *Employer's* personnel in the operation, calibration and maintenance of the works.
- The *Contractor* provides formal theoretical training to the *Employer's* personnel in the operation, maintenance and general running of the Works and equipment before commencing testing and commissioning of the works. The disciplines to be trained are operating, maintenance (electrical, mechanical, control and instrumentation), engineering and chemistry personnel. The *Contractor* shall present sufficient training interventions to accommodate all above-mentioned personnel.

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The following is considered to be the minimum requirements for such training:

- a) Theory of processes
- b) Plant and component description, layout and design
- c) Controls, interlocks and alarms
- d) Plant operation and control:
  - I. Pre start up procedures
  - II. Start-up procedures
  - III. Normal operating procedures
  - IV. Routine test and inspection procedures
  - V. Normal and emergency shutdown procedures
  - VI. Emergency and alarm conditions
  - VII. Cleaning procedures
  - VIII. Long-term storage procedures
- e) Operational problems:
  - I. Troubleshooting
  - II. Loss of supply (e.g. electrical power)
- f) Dangers and precautions
- g) Recommended settings (electrical, mechanical, control and instrumentation)
- h) Test and inspection plans (electrical, mechanical, control and instrumentation)
- i) Inspection and Maintenance Procedures (electrical, mechanical, control and instrumentation):
  - I. During plant operation
  - II. During shut down periods
- j) Special tools and equipment:
  - I. Requirements
  - II. Training
- k) Fault Finding:
  - I. Items to inspect
  - II. Typical observations and/or deviations
  - III. Recommended corrective actions
- l) Recommended spares (electrical, mechanical, control and instrumentation):
  - I. Item description
  - II. Part number/type
  - III. Supplier
  - IV. Drawing designation
  - V. Quantity installed on plant
  - VI. Recommended stock
- m) Lubrication schedule
- e) Items to inspect
- f) Typical observations and/or deviations
- g) Recommended corrective actions

During the testing, commissioning and handing over of the works, it is also incumbent on the *Contractor* to provide practical training to the *Employer's* personnel in the operation, maintenance and general running of the works and Equipment. For this purpose the Project Manager reserves the right to allocate certain staff to the *Contractor's* team during erection and commissioning period.

The *Contractor* declares the staff as competent, in writing, to operate, calibrate and maintain the *Contractor's* plant and equipment prior to hand over or provide supervision for the period.

**2.2.5 C&I Engineering and Maintenance Specific Training**

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The following C&I specific training (Engineering and Maintenance) needs to be provided by the Contractor in conjunction with all other training requirements indicated in other sections:

**2.2.5.1 Basic Engineering & maintenance training includes, as a minimum:**

1. Usage of all sub-systems in the WTP HMI system
2. Familiarisation with the documentation forming part of the *works*, including drawing configuration logic
3. Hardware familiarisation
4. Hardware configuration which includes the computers, processing modules, communication modules, IO modules, power supply monitoring modules, network modules and all other peripheral equipment supplied as part of the *works*.
5. Hardware installation
6. HMI and C&I system software reloading
7. Graphic display configuration
8. Drawing and hardcopy report generation
9. Network maintenance
10. Full course on the existing Infi90 DCS
11. Operator interface familiarisation including keyboard and display functions, controls, alarms and messages
12. System hardware maintenance through use and interpretation of diagnostic routines and error codes of on-line and off-line diagnostic software for the detection of faulty modules
13. Module problem report retrieval
14. WTP HMI and WTP C&I system hardware maintenance training including the computers, controllers, IO modules, network modules and all other peripheral equipment supplied as part of the *works*.
15. Usage of Engineering workstations

**2.2.5.2 Advanced Engineering & maintenance training includes:**

1. A system design philosophy which includes lessons and improvements from previous products, and operating and maintenance concepts.
2. The system structure showing the hierarchy from the HMI, the Automation System and field equipment. The structure must also show the hierarchy from subsystems, to modules, down to components (frequently used and critical ones) for both HMI and the Automation System. The aim is to be aware of the risks subjected by external changes in electronic technologies
3. System Configuration and Documentation Control, including all necessary activities for system expansion/modification, and software storage.
4. Power requirement calculation
5. Development, debugging and testing of all software
6. Software configuration and low-level programming
7. Compilation, cross referencing and module binding the configuration drawings

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8. Installation, configuration and maintenance of all software packages forming part of the *works*
9. Graphic display design, development and configuration
10. Data base generation, configuration and storage
11. Network design, communication, configuration, security and expansion
12. Process control loop tuning
13. A system of monitoring system failure modes, effects and criticality to the business, for more proactive maintenance and lifecycle strategies
14. Engineering of all sub-systems in the WTP HMI and WTP C&I system

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### 3 Engineering and the *Contractor's* design

The Contractor designs, procures, supplies, manufactures, delivers to site & transports at site, installs, erects commissions and tests the entire works to ensure a fully functional system.

#### 3.1 *Employer's* design and Parts of the *works* that the *Contractor* is to design

This document provides the scope for the design, procurement, fabrication, delivery to and within site, installation, erection, modification of existing infrastructure, cold and hot commissioning, performance testing of the entire engineering works to ensure a fully functional CW treatment system for the North and South CW systems at Duvha PS, herein after referred to as the *works*. The *Contractor* supplies all equipment and consumables for the construction and commissioning of the *works*.

The *Contractor* is responsible for carrying out all activities and supplying everything necessary to provide the *works* in accordance with the requirements of the *works information*.

The *Contractor* ensures that the complete design is performed by, or under the direction, control and supervision of an Engineering Council of South Africa (ECSA) registered professional person for each discipline as required by the scope of the design. The *Contractor* ensures that the complete design is signed off by an Engineering Council of South Africa (ECSA) registered professional person 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 person, the professional person shall be responsible for signing off the design as applicable to his field of registration.

The *Contractor* is required to perform a mandatory plant walk down and evaluate items described in the *works* for inclusion in their tender submission.

The *Contractor* is required to develop a detailed design for acceptance by the *Employer*.

The *Contractor* is required to adhere to 36-681 Generation Plant Safety Regulations for all *Works*.

The *Contractor* is required to adhere to the Eskom Standards and the relevant SANS standards that apply.

##### 3.1.1 General Design Requirements

There are two CWTPs on the station, one serving the North CW system and one serving the South CW system. Each upgraded plant shall consist of two storage silos (one for hydrated lime and one for soda ash) as well as a slurry makeup and transfer system per silo. The existing storage silos are to be used; however the rest of the system shall be re-designed. The available working area to install equipment is indicated in Appendix B. The drawings supplied are to be used for tender purposes only, the contractor will be required to perform measurements and compile new drawings of the plant. The makeup and transfer system, each consisting of a storage silo connected to a vibrating bin unit with the downstream feed rate being controlled via dosing screws and screw conveyors. Powder (the collective use of soda ash and lime will be labelled as powder in this *Technical Specification*) is fed to a slurry dilution tank/s, where the powder is mixed with water. The fully reacted lime/soda-ash slurry is pumped to the clarifiers centre well.

##### 3.1.2 Battery Limits

###### 3.1.2.1 Mechanical Battery Limits

Silo Battery limits:

1. Battery limits will start from the interface (including the interface) where the lime/soda ash material enters the silo.
2. The Pulse Jet Fabric Filter at the top of the silo is included.
3. The silo's interior is included.
4. The silo's discharge is included

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5. Connection between Silo and the mixing tank:
6. All equipment which affects the flow of lime/soda ash material
7. All interfaces and connections between the silo discharge and the mixing tank input.

**Mixing tank:**

1. The mixing tank as well as all internals and interfaces
2. The extraction scrubber as well as the interface between the scrubber and the mixing tank.

**Raw Water Supply:**

1. Scour valve 20VB10 S442
2. T-piece downstream of Non return valve 20VB10 S045

**Slurry Pipe Line**

1. The slurry pumps including all interfaces.
2. All pipelines responsible for transporting the slurry according to the operating procedure.
3. All pipe interfaces and valves that are part of the system to transport the slurry to the clarifiers centre well.
4. The interfacing valves between the clarifier centre well and the pipe line.

**3.1.2.2 Electrical Battery Limits**

The electrical scope shall be confined to the Water Plant Boards (South and North) and the Distribution Boards, including cable routes/trenches up to the termination point of the field equipment at the Lime Plant including motors.

**3.1.2.3 Control & Instrumentation Battery Limits**

The C&I battery limits starts from the field interface to the WTP DCS.

**3.1.2.4 Civil and Structural Battery Limits**

1. Silo Battery Limits (North and South side):
2. All four (4) Silos, which are to be fitted with vibration bins
3. One south Silo is to be internally lined with a suitable lining system and converted from storing lime to soda ash.
4. Access walkways within the plant
5. Equipment plinth supports which includes Electrical boards in the vicinity of the clarifiers

Furthermore, the *Contractor* designs and constructs ALL required infrastructure to support the plant modification. This includes structural assessment and verification to ensure structural integrity of the existing silos for re-use.

**3.1.3 Design Criteria**

1. Treated cooling water needs to adhere to the 240-55864767 Eskom Chemistry and Microbiology Standard for Condenser Cooling Water.
2. The system must ensure ease of maintenance.
3. The system must be designed such that it is accessible and operable i.e. equipment must not be inaccessible and should not restrict operator and maintenance access.
4. Slurry transfer velocity must be sufficient to prevent settling and blockages. Industry investigations have shown 2.5 m/s to be the preferred slurry transfer velocity.

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5. Operational parameters of pumps shall avoid cavitation.
6. The process design must be such that it eliminates the possibility of lime/soda ash hang-ups in the system.
7. The system design shall incorporate design features to support high reliability of safety significant equipment and high system availability.
8. As far as technically possible, to supply new loads from existing LV switchgear.

**3.1.4 Employers Process Requirements**

The Employers conceptual process design is indicated in Section 3.1.4. The *Contractor* will develop this conceptual design further to meet the requirements of this *Technical Specification*. The *Contractor* will take design liability for the detailed design produced hence it is imperative that he adds any systems or processes to the *Employers* conceptual design that he deems necessary to assure the functionality of the overall system. In cases where the *Contractor* chooses to affect such changes he must clearly motivate the reason for the change. The motivation must at a minimum contain technical, financial, operational and maintenance information.

**3.1.4.1 Process Description**

The CWTPs are required to prepare a lime/ soda ash slurry for dosage into the CW clarifiers in order to increase the pH to enable softening reactions to occur. Softening is done on the CW system to prevent scale formation on heat exchange equipment, allow for increased cycles of concentration in the CW system and in turn reduced CW blow down volumes, ash dam levels and reduced raw water consumption.

Each CWTP, North and South, will consist of one hydrated lime and one soda ash dosing system. Lime will be stored in the existing concrete silos whilst the silos for soda ash will need to be lined. The lime/soda plant is as illustrated in Figure 1, Figure 2, and Figure 3 below.

The current lime/soda ash silos at Duvha P.S. consist of reinforced concrete cylindrical structures that have conical shaped hoppers as discharge points. Each silo is fitted with a reverse pulse jet fabric filter system. There will be an interlock which will activate the pulse jet fabric filter once a tanker connects to the silo's infeed. The dry powder (Lime/soda ash) will be pneumatically loaded into the silo from road going tankers with on-board air compression equipment as per original design. When the pneumatic conveying pipeline (from the bulk tanker) is feeding into the silo, the filter located above the silo is used to separate the conveying air from the dust (lime/ soda ash powder) and expel the clean air to atmosphere. A compressed air pulse system is used on these filters to dislodge the powder from the dirty side of the filter bag. The dislodged powder particles drop down back into the silo. Soda ash is a hygroscopic material thus it is very sensitive to moisture, to reduce the possibility of the soda ash being exposed to a high humidity environment a dehumidifier will be installed on the soda-ash storage silos. One silo on the South plant needs to be converted to be able to store soda-ash. This requires that the silo be lined with a suitable lining system.

The current aeration system supplying the installed pulse jet fabric filters will also be used for the new pulse jet fabric filters. There is a control air receiver at the North plant that needs to be fitted with an automatic drain valve to remove moisture.

The aeration pad fluidising system, currently installed, will be replaced by a new mild steel conical hopper and vibrating bin unit. This will eliminate the use of air in the system and in turn any moisture that could be introduced. A vibrating bin discharger is used to ensure continuous feed of the powder out of the silo. This is used to prevent bridging in the silo bottom opening, thereby ensuring a reliable supply to the feeders.

The feeders act as the material feed controller and it is speed controlled via a Variable Speed Drive (VSD). The lime system will consist of a dosing screw and screw conveyor system in parallel, whereas the soda ash system will only have a dosing screw system. Refer to Section 3.1.6.1 for more details on the operation of the feeders. Required dosing rates were calculated based on the raw water qualities to be treated. For the North plant supplied with Vaal water and with the occasional process water recovery, lime dosage rates of 212-2500 kg/h and soda ash dosage rates of 86- 433 kg/h was calculated. The South plant supplied with Komati water with possible change to Vaal water supply requires lime dosage rates of 107-1120 kg/h and soda ash dosage rates of 24-463 kg/h. To dose these powder quantities into the clarifiers, dilution water is

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required to create a slurry of maximum 6.5% wt/wt concentration. The manual knife gates, upstream of the feeders will be used as an airlock under the vibrating bin as the material can leak through the feeders and vibrating bin during in loading of the silos via the tankers.

To accommodate for the varying clarifier flows and water qualities, a dual feeder system will need to be implemented to allow for adequate dosing on the hydrated lime system, however the soda ash system only requires a single feeder stream (dosing screw setup). The one system will cater for 0 to 1000 kg/h and the other, for higher than 1000 kg/h. A diverter chute will be installed to allow for the selection of the required feeder system. The dual feed system will consist of a dosing screw in the one feed and an intermediate bin connected to a screw conveyor in the second feeder stream.

The North side dilution water (currently supplied from one of the launders via pumps) will be supplied directly from the raw water supply line. The line should be sized to ensure that "gravity feed" from the raw water line is achieved. The top of the mixing tank (dilution water inlet) needs to be at least 1m lower than the operating level of the clarifiers to ensure gravity feed is possible. At the raw water tie-in (refer to drawing 24.57/47058) one line needs to be connected to the scour valve (20VB10 S442) on the Komati raw water supply line and another line connected to the T-piece downstream of the non-return valve (20VB10 S045), to allow for manual selection between the two raw water supplies. Each line must be fitted with a Non Return valve before combining into a single line to the silos. The existing dilution water supply on the South is fed from the clarified water sump (refer to drawings 24.57/47028 and 24.57/47042) at the WTP and will be utilised as is. The current dilution water systems need to be modified inside the silo structure as required for the new interfaces.

Dilution water is supplied for the dilution of the lime/soda ash as well as to flush the slurry transfer pipework. Electrically actuated valves will control the supply to the different users. The system will be designed to at all times be able to supply water to all mixing tanks simultaneously at a rate 20% higher than that of the slurry pumps (49.49m<sup>3</sup>/h per pump). Thus, dilution water needs to be supplied up to 240m<sup>3</sup>/h (per plant) for worst case operation.

A wet scrubber will be fitted to the top of the mixing tanks to prevent the powder dust escaping to the environment. All the dilution water runs through the scrubber and in this manner any dust particles are entrained in the water and dropped back into the mixing tank. The scrubber has an exhaust fan that keeps the mixing tank under a light vacuum at all times. This ensures that no dust escapes from any of the openings, such as the overflow pipe.

In the mixing tank a mixer agitates the powder that is in suspension within the slurry and prevents it from settling on the bottom of the tank. The tank is sized to allow an approximate residence time of 11 minutes. The water level in the mixing tank is kept at a constant level by controlling the addition of the dilution water into the mixing tank, via measuring the level with a guided radar level sensor. The slurry is drawn from the mixing tank and pumped to the clarifier centre well via the slurry pumps (Refer to Appendix A for more details). The maximum flow operation will have two of the pumps in operation while the third pump is on standby. The piping after the pumps will have a cross-over as to allow each pump to supply any of the clarifiers. This selection will be achieved via pinch valves which will be used as isolation valves.

Both the North and South plants each serves three clarifiers (raw water, raw/CCW and a CCW clarifier). Lime/ soda ash can be dosed into either one of the clarifiers (see Figure 3 below). When two (2) clarifiers require dosing, two pumps will be active, each dedicated to a clarifier. The pump selection will be selected via the actuated pinch valves.

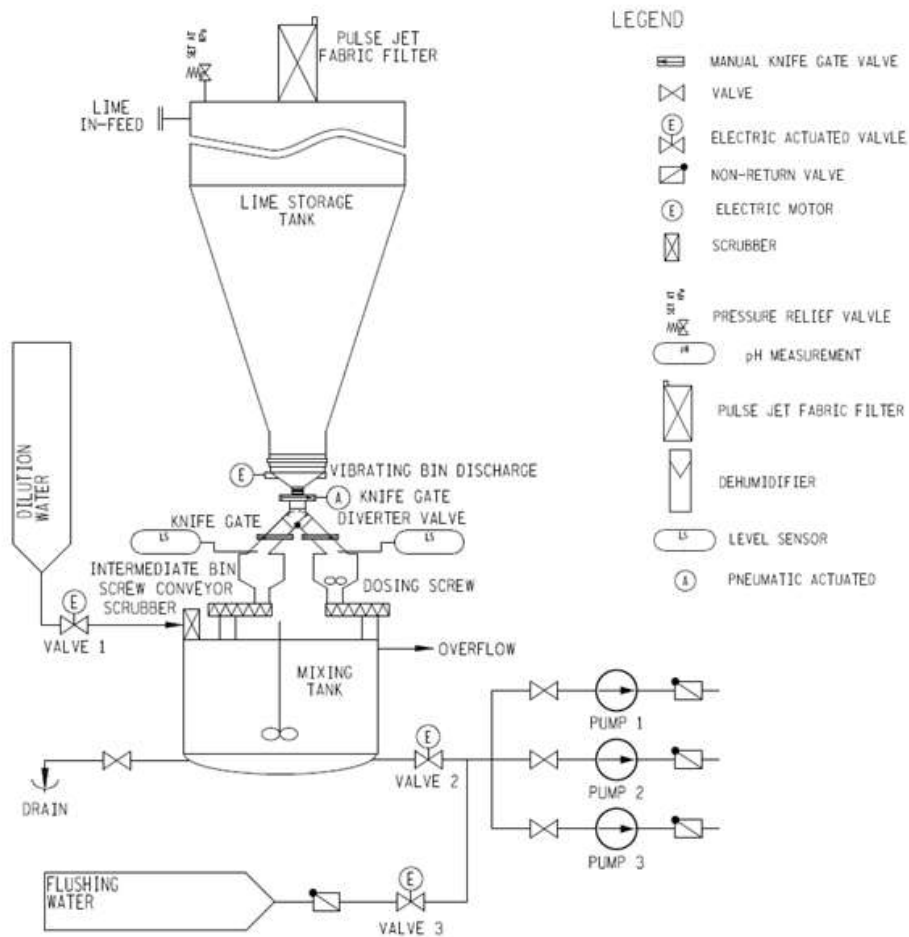
Each clarifier is designed for a maximum flow of 3 750 m<sup>3</sup>/h and minimum flow of 1 000 m<sup>3</sup>/h. Dosing should be such that lime/soda ash can be dosed into one clarifier at minimum or maximum flow, or two clarifiers with a combined maximum flow of 5000 m<sup>3</sup>/h. The North side clarifiers are supplied with Vaal raw water with occasional process water recovery. The South side is currently supplied with Komati water; however there is a possibility of switching to Vaal raw water supply as well. Dosing calculations were done taking all of these parameters into consideration.

Lime/Soda Ash dosing will be controlled by determining the outlet flow from the clarifiers and adjusting the feeder speed accordingly. Additional online pH measurement will be installed to measure the pH at the centre of each clarifier. This will allow the operator to do appropriate dosing adjustments to accommodate

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification**

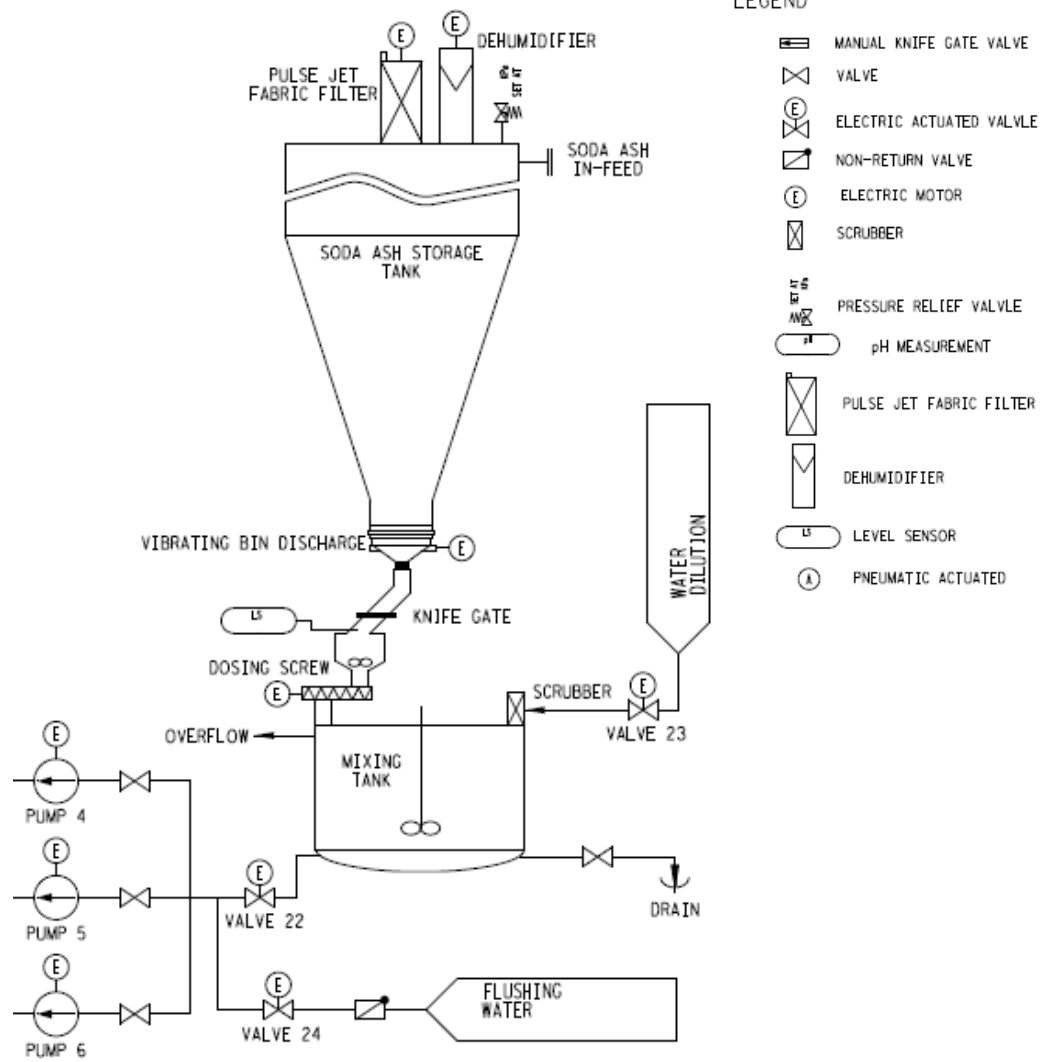
variations in water quality. The pH meters must be of a type that can allow for the probe to be backwashed online and on a user selected time-basis.

The North and South will have identical systems, this will standardise spares and allow for simpler maintenance strategies.

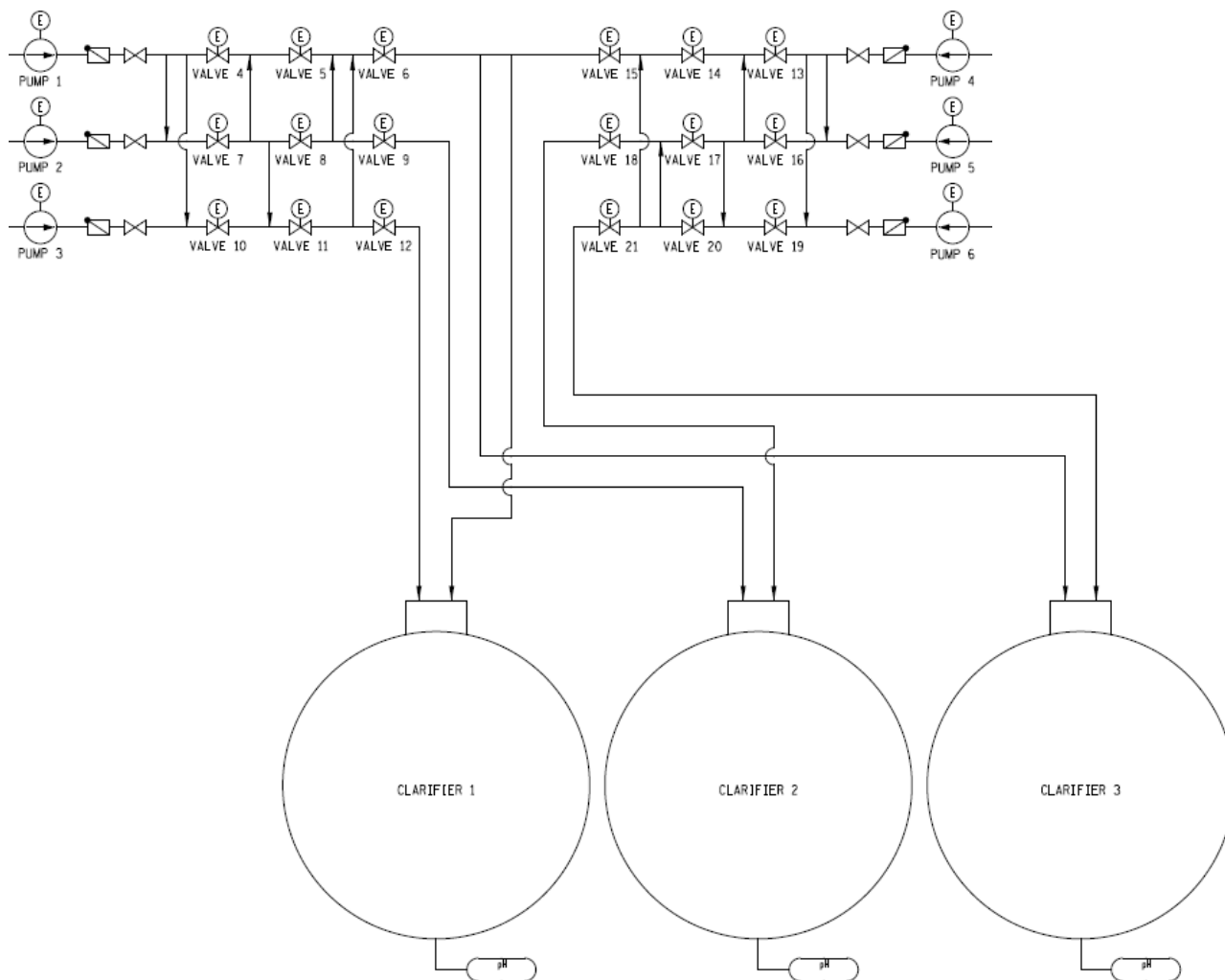


**Figure 1 Lime System**

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification**



**Figure 2 Soda Ash System**

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Figure 3 Lime/Soda Ash System downstream of pumps****3.1.4.2 Operating and Control Description****General Requirements:**

- The operation of the system will be automated as far as possible with minimum operator intervention required.
- All equipment controlled via the WTP DCS should be capable of Auto and Manual Control.
- All equipment controlled via the WTP DCS should have a local override to allow local control.
- All pumps to have suction and discharge pressure transmitters and pressure gauges to protect the pumps from low suction or high discharge pressures.

Hydrated lime/soda ash inside the silo will be prompted to flow via the vibrating bin at the silo hopper discharge. The discharged lime/soda ash passes through the vibrating bin (See Figure 1 and Figure 2), into the following arrangements:

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****3.1.4.3 Normal operation****3.1.4.3.1 Vibrating bin:**

There should be an interlock on the vibration bin system, where this system will only activate once a feeder stream is activated:

Lime system

- Vibrating bin activation requirements:
  - Pneumatic actuated knife gate open
  - Dosing screw activated
- Vibrating bin activation requirements:
  - Pneumatic actuated knife gate open
  - Screw conveyor activated

Soda ash system

- Vibrating bin activation requirements:
  - Pneumatic actuated knife gate open
  - Dosing screw activated

**3.1.4.3.2 Diverter Chute:**

When the selected feed rates cross the 1000 kg/h feed rate (either from above 1000kg/h feed rate to less or the opposite) the diverter chute should change the active feed stream to either the dosing screw or screw conveyor stream.

- Feed rates of 0 – 999 kg/h : Dosing screw feed stream
- Feed rates of 1000 kg/h – 2500 kg/h : Screw conveyor feed stream

In order to perform this operation, the vibration bin should stop and the pneumatic actuated knife gate below the vibration bin should close. By closing this knife gate, while the active downstream feed streams are active, the material is being removed from the diverter chute section, this will allow the flap inside the diverter chute to switch stream without the danger of over-torque and damaging the actuators. The C&I signal which will trigger the diverter chute will occur when the level sensors, located at the discharge section into the active stream's intermediate bin register empty. Once the diverter chute has selected the new feeder stream, the newly selected stream's feeder activates, followed by opening the pneumatic actuated knife and activating the vibration bin.

- Diverter chute activation requirement:
  - Signal to change streams from the control room
  - Level sensor in currently active stream needs to register empty chute.

**3.1.4.3.3 Hydrated lime system:**

As the hydrated lime is being discharged via the vibrating bin, it enters the discharge pipe, where it passes through the pneumatic actuated knife gate and into one of the following streams: The diverter chute will select the dosing screw setup when the required feed rate is below 1000 kg/h and the screw conveyor setup when above 1000 kg/h. The dosing rate will be determined via the feedback of the flow measurements on the clarifiers and the control room's input based on the pH sensors. Take note, the soda-ash system does not contain this dual feed setup. It also does not contain a pneumatic actuated knife gate below the vibration bin.

**Dosing screw setup selected:**

The hydrated lime flows from the vibration bin, through the pneumatic actuated knife gate, diverter chute, manual knife gate, dosing screw's intermediate bin, dosing screw and discharges into the mixing tank. The dosing screw and intermediate bin is constructed as a unit and contains an agitator in the dosing screw's opening to promote flow into the dosing screw. The intermediate bin should be kept at a constant level.

**Screw conveyor selected:**

The hydrated lime flows from the vibration bin, through the pneumatic actuated knife gate, diverter chute, manual knife gate, into the intermediate bin which flows into the screw conveyor. The screw conveyor does

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not contain an agitator due to the sufficiently sized inlet. The hydrated lime is fed through the screw conveyor into the mixing tank. The intermediate bin should be kept at a constant level.

**3.1.4.3.4 Dilution Water supply:**

Mixing tanks level control:

The level in the mixing tank should remain constant, this will be achieved through variation in the dilution water feed via control valves 1 and 23. The level sensor in the mixing tanks should serve as the control valves feedback whether to open or close.

**3.1.4.3.5 Timed Flushing (Refer to Figures 2 and 3):**

The dilution water will also be supplying a flushing line, which will activate every 30 minutes by keeping valves 3 and 24 open and closing valves 4, 7, 10, 13, 16, 19 whilst stopping all pumps. This will flush any settled particles back into the mixing tank. After 5 seconds of reverse flushing, valves 2 and 22 closes and the appropriate pumps paired with the corresponding valves (4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21) will activate and for 3 minutes the lines will be flushed with dilution water. After the 3 minutes, valves 2 and 22 opens followed by closing valves 3 and 24.

**3.1.4.3.6 Flushing during pump turnover:**

There are three (3) centrifugal pumps on the hydrated lime system and identically on the Soda-ash system. Due to the worst flow rate scenario of two [2] clarifiers requiring supply at the same time, a maximum of two (2) pumps per lime/soda-ash system will be active at the same time. The third pump will be on standby. Whenever a pump needs to be shutdown, the timed flushing sequence should be initiated with the active pump's pipe line's being flushed. The pump to be switched off will shut down after the 3 minutes flushing sequence.

**3.1.4.3.7 Pump switch over:**

The standby pump should be activated at least once every 6 hours, this will ensure all three pumps will have been flushed for at least one 30 minute cycle a day.

**3.1.4.3.8 Selecting valves to clarifiers:**

Refer to appendix A.

**3.1.4.4 Start-up procedure (Refer to Figures 2 and 3): (Refer to Figures 2 and 3):**

When the system is to be started, the following process should be followed:

- Ensure mixing tank is at working level.
- Valves (2/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 11/ 12) for lime and 13/ 14/ 15/ 16/ 17/ 18/ 19/ 20/ 21/ 22 for the soda ash) need to be correctly opened – see Appendix A.
- Pumps (1/ 2/ 3 for lime and 4/ 5/ 6 for the soda ash) should be started – see Appendix A, as well as the dilution valves (1/ 23) in open status, this should allow an equal inflow as well as outflow of water and slurry and thus maintain the working level in the tank. The scrubber should also be started now)
- Start the agitator in the mixer.
- Activate the correct dosing stream.
- Open the pneumatic actuated knife gates.
- Activate the vibration bin.
- Ensure the pulse jet fabric filter is active to ensure pulsing. On the soda-ash silo the dehumidifier should be active. The silo shall be pulsed every 6 hours during normal plant operation and every 30 minutes during silo in loading.

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****3.1.4.5 Mixing tank inactive with low level:**

The dilution water, valve 1 for the lime side and valve 23 for the soda-ash side, should be active. Valve 2 for the soda-ash side and valve 22 for the soda-ash side should be closed and the pumps should be offline.

**3.1.4.6 Shutdown procedure**

When the system does not require the addition of lime/soda ash, the vibration cone is de-activated first, followed by the closure of the pneumatic actuated knife gate and then the de-activation of the dosing stream. The system should continue pumping dilution water through the system for 15 minutes, after which the flushing sequence will start, followed by shutdown of the active equipment.

**3.1.4.7 Lime/Soda Ash Offloading System**

Before the silos are refilled, the system should follow the shutdown sequence in section 3.1.4.6.

The hydrated lime/soda ash powder is pneumatically loaded into the silo from road-going tankers with on-board air compression equipment. On the silo's roof an air filtration system is installed to prevent lime/soda ash dust laden air from escaping the silo into the environment when loading into the silo as well as to prevent foreign particles from entering the silo when the level diminishes during operation and air is drawn into the silo. A guided radar level probe monitors the level of the silo. The connection point for the tanker's hose should contain a limit switch, which will activate once the tanker connects the hose. This limit switch should also close the pneumatic actuated knife gate after the vibration bin (in case it was not closed during the shutdown sequence). The manual knife gate after the vibration bin on the soda ash system will need to be closed manually before in loading of soda ash occurs.

**3.1.5 Process/Chemical Requirements**

Raw water is used as make-up to the CW system. Vaal water is supplied to the North CW system and Komati water is supplied to the South CW system. It has been indicated that the supply to the South might switch over to Vaal water in future. Based on the water quality analysed for the past 5 years, Table 1, clarifier flows as well as ash water recovery, the dosing requirements for lime and soda ash were calculated and summarised in Table 2.

**Table 1: Raw Water Qualities**

Component	Unit	Vaal	Komati
Ca Hardness as CaCO <sub>3</sub> equivalents	mg/kg	124	32.3
Anions	mEq/L	8.02	1.93
Cations	mEq/L	6.19	2
CaCO <sub>3</sub> Precipitation Potential	-	1.4	-11.7
Cl <sup>-</sup>	mg/kg	21.3	8.3
Conductivity @ 25 °C	µS/cm	634	383
Cu	mg/kg	0.238	0.34
F <sup>-</sup>	mg/kg	0.5106	0.2
Fe	mg/kg	5.245	1.335
K <sup>+</sup>	mg/kg	8.72	5.1
m-alk	mg/kg	130	45.4
Mg Hardness as CaCO <sub>3</sub> equivalents	mg/kg	100	38.8
Mn	mg/kg	1.125	0.01
Na <sup>+</sup>	mg/kg	34.2	10.3
NH <sub>3</sub> -N	mg/kg	0.91	0.017

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Component	Unit	Vaal	Komati
NO <sub>3</sub> as N	mg/kg	0.1	1.22
pH	mg/kg	7.48	7.25
PO <sub>4</sub> as P	mg/kg	40.1	15
SiO <sub>2</sub>	mg/kg	44	6
SO <sub>4</sub> <sup>2-</sup>	mg/kg	231	33.6
Temperature	mg/kg	27.83	27.35
TOC as C	mg/kg	6	5.64
Total Hardness as CaCO <sub>3</sub>	mg/kg	224	71.1
Turbidity	NTU	86.41	12.6
Zn	mg/kg	0.42	0.29

**Table 2: Dosing Requirements**

Description	North Plant		South Plant	
	Min	Max	Min	max
<b>Hydrated Lime</b>				
Mass flow (kg/h)	212	2500	107	1120
<b>Soda Ash</b>				
Mass Flow (kg/h)	86	523	24	463

Komati water contains certain amounts of non-carbonate hardness thus soda ash will have to be dosed in this system as well. This will thus require that one of the silos in the South CWTP will have to be converted to a soda ash silo. This is also crucial in the case where the South CW system will be converted to the use of Vaal water.

It is the responsibility of the *Contractor* to ensure that the mechanical equipment such as the feeders, dilution- and slurry pumps selected are capable of delivering the required lime/ soda ash dosage to the clarifiers. Where existing plant will be used for the new system, the *Contractor* needs to verify that such plant is adequate.

**3.1.6 Mechanical Requirements**

The following requirements are a conceptual performance specification. The equipment and instrumentation types, as well as the values will be optimised during the contractor's detail design. The scope of work for the project entails the design, supply, fabrication, installation, commissioning and testing of the upgraded lime plant. This includes but is not limited to:

- Removal of existing equipment where necessary,
- Installation of a raw water supply line (North side only) for dilution and flushing water (including pipework and associated valves),
- Modification of existing dilution water piping internal to the silo structure (if required).
- Modification of compressed air piping (if required).
- Installation of Vibrating bins
- Installation of dosing screws and screw conveyors
- Installation of Mixing chamber/s (including pipework and associated valves),
- Installation of centrifugal pumps for use in pumping the lime/soda-ash slurry (including pipework and associated valves),
- Installation of Pipework and associated valves/flaps to the mixing chamber/s,

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- j. Installation of Pipework from mixing chamber/s to the clarifiers,
- k. Installation of interfaces for lime/soda ash plant into the clarifier system,
- l. Installation of tapping points for pressure transmitters on the pipes,
- m. Testing and commissioning of the pumping system, associated valves and mixing chamber/s,
- n. Supply as built drawings and documentation of the complete design to Eskom,
- o. Supply calculations as proof of the provided designs meeting the performance specifications as listed in the works information,
- p. Supply test certificates, commissioning procedures, data sheets, testing procedures and maintenance manuals to Eskom.

Design calculations should clearly identify the subject of the calculations and include, but are not limited to the following information:

- a) Project name
- b) Contractor's name
- c) Contract No.
- d) Date of calculation
- e) Revision No.
- f) Name of the item
- g) Page No.
- h) Assumptions used for design purposes
- i) Codes and standards used
- j) Computer programmes used
- k) Loading imposed by structures, plant and equipment during the erection, commissioning, operation and maintenance
- l) Safety factors and combinations of loads used
- m) Calculations of all components
- n) Settlement of plant and equipment foundations
- o) Reference sources (including text books and design manuals used)
- p) Reference to the appropriate drawings
- q) Selected materials and finishes
- r) Manufacturer's technical specifications

The final system should adhere to the performance requirements (Section 5.1.3) specified in this technical specification. To promote standardisation between plants and simplify spares, the soda ash system will be identical to the lime system, except for it only having the dosing screw setup due to the small variance in soda ash capacity required.

In Appendix B, the dimensions of the Lime and Soda ash buildings are given. This information should only be used for tender purposes, after the contract has been awarded, the contractor should measure the plant to ensure the designs are suited to the plant.

**3.1.6.1 Silo and Hopper Design**

Currently there are two useable (2) silos on the North as well as on the South plants. The one (1) silo will store lime and the other one (1) will store soda ash. The silo's dimensions will not be altered, except for the hopper discharge, which may need to be modified for the fitment of the vibration cone. Refer to the table below for the silo dimensions:

**Table 3: Silo Dimensions – 0.57/3876 rev6**

	North/South
Dimension	Value
Hopper half angle with the horizontal	60°

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Hopper discharge diameter	200 NB
Hopper height	3.9 m
Total Silo height	15 m
Silo diameter (I.D)	5 m
Silo capacity	285 m <sup>3</sup>
Silo cone capacity	28.3 m <sup>3</sup>

The soda ash silo on the South plant must be lined with a suitable liner material. A dehumidifier must be installed on the soda-ash silos (both North and South). The pressure relief valves on all silos must be checked to ensure they are still functioning.

**Pulse Jet Fabric Filter:**

The current pulse jet fabric filter suppression systems must be removed and replaced with an adequate pulse jet fabric filter system which will prevent over pressurisation during lime/soda ash loading.

**Dehumidifier:**

The maximum strength dehumidifier should be selected which will ensure the soda ash silo's interior will be kept as dry as possible, while not requiring more than 5 kW power to operate and does not negatively affect the structural integrity of the silo.

**Gravimetric Feed control:**

The hopper of the lime/soda ash silos will have to be modified to install a vibration bin. The vibration bin should be adequately shaped and sized to prevent any blockages from occurring, promote reliable material feed to the downstream system and tie into the downstream discharge pipe. The vibration of the vibrating bin should not negatively impact the silo and surrounding structures.

**Pneumatic Actuated Knife Gate:**

Below the vibration bin, for the hydrated lime system, a pneumatic knife gate will be situated. This knife gate will be isolated during the switching of the feeder streams. When the dosing screw feed line needs to switch over to the screw conveyor feedline, the knife gate will isolate, allowing the downstream material to empty pass the diverter valve and thus allow the diverter valve to switch without material resistance. The knife gate will also be closed during in-loading of the silos, this is to prevent leakage through the dosing screw and screw conveyors.

**Manual Knife Gate:**

In each of the feeder streams, before the intermediate bins, manual knife gate will be situated. These knife gates will be isolated during maintenance of the dosing streams.

**Diverter Chute:**

Below the pneumatic actuated knife gate the 200 NB chute will bifurcate into the parallel feeder streams. To allow for the selection of a feeder stream, a pneumatic chute shall be installed. This chute should select the dosing screw feeder stream during feed rates that are between 0 – 999 kg/h and the intermediate bin and screw conveyor stream for feed rates 1000 kg/h and higher. This selection should occur automatically during plant operation.

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Feeder Streams:****Table 4: Feeder Parameters**

Description	North		South	
	min	Max	min	max
<b>Hydrated Lime</b>				
Mass flow (kg/h)	212	2500	107	1120
<b>Soda Ash</b>				
Mass Flow (kg/h)	86	433	24	463

The dilution water supply should be designed to be able to supply 20% above the maximum dilution water required to maintain the mixing tank's level constant.

**Dosing screw feeder (0 – 999 kg/h):**

This stream will feed into a dosing screw. The dosing screw should have an integrated intermediate bin, feeding into the dosing screw, thus allowing for accurate feed control from the dosing screw. The dosing screw will be rubber lined. The intermediate bin should be sufficiently shaped to allow for radial stress fields at the bin's discharge into the dosing screw.

**Table 5: Dosing Screw specifications**

Installed power	Less than 5 kW
Capacity throughput	0 – 1000 kg/h

**Intermediate bin + screw conveyor (>1000 kg/h):**

This stream will feed into an intermediate bin, which discharges into a screw conveyor. The intermediate bin should be sufficiently shaped to allow for radial stress fields at the bin's discharge into the screw conveyor.

**Table 6: Screw conveyor specifications**

Installed Power	Less than 5 kW
Capacity throughput	1000 kg/h – 2500 kg/h

The screw conveyor will have a rubber lined screw.

**Mixing Tank:**

The mixing tank should have a maximum capacity to accommodate a hydrated lime inflow at a maximum rate of 2500 kg/h that will mix with a maximum amount of dilution water at 100 m<sup>3</sup>/h. At the same time the slurry pumps from the tank will be fixed speed and pump at 49.49 m<sup>3</sup>/h, while the dilution water must match this flow through the control of the actuated valve on the inlet line to the mixing tank. The tank level should be kept constant during operation to minimise build-up on the tank walls. The tank is designed for a retention time of approximately 11 minutes when only 49.49 m<sup>3</sup>/h is removed via one active slurry pump.

The slurry suction line will be connected to the mixing tank at a suitable level to ensure reliable operation. The mixing tank will contain a drainage line as well as an overflow, refer to Figure 1. The mixing tank must be fitted with a manhole that will allow the maintenance crew access to the tank floor. A half-moon shaped wash-out drain should be fitted to the side of the tank with the bottom surface of the drain flush with the floor of the tank to allow complete cleaning out of the tank should this be required. A further inspection manhole with a bolted safety grid must be fitted to the roof of the tank. A hinged lid on the inspection manhole should allow for inspection of the tank or slurry without the risk of falling into the tank. The existing mixing tank is currently fitted with an ultrasonic level probe, this must be changed to guided radar, which is used to control the level of the tank. The agitator must be designed to ensure efficient mixing of the powder with the water

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but not vigorously enough to entrain air into the water. The mixing tank will have a drain line, taking suction from the bottom of the mixing tank. A manual gate valve will be installed on this drainage line.

**Scrubber:**

A wet scrubber shall be fitted to the top of the mixing tank to prevent the dust escaping to the environment. The filtered dust should be returned to the tank. The scrubber shall have an exhaust fan that keeps the mixing tank under a light vacuum at all times. It will be ensured that no dust escapes from any of the openings, such as the overflow pipe. All the dilution water runs through the scrubber before dropping into the mixing tank and in this manner any dust particles are entrained in the water and dropped back into the mixing tank.

- Power requirement : less than 5 kW.
- Volumetric flow : 100 m<sup>3</sup>/h

The *Contractor* is responsible for supplying all tanks. The *Contractor* is responsible for noting the requirements of commonality of supply/type in so far as possible. All tanks are supplied by a certified manufacturer whose equipment has been proven for similar or more demanding duties. All mixing tanks are tested in accordance with the relevant codes and standards. The mixing chamber shall have the capability to mix a liquid and a solid to form a homogenous solution. The solid shall be slaked lime and soda ash with physical property parameters obtained from the assigned lime and soda ash supplier for Duvha P.S. The liquid shall be raw water with properties listed in Table 1. The mixing shall occur on a continuous basis. Data books, to include all necessary material and test certificates maintained as part of the QA documentation and made available for inspection if so requested by the *Project Manager*. The mixing chamber shall be designed according to applicable guides, codes and standards. All required nozzles for inflow, outflow, breathing, cleaning, overflow etc. needs to be specified as well as the requirements for manholes for inspection and cleaning.

Applicable Codes and Standards to be selected for design, fabrication and construction, for a mixing tank the following standards needs to be adhered to (For a mixing chamber that is not of a tank design should adhere to the applicable international standards). In instances where the standards contradict each other, use the more stringent standard:

- SANS 10329, The design and construction of sectional steel tanks for storage of liquids at or above ground level
- BS EN 14015, Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above
- SANS 53121, GRP tanks and vessels for use above ground

**3.1.6.1.1.1 Slurry pumps:**

The North and South plants each will have a lime silo and soda ash silo. Each silo will have three centrifugal slurry pumps (Refer to Figure 3). The maximum flow operation will have two of the pumps in operation while the third pump is on standby. The piping after the pumps will have a cross-over as to allow each pump to supply any of the clarifiers. This selection will be achieved via pinch valves which will be used as isolation valves. The pumps should contain a drain which will allow the pumps as well as the up and downstream connecting pipelines, up to any isolating valves, to be drained. Pressure transmitters and pressure gauges should be located at the suction and discharge of the slurry pumps.

**Table 7: Centrifugal Pumps Specifications (per pump)**

Installed Power	Less than 5 kW
Capacity	49.49 m <sup>3</sup> /h

Centrifugal pumps shall supply the required flowrate (49.49 m<sup>3</sup>/hr) at the pressure required by the mixing chamber and the pump system shall have a 100% redundancy. Centrifugal pumps shall meet the requirements of the Eskom Centrifugal Pumps Specification (240-56030558). All pumps must be of standard

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manufacture and proven reliability in similar service conditions. Complete details of all pumps, motors and auxiliary equipment being offered to complete the works in accordance with design codes and specifications should be provided by the *Contractor*.

Each pump assembly is supplied complete with electric motors, couplings, seals, bearings, piping and fittings, valves, instrumentation, orifices, gears, leak-off equipment as necessary, drains and all components necessary for safe and efficient operation.

Each pump operates without undue strain or wear and without damage to any part of the pumping unit. It is the responsibility of the *Contractor* to determine the exact type of pump design which will provide such service without operating difficulty or undue replacement of parts and ensure maximum availability, reliability, efficiency and optimisation of the works. All parts of each pump unit are designed to withstand stresses resulting from a full voltage start of the motor. The *Contractor* is responsible for determining that each pump and driver operates in dynamic balance as a unit without undue vibration according to applicable vibration standards.

**3.1.6.1.1.2 Piping:**

The HDPE piping will be made of PE 100. The HDPE wall thickness will be based on SANS 4427 Part 2.

**Table 8: Slurry Piping Specifications**

Diameter	90 mm NB
Nominal pressure in bar	10
Pipe Series	SDR17
Maximum wall thickness	6.1 mm
Minimum wall thickness	5.4 mm

**Actuated Valves**

There are actuated valves installed on the dilution input line to the scrubber of the mixing tank. These valves must be able to control the volume flow of dilution water.

**Manual pinch valves**

There is a manual pinch valve located before each slurry pump. These valves will be of the manual pinch valve type, also corresponding to the 80 mm inside diameter.

**Electric actuated pinch valves:**

The actuated valves in the piping streams will be of the electric actuated pinch valve type and suitable for the 80 mm inside diameter of the HDPE pipes.

**3.1.6.2 Valves**

The *Contractor* is responsible for supplying all valves, adaptor mountings, fittings and associated actuators deemed necessary to ensure a safe reliable and efficient workable system. The *Contractor* is responsible for noting the requirements of commonality of supply/type in so far as possible. All valves are supplied by a certified manufacturer whose equipment has been proven for similar or more demanding duties. All valves shall meet the requirements of the Eskom Standard for Low Pressure Valves (240-105020315) Data books, to include all necessary material and test certificates maintained as part of the QA documentation and made available for inspection if so requested by the Project Manager.

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Operated valves should be positioned for ease of operation and maintenance from permanent floors, galleries or access platforms. Special consideration should be given to the operating mechanism and correct lubrication of all valves to ensure a minimum of maintenance and ease of operation. All valves shall be furnished with nameplates, which are easily readable and of lasting construction. All isolating and control valves shall have a position indicator on the valve yoke to indicate whether they are open or shut. All valves should be functionally tested at manufacturer's facilities and test certificates are required as part of the QA documentation.

The Contractor is responsible for providing control valves including the associated electrical equipment specified (Controls & Instrumentation and Electrical Technical Specification) and as required to make the systems complete and functional.

**3.1.6.3 Couplings**

All mechanical couplings are of the solid type.

**3.1.6.4 Seals**

The Contractor ensures that arrangements are made to prevent any leakage.

**3.1.6.5 Bearings**

- The Contractor ensures that Lubricating oil is provided to all bearings and in sufficient quantity to ensure that an adequate lubrication is achieved; it shall be done according to the OEM's lubrication specification.
- The bearing housing prevents oil or oil vapours from leaking out and air from leaking in. Sight glasses are located on all bearing drains and are easily read and accessible.

**3.1.7 Piping:**

All piping to be designed in accordance with 240-123801640 Low Pressure Pipelines Standard and 240-105020315, Standard for Low Pressure Valves. The existing ground supports will be utilised (where possible), but the contractor will be responsible to assess the existing supports and modify where needed.

The design code to be used for all steel piping is BS EN 13480 Part 1 to 8.

**Dilution water piping:**

The existing dilution water supply system will be modified as required for the new system. All modifications to this system, including additional piping and equipment, will be in accordance with the currently installed piping and equipment and the relevant codes/standards.

The North Plant pipeline to be connected to the raw water pipeline has the following specification to match the current raw water piping:

- Piping in accordance with table C1 (Carbon Steel and fittings for 1,0MPa systems) of 240-123801640: Standard for Low Pressure Pipelines

**Compressed Air piping:**

The existing compressed air system will be utilised and therefore all modifications that might be required to the system will be in accordance with the currently installed piping and equipment and the relevant codes/standards. Any other additions to the compressed air system will be in accordance with 240-105929225, Compressed Air System Standard. The piping installation needs to be such that different sections can be isolated individually. The system also requires sufficient moisture traps throughout.

**Slurry piping:**

The contractor takes responsibility for the design and construction of the slurry pipeline. The system should be easily maintainable, have high reliability, minimum downtime, avoid blockages and integrate well into the existing system.

**The HDPE pipelines will be equipped with the following:**

- Concrete support plinths.
- Long radius (> 3 x NB) ceramic lined 90° bends.

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- All direction changes shall be ceramic lined.
- All direction changes shall be equipped with concrete anchor blocks.
- Internal diameter of pipelines shall be maintained under all above circumstances.
- Inclined pipeline sections should be avoided as far as possible. The deposition velocity reaches a maximum at an inclination of 30° to the horizontal and can be as much as 50% higher than for a horizontal pipe.
- The utilisation of flanges and flexible couplings can be optimised to reduce cost of overland slurry pipelines.

**Valves:**

- Manual isolation valves shall be utilised at pump suction and deliveries, to facilitate maintenance.
- Valves should be kept to the absolute minimum required to operate the system safely.
- If required, valves suitable for slurry applications should be utilised.
- Valves shall be actuated as far as practically possible.

**3.1.8 Civil Requirements**

All civil works are to meet the requirements as set out in the SANS 1200 & 2001 Standardised Specification for Civil Engineering Construction Series and Eskom's Structural Design and Engineering Standard (240-56364545 & Australian Standard- Loads on Bulk Solids Containers (AS 3774).

All testing to be done in SANAS accredited laboratories.

Civil requirements include:

- Conversion of one (1) Lime Silo to a Soda Ash silo (South Side Plant) with approved lining system lining, subject to the *Project Manager*
- Check and validation of existing equipment plinths for structural resistance with new equipment loading
- Modification of access walkways as per Eskom's Standard Stair and Handrails Details (drawing number 0.00/2901)
- Sealing on top of silos for prevention of moisture ingress
- Natural frequency & harmonic response analysis on all four (4) silos due to the addition of vibrating bins & modified hoppers
- Reinforced concrete wall check due to increasing the bulk solid material density (lime to soda ash).

If excessive stresses develop in the Silo walls and the modified/new hopper during the analysis due to the change of bulk solid material, the *Contractor* is to recommend, by means of design calculations, a safe storage level within the converted Silo which is still aligned with the chemical requirements for the CWTP processes. The *Contractor* shall furthermore provide a mechanical method, over and above the use of level instrumentation, to ensure that the safe storage level within the silo is not exceeded.

**3.1.9 Civil Structural Design****3.1.9.1 Steelwork:**

- All work is required to be in accordance with the latest edition of SANS 2001-CS1
- The *Contractor* is responsible for the stability of the entire structure and all structural elements during all the erection stages.
- All dimensions are required to be verified on site by the *Contractor* before any fabrication of steelwork commences.

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- All welding is required to be conducted by coded welders. Supporting documentation is also required to be submitted to the *Project Manager* for acceptance. All welding is required to comply with AWS D1.1 and Section 3.3.8.
- All welds are required to be inspected using visual aids, see clauses below.
- The *Contractor* is required to supply all bolts, washers, nuts etc. for the structural steelwork.
- All structural steel used is required to be grade S355JR in accordance with SANS 50025
- Welded connections are required to be welded all around with a minimum of 6 mm fillet welds or the appropriately designed fillet weld size. Butt welds are required to be full penetration welds
- Grade 8.8 bolts are to be used throughout
- Minimum thickness of gusset plates is to be 10 mm.

The table below indicates particular specifications pertaining to SANS 2001-CS1 and must be read in conjunction with the code.

Clause	Particular Specification
<b>4.1</b>	<b>Materials</b>
4.1.1	Add the following: <ul style="list-style-type: none"> <li>• All structural steelwork is required to be grade S355JR</li> </ul>
4.1.4.1	<ul style="list-style-type: none"> <li>• Electrodes for electric welding are required to be E7018.</li> </ul>
4.1.5.1	<ul style="list-style-type: none"> <li>• Ordinary bolts to be grade 8.8 with class 8 nuts, as a minimum</li> </ul>
<b>4.6</b>	<b>Workmanship – Erection</b>
4.6.5	1. On site welding is not permitted
<b>5.3</b>	<b>Non-destructive testing of welds</b>
5.3.3	<ul style="list-style-type: none"> <li>• Fillet welds are required to undergo magnetic particle inspection (20 % of welds)</li> </ul>
5.3.4	<ul style="list-style-type: none"> <li>• All butt welds and full penetration welds are required to undergo ultrasonic non-destructive testing (100 % of welds)</li> </ul>

**3.1.10 Corrosion protection**

- All structural steel is required to be hot dipped galvanised.
- All galvanising is required be done in accordance with SANS 121. Preparation of steel prior to galvanising and coating thickness is also required to be in accordance with SANS 121.
- The *Contractor* designs, modifies, supplies and installs the walkways within the CWTP limits in accordance Eskom's Standard Stair and Handrails Details (drawing number 0.00/2901)
- The *Contractor* designs, modifies, supplies and installs additional equipment supports The *Contractor* performs all design works according to the 240-56364545 - Structural Design and Engineering Standard.
- The *Contractor* is to provide drawings indicating the new/modified hopper and vibration bin details.
- Where the Eskom standards are limited on the design information, the *Contractor shall use the relevant SANS standards*.
- The *Contractor* performs all steel design works according to the relevant SANS 1200 & 2001 standards.

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- Prior to the execution of the *works*, all design documents and method statements from the *Contractor* are to be submitted to the *Project Manager* for review and acceptance by the *Employer's* design office.

**3.1.11 Concrete**

1. All concrete work is required to be in accordance with SANS 2001-CC1 and SANS 10100-2 unless otherwise stated.
2. All concrete surfaces and cast-in items is required to be inspected and accepted by the *Project Manager* in writing before casting of concrete may commence.
3. The *Contractor* is required to obtain written acceptance from the *Project Manager* for the use of any add-mixture or the use off ready mixed concrete, to pump concrete, or to use cement or cement blends other than ordinary Portland cement (OPC)
4. Compaction of concrete is required to be done by means of mechanical vibrators only.
5. The *Contractor* is required to submit the concrete mix design to the *Project Manager* for acceptance.
6. The *Contractor* is required to demonstrate, by means of a report from an approved laboratory, that the aggregates do not exhibit excessive shrinking properties in accordance with SANS 1083 and is also required to demonstrate that the aggregates do not have a potential alkali silica reaction.
7. All concrete is required to have a maximum water/cement ratio of 0.45 with a minimum cement content of 420 kg/m<sup>3</sup>
8. The *Contractor* is required to perform a slump test on the same batch of concrete every time a sample is taken and the result recorded.

The table below indicates particular specifications pertaining to SANS 2001-CC1 and must be read in conjunction with the code.

Clause	Particular Specification
<b>3.5</b>	<b>Concrete – Strength characteristics</b>
3.4.3	Concrete Grade is required to be: <ul style="list-style-type: none"> <li>• Class 15 MPa/ 19 mm for Blinding Concrete (28 days),</li> <li>• Class 35 MPa/ 19 mm for Structural Concrete (28 days).</li> </ul>
<b>4.2</b>	<b>Materials</b>
4.2.7	In general, one of the following types of non-shrink grout are required to be used: <ol style="list-style-type: none"> <li>2. Cement-based non-shrink grout, not less than 50 MPa;</li> <li>3. Special proprietary non-shrink or expansive grout, not less than 50 MPa.</li> </ol>
4.2.3.5	The following tests are required: <ol style="list-style-type: none"> <li>4. drying shrinkage on fine and course aggregates;</li> <li>5. drying shrinkage of concrete;</li> <li>6. flakiness index of the stone;</li> <li>7. alkali-silica reaction.</li> </ol>
<b>4.4</b>	<b>Reinforcement</b>
4.4	Add the following: <p style="text-align: center;">All reinforcement is stamped with a SANS quality assurance mark</p>
4.4.3.1	Cast in-situ concrete cover is required to be a minimum of:

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Clause	Particular Specification
	<ul style="list-style-type: none"> <li>50 mm for exposed to earth or water;</li> <li>40 mm for above ground or not in contact with soil.</li> </ul>
<b>4.7</b>	<b>Quality of Concrete</b>
4.7.1.1	<ul style="list-style-type: none"> <li><i>Contractor</i> submits to the <i>Supervisor</i> full details and samples of all materials which he proposes to use for making concrete at least 28 days before the concreting of the works is due to commence.</li> </ul>
4.7.10	Add the following: <ul style="list-style-type: none"> <li>A layer of blinding concrete of 50 mm minimum thickness is required to be placed under foundations.</li> <li>A polyethylene sheet with a minimum thickness of 250 microns is required under ground slabs</li> </ul>
4.7.12.2.3	<ul style="list-style-type: none"> <li>All angled corners are chamfered 20 mm x 20 mm, unless such other larger size is detailed on the Drawings.</li> </ul>
4.7.19.3	<ul style="list-style-type: none"> <li><i>Contractor</i> submits a detailed procedure for acceptance by the <i>Supervisor</i> on how he intends to carry out the repairs of structural concrete defects</li> </ul>
4.7.22	<ul style="list-style-type: none"> <li>For concrete pour records, the <i>Contractor</i> submits a detailed Quality Control Plan to the <i>Supervisor</i> for acceptance.</li> <li>In addition the <i>Contractor</i> supplies the <i>Supervisor</i> with two copies of these records each day covering works carried out the preceding day.</li> </ul>
<b>5.1</b>	<b>Testing</b>
5.1.1.4	<ul style="list-style-type: none"> <li>Six 150 mm cube samples taken from each batch or place of concrete deposition, three cubes are tested at 7 days and three at 28 days.</li> <li>Strength at 7 days is required to be at least two thirds of 28 day strength.</li> </ul>
5.1.2.1	<ul style="list-style-type: none"> <li>Any of the cube samples tested indicating a result more than 3 MPa below the specified strength is disregarded.</li> </ul>
5.1.3.3	Add the following: <ul style="list-style-type: none"> <li>..., unless no more than three batches of concrete is being mixed.</li> </ul>
<b>5.2</b>	<b>Tolerances</b>
5.2.1	<ul style="list-style-type: none"> <li>Tolerances on all concrete work is required to be a level II degree of accuracy as specified in SANS 2001-CC1 with and is to be carefully maintained throughout the construction.</li> </ul>
5.2.2.1 Table 11	Add the following under "Location of holding-down bolts": <ul style="list-style-type: none"> <li>3) The permissible deviation between any two bolts that share the same base-plate is limited to 2mm for bolt sizes up to and including M24, and 3mm for bolts larger than M24.</li> </ul>

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- Considering the existing CWTP system, the *Contractor* determines the most ideal arrangement to install the mixing tanks, taking into account the existing equipment plinths and mixing tank supports. The *Contractor* is responsible for ensuring that the structural stability of equipment plinths & access walkways.
- Where modifications are required to the concrete works, the *Contractor* ensures that structural stability and concrete resistance is maintained or improved.
- Prior to the execution of the *works*, all design documents and method statements from the *Contractor* are to be submitted to the *Project Manager* for review and acceptance by the *Employer's* design office.

**3.1.11.1 Structural Analysis & Design of Modifications to Silos**

- The *Contractor* conducts an analysis of the Silo's for the imposed load of the bulk solid materials taking into account all dynamic and vibration effects of the load and vibrating bin.
- The *Contractor* determines the extent to which vibrations are transmitted to adjacent structural members and walls
- The *Contractor* takes into account loading from adjacent structures
- The *Contractor* provides a detailed design for the modifications required to the access walkways
- The *Contractor* submits the detailed design report and drawings for acceptance before any construction can take place.

**3.1.12 Contractor's Design**

- The *Contractor* takes full professional accountability and liability for the existing structure for the loads induced by the drive units, new equipment as well as any modifications carried out to the structure. The *Contractor* provides full certification (of the design and construction) thereof in accordance with SANS 10400-A and the OHS Act.
- The *Contractor* provides the following to the *Project Manager* for review and acceptance:
  - A Level 3 schedule (schedule with defined activities) for the design scope clearly highlighting all activities involved, major milestones and provision.
    - Consolidated detailed design report signed by a Professional Civil Engineer which includes:
    - Survey drawings, design criteria/parameters, specifications and standards that were used, loadings, assumptions, calculations and results including detailed design calculations, design models, sources of information and any record of other information associated with the completed works.
- Detailed drawings for construction. Drawings are also submitted in CAD formats (.DGN).
- All submitted drawings to be signed by a Professional Civil Engineer with ECSA registration number stated on drawing.
- Construction Specifications for the *works* including measurement and payment items
- Bill of Quantities for the *works*
- Any discrepancy or ambiguity between the *Employer's* Specifications or requirements is immediately brought to the attention of the *Project Manager* for clarification.
- The *Contractor* shall be liable, as per Section 6 of the Construction Regulations 2014, for any necessary construction supervision activities that facilitate and enable the Designer/Design Authority to verify that the construction of the works is carried out in accordance with the authorised design. The *Contractor* is informed that the *Employers* representative will not be responsible to carry out such inspections.
- QCP's/ ITP's for Employer's review and inclusion of intervention points.

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- Handover documents incl. Data books, as-built drawings, O&M manuals if necessary

**3.1.13 C & I Requirements**

Duvha Power Station CWTP is divided into North and South plants. On the South Plant there are 2 lime silos (2 and 3). The two lime silos are controlled via the WTP DCS. On the north there is one lime silo (silo 12) and one soda ash silo (silo 11). Lime silo 12 is also controlled via the WTP DCS. The Soda ash silo is controlled locally by a Siemens S7-300 PLC. Originally the plant was also controlled via the WTP DCS and the control of the plant was moved to a Siemens PLC when the silo was converted for the use of soda ash dosing. Each slurry tank/mixer tank has an ultrasonic level detector to measure level of the tank continuously. The mixer tank ultrasonic level detector will be replaced by a guided wave radar level detector. Lime silo 11 ultrasonic level detectors has already been replaced by a guided radar level detector, Duvha Power Station is in the process of replacing ultrasonic level detectors with radar level detectors on the remaining silos, therefore this will not form part of this scope.

Figure 4 below shows the WTP ABB Symphony Infi90 DCS Architecture. In Figure 4, the North CWTP interfaces the DCS using the Harmony network (Hnet) via remote I/O panels (20KP02, 20KP03) and substation interface panels (20JW02). The Hnet is a redundant, high speed serial network. From the KP panels and substation interface panel, the interface with DCS is via a Repeater Mounting Unit (RMU). The RMU provides mounting slots for the Hnet repeaters used to communicate with remote enclosures. The North CWTP interfaces with the DCS using Process Control Unit (PCU) 8. The PCUs reside in the control network (Cnet) which is a high-speed data communication highway between nodes in the WTP DCS. Cnet provides a data path among PCUs, HMI and computers. The PCU is the fundamental control node of the Symphony Infi90 DCS. It connects to Cnet through a Cnet-to-PCU interface. The PCU cabinet contains the Harmony controllers and input/output devices. The actual process control and management takes place at this level.

Similarly, the South CWTP interfaces the DCS using the Harmony network (Hnet) via I/O panels (10KP56, 10KP57) and substation interface panels (10JW14). From the KP panels and substation interface panel, the interface with DCS is via a Repeater Mounting Unit (RMU). The South CWTP interfaces the DCS using Process Control Unit (PCU) 16. Figure 5 shows the Symphony Infi90 DCS Architecture. In the architecture all the cubicles that will be replaced have been highlighted in light blue.

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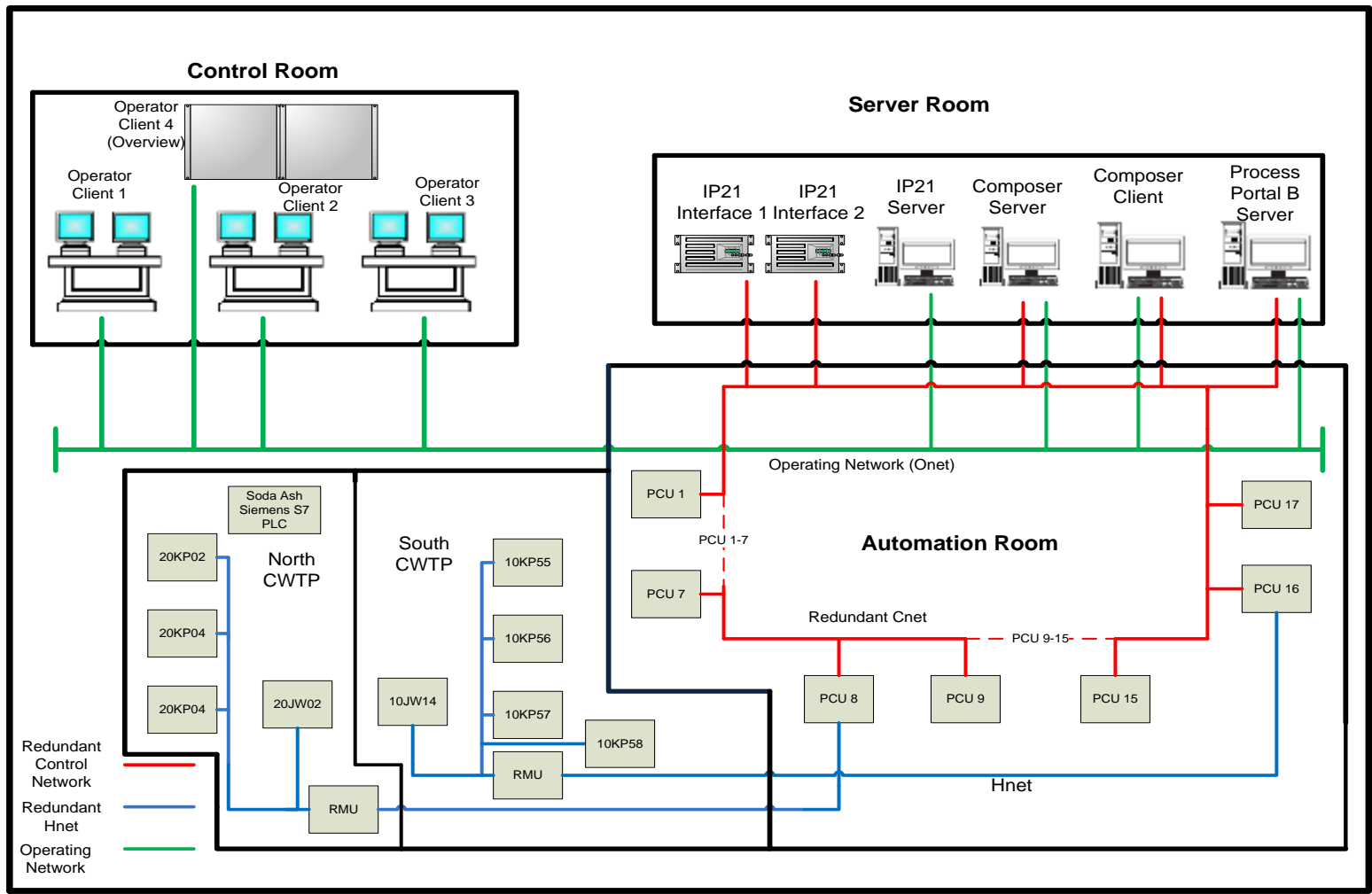


Figure 4: As Is WTP Symphony Infi90 DCS Architecture

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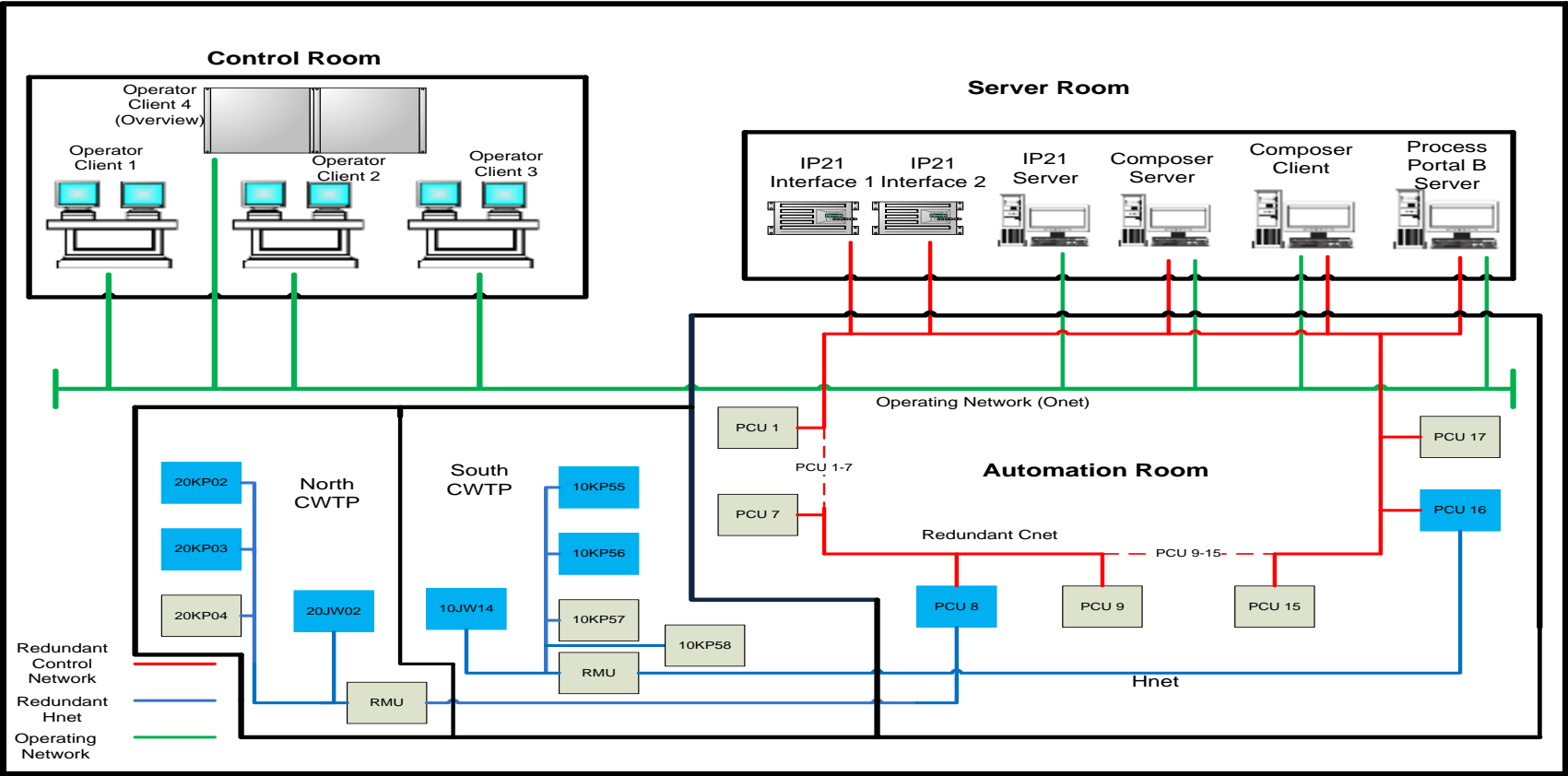


Figure 5: As Required WTP Symphony Infi90 DCS Architecture

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****3.1.13.1 C&I Scope of Work**

The Contractor shall design, engineer, supply, install and commission the following:

- Replace all KP (remote I/O: 20KP02, 20KP03, 20JW02, 10KP56, 10KP57, 10JW14) panels and to be based on ABB 800xA.
- Transfer the controls of the north soda ash plant from the Siemens S7 300 PLC to the ABB 800xA.
- Existing fibre optic cable interfacing the panels (20KP02) to the DCS will be assessed and re-used if in good condition.
- The sequences and interlocks to be checked, verified and/or modified as per all the process control requirements before commissioning.
- Updating of the HMI graphics and engineering as per the new philosophy stipulated in section 3.1.4.2.
- Updating of the station historian (VA).
- Updating of the InfoPlus 21 historian.
- Field instrumentation for the plant as per the Instrument Schedule.
- Drives interface for the plant as per the Drive Schedule.
- New tapping points for additional instrumentation.
- Cabling, racking and power distribution.
- Junction boxes

**3.1.13.2 C&I SPECIFICATION****Field Equipment Requirements**

- All instrumentation shall be provided with a nametag/plate, the contractor must comply with the Eskom Standard ETS0004: AKZX Plant Location Coding Standard and AKZX Plant Location Coding Standard ENS0002).
- All instrumentation must use either 24V for binary feedback or 4-20mA, 2-wire for analogue feedback.
- All additional signals to be trended on the station historian.
- Cabling (including termination) from the field devices to junction boxes and to WTP DCS.

**For standardisation purposes, the Contractor provides the following transmitters:**

- The PH shall be measured using Rosemount 1056 transmitters and Rosemount 396PV sensors.
- Pressure shall be measured using an ABB 266GSH gauge pressure transmitters.

All field equipment & installations comply with the following Eskom Standards:

- 240-56355535: Process Calibration Equipment Standard
- 240-56355754: Field Instrument Installation Standard
- 240-56355815: Field Instrument Installation Standard for Junction Boxes and Cable Termination.
- 240-56355843 Pressure Measurement Systems Installation Standard.
- 240-56227443 Requirements for Control and Power Cables for Power stations Standard
- ENS0002: AKZX Plant Location Coding Standard.
- ETS0004: AKZX Plant Location Labelling Standard.

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The C&I LOSS is shown in Appendix C.

**3.1.13.2.1.1 Field Requirements and Installations**

The *Contractor* to ensure that field installation inclusive of instrumentation, junction boxes, cabling and racking shall be properly labelled with permanent labels that will not be effortlessly removed. All labelling shall be consistent throughout the CWTPs.

Field device labels must be made of stainless steel, text on labelling be engraved as per the as per Duvha AKZX Plant location labelling, ETS 0004 standard, whilst also adhering to SANS 10108 Hazardous area classifications.

The equipment layout is such that when mechanical work is performed, no C&I equipment is damaged. Where harsh environmental conditions are not avoidable, the field equipment is designed for operation in that environment must be used (i.e. all field equipment is selected according to the environment in which they will operate in).

**3.1.13.2.1.2 Transmitters**

All transmitters supplied as part of the *Works* are compatible with the relevant primary measuring element. All transmitters have built in diagnostics that constantly monitor and alarm any faults on transmitter. The transmitter and its installation position are labelled such that if the transmitter is removed the label is still visible in the plant. The labels are provided as per the labelling requirements defined ETS004 Rev 4 – AKZX Plant Location Labelling.

Transmitters are suited and adequate to fulfil the following function and accuracy requirements:

- All digital transmitters have built in local digital indicators that can be programmed to indicate the range and specified engineering units for the process.
- All transmitters conform to a minimum accuracy of span of 0.05%. All transmitters are supplied with a drift free guarantee period of 10 years or better
- It is ensured that the installation of the transmitters:
  - i Allow for safe and easy access for maintenance and calibration.
  - ii. Allow for the environmental conditions.
  - iii. Allow for the removal of equipment for maintenance in the vicinity of the transducer.

**3.1.13.2.1.3 Cabling & Racking (Cable Installation and Routing)**

All Cable Installation and instrumentation cables, shall be flame retardant low smoke type, and comply with the Eskom Standard 240-56227443: Requirements for Control and Power Cables for Power Stations Standard. Instrument cabling to be installed with due respect for safety, reliability, access, maintenance, environmental conditions and best practices. All cabling must be suitably protected against mechanical damage, chemicals, dust build-up and heat.

**3.1.13.2.1.4 The *Contractor* to take note of the following for cabling design:**

- Instrument cabling defined as cabling between field instrumentation and junction boxes.
- Power supply cabling is defined as being cabling required to power field equipment.
- Cables shall only be terminated in instruments, junction boxes. No intermediate cable joints are permitted.
- Cables connected to instruments are installed with a loop of cable to provide sufficient slack for re-making the cable connection if the instrument is removed and to allow for removing the instrument without electrical disconnection.
- Instrument cables are routed separately from electrical power cables and crossovers that bring signal and power cables into close proximity are made at right angles.
- The routes for power supply cabling and the racking are of a consistent and integrated design taking into account different cabling and racking routes for common modes of failure, and the redundancy concepts of the mechanical plant design.

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- The Contractor provides 20% spare installed capacity in all multi-core cables, rounded up.
- UVG cable and Field/Trunk Cable installations will be used to transfer signals from the field equipment to the WTP DCS. The Contractor to comply with the Eskom Standard 240-56355815: Field Instrument Installation Standard for Junction Boxes and Cable Termination.
- The contractor provides 20% I/O spare capacity for the control system.

**3.1.13.2.1.5 Junction Box**

New junction boxes are to be provided to terminate all instrumentation. Junction boxes shall be properly labelled with permanent labels that will not be effortlessly removed and to also have enclosure material of 3CR12 stainless steel grade or higher and will be powder coated using RAL7035. Junction boxes are rated IP 65. The contractor to comply with the Eskom standard 240-56355815: Junction Boxes and Cable Termination.

**3.1.13.2.1.6 Power Supply Requirements (North and South)**

The employer will provide redundant 220V DC UPS supply to all the cubicles. The contractor shall supply, install and commission the 24V redundant power supplies in all cubicles. The 24V volts supply will get the input from the 220V provided by the Employer.

**3.1.13.2.1.7 Documentation Requirements**

The *contractor* shall supply the following Control and Instrumentation documentation:

- Detail electrical hook-up drawings (including instrument loop drawings)
- Detail mechanical hook-up drawings for instrumentation
- Signal and alarm list
- Equipment list
- Standard equipment operating manuals
- Equipment data sheets
- Maintenance manuals and procedures
- Updated HMI graphic files
- Updated DCS database
- Updated network configuration diagram
- KP (remote IO) panel internal equipment layout, configuration and wiring
- Cable schedules and termination schedules
- Junction boxes GA and internal layout drawings
- Field device calibration certificates
- Cold and Hot commissioning procedures and test reports
- Testing procedures
- Quality Control Plans

**3.1.13.2.1.8 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

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inspections and tests for the installation concerned have been accepted by the *Project Manager*. The *Contractor* is required to perform cold commissioning activities which include field equipment loop checks and WTP DCS interface.

Site Integration Testing (SIT) is performed by *Contractor* to ensure all interfaces have been implemented and comply with 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, HMI graphics, etc. The test is witnessed by the Employer's representatives.

**3.1.14 Electrical Requirements**

The *Contractor* shall provide the following as the Electrical Works:

- Identification and condition assessment of affected circuits or spare circuits on the switchgear panels supporting the lime plant (South Water Plant Board 1A, 1B, 2A, 2B and North Water Plant Board A and B).
- LV Switchgear – the existing switchgears will be utilised. Since there will be additional assets added to the electrical network, appropriate spare circuits shall be identified. See table 9 below for all the proposed circuits identified to supply the new motors and Distribution Boards for the lime plant. The Contractor shall assess and modify the identified circuits on the LV Switchgears if deemed necessary to supply the new loads.
- Motors – new LV motors will be required for the lime plant, with adequate base plates.
- Distribution Boards: Two electrical distribution boards will be required to supply the electrical actuators for the lime plant.
- Variable speed drives – will be required for screw conveyor motors.
- Electrical Cables and Racking – Electrical cables and racking are required from the Water Plant Boards to new motors and Distribution Boards including auxiliaries. Condition assessment of existing cables shall be done.
- Earthing and Lightning Protection – will be required for the new equipment. Earthing shall be connected to the existing earth mat.
- Lighting and Small Power – if deemed necessary.
- Calculations for sizing of equipment shall be provided
- All documentation shall be provided (drawings, schedules, training manuals)

**Table 9: Identified circuits on the 380V WTP Boards to supply the new loads**

Description	Quantities	Rating (kW or A)	380V North Board A (circuit no)	380V North Board B (circuit no)	380V South Board 1A (circuit no and existing motor rating)	380V South Board 1B (circuit no)	380V South Board 2A (circuit no)
Agitator Mixer Motor	4	15kW		49, 74	16 (2.2kW)	77	
Vibrating Bin Activator Motor	4	0.55kW	26	56	2 (0.37kW)	79	
Dosing Screw Motor and VSDs.	4	0.75kW	16 and 41	67 and 15	5, and 9	63 and 78	
Screw conveyor	2	0.75kW		69	1		

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<b>Motor and VSDs</b>							
<b>Pulse Jet Fabric Filter Motor</b>	4	0.25kW	29	59	3	65	
<b>Dehumidifier Motor</b>	2	2.2kW		65		72	
<b>Slurry Pump Motors</b>	4	3kW	33, 35, and 14	52, 75 and 70	6, 7 and 15	68, 69	16
<b>Scrubber motor</b>	4	3kW	37	51	8 (0.12kW)	93	
<b>Actuators power supply</b>	2	15A	04 (100A Fuses)			108 (60A rating)	

**3.1.14.1 Scope of work****a) Distribution Boards and LV Switchgears**

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

1. Perform detailed designs, manufacture/procure, transport, supply, install, test and commission the Distribution Boards assemblies that will be required for new electrical actuators.
2. The Distribution Boards shall be mounted on the support structure between clarifier 1 and 2 and also bonded to the existing earth mat.
3. The Contractor shall be responsible for the correct design and sizing or grading of MCB's, earth leakages protection for the Distribution Boards and cabling to the connected loads.
4. The colour of the DBs and equipment enclosures shall be "LIGHT ORANGE", colour B26 of SANS 1091 as recommended in SANS 10140.
5. The height from floor level of the distribution boards shall be in accordance with SANS 10142-1.
6. The existing LV switchgear panels shall be assessed and re-used as far as possible. Should the existing spare circuits impose limitations, they must be modified to support the new equipment.
7. Populate and finalise the switchgear load schedules as per design.
8. Populate list of switchgear signals required by the modes of operation together with interposing relays for C&I requirements.
9. Provide all equipment and components required for the *works*
10. After completion, a Certificate of Compliance as stipulated in SANS 10142-1 shall be issued to the *Employer* in terms of the Occupational Health and Safety Act, (OHS Act 85 of 1993).

**b) Cable, Racking and Routing**

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

11. Manufacture/procurement, transport, supply, install, test and commission the new cables for the new loads
12. Ensure interfacing with all the other system requirements of the plant/installation.
13. Test all cables (re-used (only for the circuit numbers as specified in Table 9) and new installation) and provide test certificate.
14. Replace old and unsatisfactory cables, only for the circuit numbers as specified in Table 9.
15. Develop, finalise and implement the optimised cable routing.
16. Produce exact cable routing designs of all the cables.

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17. Cater for cable servitudes and cable racking.
18. Implement all cable routing designs as approved.
19. Implement all cable terminations.
20. Produce all documentation and drawings.

**c) Earthing and Lightning Protection**

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

21. Perform earth resistance and earth continuity tests of the existing earthing system to determine the status of the earthing point used.
22. Provide all installed lime plant equipment and components required for the project with new earthing requirements.
23. Conduct earthing continuity tests.
24. Ensure that interfacing with all the other system requirements of the plant/installation.

**d) Motors and Drives**

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

25. Perform detailed designs, manufacture/procurement, transport, supply, install, test and commission the motors in line with the requirements.
26. Remove old motors identified
27. Provide all new equipment (IP66) and components including base plates required.
28. Ensure that interfacing with all the other system requirements of the plant/installation.
29. Produce all documentation and populate the relevant requirements of the technical schedule (Refer to Appendix D as well as templates supplied by the *Employer*).

**e) Lighting and small power requirements (if deemed necessary)**

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

30. Assess existing lights and lighting boards.
31. Perform detailed designs, manufacture/procurement, transport, supply, install, test and commission the lighting and small power circuits (distribution boards, plug sockets, etc.)
32. Confirm the compliance of the proposed layout, with the SANS 10114-1 and SANS 10142 requirements. Lighting design simulations using the photometric data of the proposed lights shall be done.
33. Provide all new lime plant lighting boards fed from the Water Plant Boards should the existing prove inadequate.
34. Ensure that interfacing with all the other system requirements of the plant/installation.

**3.1.14.2 Electrical Specification****3.1.14.2.1 Obligation**

The *Contractor* is responsible for the full functionality, basic design, detail design, installation and commissioning requirements. The *Contractor* is responsible for interface between the mechanical plant and field devices; including field devices and the interface to the *Employer* power supplies. The electrical design shall be performed by a Professional Electrical Engineer, adhering to the latest Eskom standard or SANS should the Eskom standard not be in existence.

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****3.1.14.2.2 General**

Unless otherwise specified, electrical plant necessary for the safe and efficient working of this *Works* is provided by the *Contractor*.

The *Works* as a whole are designed using an approved system approach to ensure satisfactory matching and performance of its mechanical, electrical and other sub-systems and components.

This design includes an operating philosophy, backed-up by process flow diagrams and logic diagrams for approval, for incorporation in the instruction manuals covering installation, operation and maintenance of individual components, as well as the *Works* as a whole.

Prior to delivery of electrical Plant the *Employer* reserves the right to witness the FAT's and carry out QA inspections at the *Contractor's* site. All the electrical test certificates and reports will be supplied prior to delivery of electrical equipment.

Plant power and control cabling, including cable containment, i.e. racking, earthing and bonding is included in this contract as well as plant lighting, earthing and lightning protection.

**3.1.14.2.3 Cables**

The *Contractor* designs, supplies and sets the low voltage power cables in accordance with the Cable Schedules developed by the *Contractor* for acceptance by the *Employer*.

The *Contractor* routes the power cabling, complying with the Cable Schedules and cable block diagrams, supplies and installs the cables, labels them, tests the cables, completes the quality documentation and issue it to the *Employer* for acceptance.

The *Contractor* designs, supplies and installs cable racks and supplementary steelwork for cable racking.

The *Contractor* supplies, and installs all cable accessories such as terminating and jointing kits, cable glands, lugs, bolts, washers and nuts for terminations, sleeves and other ancillary material for fitting the cables into position.

The *Contractor* completes the tables provided for in the standard referenced 240-56227443; in accordance with the cable manufacturer's cable data sheets and submit to the *Employer* for acceptance within a time period agreed to after the commencement of the contract date.

Installation of power and control cables construction is as per the requirements of the *Employer's* Works information and 240-56227443 as a minimum.

- **Cable Management System, Pull Cards and Drawings**

The *Contractor* performs a detailed design for *inter alia* the size, length and route of the cabling and compiles and submits Cable Schedules for acceptance by the *Employer*. The schedules will indicate the general cable requirements i.e. application, power, fault levels, cable termination details and special routing requirements.

The Cable Schedules will be the control document for the cabling included in the accepted detailed design.

The *Contractor* installs the cables, tests, terminates the electrical Plant and completes the cable pull cards.

The cable pull card contains the as-built status of the cables and indicates the drum number from which the cable has been pulled. The *Contractor* is responsible to red line the existing or create new cable block diagrams and submit such diagrams together with the as-built Cable Schedules (as per the cable pull cards) to the *Employer*.

The *Contractor* provides and implements a cable drum management system. This data is compared to the *Employer's* cable delivery to Site management system and is consolidated on a regular basis. All cable deliveries to the *Employer* are logged on a cable drum delivery Schedule provided by the *Contractor* and accepted by the *Employer*. The cable drum delivery Schedule is signed by both the *Contractor* and the *Employer*.

- **Cables and Cable Rack Requirements**

The *Contractor* ensures that all cables and cable racks are installed as per SANS 10198, this *Technical Specification* and 240-56227443 - Requirements for Control and Power Cables for Power Stations.

The rating, type and routing of cables are determined by the application of the feeder concerned using proven engineering methods.

All cables are adequately clamped to the support structures to ensure that there is no damage due to forces created by through faults. The clamping methods allows for contraction and expansion at different operating conditions

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****• Low Voltage Cabling**

For the low voltage cables, the *Contractor* ensures:

- The installation of low voltage cables was in accordance with SANS 10198.
- All low voltage cables are of the PVC type with, low smoke and flame retardant outer sheath in accordance with SANS 1507 and SANS 1411.
- All cable ratings are in accordance with SANS 10142-1: The wiring of premises, Part 1: Low-voltage installations and the cable manufacturers' rating tables.
- There are no low voltage cables installed directly on the 0 m floor level.
- No low voltage cables are installed in areas where there is a possibility of chemical, heat or mechanical damage to the cable insulation unless provisions have been made to overcome such dangers.
- No low voltage cables are installed within 600mm from telecommunication lines or within 300mm from a water line. Where low voltage cables cross other services, the minimum vertical distance allowed between such services and the low voltage cable should be 300mm.
- Colour coding of low voltage cable cores is in accordance with and 240-56227443, Requirements for Control and Power Cables for Power Stations.
- AC and DC voltages should not be allowed in the same trunking or cable. Trunking for AC and DC wiring shall be separate.
- Where low voltage cabling crosses any medium voltage cable, telecommunication etc., the crossing should be at 90° angles and at least 300mm apart.
- Low voltage cables buried in the ground are labelled with a yellow cable tape 300mm below ground level for the entire length of the cable trench.

The *Contractor* records any discrepancies and present to the *Project Manager* for a decision.

**• Cable Rack Design Requirements**

The following standard guidelines will be followed during the design of the cable racks for the existing and new cables:

- Wherever possible, cable racks follow the shortest route taking into account the suitable cable routes, to suit the plant layout and to minimise the cable length.
- Stacking of power cables more than 3 layers should not be allowed. Power cable runs are installed next to each other in such a way that it presents a neat appearance.
- All cable racks are designed in such a way that the cables are supported at intervals along their entire lengths. Power cables are supported at intervals not longer than 750 mm vertically and horizontally. A power cable is supported at least 300 mm from a cable gland.
- Cable racks are in accordance with SANS 10198.

The *Contractor* records the existing and new cable loadings to assess the effectiveness of the cable rack designs.

**• Fire Barrier Requirements**

Fire barriers are installed wherever electrical cables pass through wall, floors and ceilings, inside low and medium voltage switchboards, transformers, battery chargers, UPSs' which are boundary elements of a specified fire zone. Fire barriers have a fire rating of 2 hours minimum in compliance with the fire resistance criteria for insulation, stability and integrity as specified by recognised testing institutions and their standards.

The *Contractor* ensures that wherever cables pass through holes or slots in floors and walls or enter or leave sleeve pipes in floors or walls; the openings should be sealed with the approved material. This material is domed or slightly raised towards the centre to prevent the accumulation of water or oil in the seal. The sealing material should be water resistant and provides a barrier for smoke and toxic fumes.

Test certificates are provided with fire barriers in accordance with:

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- SANS 10177-2, Fire testing of materials, components and elements used in buildings Part 2: Fire resistance test for building elements.
- BS 479, Part 8: 1972, Test methods and Criteria for the Fire Resistance of Building Construction Elements.
- IEEE 634: 1978, Testing for Fire Rated Penetration Seals
- ASTM E814: Fire Test of through Penetration Fire Stops

- **Earthing of Cable Racks and Cables**

The *Contractor* ensures the integrity of the earthing of new and existing equipment affected to which cables are connected.

- **Cable Racks**

The *Contractor* verifies the electrical continuity of the existing cable racks that will be affected by this project. All cable racks are connected to the earth mat of the Plant.

Earthing is in accordance with the following:

- 240-56356396, Earthing and Lighting Protection Standards, Eskom.
- SANS 10198-12, Edition 1, the selection, handling and installation of electric power cables of rating not exceeding 33kV Part 12: Installation of earthing system, South African National Standards, Pretoria.

- **Cables**

All cable armouring of existing cables is connected electrically to the earth mat of the power station. Armouring of electrical cables is not acceptable in lieu of copper strap for earthing purposes.

Single core cables connecting between boards are single-point earthed on the feeder side. Cables connecting transformers to boards are single-point earthed at the switchboard. Trefoil earth tails are bonded together with the shortest possible earth strap to the earth bar.

Earthing is in accordance with the following:

- 240-56356396, Earthing and Lighting Protection Standards, Eskom
- SANS 10142 – 1, The wiring for premises Part 1: low-voltage installations.
- SANS 10198-3, The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 3: Earthing systems - general provisions, South African National Standards, Pretoria.
- SANS 10198-12, The selection, handling and installation of electric power cables of rating not exceeding 33kV Part 12: Installation of earthing system, South African National Standards, Pretoria.
- 240-53113666, Medium Transformers used in Power Stations Standard

**3.1.14.2.4 Motors and Drives****1. Electrical Motor Specification**

LV electrical motors comply with 240-57617975 Procurement of Power Station Low Voltage Electric Motors Specification Standard.

Electric motors should comply with the applicable Standard Specifications listed in this document and in accordance with the Works Information. In general, electrically driven auxiliaries are arranged such that motors can be removed and maintained without disturbing the driven machine and any associated oil, water, air, or electrical connection.

**2. Motor information**

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Final information on each type and size of motor in the *works* are submitted for the *Employer's* acceptance on Motor Schedules. Information on the Plant shall include size, full load current, assembly drawings, duty point operating data, performance data and curves, protection data, and location on plant. The *Contractor* submits all motor driven equipment performance data and curves to the Employer.

**3. Induction Motors Requirements**

The class of insulation used, starting the driven machine and the number of times per hour specified for the particular drive will be according to Employer's Standard Specification 240-57617975. All LV motors are premium efficiency (IE3), as per SANS IEC 60034-30.

**4. Documentation Requirement at Tender Phase**

Detailed information and drawings to enable the Employer to make a complete and fair technical analysis of the tender/s are supplied for the proposed motor design. The required details include but are not limited to the following:

- Preliminary outline drawing indicating motor mounting dimensions, shaft height, shaft diameter and coupling detail, maximum overall dimensions, weight for total motor and removable heat exchanger (if applicable).
- A completed Technical Schedule-A&B (refer to standard).
- Grid code compliance requirements in Technical Schedule A&B.
- Details of Customers that have used the same or similar design, together with descriptions of those previously manufactured motors.

**5. Variable Speed Drives**

The power (kilowatt) ratings of the VSDs used shall correspond to the range of the motors used.

Input chokes shall be required to stabilise the voltage, prevent dirty supply feeding back into the supply network and minimise interference in the control circuits, from the power circuit and keep the EMC levels on the LV switchgear assembly supplying the board at acceptable values as required by SANS 61800. The choke design shall be done during detailed design and shall also be in line with the VSD EMC requirements. The re-location of drives to the switchgear room must be done (distance must be considered). Stock item VSD must be assessed as first preference (standardisation), else justification must be made for a different VSD.

All VSDs shall be designed and constructed as required in the VSD standards (IEC 61800).

**3.1.14.2.5 Earthing and Lightning Protection**

The *Contractor* performs the engineering, design, manufacture, testing, supply, transport, off-loading, installation, erection (including the supply of consumables), site testing, commissioning and finishing, and complete lighting and earthing protection requirements for the lime plant. The *Works* includes earthing and lightning protection for the following:

- The *Contractor* is responsible for connecting the new equipment to the station earth mat via identified earthing points.
- All other new equipment provided by the *Contractor* is required to be earthed.
- Earthing and lightning protection is compliant with IEEE 665, IEEE 80 and IEEE 81.

The *Contractor* ensures that all metal non-current carrying parts are effectively connected to earth. It is done by means of their mounting arrangement or by means of a special earthing conductor. The earthing and lightning protection is in accordance with the *Employer* Earthing and Lightning Standard 240-56356396.

Conductors utilised for earthing will be appropriate for the site's soil conditions.

Earthing of the distribution boards shall be done by the *Contractor*. Earthing continuity tests shall be performed as part of the quality control process. The tested earthing points shall be marked and recorded for reference purposes (plant earthing maintenance purposes). All installation plans shall be submitted to Eskom for testing witnessing purposes.

The *Contractor* implements the correct earthing concept for reliable operation, as per the proposed DCS requirements. All components and housings of the control system are properly earthed to the earth mat to

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avoid any electromagnetic interference. Any other means of earthing to eliminate interference is the *Contractor's* responsibility. Earthing is provided for in each instrument loop.

The *Contractor* shall clearly define the design, philosophy and implementation/installation plan (with drawings, calculation, software applied and all supporting documentations) for:

1. Lightning protection
2. Equipment earthing
3. System earthing (interfaces)

For equipment and personnel safety the *Contractor* shall perform earthing *works* in accordance with applicable standards and submit to the *Employer* for verification of the design and all installations for acceptance.

The *Contractor* is responsible for connecting the new buildings earth mats (if any) to the station earthing mat. The point where the *Contractor* connects the earthing mats to the station earthing mat will be indicated by the *Employer*.

**3.1.14.2.6 Distribution Boards**

The *Contractor* performs the engineering, design, manufacture, testing, supply, transport, off-loading, installation, erection (including the supply of consumables), site testing, commissioning and finishing, and complete Distribution Boards requirements for the lime plant. The *Contractor* is responsible for the correct design and sizing/grading of MCB's, earth leakages protection and cabling to the connected load.

The colour of normal distribution boards and equipment enclosures is "LIGHT ORANGE", colour B26 of SANS 1091 as recommended in SANS 10140, Part II unless specified to the contrary.

The standby power section of emergency or essential distribution boards are coloured "SIGNAL RED", colour of SANS 1091.

The *Contractor* provides the distribution board with internal equipment cover plate in accordance with SANS 10142-1.

The height from floor level of the distribution boards is in accordance with SANS 10142-1.

The *Contractor* mounts the main circuit breaker inside the distribution board and be labelled "MAIN SWITCH" and rated in accordance with SANS 10142-1. The distribution boards make use of busbars rated for the current and fault current in accordance with SANS 10142-1.

The *Contractor* installs and tests the wiring in the distribution board in accordance with SANS 10142-1. The *Contractor* installs the wiring in such a way that it presents a neat appearance.

**3.1.14.2.7 Power supplies**

The electrical power supplies available at Duvha Power Station are:

400V – 3 phase – 50Hz

3.3 kV – 3 phase – 50Hz

11kV – 3 phase – 50Hz

230 V – single phase – 50 Hz

24V DC and 220V DC

The *Contractor* makes use of the existing 400V LV switchgear installed.

The *Contractor* shall use existing voltage levels to accommodate the new lime plant loads.

The *Contractor* shall clearly define the design, philosophy and implementation (installation) plan (with drawings, calculation, software applied and all supporting documentations) for the associated supplies.

**3.2 Procedure for submission and acceptance of *Contractor's* design****3.2.1 Document 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.

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The *Contractor* will be required to submit a detailed design pack that consists of the following discipline packages:

- [1] Chemical/Process Design Package
- [2] Mechanical Design Package
- [3] Control and Instrumentation Design Package
- [4] Electrical Design Package
- [5] Civil and Structural Design Package

These detailed design packs will be submitted to the *Project Manager* and will be reviewed for acceptance by the *Employers* representatives. Acceptance by the *Project Manager* in no way relieves the Contractor of his liability for the works. The *Contractor* remains accountable for all designs as stated herein. .

- The design documentation shall be submitted to the *Project Manager* as stipulated in the *Works Information*. The *Project Manager* accepts or rejects as stipulated in the *Works Information* after the design is submitted.
- All design work is signed and approved by the applicable ECSA registered Professional Engineer/Technologist (mechanical, electronic, electrical, chemical, civil etc.) responsible for their preparation before being submitted to the *Project Manager*.
- The *Contractor* needs to make provision for an eight (8) week period in his proposed schedule between the submission of the complete detailed design pack and acceptance from the *Project Manager*.

**3.3 Other requirements of the Contractor's design****3.3.1 HAZOP Study**

The *Contractor* is required to conduct a HAZOP study with the participation of Eskom prior to finalisation of the detail design. The HAZOP study shall be in accordance with Eskom procedure 240-49230111 Hazard and Operability Analysis (HAZOP) Guideline. Upon completion of the study the HAZOP report shall be issued to Eskom for review. The *Contractor* rectifies the design deficiencies as per the actions noted from the HAZOP as their cost.

**3.3.2 Design Life**

The design life of the works shall be up until end of station life of Duvha Power Station estimated to 2041.

**3.3.3 Noise Levels**

The *Contractor* designs the works to conform to the following requirements with respect to noise emissions:

- a) The *Contractor* guarantees the maximum sound power level (in watts) of each item of plant likely to create a noise level (sound pressure level) of 85 dB (A) according to SABS 083/1970, at a distance of 3m from any such item in its permanent location. This sound level applies to normal site operating conditions (all in situ and with the system running) with the item fitted with standard silencing equipment.
- b) For this purpose, the *Contractor* acquaints himself with the particulars of the acoustic environment, e.g., size of area, type of enclosure, locality, etc. If the *Contractor* expects the noise level, as specified above, to exceed 85 dB (A), the *Contractor* shall include the required acoustic treatment (e.g. cladding, silencers, screens) necessary to reduce noise levels to below 85 dB (A) in his offer.
- c) In the case of portable or moveable items of the system (e.g. compressors, travelling cranes, etc.), the sound pressure level, measured in the free field over a reflecting plant, does not exceed 85 dB (A) at a distance of 3m from the surface of the item when working at full load.

**3.3.4 Fire Detection and Protection requirements**

The *Contractor* performs a fire protection/detection assessment in accordance with the 240-54937439: Fire protection/Detection Assessment Standard and submits it to the *Project Manager* for acceptance only if the

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Contractor's design introduces a potential fire risk. The *Contractor* shall not be responsible to provide a fire detection/protection design or any permanent means thereof.

**3.3.5 Human Factors Engineering Requirements**

The *Contractor* is to ensure that ergonomics are considered for installation, operation and maintenance of all equipment.

**3.3.6 Physical Characteristics Requirements**

The *Contractor* is to ensure that the design of the system is consistent throughout; such as valves, pumps and tanks. This is to include the same type and mode of operation for the valves and pumps.

All equipment shall be protected from external ingress, corrosion and be explosion proof where applicable.

The design of the system shall cater for the lifting and removal of all plant equipment.

The *works* shall fit in the existing areas and no new areas will be identified for large or extra equipment/plant.

The *Contractor* is to ensure that the current ergonomics of the plant are to be improved with the implementation of the *works*.

**3.3.7 Corrosion protection**

The system is designed to ensure that equipment is adequately protected from physical damage and corrosion during storage, erection and operation.

**3.3.7.1 Internal Corrosion Protection**

The required internal corrosion protection required for a system is dependent on the properties of the liquid in contact with it. The *Contractor* is to comply with all sections of the *Employer's* Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings (240-101712128).

**3.3.7.1.1 Contractor Roles and Responsibilities during design**

The *Contractor* as part of their design package is to capture all the information sheets, as per Annexure C in the *Employer's* Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings (240-101712128), required for each component of the system for it to be used for the selection of the corrosion protection.

**3.3.7.2 External Corrosion Protection**

External corrosion protection for a system is dependent on its operating environment. The *Contractor* is to comply with all sections as per the *Employer's* Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings (240-106365693).

**3.3.7.2.1 Contractor Roles and Responsibilities during design**

The *Contractor* as part of their design package is to capture all the information sheets, as per Annexure C in the *Employer's* Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings (240-106365693), required for each component of the system for it to be used for the selection of the corrosion protection.

**3.3.8 Welding requirements**

The *Contractor* is to provide all the welding and related documentation to *Employer's* Welding Engineer for review and approval prior to any welding activity.

All welding conforms to the following:

- 240-106628253, Standard for Welding Requirements on Eskom Plant

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

**3.3.8.1 Welding codes, standards and specifications**

Welding procedure qualification for welds shall be in accordance with the appropriate welding standard incorporated into the relevant design and construction code. Combination or mixing of different codes shall not be permitted.

A Welding Procedure Specification (WPS) supported by a valid Welding Procedure Qualification Record (WPQR)/Procedure Qualification Record (PQR) shall be required for all welding work on the Employer's plant. The WPQR/PQR shall be approved by a registered International Welding Engineer (IWE) or International Welding Technologist (IWT) with minimum qualifications as defined in 3.3.8.2. The Employer shall reserve the right to review a WPS and associated weld maps prior to commencement of fabrication.

Weld build-ups for pressure boundary thickness restoration shall not be permitted.

Mechanical tests conducted during welding procedure qualifications shall be performed at an accredited mechanical test laboratory conforming to the requirements of ISO/IEC 17025.

Welding and testing (destructive and non-destructive) of the test pieces shall be witnessed by an AIA or Notified Body.

**3.3.8.2 Qualification and Accreditation****3.3.8.2.1 WELDERS****1. CONSTRUCTION CODE QUALIFICATION**

Welders and welding operators working on the Employer's plant shall be qualified in accordance with the latest applicable health and safety standard.

**2. INTERNATIONAL WELDER QUALIFICATION**

Welders working on *Employer's* Level One and Two Plant shall have at least one of the following requirements and only conduct welding for the type of welding qualified; e.g. tube welding shall require an International Tube Welder qualification for the specific welding process being used.

- International Tube Welder
- International Plate Welder
- International Fillet Welder

This welder training shall be based on International Institute of Welding (IIW) documents IAB-089r5-14 Parts 1 and 2.

**3.3.8.2.2 WELDING COORDINATOR**

Welding coordinators shall have one of the following minimum requirements for education, examination and qualification:

- IWE in line with IIW document IAB-252R2-14
- IWT in line with IIW document IAB-252R2-14

In addition the Welding Engineer/Technologist shall be registered with ECSA as Professional Engineer/Technologist. Registration with other professional bodies shall be subject to approval by the Employer.

**3.3.8.2.3 WELDING SUPERVISOR**

Welding supervisors shall have at least one of the following minimum requirements for education, examination and qualification:

- International Welding Specialist (IWS) in line with IIW document IAB-252R2-14
- International Welding Practitioner (IWP) in line with IIW document IAB-252R2-14

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****3.3.8.2.4 WELDING INSPECTOR**

Welding inspectors shall have at least one of the following minimum requirements for education, examination and qualification.

Minimum requirements for welding inspection on Employer's plant:

- SAIW Welding and Fabrication Inspector Level 2
- IIW International Welding Inspector: Comprehensive (IWI- C)
- IIW International Welding Inspector: Standard (IWI- S)

**3.3.8.2.5 COMPANIES ACCREDITATION PERFORMING WELDING ON EMPLOYERS PLANT**

The *Contractor* shall ensure that the parties performing welding related activities on the *Employer's* plant shall have accreditation to ISO 3834 Part 2 – Standard.

**3.3.9 Reliability, Availability & Maintainability Assessment**

The *Contractor* is to carry out a detail design RAM study and the *Contractor's* study shall include the maintenance logic. The overall average availability of the CWTPs shall be 95%.

**3.3.10 Decommissioning Requirements**

The *Contractor's* scope includes the decommissioning of all existing plant that will not be reused as per their design of the *works*. The *Project Manager* shall identify which decommissioned plant needs to be disposed of and such plant shall be removed by the *Contractor* from the site for disposal. The *Contractor* is to follow the Duvha Power Station Waste Management Work Instruction when disposing of this plant. The removal and storage of all decommissioned equipment that will not be disposed of shall be the responsibility of the *Project Manager*.

**3.3.10.1 Existing pipeline decommissioning**

The existing lime/ soda-ash pipelines also need to be removed and replaced by the piping as specified in this document. The following values can be used for tender purposes:

Length of piping = 350 m

Diameter of piping = 150 NB

The amount of pipe supports can be based on the applicable standards.

**3.4 Use of Contractor's design**

The completed design shall become the property of the *Employer*.

**3.5 Equipment required to be included in the works**

The *Contractor* shall include all calibration equipment used as part of the *works*.

**3.6 As-built drawings, operating manuals and maintenance schedules**

The *Contractor* is responsible for the compilation and the supply of all the documentation required during the various project stages and to provide the documentation program to link with the milestone dates.

At Take-over the *Contractor* provides two full sets of as-built documentation to the Employer.

All documentation, including reports, manuals, etc. is in the English language.

**3.6.1 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 its Subcontractors. Drawing numbers will be assigned by the Employer as drawings are developed.

**3.6.2 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-

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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 as electronic and hard copies and both copies must be delivered to the *Eskom Representative* with a transmittal note.

In addition, the Contractor shall be provided with the following standards which must be adhered to:

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

**3.6.2.1 SharePoint Transmittal**

The Contractor shall submit all documentation to the Eskom Representative as well as the Project's Documentation Centre in the following media:

1. Electronic copies shall be submitted to Eskom Documentation Centre through SharePoint transmittal site that will be provided during contract award.
2. Hard copies shall be submitted to the Eskom Representative accompanied by the Transmittal Note.

**3.6.3 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).

**3.6.4 Drawings Format and Layout**

The creation, issuing and control of all Engineering Drawings will be in accordance to the latest revision of 240-86973501 Engineering drawing Standard. 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, 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.

**3.6.5 Plant Coding and Labelling****3.6.5.1 Plant Coding**

The Employers AKZX Plant Location Coding (ENS0002) shall be used to allocate codes to plant or system included in the Works. Plant Coding shall be undertaken by the employer and as such the service provider shall make available the following documentation to code:

**1. Mechanical**

- Piping and Instrumentation Diagrams (P&IDs)
- interface list
- process flow diagrams (PFDs)

**2. Electrical**

- single line diagrams
- electrical board general arrangements (GA)
- cable schedule

**3. C&I**

- C&I architecture drawings
- C&I Cubicle GA
- cable block diagrams
- remote control station lists
- cable schedules

**4. Civil**

- site layouts
- building layouts

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- 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 AKZX code defining Documentation listed above. The employer will assign a coding technician who will interact with the *Contractor* in coding the plant as listed above. It may be required that the person be based at the *Contractor's* offices full time. The *Contractor* 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 AKZX 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 *Contractor* shall ensure that all documentation is coded (as per the codes assigned by the technician) prior submission to Employer for review.

**3.6.5.2 Plant Labelling**

It is the responsibility of the *Contractor* to manufacture and install labels according to station based labelling standard. Eskom to provide the labelling standard. Labels are manufactured and installed according to Plant Labelling Standard– (240-71432150). The Coding Technician shall facilitate base-lining of all equipment lists, and only baseline equipment lists shall be used as a basis for the production of labels. The Abbreviation Standard for Labelling of Plant at Power Stations (240-109607332) shall be provided to the Service provider as a reference for the creation of equipment lists.

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

**3.6.6 Material Certificates**

The *Contractor* provides a copy of the Materials Test certificates as per EN 10204 for all components to be included in the Data Books this requirement is reflected in all *Contractor* Purchase orders specifying the appropriate type aligned to the *Employer* requirement for, Control of Plant Construction Repair and Maintenance Welding Activities Standard 240-56241933, Rev 1.

**3.6.7 Final Data Book**

The *Contractor* is responsible for the provision of a final data book.

The final data book is broken down in two main categories:

- Technical category
- Cost and planning category

The document contains all the relevant documentation, designs, drawings, Plant and Materials certificates, NDE tests and results etc. which were applicable during the contract. The *Contractor* ensures that all relevant documentation is traceable and cross referenced where applicable.

All planning, scheduling, bar charts, milestones, detailed cost breakdown information, packing and transport are included in the final document.

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The content is laid out in a logical manner with main and sub-sections where all the relevant documentation is grouped.

The contents are presented in a hard cover file or files.

The data packages are prepared on a daily basis for all completed work.

Two hard copies and one soft copy of the Data Book are handed to the *Employer* for acceptance.

**3.6.8 Manuals**

The *Contractor* supplies the following manuals:

- Operating manual
- Maintenance manual

The manuals conform to the specifications set out in this works and are submitted to the *Employer* for acceptance.

Types of Documentation to be handed over to the *Employer*:

- Operational Documentation:
  - Operating Procedures.
  - Emergency operating procedures.
  - Operating Training Information.
  - Routine Inspection and Test Procedures.
  - Re-commissioning Procedures.
- Maintenance and Engineering Documentation:
  - Technical Specification Sheets for different equipment to be compiled, inclusive of the KKS Codes relevant to the different equipment.
  - Routine Inspection Specification.
  - Service Interval Specification
  - Bill of Material, Material Number and Supplier.
  - Equipment lists
  - Maintenance Plans per system
  - Overhaul Procedures and Specifications.
  - Test Procedures and Specifications.
  - Special Tool Requirements.
  - Drawings applicable to Plant.
  - Spares and Critical Spares list.

The manuals, which are in English, are complete with:

- The power station name and order number
- An index
- A list of reference drawings
- Details of all the components
- General arrangements drawings
- Installation drawings and instructions
- Detailed parts lists which must be accompanied by exploded view type drawings clearly detailing the part and uniquely identifying it
- Technical descriptions of the equipment and components parts with KKS coding.
- Spare parts ordering information
- Detailed specifications of the recommended maintenance and test equipment for testing, commissioning, fault finding and routine maintenance of all equipment covered by this specification
- Routine maintenance schedules are to be provided in detail for each component and a complete description of the operation and use of the test equipment offered;

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As a minimum the *Contractor* supplies the following:

- 2x electronic copies for each manual in PDF format
- 1x maintenance software for each manual
- 5x hard covered operating manuals
- 5x hard covered maintenance manuals

Any special instructions pertaining to the storage of spare parts or to their shelf life is included in the manual and is specifically pointed out in writing with the delivery of the equipment. All drawings required for component locations, dismantling and re-assembly for maintenance are included in the manual. The *Contractor* identifies all special tools that are required for maintaining and operating the equipment and includes a schedule of the identified tools and spares in the manual.

The *Contractor* prepares maintenance plans that specify when, at what frequency and how maintenance tasks must be performed on specific systems. The *Contractor* submits maintenance plans according to this generic maintenance plan as far as possible. Each maintenance plan includes tasks for condition monitoring, failure finding surveillance tasks and descriptions for each task. Each maintenance plan includes inspection schedules.

### **3.6.9 Civil Structural Drawings**

The drawings include final general arrangements, details of members, connections, reinforcement details and bending schedules.

Drawings include sections and details to fully identify design concepts, design loadings, allowable foundation bearing stresses and any other special features.

Drawings are fully dimensioned and the dimension figures on the drawing are deemed to be correct, even if the drawings are not to scale. No dimensions are obtained from a drawing by scaling.

All drawings show full endorsement by a Professional Engineer (including Pr. Eng Number and signature to be evident on all civil drawings).

## 4 Procurement

### 4.1 Plant and Materials

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

No “free issue” items shall be supplied. All Plant and Materials are to be provided by the *Contractor*.

### 4.2 Tests and inspections before delivery

The *Employer* carries out quality inspections at his discretion.

All inspections and testing to be performed in accordance with the Quality Control Procedure developed by the *Contractor* and in accordance with 240-105658000 Eskom Quality Management Specification.

The *Employer* shall 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 *Contractor* shall obtain 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.

No Plant shall be released for dispatch without the AS MANUFACTURED documentation and drawings accompanying them.

## 5 Construction

### 5.1 Completion, testing, commissioning and correction of Defects

#### 5.1.1 Commissioning

The *Contractor* tests and commissions the *works* whereby all sections of the system are made ready for full duty operation.

Testing and commissioning includes:

1. The services of skilled Engineers to supervise the testing and commissioning and making ready for the full duty operation of the complete *works*.
2. 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.

The operating and maintenance manuals shall be submitted as stipulated in the *Works Information* for acceptance by the relevant *Employer's* representative. The *Contractor* is to supply all data books with signed ITPs and as build drawings of the *works*.

Commissioning of the system shall be done by the *Contractor's* staff with the *Employer's* dedicated operations/commissioning staff.

The *Contractor* provides a program for acceptance by the *Project Manager*.

Before plant and equipment is placed in service the *Contractor* certifies that it is in a suitable and safe condition. In addition, the *Contractor* provides a complete list of numbered schematic, wiring and cable diagrams which are a true record of the plant and equipment as installed and certifies that the system has been wired in accordance with these diagrams.

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* is responsible for the commissioning of all the plant and equipment he/she is to supply to meet the requirements of this specification in conjunction with the *Project Manager* and the *Employer's* representatives. Where various components are already in place, or are supplied by the *Employer* to form an integrated system, the *Contractor* at the time of commissioning, carries the responsibility for the correct functioning of the whole system.

In the event of incorrect functioning, the *Contractor* determines the cause and he/she corrects the defect if the defect is within plant and equipment of his/her own supply. 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/herself as to the safety of his/her own plant and equipment in respect of any particular commissioning test and in the event of damage accept responsibility for such plant and equipment.

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

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

The *Contractor* shall put the *works* into operation after safety clearance of all plant and systems and successful completion of functional testing.

Sign off will be scheduled as per the project schedule on completion of each activity.

#### 5.1.3 Performance tests after Completion

Acceptance tests shall be carried out to prove all the plant guarantee figures provided by the *Contractor* in the technical schedules. The plant should be run at its maximum capacity for a 72 hour period with no trips. The following performance tests should also be done:

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****1. Feeder supply accuracy**

The dosing range of the feeder streams should be verified (lime system with its 0 to 999 kg/h and 1000 to 2500 kg/h parallel feeder setup, as well as the soda ash feeder stream with its corresponding feed rate). Proof of the system's capability to deliver these capacities should be provided to Eskom.

**2. Fluid velocity**

The fluid velocity in the pipelines should be above 2.5 m/s. The contractor needs to supply proof of the fluid velocity in the slurry pipelines being above 2.5 m/s during all of the following scenarios:

One pump active:

One pump active supplying clarifier 1

One pump active supplying clarifier 2

One pump active supplying clarifier 3

Two pumps active:

Two pumps active supplying clarifiers 1 and 2

Two pumps active supplying clarifiers 2 and 3

Two pumps active supplying clarifiers 1 and 3

**3. Pump curves**

The contractor should provide proof that the pumps are performing as per their designed pump curves.

Where the results of the performance tests performed don't correlate with expected results (concentration values, flow rates) 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*. All adjustments and modifications are subject to inspection and approval by the *Project Manager*.

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*.

**5.1.4 Operational maintenance after Completion**

The *Contractor* does not make provision for this.

## 6 Plant and Materials standards and workmanship

### 6.1 Employer Standards

1. 240-76992014 Project / Plant Specific Technical Documents and Records Management Work Instruction
2. 240-66920003 Project Handover Documentation Management Procedure
3. 240-65459834 Project Documentation Deliverable Requirement Specification
4. 240-54179170 Technical Documentation Classification and Designation Standard
5. 240-53114026 Project Engineering Change Management Procedure
6. 240-53113685 Design Review Procedure
7. 240-86973501 Engineering Drawing Standard
8. ENS0002 AKZX Plant Location Coding
9. 240-71432150 Plant Labelling Standard
10. 240-109607332 Abbreviation Standard for Labelling of Plant at Power Stations
11. 240-105658000: Supplier Quality Management: Specification

#### 6.1.1 Chemical Standards

1. 240-55864767 Chemistry Microbiology for Condenser Cooling Water Standard
2. 240-101712128 Internal Corrosion Protection of Water Systems Chemical Tanks and Vessels with Linings Standard
3. 240-106365693 External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings.

#### 6.1.2 Eskom Regulatory Standards

1. 32-966 – Compliance Charter

##### 6.1.2.1 Mechanical Hydraulics Standards

1. SANS 347: Categorization and conformity assessment criteria for all pressure equipment
2. ISO/DIS 3458: Assembled joints between fittings and polyethylene (PE) pressure pipes -Test of leak proofness under internal pressure.
3. SANS 32: Internal And/or External Protective Coatings For Steel Tubes - Specification For Hot Dip Galvanized Coatings Applied In Automatic Plants
4. SANS 664: Wedge Gate And Resilient Seal Valves For Waterworks - Part 1: General
5. SANS 776 Class 125: Copper Alloy Gate Valves - Heavy Duty
6. SANS 815-1: Shoulder-Ended And Groove-Ended Piping Systems - Part 1: Shoulder-Ended Steel Pipes, Fittings And Coupling
7. SANS 815-2: Shoulder-Ended And Groove-Ended Pipe Systems - Part 2: Groove-Ended Steel Pipes, Fittings And Coupling

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8. SANS 1056-3: Ball Valves - Part 3: Light Duty Valves (Not Fire-Safe)
9. SANS 1109-1: Pipe Threads Where Pressure-Tight Joints Are Made On The Threads - Part 1: Dimensions, Tolerances And Designation
10. SANS 1117: Plastics Wrappings For The Protection Of Steel Pipelines
11. SANS 1356: Fixed Electric Instantaneous Water Heaters
12. SANS 1412: Standard Specification For Polyolefin Pipe And Fittings For Corrosive Waste Drainage Systems
13. SANS 10269: Welding of thermoplastics – Testing and approval of welder
14. SANS 10140-3: Identification Colour Markings - Part 3: Contents Of Pipelines

**6.1.3 Piping:**

1. 240-123801640: Low Pressure Pipelines Standard
2. 240-105020315: Standard for Low Pressure Valves.
3. 240-105929225: Compressed Air System Standard.
4. BS EN 13480 Part 1 to 8: Metallic industrial piping

All welding jobs shall meet the requirements of Control of the following standard; 240- 56241933: Welding during Construction, Repair and Maintenance Activities Standard.

**6.1.4 Mechanical Standards for Lime Silo:**

1. AS 3774-1996, Loads on bulk solids containers
2. ISO 5208-2015, Industrial valves
3. ISO 8573.1. 2001, Air Quality Classifications

**6.1.5 Electrical Standards:**

1. 240-56227443: Requirements for Control and Power Cables for Power stations Standard.
2. 240-57617975: New LV Motors Procurement Standard.
3. 240-56360387: Storage of Power Station Electric Motors Standard.
4. 240-56361435: Transport of Power Station Electric Motors Standard.
5. 240-56356396: Earthing and Lightning Protection.
6. 240-56227516: Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard.
7. SANS 1973 (Low Voltage switchgear and Controlgear Assemblies)
8. SANS 10142 (The wiring of Premises)

**6.1.6 Civil & Structural Standards:**

1. SANS 10100 -1: - The structural use of concrete Part 1: Design
2. SANS 10162 -1: - The structural use of steel Part 1: Limit-states design of hot- rolled steelwork
3. SANS 10160 - Basis of structural design and actions for buildings and industrial structures
4. BS EN 1-4: - Eurocode 1 – Actions on Structures Part 4 : Silo and Tanks
5. 240-56364545: Structural Design and Engineering Standard

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6. 240-107981296: Constructability Assessment Guideline
7. 240-99527377: Inspection Manual for Civil works at Eskom Coal Fired Power Stations
8. SANS 2001 series
9. SANS 1200 series
10. AS 3774-1996: Australian Standard- Loads on Bulk Solids Containers

## 7 List of drawings

### 7.1 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	Revision	Title
0.57/3876	G	Duvha Power Station G.A of Lime Silos
0.57-03877	-	Duvha Power Station Concrete Layout of Lime Silo
0.57-04832	C	Duvha Power Station Silo Wall Reinforcement for Silo No. 3
0.57/04833	A	Duvha Power Station Silo Wall Reinforcement for Silo No. 2
0.57-04834	A	Duvha Power Station Silo Wall Reinforcement for Silo No. 1
0.57-29284	O	Duvha Power Station- North Side Silos
0.00/2901	9	Eskom's Standard Stair and Handrails Details
24.57/47058		Duvha Power Station, Raw Water Clarification North P&ID (Redlined P&ID)
24.57/47042		Duvha Power Station, Lime Storage Doing South P&ID
24.57/47028		Duvha Power Station, Filtered and Clarified water pumping P&ID

**APPENDIX A: CLARIFIER SELECTION SEQUENCE****a. Supplying one [1] clarifier****Table 10 – Pump 1 to clarifier 1**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 11 – Pump 1 to clarifier 2**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 12 – Pump 1 to clarifier 3**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Off
Valve 2	Open
Valve 4	Open
Valve 5	Open
Valve 6	Open
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Table 13 – Pump 2 to clarifier 1**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Closed
Valve 9	Closed
Valve 10	Closed
Valve 11	Open
Valve 12	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 14 – Pump 2 to clarifier 2**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Table 15 – Pump 2 to clarifier 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Open
Valve 6	Open
Valve 7	Open
Valve 8	Closed
Valve 9	Closed
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 16 – Pump 3 to clarifier 1**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 17 – Pump 3 to clarifier 2**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Closed
Valve 8	Closed
Valve 9	Open
Valve 10	Open
Valve 11	Open
Valve 12	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 18 – Pump 3 to clarifier 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Open
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Closed

**Table 19 – Pump 4 to clarifier 1**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Off
Valve 22	Open
Valve 13	Open
Valve 14	Open
Valve 15	Open
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 20 – Pump 4 to clarifier 2**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Table 21 – Pump 4 to clarifier 3**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 22 – Pump 5 to clarifier 1**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Open
Valve 15	Open
Valve 16	Open
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Table 23 – Pump 5 to clarifier 2**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 24 – Pump 5 to clarifier 3**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Open
Valve 21	Open

**Table 25 – Pump 6 to clarifier 1**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Open
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 26 – Pump 6 to clarifier 2**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Closed
Valve 17	Closed
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Closed

**Table 27 – Pump 6 to clarifier 3**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****2.1 Supplying two [2] clarifiers****2.1.1 Supplying clarifiers 1 and 2****Table 28 – Pump 1 + Pump 2**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 29 – Pump 2 + Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 30 – Pump 1 + Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 31 – Pump 4 + Pump 5**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Open
Valve 14	Open
Valve 15	Open
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 32 – Pump 5 + Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Open
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Closed

**Table 33 – Pump 4 + Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Open
Valve 14	Open
Valve 15	Open
Valve 16	Closed
Valve 17	Closed
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****2.1.2 Supplying clarifiers 1 and 3****Table 34 – Pump 1 + Pump 2**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Open
Valve 5	Open
Valve 6	Open
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 35 – Pump 2 + Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Open
Valve 7	Open
Valve 8	Open
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 36 – Pump 1 + Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Open
Valve 5	Open
Valve 6	Open
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 37 – Pump 4 + Pump 5**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Open
Valve 14	Open
Valve 15	Open
Valve 16	Open
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 38 – Pump 4 + Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Open
Valve 14	Open
Valve 15	Open
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Table 39 – Pump 5 + Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Open
Valve 15	Open
Valve 16	Open
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****2.1.3 Supplying clarifiers 2 and 3****Table 40 – Pump 1 + Pump 2**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Open
Valve 5	Open
Valve 6	Open
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Table 41 – Pump 2 + Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Open
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Open
Valve 11	Open
Valve 12	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 42 – Pump 1 + Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Open
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Open
Valve 11	Open
Valve 12	Closed

**Table 43 – Pump 4 + Pump 5**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 44 – Pump 4 + Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Table 45 – Pump 5 + Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****2.1.4 Supplying clarifier 1****Table 46 – Pump 1**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 47 – Pump 2**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Closed
Valve 9	Closed
Valve 10	Closed
Valve 11	Open
Valve 12	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 48 – Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Open

**Table 49 – Pump 4**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Off
Valve 22	Open
Valve 13	Open
Valve 14	Open
Valve 15	Open
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 50 – Pump 5**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Open
Valve 15	Open
Valve 16	Open
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Table 51 – Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Open
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****2.1.5 Supplying clarifier 2****Table 52 – Pump 1**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Table 53 – Pump 2**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Open
Valve 8	Open
Valve 9	Open
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 54 – Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Closed
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Closed

**Table 55 – Pump 4**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 56 – Pump 5**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Open
Valve 18	Open
Valve 19	Closed
Valve 20	Closed
Valve 21	Closed

**Table 57 – Pump 6**

<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Closed
Valve 17	Closed
Valve 18	Open
Valve 19	Open
Valve 20	Open
Valve 21	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****2.1.6 Supplying clarifier 3****Table 58 – Pump 1**

<b>Description</b>	<b>Status</b>
Pump 1	Active
Pump 2	Off
Pump 3	Off
Valve 2	Open
Valve 4	Open
Valve 5	Open
Valve 6	Open
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Table 59 – Pump 2**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Active
Pump 3	Off
Valve 2	Open
Valve 4	Closed
Valve 5	Open
Valve 6	Open
Valve 7	Open
Valve 8	Closed
Valve 9	Closed
Valve 10	Closed
Valve 11	Closed
Valve 12	Closed

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 60 – Pump 3**

<b>Description</b>	<b>Status</b>
Pump 1	Off
Pump 2	Off
Pump 3	Active
Valve 2	Open
Valve 4	Closed
Valve 5	Closed
Valve 6	Open
Valve 7	Closed
Valve 8	Closed
Valve 9	Closed
Valve 10	Open
Valve 11	Open
Valve 12	Closed

**Table 61 – Pump 4**

<b>Description</b>	<b>Status</b>
Pump 4	Active
Pump 5	Off
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Open

**Duvha Cooling Water Treatment Plant Upgrade Technical Specification****Table 62 – Pump 5**

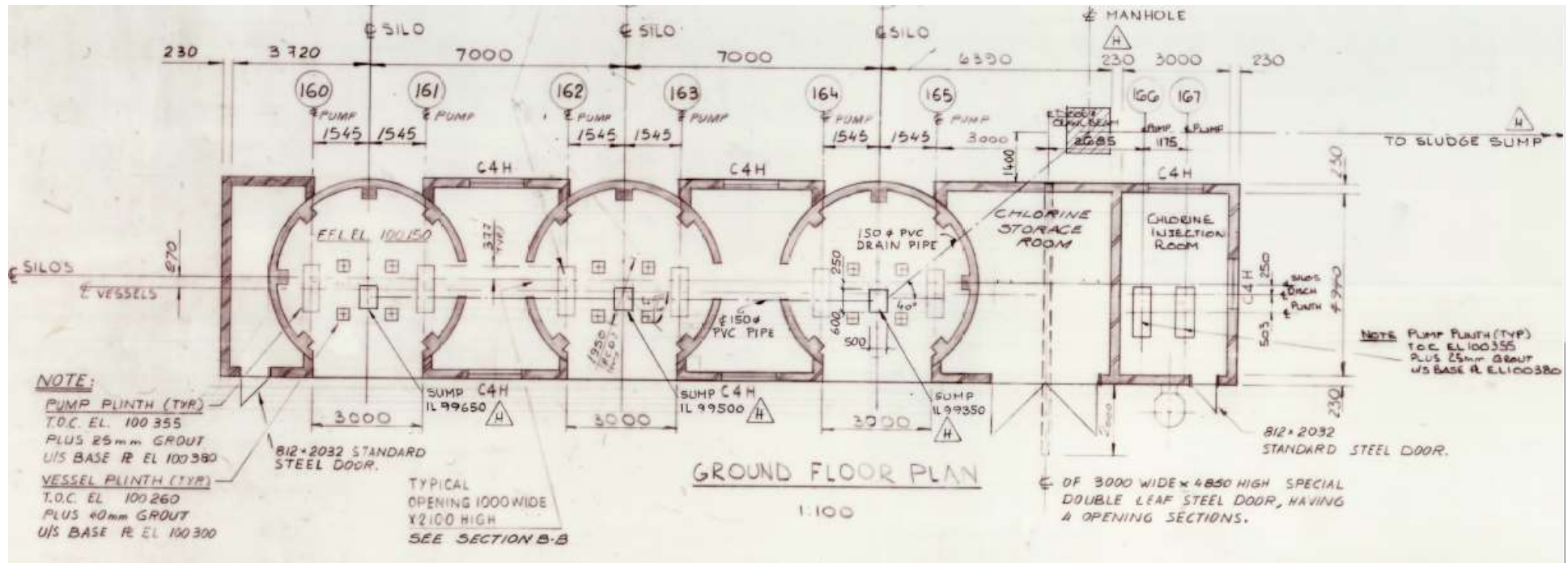
<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Active
Pump 6	Off
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Open
Valve 17	Closed
Valve 18	Closed
Valve 19	Closed
Valve 20	Open
Valve 21	Open

**Table 63 – Pump 6**

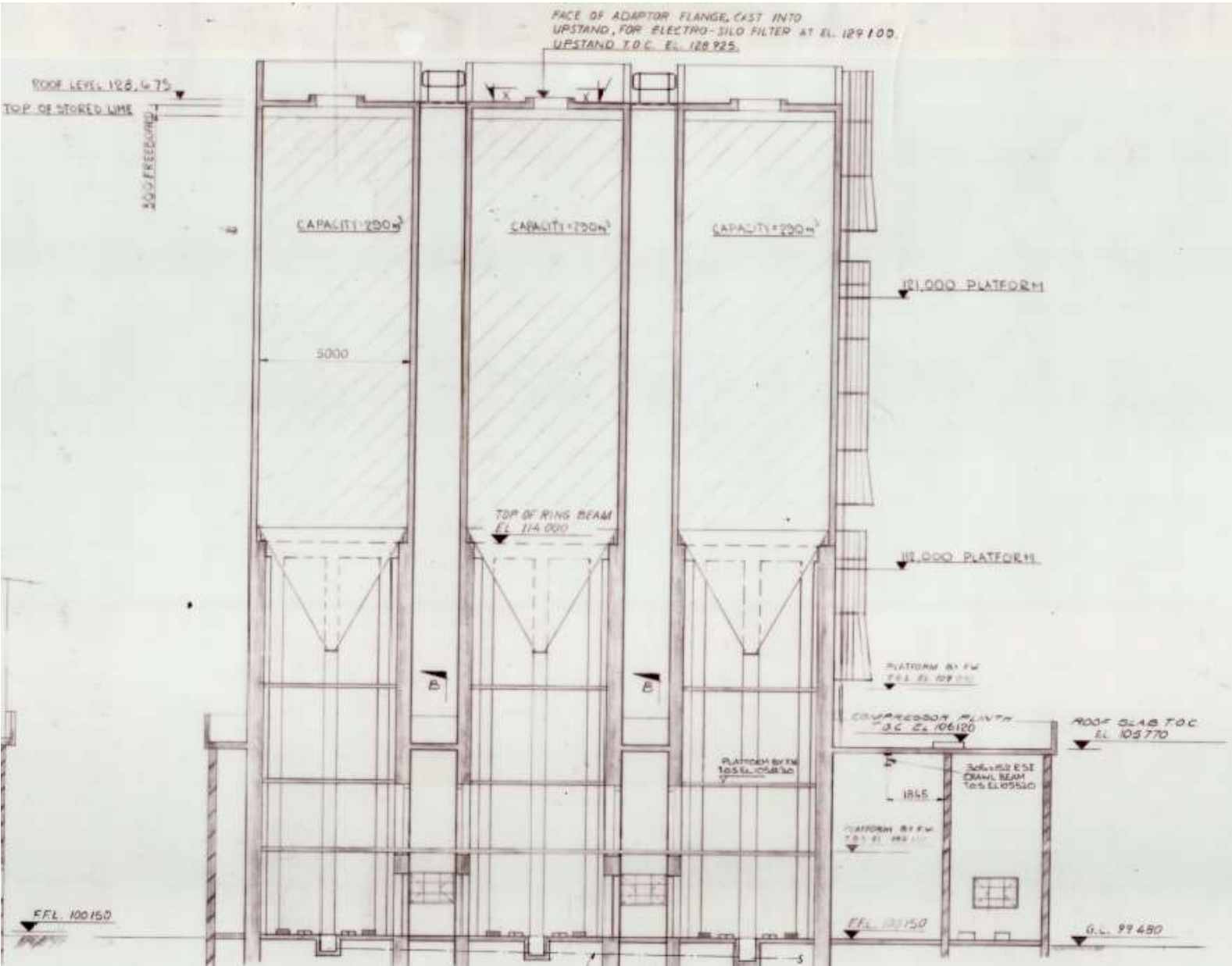
<b>Description</b>	<b>Status</b>
Pump 4	Off
Pump 5	Off
Pump 6	Active
Valve 22	Open
Valve 13	Closed
Valve 14	Closed
Valve 15	Closed
Valve 16	Closed
Valve 17	Closed
Valve 18	Closed
Valve 19	Open
Valve 20	Open
Valve 21	Open

## Duvha Cooling Water Treatment Plant Upgrade Technical Specification

## APPENDIX B: LIME AND SODA ASH BUILDING DIMENSIONS



Duvha Cooling Water Treatment Plant Upgrade Technical Specification



**APPENDIX C: C&I LOSS**

**APPENDIX D: ELECTRICAL SCHEDULES**