
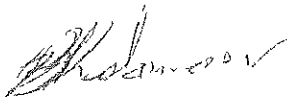
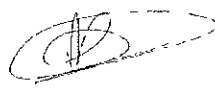
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Title	Technical specification for Tutuka SSC Upgrade project	Unique Identifier	360-TUT-AABZ28-SP0004-23
		Alternative Reference Number	N/A
		Area of Applicability	Engineering
		Documentation Type	Report
		Revision	3
		Total Pages	70
		Next Review Date	N/A
		Disclosure Classification	CONTROLLED DISCLOSURE

Compiled by	Functional Responsibility	Authorised by
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Date 09/12/2021	Date 05/01/2022	Date 11/01/2022

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Executive Summary

The change in coal quality at Tutuka Power Station (P S) has resulted in the Submerged Scraper Conveyor (SSC) being under designed for the current coarse ash production Furthermore, high frequency of submerged idler wheel, scraper bar, chain and electrical related failures have resulted in SSCs being one of the major contributors to the station's Unplanned Capability Loss Factor (UCLF) SSCs are currently not only the primary cause of load losses, but are also now the cause of major secondary losses and damages due to ash ingress into the cooling water affecting the cooling towers and condensers

The proposed design, which addresses challenges stated in the above paragraph, is to upgrade the SSC The SSC upgrade project is aimed at enabling start-up after a four (4) hour standing time period (1 hour at full boiler load and 3 hours at half boiler load) The SSC upgrade project shall enable the plant to have a throughput of 74 Tph per

The following components of the SSC shall be upgraded

- A Drive System
 - Hydraulic drive,
 - Drive sprocket,
 - Drive shaft,
 - Drive shaft bearings, and
 - Power pack cabinet position
- B Conveying chain
- C Take up System
 - Idlers,
 - Tensioner stub shafts, and
 - Tensioner hydraulic cylinder
- D Submerged idler wheel.
- E Structural Modification
- F Agitation system
- G Idler wheels
- H Conveying chain movement design
- I SSC water make up system design
- J Control and Instrumentation
- K Electrical power supply
- L Normal - and emergency water supply

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1. INTRODUCTION

The change in coal quality has resulted in SSCs being under designed for the current coarse ash production. Furthermore, high frequency of submerged idler wheel and chain related failures have resulted in the SSC being one of the major contributors to the station's Unplanned Capability Loss Factor (UCLF)

During normal operation the system requires 20.6 kN/m of torque. When SSCs are stopped for maintenance or during downstream plant failures that stop the machine for extended periods, ash is accumulated inside the SSC. To enable subsequent restart/break away and operation under backlog recovery conditions, 80 kN/m of torque is required. The current drive system is thus under-designed for the current drive requirements.

All SSCs were modified to have submersible idler wheels, these wheels leak and get stuck before the required 18 months maintenance interval. Sealing failures of the submerged idler wheels have resulted in high usage of water and are now the cause of major secondary losses and damages due to ash ingress into the cooling water affecting the cooling towers and condensers.

The current SSC does not have an agitation system. An agitation system is required to agitate ash that is accumulated at the SSC's transition point, during a start-up, in order to reduce the machines required starting torque. The installation of an agitation system will help restart the SSC when it has stopped for periods shorter than four (4) hours. The agitation system will also prevent ash spillages at the SSC's transition area. The height of the bath sides in this area will be increased to prevent ash spillage.

The purpose of this *Technical Specification* is to state the *Employer's* requirements and provide the *Contractor* with the necessary information to submit a comprehensive tender in order to upgrade the SSC's drive and chain conveying systems.

SSCs are employed at seven of Eskom's coal fired generating fleet. This upgrade project is based on the use of hydraulic drive system and 30 x 120mm chains which will standardize Tutuka Power Station's SSCs with other SSCs in the fleet.

2. SUPPORTING CLAUSES

2.1 Scope of the works

The scope of work included the provision for dismantling, design, procurement, fabrication, manufacturing, workshop assembly, factory testing, storage, labelling, packing, delivery to Tutuka Power Station, erection, installation, site testing, cold and hot commissioning, quality control and project management of the entire engineering works to ensure a fully functional system, herein after referred to as the Works.

The *Contractor* is responsible to hand over a fully functional SSC system as described in this Technical Specification document.

2.2 PURPOSE

This scope of work is developed to:

- Improve SSC availability and reliability
- Standardize SSC drive technology to be compatible with drives installed at Kendal, Majuba and Lethabo Power Stations
- Standardize SSC chain technology to be compatible with chains used at Medupi, Kusile, Majuba and Kendal Power Stations

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- Change the SSC's submerged idler wheel type and sealing designs with the aim of improving the components maintenance interval to be above 18 months
- Installing an agitation system to reduce drive torque during backlog conditions and prevent ash spillage at the front of the SSC

2.3 APPLICABILITY

This document is applicable to various engineering disciplines Bulk Materials Handling (BMH), Low Pressure Services, Electrical, Control and Instrumentation (C&I), Civil & Structural, Integration, and functional areas interfacing with Engineering on the project Project development, Finance, Sustainability, Risk and Tutuka Power Station

2.4 ROLES AND RESPONSIBILITIES

Group Technology Engineering will be responsible for the compilation of a Technical specification document which will be included in the tender documents by Tutuka P S

Tutuka P.S will be responsible for the compilation of tender documentation and issuing of these documents to the open market.

The appointed *Contractor* will be responsible for the execution of the works

2.4.1 System Interface

- a The *Contractor* is responsible for all system interfaces which forms part of the works The *Employer* will provide the relevant information defining the system interfaces The *Contractor* caters for all the identified interfaces.

2.4.2 Battery limits

The battery limits will be:

- Head end discharged section of SSC structure (SSC Structure not included) ,
- Top of carry trough of SSC structure (excluding dipper plates),
- All pipes supplying water to the SSC
- From the LV switchgear to the field and from the LV switchgear to the DCS
- From field devices to the DCS

2.5 INTERPRETATION AND TERMINOLOGY

2.5.1 List of Definitions

Definition	Description
Ash	A waste product resulting from burning coal
Basic Design	In general, a process to establish an agreed basic design baseline that complies with the concept design baseline and stakeholder requirements.
Backlog recovery	An accumulation of Boiler Bottom Ash (BBA) needing to be removed from within the SSC

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Definition	Description
Coarse ash	Ash particles formed in the boiler that is too large to be carried in the flue gases It is usually referred to as BBA
Idler wheel	A pulley that transmits no power but guides the chain within the SSC
Idler wheel assembly	An assembly which includes an idler wheel, shaft, seals, bearings and is mounted onto the SSC's structure The wheel of the assembly does not transmit power but guides the chain within the SSC
Submerged idler wheel	An assembly which includes an idler wheel, shaft, seals and bearings which is mounted onto the SSC's structure. The wheel of the assembly does not transmit power but guides the chain within the SSC The wheel is located inside the carry trough of the SSC and is submerged in water The bearing and casing of the assembly are located outside the SSC structure
System	An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective These pieces include people, hardware, software, firmware, information, procedures, facilities, services and other support facets

2.5.2 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary)

2.5.3 List of Abbreviations

Abbreviation	Description
AR	Abrasion Resistant
BBA	Bottom Boiler Ash
BMH	Bulk Materials Handling
CAC	Coarse Ash Conveyor
cc	Cubic Centimetre
C&I	Control and Instrumentation
CoE	Centre of Excellence
D	Diameter
DCS	Distributed Control Systems
DRA	Definition Release Approval
EDMS	Electronic Document Management System
ERA	Execution Release Approval
FAT	Factory Acceptance Testing
HMI	Human Machine Interface
HWL	High Water Level

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Abbreviation	Description
Hz	Hertz
JB	Junction Box
LCS	Local Control Station
LCP	Local Control Panel
LOSS	Limits of Scope and Supply
kW	Kilo Watt
Le	Equivalent length
MPa	Mega Pascal
m a m s l	meters above mean sea level
NRV	Non-return valve
NPSHa	Net Positive Suction Head available
NPSHr	Net Positive Suction Head required
OEM	Original Equipment Manufacturer
PCD	Pitch Circle Diameter
PLC	Programmable Logic Controller
P&ID	Piping and instrumentation diagram
P S.	Power Station
rpm	Revolutions per Minute
SHE	Safety, Health & Environmental
SSC	Submerged Scraper Conveyor
Tph	Tonnes per hour
V	Volts

3. TECHNICAL SPECIFICATION

The purpose of this *Technical Specification* is to state the *Employer's* requirements and provide the *Contractor* with the necessary information to submit a comprehensive tender in order to upgrade the SSC's drive and chain conveying systems

3.1 EMPLOYER'S DESIGN

3.1.1 SSC Process description

Coarse ash, from the boiler, falls into a bath of water contained by the SSC's top trough structure, which quenches the hot ash. The quenched ash is then conveyed to the front of the SSC by scrapers connected to a chain driven system. Part of the water is removed from the ash on the dewatering slope of the SSC. The de-watered ash is then transferred by discharge chute onto one of two Coarse Ash Conveyors (CAC).

SSC performs the functions of Boiler Bottom Ash (BBA) collection, dewatering of BBA, and provides a controlled rate of BBA discharge onto downstream plant. The SSC's top trough correctly filled with water working in conjunction with the dipper plates provides boiler sealing by preventing air ingress into the boiler via the SSC.

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3.1.2 Mechanical Design

Drive system

Tutuka Power Station is designed to have the SSC employed underneath the boiler for the purpose of boiler bottom ash (BBA) and slag removal, as well as furnace sealing. SSCs are equipped with a 69 kN/m hydraulic drive system. The electro-hydraulic drive system consists of a hydraulic power pack which houses an 18.5kW, 380 V, 50 Hz electric motor, 85cc hydraulic pump, oil tank and all associated components that form the power pack unit. The power pack is placed at the bottom of the SSC's dewatering slope and all its hydraulic components are housed in a steel frame directly exposing these components to the ash dust/water environment.

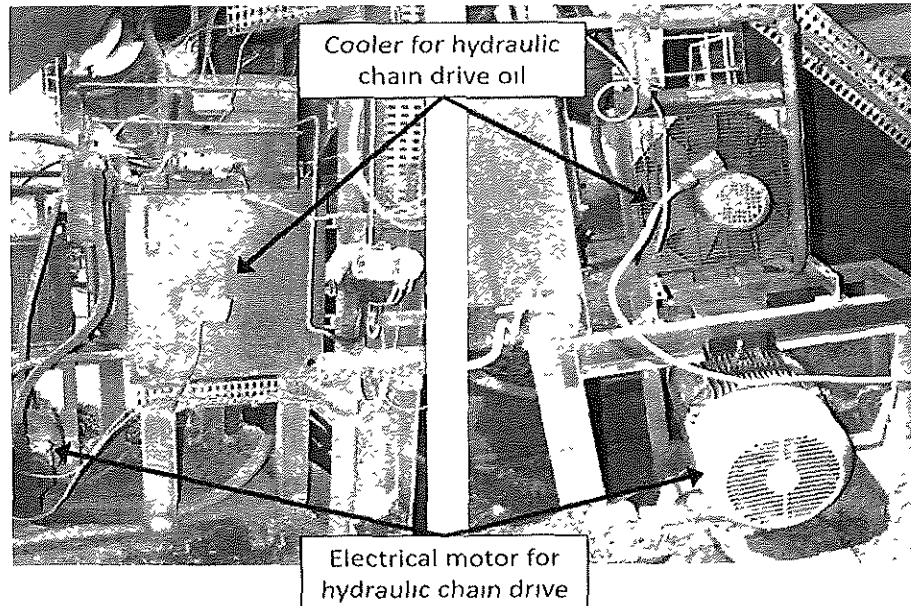


Figure 1: SSC Hydraulic power pack

A closed loop hydraulic system for continuous duty is employed. The electric motor is directly coupled to a hydraulic pump with variable speed drive in order to pump oil within the system. The drive pump is a variable displacement pressure compensated unit, the displacement of which dictates the final speed of the drive motors. Variable oil flow is achieved by using a 4 – 20 mA signal from the DCS, this signal is set to control the oil flow rate which in turn drives the hydraulic motor whilst controlling the SSC's drive speed. The drive can operate at variable speeds ranging from 0.1 to 5 meters per minute. Reversing of the drive is also possible to help recover the SSC during backlog start up conditions. The pump receives oil from the oil reservoir and pumps it to the two hydraulic drive motors.

Cooling of the hydraulic oil is achieved by an air- to-oil cooler (driven by one 0.75 kW electric motor) which is thermostatically controlled. The air cooler is positioned on the power pack.

Two hydraulic motors are directly mounted onto the drive shaft using a key connection. The drives utilise a radial piston cam curve hydraulic motors. Torque arms are utilized to contain the reaction forces and eliminate any undesirable forces on the motor bearings.

The drive assembly consists of a drive shaft with sprockets connected to the two hydraulic drives. The drive assembly is located at the head end of the SSC (at the top of the dewatering slope) with the hydraulic drive mounted to the SSC's structure using two bearings on the shaft and a torque arm connection to the SSC structure. The new drive shaft has a minimum shaft diameter of 150 mm. Refer to drawing 0 61/6045 for the drive shaft design.

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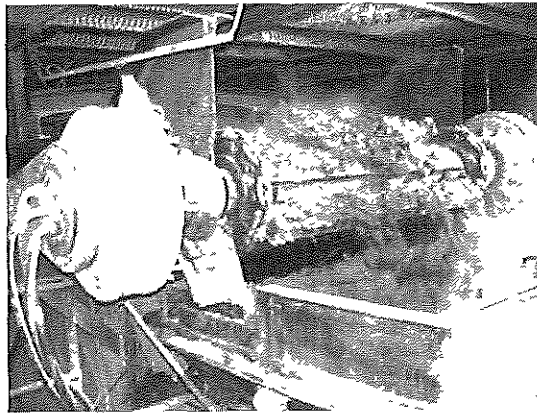


Figure 2: Drive Assembly

Drive torque from the drive shaft assembly is transmitted to the chains by means of removable sprocket teeth bolted onto the drive shaft via removable shaft hubs. Drive shaft hubs are locked onto the drive shaft using two keys per drive shaft hub. Sprocket drive teeth are radially mounted onto the hubs and locked into position by side fitted bolts between the hub and sprocket teeth. All idlers will use sprocket teeth which are made from Cr Ni steel and are case hardened to 2 mm from the surface to have a hardness of 800HV.

Conveying Chain

A 22 x 86 mm power station chain is used to drive the system. The chain is also made of Cr Ni material which is a steel alloy fabricated with a minimum of 10.5% chromium content by mass. This steel is a stainless steel alloy (also known as inox steel) and is normally used for highly abrasive products and large dynamic loads. The chain is case hardened to 800HV (2 mm from the surface) in order to prevent wear during operation. The core of the chain is not hardened to ensure that material tensile strength is not compromised.

Standard 10 meter chain strands are connected to each other using master-links in order to form the total chain length of 80 meters required. Chain master links are also made of a Cr Ni steel alloy. Master-links have the same strength and case hardness as the chain they are matched to. Chain master-links are designed to have the same chain life as the chain.

Scraper Bar

An enclosed boxed scraper assembly is used to physically move the ash. This arrangement allows the scraper to have buoyancy on both the carry and return troughs of the SSC. The carry and return troughs are filled with water, the buoyancy of these scrapers then reduces the vertical mass and thereby the friction generated as the scraper moves along the wear liner. These scraper bars have a pitch of 86mm and are connected to the chain using claw type connectors. VRN 500 liner material is welded at the top and bottom face of the scraper box to mitigate wear.

Idler wheels

The conveying chain is guided within the SSC using idler wheels. Idler wheels are named in a chronological manner which describes how the chain moves inside the ash box in the following order:

- Front idler in return trough L&R 3
- Rear idler in return trough L&R 4
- Tail pulley idler L&R 5
- Rear submerged idler in carry trough L&R 6
- Front submerged idler in carry trough L&R 7

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Note

The drive shaft is not an idler wheel however that station has named it L&R 1 Bladder guides which guide the chain back into the return dewatering slope are also not idler wheels however they are also known as L&R 2

Submerged idler wheels (L&R 6 and 7) are used in the upper trough in order to guide the chain whilst retaining the SSCs seal water. These idler wheels require an adequate sealing arrangement to prevent water leakage from the upper trough that is filled with water. The rotation of the idlers (stub shaft arrangement) downstream of the tension station is monitored by the revolution controllers. This ensures detection of a breakage in any of the two chain strands.

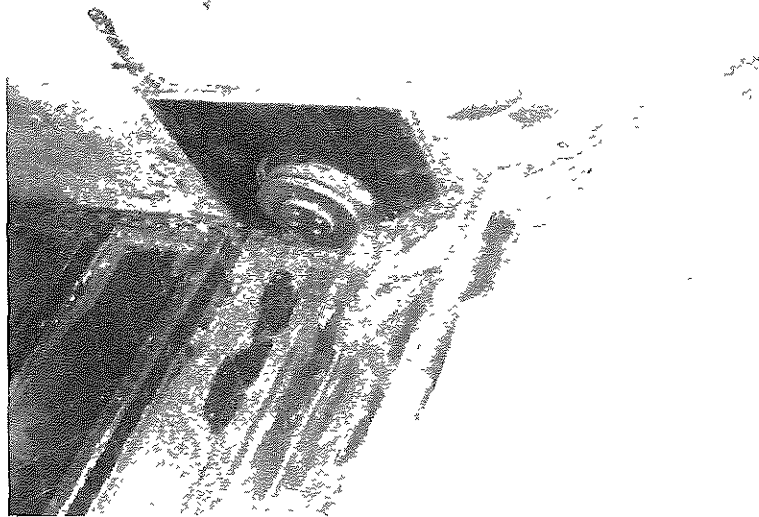


Figure 3: Submerged idler wheel assembly in SSC box

Submerged idler wheels have presented operational challenges because they often get stuck and stop rotating as a result of ash build-up between the rear face of the idler wheel and the SSC side wall. When this happens, the chain slides along the contact face of the idler wheel and then wears into the idler's material as a result of the hardness of the chain and the friction generated at the contact sliding face. In this manner the idlers are worn away by the chain links. Master links are broader than the standard chain links, therefore after a certain degree of idler wear the master link gets trapped in the narrow wear groove and this then results in the drive system stalling or breakage of the chain and sometimes bending of the scrapers as well.

Tensioner System

The tensioner system is used to keep the chain in tension during all operating modes of the SSC. Failure of the tensioner system results in the loss of chain tension which can cause chain failures; (normally identified around the L&R 3 idler wheels.)

Two independent idler wheels (L&R 3) are used to keep the chain in tension through the use of hydraulic tensioning cylinders.

A closed loop hydraulic system is employed to tension the system. 0.75 kW, 380 V, 50Hz electric motor is directly coupled to the hydraulic pump in order to pump oil within the system. The pump is a single displacement unit. Oil flow is achieved by switching on the electric motor in order to pump the oil. Cylinder movement is achieved by controlling a three way hydraulic valve. This valve allows the hydraulic cylinders to move up, down or maintain a set position. The electric drive motor starts from an unloaded condition and operates continually at synchronized speed, driving the hydraulic pump via a direct coupling. The pump receives oil from the oil reservoir and pumps it through the

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control valve to the two hydraulic cylinders via stainless steel and flexible hydraulic piping mounted onto the SSC's structure

The current design employs a system which can produce 12 MPa of pressure and two 160 mm D 80/45X410 hydraulic cylinders are employed. The two (2) double acting hydraulic cylinders (used to tension the chain) are located at the rear section of the SSC. These cylinders are mounted onto the tail structure of the SSC.

3.1.3 Operating Description

The following section describes the SSC's operating philosophy.

SSCs are operated locally in the field (all units) or remotely in the unit control rooms (units 4-6).

Local Mode (all Units)

This mode is used for local operation in the field should it be required for maintenance purposes. This mode allows the system to be operated with all protections in place. All control buttons, selector switches and emergency stop push buttons are interfaced to the SSC's main drive control panel (0*0HY101).

Remote Mode (Units 4-6)

This mode is used during normal operations of the system. The operator has the ability to automatically control the SSC in the unit control room, and all protections are in place. The operator does not have the ability to tension or de-tension the system in the control room.

SSCs are automatically controlled by the DCS (units 4 - 6) or local control system (units 1 - 3) to perform the following functions:

- SSCs are Interlocked to start and stop based on
 - the availability of Short Coarse Ash Conveyor (CAC),
 - Drive oil temperature
 - Drive oil tank level
 - Drive oil filter alarm
 - Tensioner proximity switch
 - Tensioner pressure
 - Low charge pressure
- Use the SSC's main drive system pressure to determine the required operating speed (units 4 - 6), and
- Trend SSC operating parameters

Note. The tensioner system is operated locally using the local control panel.

3.1.4 Civil and Structural Design

The main SSC structure has 95 m³ of ash storage space. The SSC can store 5 hours (one (1) hour full boiler load and four (4) hours half boiler load). Alternatively the SSC can store six (6) hours of ash with the boiler at half load. Refer to drawing 33334 for the SSC structure.

The SSC's control box is placed on the Short CAC drive head platform, Refer to drawing 3737354 for the Short CAC drive head platform.

3.1.5 Control and Instrumentation Design

This section gives an overview of the existing Control and Instrumentation (C&I) SSC design.

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Units 1-3

The control system design is such that the operation of all drives is achieved by electrical panels. All local operations are performed manually. Installed is a level indicator that is used by the operator to manually open the make-up water system to fill the bath. In addition the system governing the tensioning system, which is a provision of oil to the chain tension cylinders in order to provide correct pressure for operation is controlled by a pressure switch and a pressure gauge installed to indicate the pressure.

The interlocks are automated through the local control panels. There exists an interface to the control room, which provides remote starting and stopping of the SSC system.

Unit 4-6

Locally installed is an electrical panel and control panel. Control is achieved through the control panel that has an interface to the electric panel for starting and stopping the pumps associated with the SSC. There is a pressure transmitter installed which serves as an interlock for starting the SSC. Its operation is that it tracks the pressure when oil is provided for the jacking of the chain. When the pressure is correct it stops pumping the oil and the SSC is allowed to start. Installed is a level indicator that is used by the operator to manually open the make-up water system to fill the bath.

The interlocks are automated through the local control panels. There exists an interface to the control room, which provides remote starting and stopping of the SSC system.

3.1.5.1 Overview of Existing SSC Control System Architecture

The unitized process plant control and monitoring functions at Tutuka Power Station are realized through the Siemens Teleperm C/Iskamatic B at unit 1 -3 and ABB P14 ProControl automation systems at unit 4 -6. The two automation systems are integrated into their HMI for the unitized operation and monitoring platform of the unitized plant. The Teleperm C/Iskamatic B system is responsible for the control and coordination of all activities required for the operation of the unit. The Teleperm C/Iskamatic B is responsible for the control of boiler auxiliary's plant systems including the SSC and Coarse Ash Conveyors. Key functions are remote starting and stopping of the SSC. *Similar functionality is provided for by the ABB P14 ProControl with an addition of PLC programming for monitoring and control of the SSC Main drive, cooling fan, ash box level and chain tensioning system.*

The high level architecture of the SSC automation system consists of a remote IO panel located in the field, Teleperm C/IB automation and P14 ProControl cubicles located in the computer room and HMI operator stations located in the respective unit control room.

3.1.6 Electrical Design

There are currently two variations of SSC Control Panels installed at Tutuka. The first variation is implemented on Units 1, 2 and 3 and the second variation is implemented on Units 4, 5 and 6. There are also variations in the interfaces for these two variations. Refer to drawings 8553783443 for the Electrical circuits of units 1- 6.

The 380V Unit Board A currently supplies the existing SSC local control panel utilizing a 125A feeder (Circuit 423). The 380V Unit Boards A and B are fed from the 11kV Unit Boards via 1.6MVA transformers (11/0.4kV). The philosophy dictates that the 380V Unit boards A and B utilize their respective Transformers with the bus-section open and the maximum operating load is 1.5MVA (TIM 100 manual).

The unitised 380V Coarse Ash Boards A and B are supplied from their 380V Unit Boards A and B respectively. The Unit Boards supply the Coarse Ash Boards utilizing a 250A feeder (Unit Board A/B Circuit 419) and 200A fuses. The 380V Coarse Ash Boards are equipped with 250A incomers.

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and operate with the bus-section open. According to high-level estimation, the total connected load on each board is as follows

- 380V Unit Coarse Ash Board A = 64 2A (135 8A available)
- 380V Unit Coarse Ash Board B = 193A (7A available)

The *Contractor* confirms all the above for Electrical plant, using the electrical reticulation layout drawings and documentation, combined with inspection of the As Built plant. The *Contractor* marks up any discrepancies between As Built plant and latest drawings. The *Contractor* assesses the available electrical capacity on the switchgear supplying the SSC plant, by way of a load flow and fault study, taking into account the incoming cables, transformers and upstream switchgear, to ensure that the new plant does not lead to overloading in any part of the electrical systems. The *Contractor* updates the existing IED protection settings where needed.

The *Contractor* uses existing documentaton and drawings, combined with inspection of the As Built plant, when designing the plant.

3.1.6.1 Units 1, 2 and 3

SSC systems installed on units 1, 2 and 3 are older than the units installed in units 4, 5 and 6. Individual SSC control panels are installed on each unit, with a range of functions.

The configuration of the SSC Control Panels for Units 1, 2 and 3 allows for both local and remote operation by plant operators. The *Contractor* confirms the current status of the plant and the interfaces relevant to remote operation. The Contractor standardises the design across all units, in collaboration with Tutuka C&I and Tutuka Station Ops.

3.1.6.2 Units 4, 5 and 6

SSC systems installed on units 4, 5 and 6 are more recent than those installed on units 1, 2 and 3. SSC Control Panels on units 4, 5 and 6 incorporate a direct connection to the Power Station DCS (Distributed Control System).

Interface details on units 4, 5 and 6 are well-documented, with the existing ABB systems falling under C&I. The *Contractor* verifies the interfaces between switchgear, SSC field equipment, local SSC control panels and any other systems that loop or interface via the SSC control panels.

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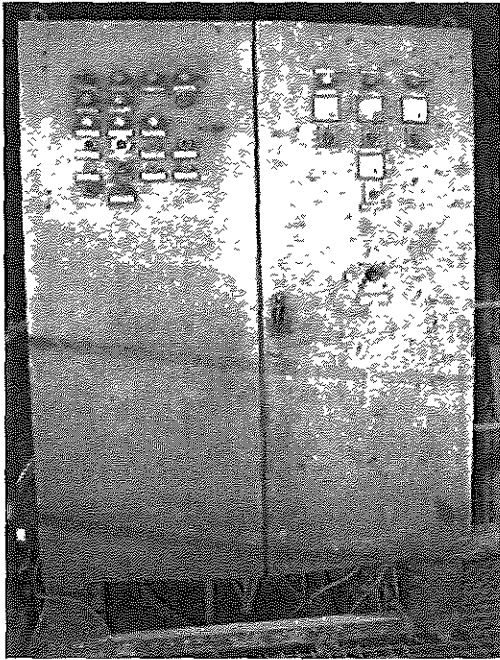


Figure 4: Units 1, 2 and 3 Control Panels

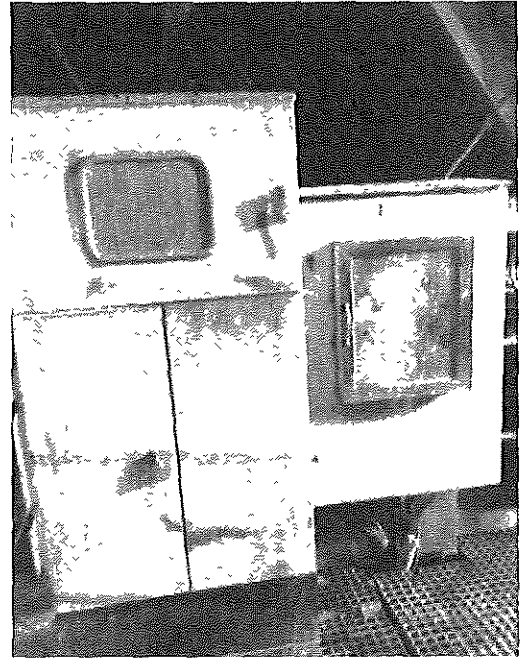


Figure 5: Units 4, 5 and 6 Control Panels

3.2 PARTS OF THE WORKS WHICH THE CONTRACTOR IS TO DESIGN

3.2.1 General

The *Contractor* provides the *Employer* with the most suitable design for the application on Tutuka Power Station. The aim will be to improve the SSC's availability and reliability with the aim of ensuring that they remain operational (without failure) for at least eighteen (18) months, to synchronise with the period between outages

The *Contractor* takes full responsibility for designing and supplying of all modifications that require the installation of the new power supplies and associated equipment.

The *Contractor* modifies the SSC during an outage

The *Contractor* submits a detailed installation plan for the acceptance by the *Employer*

The *Contractor* submits a detailed method statement for the installation of the upgraded system for the acceptance by the *Employer*

The *Contractor* supplies the *Employer* with drawings of all modifications of the upgraded system

The *Contractor's* design is expected to meet the performance guarantee as stipulated in this document

The *Contractor* provides technical support as follows for the upgraded design warranty period

- Telephonic support within 24 hours after a reported fault/failure
- Based on the outcome of the telephonic support if call out support is required the Contractor needs to give on-site support within 48 hours from the reported fault

The *Contractor* identifies critical spares requirements and indicates the availability locally and foreign

The *Contractor* indicates the lead time on critical spares

The SSC has a history of resulting in deaths due to steam burns and thus the *Contractor* designs the SSC taking into account all safety requirements as indicated in 240-83459207, Safe Operation and Maintenance of Submerged Scraper Conveyors Standard, 240-105453648 Fossil Fuel Firing Regulations Standard and 240-138445406 Clinker Prevention and Management in Fossil Fuel Fired Boilers Guideline

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The *Contractor* designs the SSC to allow for the following components to be maintained with the unit on load (replacement should only be 2 hours at most)

- Hydraulic drive system including drive shaft bearing, hydraulic motor, hydraulic pump, electric motor and all associated components in the hydraulic power pack
- Return idler wheels
- Drive sprockets.
- Tensioner idler wheels and tension idler shaft bearings
- Hydraulic tensioning system including electric motor, hydraulic pump, hydraulic cylinders and all associated components in the hydraulic power pack
- Greasing of all bearings
- Scraper bars
- All sump pumps and sump ash mixers

The *Contractor* designs the SSC to allow for the following components to be maintained during outages.

- Wear liners
- Chain
- Submerged idler wheels
- Chain guides
- Drive and tensioner shafts.
- SSC Structure and all associated platforms

The *Contractor* supplies a full operating maintenance cost schedule with associated labour cost to perform each item per maintenance item and will include the cost as a takeout option for the entire warranty period

3.2.2 Process description

The Tutuka process description *shall* remain as described in 3 1 1

3.2.2.1 Design Inputs

Boiler bottom ash

- | | |
|--------------------|-------------------|
| • Fraction | 20% of total ash, |
| • BBA production | 26 17 Tph (dry) |
| • Moisture content | 50% |

3.2.2.2 Design Constraints

Scraper Bar

- | | |
|--|--|
| • Mass | 50 kg |
| • Length | 1 8 m |
| • Top width | 142 mm |
| • Height | 280 mm |
| • Web thickness | 16 mm |
| • Pitch | 1 m |
| • Volumetric efficiency at discharge | 50% (normal operation) |
| • Retained ash bed in water trough height) | 568 mm (normal operation, based on 2 x scraper height) |

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Chain

- Mass (single strand) 17.5 kg/m
- Breaking strength 640 kN

SSC arrangement

- Length 30.6 m
- Lift 5 m
- Inclination angle 40 degrees
- Water level above trough floor 1.06 m
- Number of idler wheel assemblies 10
- Mass of Submerged idler wheel 750 kg

Drive System

- Sprocket PCD 691 mm
- Hydraulic drive system efficiency 80%

Agitation system (Equivalent length in pipe diameters)

Refer to drawing 0 61-BMH-SSC-016 for the isometric layout of the agitation system

- Gate valve – fully open 5 m
- 30° elbow 10 m
- 45° elbow 15 m
- 60° elbow 17 m
- Long radius 90° bend 20 m
- Standard 90° bend 30 m
- Non-return valve – ball type 150 m

Agitation system Key Elevations

- Station Datum Level 1 625.700 m a m s l
- Pump centreline 1 627.148 m a m s l
- SSC HWL 1 628.711 m a m s l
- SSC LWL 1 628.690 m a m s l

Agitation system Pipe lengths

- Suction 2.23 m
- Discharge to discharge nozzle 1 21.87 m
- Discharge to discharge nozzle 2 31.25 m

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- Discharge to pipe outlet 32 25 m

Agitation system Pipe losses

Suction

- 2 x Long Radius 90° Bends
- 1 x Gate valve

Discharge

- 9 x Long Radius 90° Bends
- 8 x Long Radius 45° Bends
- 3 x Ball Type NRV
- 4 x Gate Valves

Agitation pump and motor

- Number of pumps in series One (1)
- Pump type Centrifugal Slurry Pump
- Number of electric motors in service One (1)
- Electric motor type Constant speed motor

3.2.2.3 Design Properties

Boiler bottom ash

- Bulk density 800 kg/m³ (dry)
- Bulk density 850 kg/m³ (wet)
- Effective angle of internal friction 20 degrees

The *Contractor* confirms BBA properties for use in their design from an ash sample if so required for design and component selection

Scraper Bar

- Friction angle with liner 28°
- Friction angle with BBA 14°

3.2.3 Design Criteria

The design criteria for this project are

- The solution *shall* allow for 200 % backlog recovery
- The mechanical solution *shall* as far as possible include technologies already in use by Eskom, such as chain and hydraulic drive motor design
- The final solution *shall* not require extensive changes to the existing equipment
- The current operating philosophy of the plant *shall* remain the same
- Design life – 30 years, and

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- 99.99% availability of the SSC from Outage to Outage (Eighteen (18) month period)

3.2.4 Design Outputs

This section presents design outputs achieved as a result of using design input, design constraints and design properties stated above

System output

- Maximum conveying capacity 74 Tph (based on maximum ash production)
- Normal conveying capacity 37 Tph (half of maximum ash production)

Conveying Speed

- Normal running chain speed 2.2 m/min
- Backlog running chain speed 4.5 m/min

Storage Capacity Design

- BBA storage space in SSC 95 m³
- Available storage time 3.5 hours (full boiler load)
- Available storage time 6.9 hours (half boiler load)

Resistance loads produced by the system

- Empty running resistance 37 300 N
- Empty running absorbed torque 14 210 Nm
- Normal running resistance 127 000 N
- Normal absorbed torque 48 735 Nm
- Backlog running resistance 318 495 N
- Backlog absorbed torque at motor 122 223 Nm

According to design outputs described above, the proposed drive force *shall* have the capability to overcome a torque of 122 223 Nm when the SSC has to start under backlog conditions. A hydraulic drive system that can produce a minimum torque of 130 KNm *shall* be installed

Agitation system pump performance

- One (1) SSC agitation pump coupled to a motor
- Pump speed 1 400 rpm
- Flow rate range 64 - 212 m³/hr
- Total Head range 44- 48 m
- Max Hydraulic pressure 0.513 MPa
- NPSHa LWL – 8 m
- NPSHr HWL – 3.8 m
- Pump efficiency 65%

Agitation system motor

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- Absorbed power 45 kW
- Motor efficiency 93%
- Installed motor rating 55 kW

Agitation system operating parameters at different discharge points

- Nozzle one (1) discharge flow rate 64 m³/hour
- Nozzle two (2) discharge flow rate 60 m³/hour
- Nozzle three (3) discharge flow rate 101 m³/hour
- Nozzle one (1) discharge pressure 4.1 Bar
- Nozzle two (2) discharge pressure 3.8 Bar
- Nozzle three (3) discharge pressure 2.8 Bar

3.2.5 SSC Mechanical Design

3.2.5.1 General Mechanical Scope

The general Mechanical scope relating to the SSC upgrade project include but is not limited to the following.

- Decommissioning of the installed electro hydraulic drive system including an air to oil cooler system,
- Decommissioning of the installed chain, scraper bar connector, drive sprockets, drive shaft bearings, tensioner hydraulic cylinders, tensioner wheels and tensioner bearings
- Provision for the installation and commissioning of an upgraded electro hydraulic drive system including an air to oil cooler system,
- Provision for the installation and commissioning of a 30 x 120 mm chain system with all supporting components including master links, drive sprockets and scraper bar connectors,
- Provision for the installation and commissioning of a modified tensioner station and upgraded electro hydraulic tensioning system,
- Provision for the installation and commissioning of an agitation system,
- Provision for the installation and commissioning of fork tooth sprocket idler wheels and incorporate the fork tooth idler wheels to the design of the submerged idler wheels with different sealing designs,
- Provision for the installation and commission for an automated SSC water supply system and interfacing with different water supply sources, and
- Provision for the effective operation of the SSC with the new chain and submerged idler wheel design

3.2.5.2 Mechanical Scope Description

The drive upgrade modification *shall* allow the SSC to convey a maximum of 74 Tph of BBA under backlog conditions at a speed no greater than 5 meters per minute. Under normal operating conditions, when the Boiler is at MCR, the SSC will convey an average of 37 Tph of ash at a speed of no greater than 2.5 meters per minute.

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Modified SSC components *shall* be designed in a manner that allows for any maintenance activities to be performed without difficulty or the need to shut-down a unit excluding the replacement of chains and submerged idler wheels

The following areas of the SSC *shall* be modified by the *Contractor*

- A Drive System
 - Hydraulic drive,
 - Drive sprocket,
 - Drive shaft,
 - Drive shaft bearings, and
 - Power pack cabinet position
- B Conveying chain
- C Take up System
 - Idlers wheels,
 - Tensioner shaft and bearings, and
 - Tensioner hydraulic cylinder
- D Idler wheels and submerged idler wheel assemblies
- E Structural Modification
- F Agitation system
- G Conveying chain movement design
- H SSC water make up system design
- I Control and Instrumentation
- J Electrical power supply
- K Normal - and emergency water supply

3.2.5.2.1 Drive System

Electro-Hydraulic drive technology *shall* be selected for this design in order to take advantage of high torque capabilities of this technology. A cam curve radial piston direct drive arrangement *shall* be used for this design. The use of a planetary reduction gearbox *shall* not be used due to the increase in components of the drive assembly, oil maintenance requirements and the reduction in drive efficiency due to the addition of a gearbox.

A hydraulic power pack unit *shall* be used to house the electric motor, hydraulic pump, stainless steel reservoir (adequately sized for continuous duty) and all associated components that form the power pack unit. These hydraulic components *shall* be housed in an IP 65 rated cabinet in order to protect them from ash and coal dust around the SSC area. The power pack *shall* be positioned on the modified Short CAC drive head platform, refer to Section 3.2.7.1 for the design of the new platform.

A closed loop hydraulic system for continuous duty *shall* be employed. One 30 kW, 380 V, 50 Hz electric motor directly coupled to a 125 (cc) hydraulic pump with variable speed drive *shall* be used to pump oil within the system. The drive pump *shall* be a variable displacement pressure compensated unit, the displacement of which dictates the final speed of the drive motors. Variable oil flow *shall* be achieved using a 4 – 20 mA signal from the DCS, sent to the pump's servo to control the oil flow rate which in turn drives the hydraulic motor whilst controlling the SSC's drive.

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speed The drive *shall* be capable of operating at variable speeds ranging from 0.1 to 5 meters per minute. Reversing of the drive system *shall* also be possible to help recover the SSC during backlog start up conditions. The Contractor *shall* use a combination of stainless steel and flexible piping (suitable to transport hydraulic oil at the set operating pressure) to transport hydraulic oil from the pump to the drive motor. The Contractor ensures that sufficient flexibility is allowed for the SSC to move from its normal operating post to the maintenance bay without the need to disconnect the piping.

The electric drive motor *shall* start from an unloaded condition and operate continually at synchronized speed, driving the hydraulic pump via a direct coupling. The pump receives oil from the oil reservoir and pumps it to the hydraulic drive motor which *shall* be directly coupled to the existing drive shaft using a connecting stub.

Torque arms *shall* be utilized to contain the reaction forces and eliminate any undesirable forces on the motor bearings, thus providing a compact, simplified solution, also minimising replacement time. A hydraulic drive system which can produce a maximum torque of 75 000 Nm *shall* be employed.

Cooling of the hydraulic oil *shall* be achieved by an air-to-oil cooler (driven by one electric motor) which is thermostatically controlled. The air-to-oil cooler *shall* also be positioned on the modified Short CAC drive head platform.

The drive assembly *shall* consist of a drive shaft with sprockets connected to the hydraulic drive train. The drive assembly *shall* remain at the head end of the SSC (at the top of the dewatering slope) with the drive shaft mounted to the SSC's structure using two split bearings on the shaft and a torque arm connection to the SSC structure. A new drive shaft sized to accommodate the new drive torque requirements *shall* be installed. The shaft ends *shall* be splined in order to connect to the new hydraulic drive motor/s.

The drive shaft *shall* use split bearings assembled inside a plumber block to allow for the bearing to be replaced without the need to remove the drive shaft. Split bearing *shall* be sized to fit onto the new drive shaft. A safety factor of no less than 2 *shall* be employed.

Drive torque from the drive shaft assembly *shall* be transmitted to the chains by means of removable sprocket teeth bolted onto removable sprocket hubs. Sprocket hubs *shall* be locked onto the drive shaft using one key per sprocket hub. Drive sprocket teeth *shall* be radially mounted onto the hubs and locked into position by side fitted bolts between the hub and sprocket teeth. Sprocket drive hubs *shall* fit onto the new drive shaft and *shall* accommodate eight (8) drive sprocket teeth. These sprocket teeth *shall* also be made from Cr Ni steel and will also be case hardened to have a hardness of 800HV.

3.2.5.2.2 Conveying Chain

A 30 x 120 mm chain *shall* be installed on the SSC. This new chain *shall* also be made of Cr Ni with a minimum of 10.5% chromium content by mass. The chain *shall* also be case hardened with a case hardening depth of 3 mm and hardness of 800HV in order to reduce wear during operation. The core of the chain *shall* not be hardened to ensure that material tensile strength is not compromised.

Standard 5 or 10 meter chain strands *shall* be connected to each other using master-links in order to form the total chain length required. Master-links *shall* also be made from a Cr Ni steel alloy and have the same strength and case hardness as the 30 x 120 mm chain they are matched to.

Cooling water will be supplied to wash the chain at the top of the dewatering slope (before the drive sprocket) in order to preserve the chain's life. The supply piping consists of 25 NB galvanised piping. The Contractor's design must include a tie-in to the supply piping as well as the best suitable routing to the required location. Refer to drawing 0 61-BMH-SSC-006 Rev 0 0 in Table 7 for system P&ID.

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3.2.5.2.3 Scraper Bar

Tutuka P S SSCs *shall* continue to use Boxed shaped scraper to physically move the ash. These scraper bars *shall* be connected to the chain using the scraper bar connectors suitable for use with fork teeth type sprocket idler wheels. The scraper bars will be 0.48 m from each other. The Contractor designs the new scraper bars to move within the current SSC Structure.

The chain's centre may be reduced from 1840 to 1800mm in order to accommodate the new chain and scraper bar design and return trough of the current SSC structure. Refer to drawings 0.61-BMH-SSC-012 and 0.61-BMH-SSC-013 in Table 7 for the new chain and scraper bar design.

3.2.5.2.4 Idler wheels assemblies

Fork tooth sprocket type idler wheels *shall* be used to guide the chain within the SSC on the drive shaft, tensioner shaft and all idler wheel assemblies. All idler wheels *shall* have a PCD of 614 mm and accommodate the new 30 x 120 mm chain and Scraper bar design selected.

The Contractor provides three (3) sealing designs for submerged idler wheels. These designs will be reviewed and accepted by the Employer before being manufactured and installed. The Contractor ensures that all supplied submerged idler wheel assemblies have the same bearing, idler wheel, flange design and external dimensions and only the sealing arrangement may differ.

New return trough idler wheel assembly shafts (Idler position L3/R3 and L4/R4) *shall* be employed with a minimum shaft diameter of 120 mm. New segmented fork toothed idler wheels *shall* be installed on this new shaft. Idler wheels *shall* be sized to accommodate the new 30 x 120 mm chain. Return trough idler wheel assembly shafts *shall* use split bearings in order to minimise the need for shaft removal. A bearing safety factor not less than 2 *shall* be employed. The chain centre may be adjusted from 1 840 to 1 800 mm in order to accommodate the new chain.

Idler wheels are named in a chronological manner which describes how the chain moves inside the ash box in the following order:

- | | |
|--|-------|
| • Front idler wheel assembly in return trough . | L&R 3 |
| • Rear idler assembly in return trough. | L&R 4 |
| • Tail pulley idler wheel assembly. | L&R 5 |
| • Rear submerged idler assembly in carry trough | L&R 6 |
| • Front submerged idler assembly in carry trough | L&R 7 |

Note

The drive shaft is not an idler wheel assembly however that Tutuka P S has named it L&R 1. Bladder guides which guide the chain back into the return dewatering slope are also not idler wheels, however they are also known as L&R 2.

3.2.5.2.5 SSC Take up system design

The tensioner system is used to keep the chain in tension during all operating modes of the SSC. Failure of the tensioner system results in the loss of chain tension which can cause chain failures, (normally identified around the L&R 3 idler wheel assembly).

The SSC's chain tensioner station *shall* be modified to accommodate the new 30 x 120 mm chain and tail pulley shaft assembly together with the new drive torque produced by the new drives, refer to drawing 0.61-BMH-SSC-001 in Table 7 for the proposed take up (tensioner) design.

Take up station design changes include:

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- Tensioner idler wheels (fork tooth type idler wheels) assembly,
- Tensioner hydraulic system, and
- Structural modifications to tensioner station

Tensioner idler wheel assembly

Fork toothed sprocket idler wheels sized for the 30 x 120 mm chain *shall* be employed. These idler wheels *shall* have a PCD of 614 mm and *shall* be compatible with the fork toothed idlers employed on the drive shaft together with the carry and return trough idlers of the SSC, L&R 1, 3, 4, 6 and 7. The *Contractor* modifies the two independent tensioner idler wheel assembly systems to one idler wheel assembly. This new system *shall* consist of two fork toothed sprocket idler wheels keyed to a common tensioner shaft that is mounted onto two split bearings to make one idler wheel assembly.

The Tensioner idler wheel assembly shaft is designed for

- Infinite fatigue life with the maximum operational torque applied, and
- For the stress in the shaft to remain below material yield with the maximum drive torque applied

A single 170 mm diameter shaft *shall* be employed using EN 8 material. The shaft is fitted with split bearings assembled inside a plumber block to allow for the bearing to be replaced without the need to remove the tensioner shaft. A minimum shaft diameter of 150 mm *shall* be used for the bearings. Idler wheels *shall* be mounted onto the shaft using key ways.

Split bearings *shall* be sized to fit onto the new bearing turn and *shall* have a safety factor not less than 2 (Bearing LSM150BR).

Tensioner hydraulic system

The tensioner hydraulic system *shall* consist of the following components

- Hydraulic Power Unit, and
- Hydraulic Cylinders

Hydraulic Power Unit (Tensioner cabinet)

The *Contractor* installs a hydraulic power pack which houses the electric motor, hydraulic pump, stainless steel oil tank and all associated components that form the power pack unit. These hydraulic components *shall* be housed in an IP 65 rated cabinet in order to protect them from ash around the SSC area. The power pack *shall* be placed at the back of the SSC and directly mounted onto the SSC's rear structure,

Oil flow *shall* be achieved by switching on the electric motor in order to pump the oil. Cylinder movement *shall* be achieved by controlling a three way hydraulic valve. This valve allows the hydraulic cylinders to move up, down or maintain a set position. The pump receives oil from the oil reservoir and pumps it through the control valve to the two hydraulic cylinders via stainless steel hydraulic piping mounted onto the SSC structure.

Hydraulic cylinders

The current design employs a system which can produce 12 MPa of pressure, and two (2) 160D 80/45X410 hydraulic cylinders are employed. The two (2) double acting hydraulic cylinders (used to tension the chain) are located at the rear section of the SSC. These cylinders are mounted onto the tail structure of the SSC. Each hydraulic cylinder has a minimum piston area of 0.003436 m². This means each cylinder can produce a force of 41 233 N when a pressure of 12 MPa is applied.

The contractor evaluates whether the current system can be reused or a new system should be installed to tension the upgraded SSC system and provides his or her recommendation to the

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Employer for review and acceptance Refer to drawing 0 61-BMH-SSC-001 in Table 7 showing the location, positioning and design of the tensioner system

3.2.5.2.6 Agitation system

The agitation system is installed on the right hand side of the SSC The main purpose of the agitation system is to reduce the drive torque required by the drive when the SSC has to restart during backlog operations

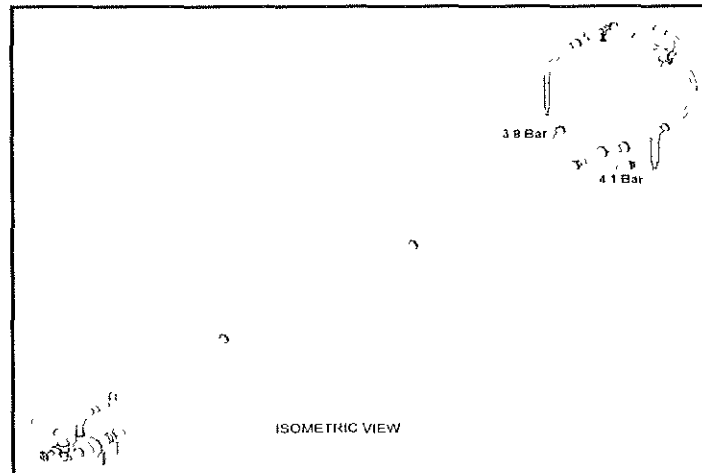


Figure 6: Isometric view of agitation system

The water agitation system *shall* include a slurry type centrifugal pump located at the tail end of the SSC mounted on the SSC structure to ensure easy movement of the SSC when required The minimum duty requirement of the pump is 212 m³/hr at a pressure of 513 kPa The pump *shall* be located at the tail end of the SSC to ensure that the suction water quality is as clean as possible From the delivery side of the pump, a steel pipe *shall* run along the side of the SSC to the front end, this pipe with its isolation valves and bends *shall* be also supported onto the SSC structure At the SSC head end, two water injection nozzles penetrate the water bath close to the intersection between the horizontal and incline sections These nozzles *shall* be located just above the top of the scrapers with a 30 degree included angle to the sidewall and pointed upwards at 3 degrees relative to the horizontal axis A third water nozzle penetrates the water bath from the top end at an angle to ensure that the water jet clears the front-end dipper plate into the SSC ash storage area The sections of pipe interfacing with each nozzle as well as the nozzles are fabricated from 316 stainless steel piping It is important to manufacture these sections from stainless steel as this eliminates pipe blockages to a great extent as a result of the characteristic of stainless steel for good flow characteristics Refer to drawing 0 61-BMH-SSC-016, 0 61-BMH-SSC-017, 0 61-BMH-SSC-018 and 0.61-BMH-SSC-019 in Table 7 for the agitation system.

Nozzles

- Lining ceramic lined
- Internal diameter 30 mm
- Material stainless steel
- Standard AISI 36, AISI 37

Valves

- Valve type Resilient seal gate valve, double flanged, rising spindle
- Valve body & gate material Spheroidal graphite iron

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Non Return Valves

- | | |
|-------------------|--|
| • Type | "Dual" ball valve, with manual hand wheel |
| • Body & material | Carbon steel with high chrome content The valve body is to have ceramic lining |
| • Ball material | Hollow carbon steel and urethane coated |
| • Seat material | Abrasion resistant steel |

3.2.5.2.7 SSC water supply system design

The SSC will be supplied with water from the following streams

- Demin Regen Effluent
- Cooling Water Supply
- De-gritting Sump
- Recovery Sump

Refer to drawing 0 61-BMH-SSC-006 Rev 00 in Table 7 for the system's P&ID

Demin Regen Effluent

Demin regen effluent will flow directly into the SSC The *Employer* will be responsible for this scope

Cooling Water

The cooling water supply line which originally discharged at the back of the SSC *shall* continue supplying water to the SSC for start-up conditions using the manual isolation valve 0*WD40S101 A new pipe *shall* be tapped before the manual isolation valve 0*WD40S101 in order to supply the SSC with cooling water This pipe *shall* be used under normal operating conditions and supply cooling water in a controlled manner using an electrically actuated globe valve An ultrasonic level indicator (0*NU10L010) *shall* be installed and used to measure the SSC's water level This level indicator *shall* give control signals to the actuated globe valve to open or close cooling water supply to the SSC based on the SSC's top trough water level Water tapped off from the cooling water supply line *shall* be routed to the chain washing systems located at the front carry trough of the SSC

Cooling water *shall* also be used to wash the chain at the top of the dewatering slope just before the drive sprocket in order to preserve the chain's life Pipe routing of this system *shall* be done in a manner that allows water to be sprayed on both sides of the SSC's dewatering slope incline structure Due to the Cooling Water used, nozzles *shall* not be installed Pipe ends *shall* be partially closed to create a spray to wash the chain on the incline section of the dewatering slope Sockets *shall* be welded onto the sidewalls of the SSC structure, through which the pipes are supported and routed Isolating valves *shall* be installed on each of the pipes in order to adjust the flow to each spray Water used to wash the chain falls back into the SSC's top trough and will serve as normal water makeup Routing of this pipe *shall* form part of the *Contractor's* design

De-gritting Sump

Water received from the SSC's structure and CAC systems is collected in the De-gritting sump This water *shall* be pumped back into the SSC using the De-gritting sump pump An ultrasonic level indicator *shall* be used to detect the water level in the De-gritting sump The sump's water level indication *shall* be one of the signals used to start and stop the pump when a high water level indication is received De-gritting water *shall* be pumped to the back of the SSC in order to ensure that no agitation of ash occurs at the front of the SSC Ash *shall* be suspended in the sump by a

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mixer The *Contractor* scope *shall* include the design, construction, installation and commissioning of a suitable sump pump, piping, ash mixer and associated equipment for the De-gritting sump system The *Contractor* must carry out a fit for service investigation on the existing ash mixer This must be done to determine if the existing mixer can be integrated for use in the upgraded system

Recovery Sump

Water collected in the Recovery sump *shall* also be pumped back into the SSC This water *shall* be pumped back into the SSC using the Recovery sump pump An ultrasonic level indicator *shall* be used to detect the water level in the sump The sump's water level indication *shall* be used to start the pump when a high water level indication is received and stop the pump when a low sump water level indication is received Recovery water *shall* pumped to the back of the SSC in order to ensure that no agitation of ash occurs at the front of the SSC (this ensures that the SSC's throughput capacity is not decreased) The *Contractor's* scope *shall* include design, construction, installation and commissioning of a suitable sump pump, piping and associated equipment for the Recovery sump system

Selected pumps for the De-gritting and Recovery sumps *shall* be compatible as far as possible and *shall* be sized to accommodate electrical power ratings as indicated this document

Control panels *shall* be provided to manually start and stop electric motors which drive the Recovery and De-gritting sump pumps These control panels *shall* allow these electric motors to only be operated in local mode

3.2.6 Control Philosophy

3.2.6.1 SSC Drive System

Details of the operating philosophy *shall* be determined by the *Contractor* during the detail design phase of the project The detailed design *shall* indicate the following parameters

- Normal operating pressure of the main hydraulic drive system, and
- Backlog operating pressure of the main hydraulic drive system

The *Contractor* interlocks the SSC to start when the following parameters are met

- Short Coarse Ash Conveyors is available,
- Oil temperature is within the required detail design requirement,
- Charge pressure is as per detail design set-point (normally 20 MPa),
- Oil filter deferential pressure is as per detail design set-point,
- Tensioner pressure is above detail design set-point, and
- Tensioner limit switch is not activated

The *Contractor* interlocks the SSC to trip when the following parameters are met

- Short Coarse Ash Conveyor not available,
- Emergency stop button is activated,
- Oil temperature is below or above the required detail design requirements,

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- Charge pressure is below detail design requirement (below 20 MPa),
- Oil filter differential pressure is above detail design requirement,
- Tensioner pressure is below detail design requirement setting, and
- Tensioner limit switch is activated

3.2.6.2 SSC Tensioner System

The *Contractor* designs the SSC tensioner system to be operated locally

3.2.6.3 SSC agitation system

The *Contractor* designs the agitation system to have the following agitation modes

- Periodic agitation, and
- Backlog recovery agitation

Periodic agitation *shall* be used to clean the piping and nozzles of the agitation system. Backlog recovery agitation mode *shall* be used during backlog recovery conditions to agitate settled ash inside the ash box

Periodic agitation

Agitation electric motor start-up Conditions:

- SSC water level is above 2200 mm of water trough, and
- 30 minutes after last agitation stop signal

Agitation electric motor shut down conditions

- 1 minute after agitation system start-up.

Agitation electric motor trip (Emergency Stop) Conditions

- SSC water level drops below 2 100 mm of water trough, or
- Agitation pump discharge pressure above 650 kPa

Backlog recovery

Agitation electric motor start-up conditions

- SSC water level is above High SSC water level in carry trough, and
- SSC drive pressure above 20 MPa

Agitation electric motor shut down conditions

- SSC drive pressure drops below design set-point

Agitation electric motor trip (Emergency-Stop) conditions

- SSC water level drops below SSC water low level in the carry trough, or
- Agitation pump discharge pressure above design set-point

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3.2.6.4 SSC water supply operating philosophy

The SSC will be supplied with water from the following streams

- Demin Regen effluent,
- De-gritting sump,
- Recovery water sump,
- Cooling water supply

Refer to drawing 0 61-BMH-SSC-006 Rev 00 in Table 7 for the system's P&ID

The following levels *shall* be registered by the Contractor to the SSCs water control system:

- High Water Level – H (SSC water level equal to or above 2 200 mm),
- Low Water Level – L (SSC water level equal to or below 2 150mm), and
- Critical Low Water Level – CL (SSC water level below 2 100 mm)

The following levels will be registered for the Recovery and De-gritting sumps

- High Water Level – H (Site to indicate),
- Low Water Level – L (Site to indicate)

The Contractor designs the system to have the following operational philosophy to supplying water to the SSC

3.2.6.5 SSC water supply starting sequence

- The Recovery sump pump delivers water to the SSC when the following two signals are received
 - Recovery sump level is H, and
 - SSC water level falls below L
- The De-gritting sump pump delivers water to the SSC when the following two signals are received
 - De-gritting sump level H, and
 - SSC water level falls below L
- Cooling water piping supplies water to the SSC by opening the actuated valve when the following signal is received
 - SSC water level falls below CL

It is expected that this signal will only be received if both the Recovery and De-gritting sump pumps are not available to deliver water to the SSC or both sump levels are below the H set point

3.2.6.6 SSC water supply stopping sequence

- The Recovery sump pump stops pumping water when either of the following two signals are received

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- Recovery sump water level L, or
 - SSC water level H
- The De-gritting sump stops pumping water when either of the following two signals are received
 - De-gritting sump water level L, or
 - SSC water level H
- Cooling water supply to the SSC *shall* be stopped by closing the actuated valve when the following signal is received
 - SSC water level L

Recovery and De-gritting water supply *shall* be independent from each other, this means recovery and de-gritting water pumps can supply water to the SSC at the same time.

During SSC start-up conditions, the following sequence shall be followed when filling the SSC

- Water from the Recovery sump *shall* be used to fill the ash box (if available)
- Simultaneously, water from the De-gritting sump *shall* be used to fill the ash box (if available)
- Alternatively, cooling water *shall* be used to fill the ash box. The valve shall be automatically opened to achieve this

Control panels *shall* be provided to manually start and stop electric motors which drive the Recovery and De-gritting sump pumps. These control panels *shall* allow these electric motors to only be operated in local mode.

3.2.7 Civil and Structural System Design

This section covers minimum requirements for the civil and structural designs related to the Tutuka SCC upgrade project.

A finite element analysis must be done by the *Contractor* to ensure that the structure can resist increased torque and/or loadings

Structural Designs to be conducted in accordance with

- 240-56364545 Structural Design and Engineering Standard
- 240-57127951 Standard for the Execution of Site Investigations
- SANS 10100-1 Reinforced Concrete Design

Contractor appoints a Pr Eng/Pr Tech specialising in structures to conduct detailed structural condition assessment on the existing foundation/slab

The following subsections are described

- SSC power pack platform modification with crawl beam,
- SSC drive wheel assembly section structural modification,
- SSC idler wheel assembly structural modification,
- SSC tail section structural modification, and
- SSC agitation system platform design

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3.2.7.1 SSC power pack platform modification with Crawl beam

The Short Coarse Ash Conveyor (CAC) head platform *shall* be modified to accommodate the new hydraulic power pack, drive hydraulic oil cooler, new SSC control box and eight (8) maintenance personnel working around these new components. The Short CAC drive head platform *shall* be extended in order to accommodate the new hydraulic drive power pack. Support beams from the current Long CAC tail station *shall* be extend upwards in order to modify the platform. The *Contractor* further adds a new crawl beam in order to allow for ease of on and offloading of spare components. Refer to drawings 0 61-BMH-SSC-004 and 0 61-BMH-SSC-015 in Table 7 for the layout design of the proposed platform.

Support beams from the current Long CAC tail station *shall* be further extend upwards in order to build the new crawl beam which *shall* be used to lift equipment for the Short CAC or the hydraulic drive system.

3.2.7.2 SSC structural Modification

The SSC's drive structure is modified to accommodate the following systems

- New drive shaft,
- Nose cone,
- New drive motor/s,
- Split bearings, and
- New drive torque arm/s

The *Contractor* sizes all these components to accommodate the new 30 x 120 mm chain and the increased drive torque produced by the upgraded drive system, refer to drawing 0 61-BMH-SSC-012 and 0 61-BMH-SSC-013 for the upgraded SSC structural drive station.

3.2.7.3 SSC idler sections structural modification

Idler wheel assembly structures of the SSC *shall* be modified in order to accommodate the new 30 x 120 mm chain and new idler wheel diameter. Furthermore, the *Contractor* reinforces the SSC's structure in order to withstand the additional forced produced by the new drive system and new chain tensions produced.

3.2.7.4 SSC tail Section structural modification

The SSC's tensioner station *shall* be modified to accommodate the new 30 x 120 mm chain, tensioner idler wheels and new tensioner force requirements created by the upgraded drive system. Reinforcement structures *shall* be added to the tail section in order to accommodate the new operating loads, refer to drawings 0 61-BMH-SSC-001 in Table 7 for the upgraded SSC tail structure.

3.2.7.5 Agitation System

The pump base *shall* be located at the back of the SSC. Its main function *shall* be to accommodate the agitation system's pump and electrical motor assembly. Drawings 0 61-BMH-SSC-018 and 0 61-BMH-SSC-019 in Table 7 show the proposed civil design of the agitation system.

For the Detailed Design, the *Contractor* must consider the following parameters

- Weight of the Motor,
- Weight of the Pump,

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- Vibration Loading as a result of the Motor & Pump operations, and
- Live loading on the platform as a result of maintenance (four (4) People and equipment), accessible platform loading from SANS 10160

The following checks must be carried out by the *Contractor*

- Deflection,
- Bending,
- Compression, and
- Flexure and Torsion

3.2.8 Electrical System Design

The *Contractor's* design takes into full consideration the conditions and limitations of the existing electrical reticulation

The *Contractor* carries out a site assessment of the available switchgear during clarification stage, accompanied by the *Employer*, to establish a clear understanding of circuit availability, rating, cabling and routing to ensure that power supply requirements are satisfied. The *Contractor* ensures that electrical supplies are identified and provided for from existing electrical switchgear. The *Contractor* refurbishes and/or equips the required switchgear buckets where necessary, after agreement with the *Employer*

The *Employer* provides the *Contractor* with all existing drawings and documentation for the local unitised SSC Control Panels. The *Contractor* inspects the panels, cables and loads, to verify the accuracy of the drawings and documentation. The *Contractor* marks up the drawings where required to indicate where drawings don't match what is in the plant. The *Contractor* verifies the operating philosophy of the SSC system and ensures that the new SSC Control Panels comply with the requirements for correct plant operation

The *Contractor* assesses the feasibility of reusing the existing cables. In the event that existing cables are proved to be fit for purpose, in terms of insulation resistance and sizing, the cables are reused. In the event that existing cables are deemed to be unfit for purpose, these are replaced. Costing for replacement of cables is listed as individual line items and treated as take out items

There are currently two variations of SSC Control Panels installed at Tutuka. The first variation is implemented on Units 1, 2 and 3 and the second variation is implemented on Units 4, 5 and 6. There are also variations in the interfaces for these two variations. The *Contractor* rings out two complete panels, one chosen from Units 1, 2 or 3 and another from Units 4, 5 or 6. This work is subject to Unit outage schedules

The *Contractor* is responsible for assessing the feasibility of electrical loading increases resulting from their detailed design, as well as any associated risks. In the event that changes are made to the final load list, the *Contractor* is responsible for assessing the possible impacts of such changes and accommodating the power requirements accordingly. The *Contractor* communicates such changes to the *Employer* timeously for review and approval

3.2.8.1 SSC Electrical Loads

The electrical loads on the SSC system include the following

- Electrical motor for main hydraulic chain drive (x 1)
- Cooler for main hydraulic chain drive oil (x 1)
- Electrical drive for chain tensioner system (x 1)

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- Heater for hydraulic drive oil (x 1)
- Power pack auxiliary (x 1)
- Motor for agitation pump (x 1)
- Motor for de-gritting sump pump (x 1)
- Motor for de-gritting sump mixer (x 1)
- Motor for recovery sump pump (x 1)
- Valve actuators for Agitation and Water Make-up systems (x 4)

3.2.8.1.1 Electrical motor for main hydraulic chain drive

The existing load is confirmed to be 18.5 kW, with the possibility of increasing this to 30 kW when replaced. The *Contractor* assesses the feasibility and impact of any increased loading on the circuit.

3.2.8.1.2 Cooler for main hydraulic chain drive oil

The existing load is confirmed to be 0.55 kW, with the possibility of increasing this to 0.75 kW when replaced. The *Contractor* assesses the feasibility and impact of any increased loading on the circuit.

3.2.8.1.3 Electrical drive for chain tensioner system

The existing load is confirmed to be 1.5 kW. The *Contractor* assesses the feasibility and impact of any increased loading on the circuit.

3.2.8.1.1 Heater for hydraulic chain drive oil

This is a new load for the SSC and is expected to be 0.75 kW. The *Contractor* verifies that this load can be provided from the local SSC Control Panel, based on their assessment of the circuit rating and increased loading on the switchgear.

3.2.8.1.2 Power pack auxiliary

This is a new load for the SSC and is expected to be 0.75 kW. The *Contractor* verifies that this load can be provided from the local SSC Control Panel, based on their assessment of the circuit rating and increased loading on the switchgear.

3.2.8.1.3 Motor for agitation pump

This is a new load for the SSC and is expected to be as 55 kW. Initial investigation indicates that this load requires a dedicated supply from the 380V Unit Board switchgear, due to it being too large to be supplied from the local SSC Control Panel.

The *Contractor* assesses the loading on the local SSC Control Panels, verifying whether or not the agitation pump motor can be supplied and controlled from the local SSC Control Panel. If this is not possible, the *Contractor* assesses the alternative of supplying the agitation pump motor from the following spare circuit:

380V Unit Board *A, (where * denotes unit number)

- Circuit number: 424
- Current rating: 100A

The *Contractor* assesses the condition of this spare circuit and refurbishes the bucket if necessary. The *Contractor* ensures that any interlocks between the agitation pump motor and other SSC plant are catered for.

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3.2.8.1.4 Motor for degritting sump pump

This is an existing load confirmed as 7.5 kW, with its own dedicated supply from the 380V Unit Board (380V Unit Board *A, Circuit 406, where * denotes unit number). The *Contractor* does not change this design but incorporates it into his/her design.

3.2.8.1.5 Motor for degritting sump agitation mixer

This is an existing load confirmed as 7.5 kW, with its own dedicated supply from the 380V Unit Board (380V Unit Board *B, Circuit 406, where * denotes unit number).

3.2.8.1.6 Recovery sump pump system

The recovery sump pump system consists of one submersible pumps, rated at 7.5 kW. At time of writing, this system was in the process of being re-commissioned and optimised. For Unit 3, these motors are supplied from the following circuit:

380V Incline Conveyor Board *, where * denotes unit number

- Circuit number 057
- Current rating 63A

The Eastern sump is to be used for recovery and pumping back to the SSC while the western sump is used as a settling pond that overflows to the eastern sump. In order to reduce the amount of ash flowing to the sump with the pump:

The *Contractor* assesses the current status of the recovery sump pump system in order to have together with the Employer, and establishes any additional work that is required for the complete operation of the system.

3.2.8.1.7 Valve actuators for agitation and water make-up systems

Four (4) additional actuators are required, two (2) for the agitation system and two (2) for the water make-up system, with these actuators supplied from a local Distribution Board, and installed by the Contractor, with details of the arrangement to be agreed on during Detailed Design phase.

The Distribution Board *shall* either receive supply from the SSC control panels directly, from a local C&I Control Panel or from a dedicated circuit supplied from the 380V Unit Board. The *Contractor* assesses which supply will best suite his/her design and submits the proposed design to the *Employer* for review and acceptance.

3.2.8.1.8 Existing and new supplies

The *Contractor* confirms the supply points for existing electrical loads, using the latest electrical switchgear load schedules. The *Contractor* conducts plant site inspections with Tutuka Electrical Engineering, Tutuka Operating Department and Tutuka Boiler Engineering during site clarification meetings, confirming that all required points of supply are available and suitable for any equipment that is being upgraded. The *Contractor* also finalises designs for cables (type, size, length, routing, racking and termination) and earthing/bonding arrangements during site clarification meetings.

The 380V Precipitator Boards are in the process of being upgraded as part of another project. The *Contractor* consolidates old and new switchgear schedules and identifies the available spare circuits for new SSC electrical loads during Detailed Design phase, in collaboration with Tutuka Electrical Engineering, Tutuka PTM and Tutuka Boiler Engineering.

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3.2.8.2 SSC Control Panels

Before removal of the SSC Control Panels, the *Contractor* documents the entire system to ensure that the installation of the new SSC Control Panels is a seamless process

The *Contractor* produces an electrical Single Line Diagram (SLD) set for each unit, an electrical operating philosophy, a spares list, as well as maintenance and training manuals

At present, the SSC systems at Tutuka are of two distinct types

SSC systems installed on units 1, 2 and 3 are older than the units installed in units 4, 5 and 6 Individual SSC control panels are installed on each unit, with a range of functions

The configuration of the SSC Control Panels for Units 1, 2 and 3 allows for both local and remote operation by plant operators The *Contractor* confirms the current status of the plant and the interfaces relevant to remote operation The *Contractor* standardises the design across all units, in collaboration with Tutuka C&I and Tutuka Station Ops

SSC systems installed on units 4, 5 and 6 are more recent than those installed on units 1, 2 and 3 SSC Control Panels on units 4, 5 and 6 incorporate a direct connection to the Power Station DCS (Distributed Control System)

Interface details on units 4, 5 and 6 are well-documented, with the existing ABB systems falling under C&I The *Contractor* verifies the interfaces between switchgear, field equipment, local control panels and any other systems that loop or interface via the control panels

The *Contractor* removes all existing Control Panels, replacing them with new panels, while maintaining all required signals and interfaces The *Contractor* ensures that local SSC Control Panels are IP65, because of the extreme conditions, both in terms of dust and moisture

3.2.8.3 Loading Considerations

The supply circuit to each SSC Control Panel is rated at 100A Two of the loads supplied from each SSC Control Panel are going to increase

- Electrical motor for hydraulic chain drive. 18.5 kW to 30 kW
- Fan for hydraulic chain drive oil cooler. 0.55 kW to 0.75 kW
- New agitation pump motor. 55 kW

Combined with the other SSC loads, the estimation of total kW comes to 88.75 kW This translates into full load current of 149.82

While the current carrying capacity of each 95mm² cable is over 200A, the current rating for the circuit supplying the SSC Panel is rated at 100A, which is not sufficient to supply the combined load

The Supplier investigates the options of

- 1 Upgrading the bucket to allow for the increase in loading for the existing circuit, after site walk-down
- 2 Assigning a dedicated circuit to the new Agitation System Motor, after confirming the arrangement and accuracy of the latest switchgear load schedules in comparison to the plant, together with Tutuka Electrical Engineering, Tutuka PTM and Tutuka Boiler Engineering

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Table 1: SSC Circuit Loading

	Present Loading	Future Loading
Electrical motor for hydraulic chain drive	18.5 kW	30 kW
Cooler for hydraulic chain drive oil	0.55 kW	0.75 kW
Electrical drive for chain tensioner system	1.5 kW	1.5 kW
Heater for the hydraulic drive oil	N/A	0.75 kW
Power pack auxiliary	N/A	0.75 kW
Agitation system pump	0 kW	55 kW
Total Power Rating	20.55 kW	88.75 kW
Full Load Current	36.73 A	149.82 A

3.2.8.4 SSC Cabling

Much of the existing cabling is not in a good state of repair and needs to be replaced. The *Contractor* assesses all cabling related to the SSC system, and installs new cables and racking in accordance with 240-56227443 *Requirements for Control and Power Cables for Power Stations Standard*.

3.2.8.5 General

Testing and commissioning of the integrated system *shall* be conducted to prove the correct functionality of the plant.

Handover of the plant *shall* include all relevant documentation including but not limited to the following:

- Cable test certificates,
- Cable routing diagrams and cable schedules
- Motor test certificates

3.2.9 Control and Instrumentation System Design

The *Contractor* utilise the information provided by the *Employer* to design the C&I system consisting of the following:

- a) Perform all engineering design and installation according to the scope as contained within the following engineering documents:
 - IO Function Block
 - LOSS Diagrams (LOSS)
 - Vendor Documentation Submission Schedule (VDSS)
- b) All field designs and installations
 - Instrument Schedules
 - Actuator & Drive Schedules.
 - All Field Cabling Schedules

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The *Employer* provides the standards available for the *Contractor* to use in his design as part of his offer for the Works. The *Contractor* ensures that his designs conform to the issued standards and complete the C&I Tender Returnable (see Appendix A)

The *Contractor* is responsible to verify all details provided in the Employer's Works information and incorporate these into the Contractor's design documents to be submitted as specified

The existing ABB ProControl DCS for Units 4- 6 and SAM Siemen SSC panels for Units 1-3 *shall* be used to interface to the new hydraulic power packs. The power pack will be controlled by a proprietary controller. Both the existing cabling and DCS infrastructure in the unit equipment rooms do not have sufficient capacity to effectively interface the power pack controllers to the DCS. To make provision for this and future expansion around the SSCs, new DCS IO clusters will be installed in the precipitator substations with new trunk cabling and junction boxes at the SSCs

- Decommission existing power pack junction boxes, field cabling and IO
- Install new DCS IO cluster in an existing cubicle in precipitator substation, complete with baseplates, termination assemblies, trunk cabling terminals and power distribution
- Install new trunk cabling from precipitator substations to the power packs' locations
- Install new trunk cabling from precipitator substations to the non-drive end of the SSCs.
- Install new junction boxes for new trunk cabling
- Install new switchgear interface cabling for additional 380V AC switchgear control circuits
- DCS configuration
 - Update HMI to include operation and control philosophy of SSC system
 - Configuration of the Plant Historian to include newly installed measurements and control signals according to new philosophy
- Commissioning and Acceptance Testing
 - Aspects relating to commissioning and performance/acceptance testing of the overall unit after the installation

3.2.9.1 General Requirements for the *Works*

- The *Contractor's* design and engineering is done at site, Tutuka Power Station
- The *Contractor* provides all equipment and services and executes all works to fulfil all requirements specified in this Works Information
- The works complies with professional engineering practice and standards for fossil fuel power plants, and is designed for the environmental conditions prevailing at Tutuka Power Station Site
- The *Contractor shall* design, supply, manufacture, install, commission and document all modifications necessary to commission the new SSC C&I control system. The proposal *shall* cover the following activities and services in respect of all equipment and works specified in various sections of this specification
 - The workmanship *shall* be of the highest quality and *shall* conform to all the applicable quality standards of the Original Equipment Manufacturer (OEM) and that of the Contractor.
 - All hardware components *shall* conform to the latest products based upon industry standards
 - Basic engineering of all equipment *shall* be performed by the Contractor

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- Detailed engineering of all the equipment and the equipment systems(s) *shall* be performed by the Contractor
- Providing engineering drawings, data, instruction manuals, as built drawings and other information for the review, approval and for records
- All items and equipment though not specifically mentioned in this specification but needed to complete the system to the intent of the specification *shall* be deemed to be included in the scope of the Contractor
- This technical specification contains as a minimum hardware requirements
 - However, the *Contractor shall* provide hardware configuration equal to or above to meet the technical, functional and performance requirements, and *shall* provide a complete solution.
 - All hardware / software required to meet the functional, performance and availability requirements *shall* be provided by the Contractor
- The *Contractor* provides engineering professionals with background in boiler control systems with authorization to engineer on both Siemens and ABB control systems, in accordance with the functional and control philosophy requirements of the SSC upgrade project
- The *Contractor* is an accredited and approved installer or system integrator of the following systems
 - Units 1-3
 - i Siemens Teleperm C and Iskamatic B Control System
 - ii Siemens HMI
 - iii ABB P14 DCS (Turbine Control)
 - iv SAM PLC
 - o Units 4, 5 & 6
 - v ABB PROCONTROL P14 DCS Distributed Control System
 - vi ABB POS 30 HMI
 - Plant Information System
 - i ABB PGIM
 - ii VA System
- The *Contractor* provides a complete design package for review by the *Employer* as per
 - Appendix A – Vendor Document Submittal Schedule
- The documentation requirements which form part of the *works* are defined in
 - Appendix A – Vendor Document Submittal Schedule
- The equipment requirements are defined in this Works Information and also in the following documents

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- Appendix A– Input / Output (IO) Block Diagrams
- Appendix A – Limits of Service and Supply
- Appendix A – Instrument Schedule
- Appendix A – Drive and Actuator

3.2.9.2 Specific Requirements for the Works

- The *Contractor shall* provide engineering services and labour and execute all work necessary to provide the works. This includes the supply of all equipment and materials necessary for project execution
- The works *shall* be provided as a fully functional system and shall include all the required accessories and devices for installation
- All equipment used for the measurement of process variables *shall* in all cases be “fit for purpose” and *shall* be suitably selected for use under the process and environmental conditions of the plant

3.2.9.3 Project Execution Methodology

The *Contractor shall* undertake all activities as listed below

- Detailed Engineering
- Procurement & Installation
- Cold & Hot Commissioning
- Functional Performance & Acceptance Testing

3.2.9.4 Detailed Engineering

- Detailed engineering is defined as being the activities required to translate the *Contractors* scope of work into a fully functional system Interfaces with external systems (SSC) forms part of the works and is to be conducted in conjunction with the *Employer* The *Contractor shall* coordinate and design the SSC interface to ensure that the overall design is complete and consistent with the current interface
- As a minimum, detailed engineering consists of the following activities
 - Plant Investigation – In plant investigation, the *Contractor shall* perform plant investigations in preparation of the detailed design
 - Scope Definition – The *Contractor shall* define the scope of the detailed engineering and *shall* perform technical clarifications
 - Detailed Design – The *Contractor shall* perform the detailed design, perform technical clarifications and *shall* prepare all documents according to the VDSS
- The *Contractor shall* identify any discrepancies that may lead to shortcomings in the design and *shall* provide recommendation to the *Employer*, and where applicable the *Contractor shall* take action on such discrepancies

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3.2.9.5 Procurement & Installation

- The *Contractor shall* procure and install all required, instrumentation and field equipment necessary to complete the works. This includes the installation, on-site inspection and testing of all equipment forming part of the works
- The erection, installation and optimisation of boiler control systems does not begin until
 - The detailed engineering documentation for the section of plant concerned has been approved and accepted by the Project Manager
 - The *Contractor shall* also submit detailed design freeze documentation (of both applicable hardware and software design changes) for review by the Project Manager
- The *Contractor shall* submit quality inspection and test plans for review and acceptance to the Project Manager, and once the quality and inspection and test plans are accepted, installation (field instrumentation, designs for fine tuning) can proceed
- The *Contractor shall* provide all equipment necessary for installation, testing and inspections.

3.2.9.6 Field Requirements

3.2.9.6.1 General

- The *Contractor* follows the existing standardised field concepts for Tutuka PS
- The *Contractor shall* commission the instrumentation according to the IO and LOSS diagrams as contained within the appendix A
 - Appendix A – Input / Output (IO) Block Diagrams
 - Appendix A – Limits of Service and Supply
 - The *C&I Contractor* will install the cabling, connections and infrastructure to provide the relevant signals in the DCS and HMI for control and indication purposes
- The *Contractor* provides all field devices as per
 - Appendix A – Instrument Schedule.
- The *Contractor* commissions instrumentation for all Units, these instruments will play a role during SSC commissioning, and *shall* also be configured on the DCS control system for all Units for monitoring and archiving purposes
- All field installations *shall* adhere to 240-56355754 – Field Instrument Installation Standard
 - In all cases, the installation of field instrumentation *shall* be sufficient to fulfil the process / unit performance requirements
- The *Contractor* calibrates all new instruments and provides calibration certificates
- *Commissioning is performed by the Contractor* in conjunction with the C&I system engineer and the SSC commissioning engineer
 - All instrumentation, sensors and measurement devices *shall* be commissioned and tested according to their specific functional requirements. This includes all interfaces to

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the SSC, the SSC control panel, and all signal exchanges between the SSC panel and the auxiliaries

- The *Contractor* loop checks all instrumentation in accordance with IEC 62382

3.2.10 Limits of Supply and Services (LOSS)

- The LOSS diagrams demarcate the limits of supply and services for the various stages of the project from basic engineering up to and including commissioning
- Components not shown in the LOSS diagram but that are required for the works are provided as part of the works
- The LOSS diagrams provided by the *Employer* are corrected and updated by the *Contractor* and submitted as part of the detailed design package as per Appendix A
- If there are no changes to the LOSS diagrams the *Contractor* will inform the *Employer* and submit the unchanged LOSS diagrams as per Appendix A

3.2.10.1.1 Input / Output Function Block Diagrams (IO Blocks)

- The Input / Output Function Block Diagram (IO Blocks) indicates the analogue inputs and outputs to and from the C&I system for the applicable device(s)
- Each IO Block also indicates which C&I system inputs / outputs are hardwired signals and which are bus signals
- The IO Block diagrams provided by the *Employer* are corrected and updated by the *Contractor* and submitted as part of the detailed design package as per Appendix A
- If there are no changes to the IO Block diagrams the *Contractor* will inform the *Employer* and submit the unchanged IO Block diagrams as per Appendix A

3.2.10.1.2 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
- Transmitters are suited and adequate to fulfil the following function and accuracy requirements
 - All digital transmitters (excluding temperature) have built in local digital indicators that can be programmed to indicate the range and specified engineering units for the process
 - All transmitters are connected to the process through a ½" BSP connection with a parallel thread
- It is ensured that the installation of the transmitters
 - Allow for safe and easy access for maintenance and calibration
 - Suit the environmental conditions in which it operates
 - Allow for the removal of equipment for maintenance in the vicinity of the transducer

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- All field equipment will be installed with regard for the following
 - Passageways and the movement of people and equipment during maintenance activities,
 - Ergonomics and maintenance access to the equipment,
- All cable cores will be terminated in JBs and DCS marshalling cubicles
- The *Contractor shall* be responsible for all labelling and coding requirements
 - The *Contractor shall* code and label all plant equipment, instrumentation and devices forming part of the Contractors scope of work
 - The *Contractor shall* apply the Coding and Labelling standards, applicable to Tutuka Power Station
 - Existing plant coding and labelling *shall* be used as far as is practically possible

3.2.10.1.3 TRANSMITTER RACKS

- All transmitters excluding temperature transmitters are mounted on suitable transmitter racks
- All transmitter racks provided are made of hot dip galvanized steel, durable, sturdy and suitable for the environment in which they are installed
- If angle iron is used for transmitter racks, a minimum wall thickness of 3mm is provided
- Where transmitters cannot be mounted on a transmitter racks the *Contractor* obtains clearance with the *Employer* for alternative installation
- The transmitter racks are supplied complete with all necessary holding down bolts and equipment to make a complete assembly

3.2.10.2 SWITCHES

- 3-wire change-over-contact type switches are provided to facilitate contact monitoring
- Contacts making action are instantaneous by a snap action
- There is no interconnecting of contacts
- All contacts are capable of handling at least 250 mA at 36 V continuously
- All contacts are protected against adverse environmental effects e.g dust, moisture, corrosive gasses, high temperature etc

3.2.10.3 JUNCTION BOXES

- As the detailed design dictates, the *Contractor shall* be responsible for the installation of field junction boxes
 - It is required that as far as is practically possible, the *Contractor shall* utilise existing field function boxes, however, if the detailed design require new junction boxes, the *Contractor shall* erect, install and commission all new junction boxes
- Junction boxes are installed, earthed and commissioned in accordance with 240-56355815 Control and Instrumentation Field Enclosures and Cable Termination Standard
- Expandability is provided at detail design freeze as per the following
 - All cable cores will be terminated in junction boxes, marshalling panels and DCS cubicles

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- 10% spare installed terminals in all junction boxes for field cables
- 5% unused and terminated cores in all trunk cabling
- 10% reserve physical space (rounded up) on all trunk cabling infrastructure
- All field equipment will be installed with regard for the following
 - Passageways and the movement of people and equipment during maintenance activities,
 - Ergonomics and maintenance access to the equipment,
- All cable cores will be terminated in JB's and DCS marshalling cubicles
- The *Contractor shall* be responsible for all labelling and coding requirements
 - The *Contractor shall* code and label all plant equipment, instrumentation and devices forming part of the Contractors scope of work
 - The *Contractor shall* apply the Coding and Labelling standards, applicable to Tutuka Power Station
 - Existing plant coding and labelling *shall* be used as far as is practically possible

3.2.10.4 ACTUATORS & VALVES

3.2.10.4.1 General requirements

- The correct sizing, adaptability and suitability of all actuators are provided as part of the works
- All actuators supplied for the works are "Intelligent" with on-board self-diagnostic facilities
- All existing actuators in the scope of supply are replaced and provided as part of the works
- Where gearboxes are used on the existing actuators, the new actuators are provided with gearboxes
- All actuators provided meet the requirements of the valves and dampers that they operate
- Actuators are rated for the following duty classifications as per specification IEC 60034-1 (11th Edition 2004/04)
 - Short - time duty (S2-15min)
 - Intermittent duty (S4-25% ED), up to 1200 starts per hour, no of starts depending on actuator size and output speed
- Position transmitters of the two-wire type for the actuators are provided
- All necessary, flanges and gearboxes from the actuator to the damper shaft or valve spindle are provided
- Dimensions of the shafts and technical details such as turning direction, multi-turn, quarter turn, standard linear turn (not modified multi-turn) are determined during the basic engineering phase
- Direct mounted flanged type actuators are used for binary dampers with a keyed adaptive coupling (damper shaft/actuator shaft).
- The actuator is secured on a mounting which is included as part of the works
- The weight of the actuator does not compromise the valve & pipe structure on which it is mounted.

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- The design and sizing of actuators takes into account the duty cycle for the plant operation
- Actuators are designed and selected such that no overheating occurs under worst-case conditions
- The environmental conditions are taken into account Where harsh environmental conditions exist, only actuators designed to operate in such environments must be used
- In particular, the de-rating for the altitude at Tutuka Power Station is taken into account in the design
- All special tools (other than the normal hand tools) are provided by the *Contractor* at Completion
- All solenoid valves provided for the works are rated at 24 volts

3.2.10.4.2 Electric Actuators

- All actuators are 3 phase electric actuators and are to incorporate
 - motor,
 - integral reversing starter,
 - Local control facilities with terminals for remote control and indication housed within a self-contained, sealed enclosure
- All actuator motors run with the correct rotation for the required direction irrespective of the connection sequence of the power supply
- In order to ensure the integrity of the enclosure, setting of limits and configuration of the indication contacts is carried out without removal of any covers
- The actuator incorporates local controls for open, close, and stop and a local/stop/remote mode selector
- This mode selector is lockable in any of the following positions
 - local control
 - stop (no electrical operation)
 - remote
- All electrically driven modulating actuators provided have integrated switchgear and thermal overload protection
- Solid state based integrated switchgear is provided for all electric power actuators
- For analogue controlled electric actuators, an analogue 4-20mA command signal is employed for positioning the valve/damper
- Modulating actuators have on-board positioners operating of a 4 to 20mA signal
- Control actuators that operate on a high duty cycle must be rated for high duty operation
- Standardisation is achieved by selecting the minimum number of actuators that can cover all the load requirements for the entire plant
- The internal limit switches on the actuators must be micro switches, with loop integrity checking capabilities

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3.2.10.4.3 Actuator splitter boxes

- Splitter boxes are provided for the termination of the actuator power and control cables. The power and C&I splitter boxes should be separated.
- 'Parking facilities' are provided at the splitter box for parking of the cable plug when the actuator is removed.

3.2.10.4.4 Actuator Plugs

- Plugs for power and control interface connections are provided to the actuator for ease of maintenance.
- The male connectors are installed on the actuators and the female connectors on the cables.
- The positioning is such that the movable section of the plug is easily removed and re-installed into its connected position.
- The power and control cables from the actuator to the splitter box are of a flexible type.

3.2.10.5 LOCAL CONTROL STATIONS (LCS)

- LCS(s) *shall* have dual enclosures with both enclosures provided with a door.
- All buttons and indications form part of the interior door.
- Push buttons *shall* be provided for local start and stop, lamp test button.
- The exterior enclosure/door *shall* be IP 68 rated.
- Safety Integrity Level (SIL) rated panels are Ex rated and are certified through the Approved Inspection Authority.
- Locking mechanism *shall* be industrial cubicle handle with padlock.
- All junction boxes and/ local control stations (LCS) *shall* be designed according to the 240-56355815 Field Instrument Installation Standard - Junction Boxes and Cable Termination.

3.2.10.6 Earthing

Earthing concepts *shall* follow the OEM best practices and 240-56356396 Earthing and Lightning Protection Standard to ensure safe and reliable operation.

3.2.10.7 Labelling and Coding

Tutuka AKZ Coding Manual 15ENG MN-675 is used for coding of all Plant and Materials. AKZ coding is applied from the design stage and cross referenced accordingly (as a unique identification) to all documentation.

3.2.10.8 Standardization

Standardisation of all field equipment is required (instrumentation provided should be from the same OEM), this should be carried out throughout all Units.

3.2.10.9 Control System Requirements

3.2.10.9.1 General

Here, the control system requirements refer to all SSC system and subsystem control, protective and interlocking functions associated with the control, protection and operation of the SSC system.

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and subsystems. This includes but is not limited to, the SSC interface (instrumentation and actuation), the power pack panel, the boiler control system.

It is the objective of this project to utilise existing control system infrastructure as far as possible, with minimum hardware and software changes to the control system. It is the expectation that the majority of the control implementation for this modification requires minor adjustment to control system parameters, performance curves and tuneable parameters to match the performance of the newly installed SSC speed control.

- The *Contractor shall* configure, design, engineer and commission the C&I control system using the best practices and industry best practices
- New DCS modules as required for the project and associated wiring within the control system cabinets in the equipment room is provided by the Contractor
 - All signals from field plant installed as part of the works are interfaced to the Unit DCS/PLC for Units 1 – 6
 - The *Contractor* provides new IO modules as required to cater for all new signals from the field
 - The *Contractor* provides updated loop drawings for all changes made to the DCS/PLC for Units 1 – 6
- All cable cores will be terminated onto marshalling panels and control system cubicles
- The *Contractor* supplies, installs and configures Analogue / Digital Input modules and any equipment required to support the installation of system to meet the functional requirements of the this specification
- The *Contractor* installs all new internal wiring and accessories required to support the new IO cards
- The *Contractor* terminates incoming trunk cabling onto the marshalling panels and wiring between marshalling panel and DCS cubicle

3.2.10.9.2 The Plant Operator HMI System

- The *Contractor shall* develop and install new HMI mimics or updates the current HMI mimics to display the analogue measurements installed as part of this Works
- HMI mimics *shall* conform to the functional and control philosophy requirements of the SSC modification
- All HMI mimics will follow the design and ergonomic principles currently followed at Tutuka PS and will require input from the plant operators prior to implementation
- Also see 240-56355782 Human Machine interface Design requirements Standard for more information on HMI design requirements
- All changes incurred by the works that have an influence on the Unit must be incorporated into new or updated HMI's.
- In the case where the existing HMI mimics are not sufficient, the *Contractor* will develop new HMI mimics to fulfil the HMI requirements of the works
- The *Contractor* is responsible for archiving signals for use in the Plant Historian. The *Contractor* must consult with the *Employer* regarding which signals are to be archived

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3.2.10.9.3 Control System Optimization Requirements

Although there are not many control system changes and modifications, apart from calibration of the SSC speed control of the SSC speed which is a function of the SSC system pressure. The calibration addresses signal exchange from the DCS up to the local control modules installed at the plant, in order to ensure reliable and safe operation.

3.2.10.9.4 Functional Requirements In Terms of Philosophy

The overall Functional Representation of Scope and Design Requirements for the affected subsystems are depicted in Figure 7 below.

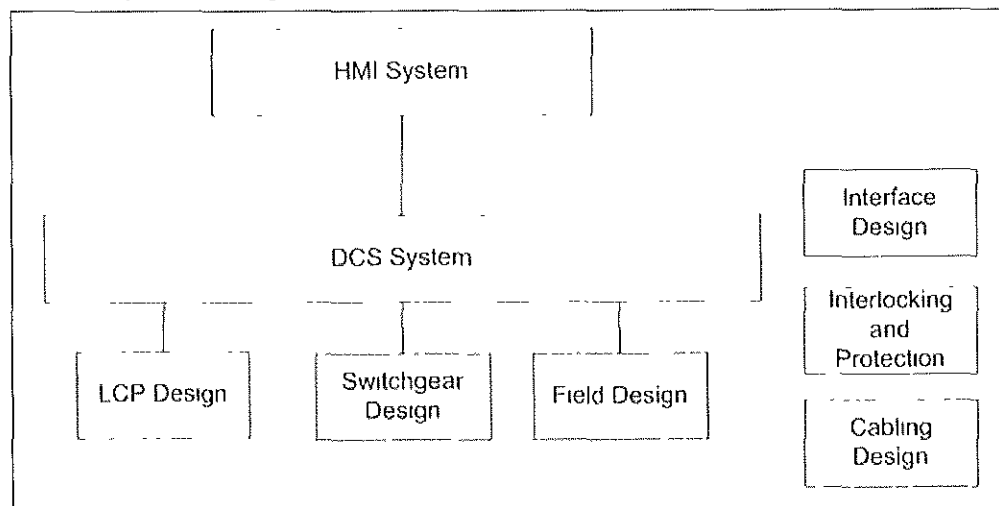


Figure 7: The control system consists of the following functions and scope

The control system consists of the following functions and scope

- Human Machine Interface (HMI) Design
- Distributed Control Systems (DCS) and Analogue controller
- Local Control Station (LCS) Design.
- Switchgear Interface
- Field Design
- Interfaces and Interlocking.
- Cabling Design

3.2.10.9.5 System Description

SSC drive system

The purpose of the SSC is to remove boiler bottom ash. The principle of operation for the SSC drive system is via local control panel, which interfaces to the control system. The control system then controls the motors via the electrical switchgear. The drives that form part of the SSC are as follows:

- SSC,
- Downstream interlocks
 - Short Coarse Ash Conveyor, and
 - Long Coarse Ash Conveyor

Grizzly Conveyor

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The Grizzly Conveyor retains its existing functionality through an electrical control panel, with local operations only

Tensioner system

The tensioner system is used to keep the chain in tension during all operating modes of the SSC

Agitation system

The main purpose of the agitation system is to reduce the drive torque required by the drive when the SSC has to restart during backlog operations

De-gritting Sump

Water collected in the de-gritting sump is pumped back into the SSC in order to ensure zero effluent discharge from the SSC and its floor area

Recovery Sump Pump

The recovery sump recovers water and ash mixture and supplies it back to the submerged scraper conveyor (SSC) ash box, it also serves as a back-up system for the de-gritting sump

Cooling Water Pump

Cooling water is used as backup water supply to the SSC, thereby ensuring that an air seal between the SSC and the boiler is maintained

3.2.10.9.6 New Operating Controls

Relevant to SSC drives, SSC tensioner system and Agitation system
Refer to section 3.1.3

3.2.10.9.7 Operating and Control Philosophy

Relevant to SSC drives, SSC tensioner system and Agitation system.
Refer to section 2.6

SSC drives

SSCs will be operated from the unit control room. The operator has the capability to start and stop the SSC in the control room. SSCs are automatically controlled by the control system. Interlocks ensure that the SSC is not to operate when the Short Coarse Ash is not in operation. The other interlock is regarding the positioning of the tensioner system. Control is also achieved locally through a local control panel (power pack) that is interfaced to a LCS.

In achieving the desired functionality the following is required

- The hydraulic power pack is installed with an on board control system. This independent control and monitoring system incorporated into the power unit assembly is responsible for the controls associated with the SSC drives. The power pack provides a status signal to allow remote operation at the control room. The interface with the unit control room and the independent control system via instrument cabling to a module located in the Precipitator Substation local to the affected unit. From the Precipitator Substation there is an interface to the equipment room.
- Speed switches installed at the tail end and head end of the SSC conveyor in order to indicate that the chain is not broken.

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- The speed switch on the Short Coarse Ash Conveyor will provide an interlock that the SSC will not run if the downstream Short Coarse Ash Conveyor is not running
- Limit switches installed on the tensioner system will also provide an interlock to allow operation of the SSC

Tensioner system

The over tension protection consists of two limit switches that should be wired fail-safe. New Limit switches *shall* be installed on the tensioner for interlocking and protections purposes which *shall* communicate position to the independent control and monitoring system (relevant to tensioner system)

Proximity switch *shall* operate when the piston object is brought into close proximity to the switch sensing area. The installed limit switches installed on the tensioning system *shall* communicate to the DCS/Analogue controller through the LCS.

In achieving the desired functionality the following is required

- Installation of limit switches

Agitation system

The Agitation system is a new system

The main purpose of the agitation system is to reduce the drive torque required by the drive when the SSC has to restart during backlog operations. The water agitation system includes a centrifugal type slurry pump located at the tail end of the SSC. The pump base assembly is mounted on the SSC structure to allow for easy movement of the SSC during outages.

The Agitator pump control needs to energise a relay in the pump's local control panel to start the pump and receive feedback from the contactor. The Agitation system will not operate if level within the bath is not met, which is primarily achieved through the interfacing with water makeup system.

In achieving the desired functionality the following is required:

- Installation of Pressure, Level and Flow transmitters
 - 3 Analogue Inputs (4 – 20mA) for measurement of Pressure, Level and Flow
 - 1 Analogue input (4 – 20mA) for current indication on the pump
 - 1 Analogue Outputs (4 – 20mA) for current feedback on the pump
 - 28 Binary Inputs (24V DC) for valve monitoring
 - 11 Binary Output (24V DC) for valve control

These analogue and digital inputs and outputs are defined in section 2.5.3

SSC water supply

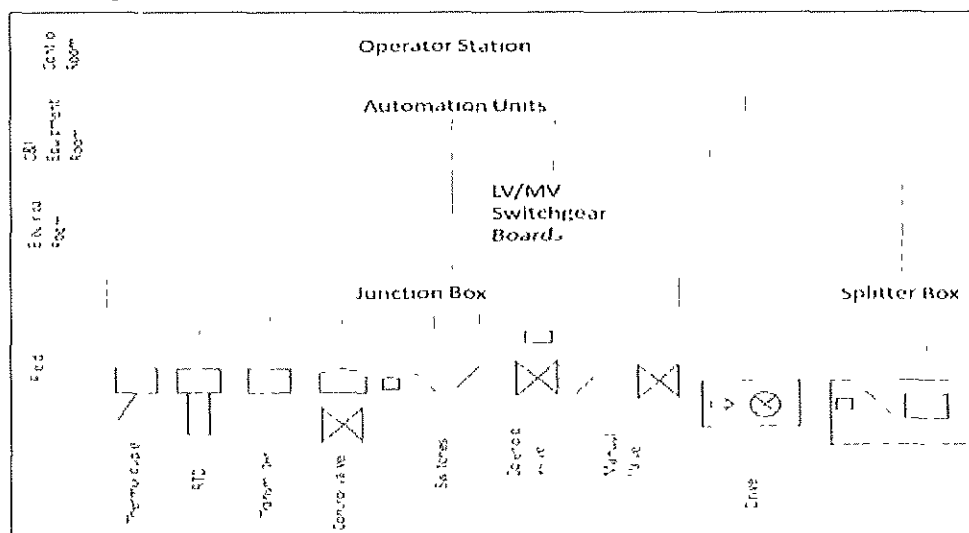
The water box level, de-gritting sump and recovery sump control consist of ultrasonic level transmitters and three solenoid operated valves. Upon defined scenarios as defined in Section

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3.2.10.9.8 Human Machine Interface

- A fully functional existing HMI is provided. Update to reflect the modifications. The functionality provided by the HMI includes – but is not limited to – the following:
 - Operating functionality,
 - Indication,
 - Alarming,
 - Event viewing (including operator and configuration action events linked to user),
 - Viewing of the reports, and
 - Access to historical data.
- Uniformed signal descriptions and standard abbreviations to be used throughout the HMI
- Any incorrect operation to be indicated to the operator by audible signal or suitable text message

The C&I design architecture for the main hydraulic drive system based on the selected option is depicted in the Figure 8 below



3.2.10.9.10 Plant Information System

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3.2.10.9.11 Instrumentation, Drive and Actuation Equipment

The proposed hydraulic based technology for the SSC drive is typically composed of instrumentation, drive and actuation equipment. The instrumentation equipment typically includes level, pressure, temperature and positioners. The drive and actuation equipment include pumps, heaters and oil coolers.

Temperature measurements

Temperature measurements must be provided as part of the design for measuring of the oil tank temperature. The measurements will be mounted directly onto the oil tanks. Given that temperature measurement is for control and interlock protection purposes, the design provides for 2 temperature measurements for availability purposes.

Level measurements

Level measurements must be provided as part of the design for measuring of the oil tank level. The measurements will be mounted directly onto the oil tanks and will be capacitance based inline level measurement. Given that level measurement is for control and interlock protection purposes, the design provides for 3 level measurements for availability purposes. Level measurements are required for the SSC bath, De-gritting sump and Recovery sump for the water make up system in the bath.

Positioners

The hydraulic actuation cylinders will be equipped with electrically actuated analogue positioners for conveyer speed and water make up system control purposes.

Pressure Measurements

The pressure measurements will be utilized to monitor and perform control interlock of pressurized oil to the hydraulic pump.

Differential pressure

The hydraulic oil filters will be equipped with differential pressure measurement for the purposes of announcing and alarming of a blocked filter.

Electric Pumps

The design will be equipped with electric pumps for the purpose of supplying the required oil pressure to the hydraulic cylinder drive. For availability purposes, the design will be equipped with two electric pumps. The IO interface to the DCS will be based on the switchgear interface but must as a minimum provide for start/stop commands and signal related to switchgear fault.

Electric Heater

The design will be equipped with electric heater for the purpose of avoiding the development of any condensate inside the oil tank. The IO interface to the DCS will be based on the switchgear interface but must as a minimum provide for start/stop commands and signal related to switchgear fault.

Oil Coolers

The design will be equipped with electric oil coolers for the purpose of ensuring optimal operating temperatures inside the oil tank. The IO interface to the DCS will be based on the switchgear interface but must as a minimum provide for start/stop commands and signal related to switchgear fault.

LCS

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The design will provide for LCS for localized operation of the SSC particularly for maintenance and commissioning purposes. The LCS will be equipped with emergency stop button to be wired directly to switchgear.

3.2.10.10 Local Control Panel

The current ABB DCS (units 4-6) and Siemens SAM panel (units 1-3) will interface to the LCS for purposes of monitoring and control with feedback signals from switchgear.

3.2.10.10.1 Local Control Station Design

The provision to control and operate the motor at the field will be made possible by the Local Control Panel. The LCS will be capable of interfacing with the relevant UCR for operating, control, monitoring and alarms. The control panel will have the following functionality:

- Fault and Lamp Test/ Reset Push Button (PB)
- Forward PB (tensioner system)
- Reverse PB (tensioner system)
- Start PB (SSC)
- Stop PB (SSC)
- Start (Agitation)
- Stop PB (Agitation)
- Emergency PB
- Remote/local/off Section toggle
- Fault Lamp bulb
- Lower limit bulb (tensioner system)
- Upper limit bulb (tensioner system)

All drive controls are configured to show the operator the status of all interlocks and permissive on the hard wired local control stations (LCS). The LCS is local control panel which is used for local control applications, using discrete selections switches, pushbuttons and indication.

Start and stop functions are to be provided on the panel for the operator. The emergency switch to be interfaced to the DCS equipment. The scope of supply for the LCS is identified and indicated in the LOSS diagram (see Appendix A) with reference to the drive schedule Drive and Actuator List (see Appendix A) and Instrument schedule (see Appendix A).

SSC drives

The SSC drives (all conveyors) will be operated from the local control panel that forms part of the hydraulic power pack. The drives *shall* be operated remotely as well as at the respective control room units. This *shall* be achieved through LCS that will provide an interface between the power pack and the relevant control system to allow for remote operating. The LCS *shall* be in the vicinity of the hydraulic power pack and will be a hardwired interface. The LCS will provide functionality for local operation of the SSC drives and an interface to the switchgear.

Start and stop functions *shall* be provided on the panel for the operator. Local emergency switch to switch off the conveyor is provided.

Tensioner system

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The above information with regards to the LCP for SSC drives (hydraulic power pack) design is relevant to the tensioner system as well

Agitation system

With regards to the agitation system, the provision to operate and control the motor at the field will be made possible by the LCS. The LCS *shall* have an interface to the DCS. The control panel *shall* have functionality as provided in section 2.5.3.

All drive controls are configured to show the operator the status of all interlocks and permissive on the hard wired local control stations (LCS). These LCSs are local control panels which are used for local control applications, using discreet selections switches, pushbuttons and indication.

The design *shall* take into account the environmental conditions where it is installed. The details of these requirements are detailed in 240-56355731 Environmental Conditions for Process Control Equipment Used at Power Stations Standard.

3.2.10.11 Switchgear

Relevant to SSC drives, SSC tensioner, Agitation and De-gritting sump system.

The interface to the switchgear is hardwired. This interface will provide for interface cables to the Interposing Relays and Emergency Trip relays to allow for emergency trips and desired interlocks. Installations, terminations and commissioning are required for the above mentioned interfaces cables.

3.2.10.11.1 Interlocking and Protections

The control system provides interlocks and ensures the capability of all plant to be properly matched thus preventing the plant from reaching potentially hazardous conditions.

The control system is a hardwired interface to the switchgear. The protection of the affected systems motors is achieved through tripping the motors via the switchgear.

Any fault condition detected by protection devices, which may place persons or equipment at risk, immediately trips the conveyor drive. Refer to section 2.5 and 2.6 for the requirements for interlocks and protections.

3.2.10.12 Decommissioning scope

As already mentioned the SSC system and subsystems include a number of functionalities. These functionalities will have to be decommissioned as part of the SSC hydraulic drive replacement project. The related decommissioning scope and functions are summarised in table below.

Table 2: Functionalities to be decommissioned

Function	Description
Push Buttons	Refers to the push buttons located in front of the LCP panel for starting/stopping and increasing/decreasing of the SSC main motor and variable oil flow speed control respectively. The decommissioning includes removal of internal wiring to the channels of the relevant IO modules. The push buttons can either be blanked off with appropriate tape or completely removed with the remaining hole blanked off with appropriately sized plug.
Lamp Test	Refers to the illuminating light indicator located in front of the panel. The decommissioning includes removal of internal wiring to the channels of the relevant IO modules. The push buttons can either be blanked off with appropriate tape or completely removed with the remaining hole blanked off with appropriately sized plug.

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Selector switch	Refers to the remote/local selector switch for operating the SSC main motor drive in operator control room or locally from the LCP located in the field. The decommissioning includes removal of internal wiring to the channels of the relevant IO modules. The push buttons can either be blanked off with appropriate tape or completely removed with the remaining hole blanked off with appropriately sized plug.
SSC Main Motor Interface	Refers to the SSC main motor drive interface. The decommissioning scope only includes interfacing instrument cabling to the switchgear.
Application Logics	Refers to the software control application logics implemented in the Teleperm C/IB and P14 ProControl control systems.
HMI	Refers to the HMI animation application logics.
DCS Cubicle Wiring	Refers to the trunk cabling between LCP panel and DCS cubicle as well as cubicle criss-cross marshalling. The decommissioning scope will be the removal of trunk cable termination as well as the criss-cross cubicle termination of the related trunk cable inside the DCS cubicle. The removal of the trunk cable itself is not required and can be neatly rolled-up and left inside the cable tunnel.
Push Buttons in control room	Refers to the conveyor speed actuation push button located in the control room. The decommissioning scope includes removal of cable between LCP and DCS. The push button will be retained and used as operator interface to the hydraulic drive system for actuating the conveyor speed.
SSC speed control signal	Refers to the SSC speed indicator showing the speed of the SSC. The decommissioning scope includes removal of cable between LCP panel and DCS. The position indicator will be retained and used as operator interface to conveyor speed.

The *Contractor* is responsible for the decommissioning and removal of the existing equipment and panel as specified in the Works Information and relocation of the equipment to an identified area. All equipment and material that is removed is deemed re-usable, and remains the property of the Employer.

The *Contractor* repairs civil and mechanical alterations to the rooms and plant affected by the installation of new equipment and the removal of existing equipment and obtains acceptance for these areas from the Project Manager.

3.2.10.13 Test Inspection and Testing

3.2.10.13.1 Pre – FAT

During Pre – FAT the *Contractor* conducts a pre– factory acceptance test at the Contractors factory as preparation for the factory acceptance test with the Project Managers representatives. During this test, the Contractors engineers test and verify all software and hardware designs of the design specification and fully test the integration of the software and hardware of the works. All pre – FAT tests are documented as part of the quality assurance and control procedures by the Contractors engineers and are available to the Project Manager prior to the commencement of the FAT.

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3.2.10.13.2 FAT

Factory acceptance tests are performed to test the functionality of equipment and to test whether the equipment meets design specifications. These tests are performed by *Contractor* commissioned to do the work and are witnessed by the *Employer*. This will take place prior to the delivery of equipment for the first installation.

Each item that forms part of the acceptance test should be detailed and signed off indicating acceptance by both the *Contractor* and *Employer* representatives. Any exceptions or deviations are noted.

The *Project Manager* has the authority to select a representative or group of representatives to inspect all parts during the manufacturing of equipment and to be present at any of the tests being performed.

The *Contractor* performs all testing of the interfaces within this contract and the interfaces with other systems forming part of the works. The *Contractor* performs the FAT at *Contractor's* local establishment. The *Project Engineer* and any parties appointed by him will assess the quality of the methods used for testing of the works.

As a minimum, the FAT's are used to certify the following:

- Panel design
- Correct operation of the logics

3.2.10.13.3 SAT

The *Contractor* performs a system integration test to confirm and demonstrate to the *Employer* that the new panel is correctly installed and that it is fully operational.

The *Contractor* performs the test with all hardware installed and connected. When the test is completed and certified successful, the system is classified "ready for use". The control system is then deemed available for cold commissioning (functional testing).

3.2.10.13.4 Test equipment

All test and calibration equipment necessary is provided and maintained to the required accuracy by the *Contractor*.

The accuracy of test equipment for checking and calibration of instrumentation is required to be better than $\pm 0, 1 \%$. The type and class of equipment used is subject to the acceptance of the *Project Manager* and the *System Engineer*.

All the *Contractor's* calibration equipment is accompanied by valid calibration certificates from an approved authority. The *Project Manager* may at any stage during the contract require such equipment to be checked by an approved laboratory or the South African Bureau of Standards.

3.2.10.14 Commissioning

3.2.10.14.1 Cold Commissioning

The *Contractor* cold commissions the new panel by performing a functional system test. This test includes the checking of all interlocks and protections, sequence controls and analogue controls. These tests must prove plant reliability and suitability for safe operation to the *Employer*.

The *Contractor* further performs the following checks as part of the cold commissioning.

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Loop checks

- The *Contractor* checks each loop to ensure that each input and output circuit functions correctly. This includes all existing equipment as well as new equipment supplied by the *Contractor*.

The *Contractor* checks that each measuring loop falls within the loop accuracy of $\pm 0, 1\%$

Integrity checks

- The integrity checks are function checked by simulation at the field equipment device. The *Contractor* provides a printed log to confirm signals and integrity.

3.2.10.14.2 Hot Commissioning

The operation and control of the plant is provided by Tutuka Operators. The *Contractor* provides the training required to ensure operating, maintenance and engineering are competent in interfacing to the plant through the new system and knowledgeable of new operational philosophies before the hot commissioning commence. A total number of 20 stakeholders are to be trained.

3.2.10.14.3 Commissioning co-ordination

The commissioning of the plant is thus coordinated by the Employer's Outage Department and final arrangements and requirements of the *Contractor* are made with the Project Manager in advance of the start of the plant-commissioning period as specified in the overall program.

3.2.10.14.4 Commissioning Procedures and Test Certificates

The *Contractor* prepares commissioning procedures and test certificates for the commissioning of the new equipment and interfaces. The format of this procedure and certificate is for the *Project Manager's* acceptance.

3.2.10.15 Redundancy and Availability

3.2.10.15.1 Design Philosophy

The reliability, availability and maintainability of the system are of critical importance in the design of the system. The *Contractor's* design takes into account.

- Criticality of the application
- Impact of failure
- Minimisation of duration of failure
- Detection and recovery of failure
- The correct action when failure is detected
- The physical plant redundancy and configuration
- On load maintenance

3.2.10.15.2 Maintainability

Maintainability of the *works* is enhanced by consideration of.

- Standardized system configuration and equipment
- Modular system construction
- Integrated fault diagnostics and maintenance tools

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- On-line repair and hot swapping of modules
- Redundancy where appropriate
- Reduced range of types of electronic modules and equipment

3.2.10.15.3 Reliability

The *Contractor* ensures high reliability of the works by achieving the following

- No single fault or no two simultaneous faults are to endanger the safety of the plant or jeopardize the integrity of the plant
- No single fault can endanger the operation or the safety of the plant The reliability is achieved by the two versus three redundant configurations for protection systems
- Configuration simplicity
- Field proven and off the shelf equipment, technology and configuration
- Quality assurance procedures
- Design reviews and factory inspections.
- In-depth factory tests
- Supervision of commissioning
- Operation of equipment in a controlled operating environment

3.3 TECHNICAL RISK ASSESSMENTS

3.3.1 HAZOP Studies

- a The *Contractor* carries out formal HAZOP Studies on all systems in their supply These studies are done in accordance with the requirements as laid down in the Eskom HAZOP Guideline 240-49230111.
- b All recommendations are included in the *Contractors* designs. This is submitted to the *Project Manager* for acceptance

3.3.1.1 FMEA (FAILURE MODE AND EFFECT ANALYSIS)

- b The *Contractor* carries out formal Failure Mode and Effect Analysis (FMEA) Studies on all systems in their supply These studies are done in accordance with the requirements as laid down in the Eskom FMEA Guideline 240-49230046

3.3.2 Fire Protection Requirements

The *Contractor* complies with the requirements of Form 74 – SHEQ Specification pertaining to fire protection The *Contractor* ensures that adequate firefighting apparatus is provided at all his/her work sites, and that their staff is trained in the use of this apparatus

3.3.3 Safety Signs

The *Contractor* supplies all Symbolic Safety Signs for the respective areas under this contract as per SANS 1186

3.4 OTHER REQUIREMENTS OF THE *CONTRACTOR'S* DESIGN

The *Contractor* submits designs to the *Employer* for review and approval The *Contractor* may only purchase or fabricate components after designs have been approved by the *Employer* Drawings produced by the *Contractor* and accepted by the *Employer* will belong to the *Employer*

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4. DOCUMENTATION AND CONFIGURATION MANAGEMENT

4.1 DOCUMENTATION

All documents supplied by the *Contractor* shall be subject to Eskom's approval. The language of all documentation shall be in English. The *Contractor* shall include the *Employer's* drawing number in the drawing title block. This requirement only applies to design drawings developed by the *Contractor* and his Subcontractors. Drawing numbers will be assigned by the *Employer* as drawings are developed.

4.1.1 Document Identification

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

4.1.2 Document Submission

All project documents must be submitted to the delegated *Employer Representative* with transmittal note according to Project / Plant Specific Technical Documents and Records Management Work Instruction (240-76992014). In order to portray a consistent image it is important that all documents used within the project follow the same standards of layout, style and formatting as described in the Work Instruction. The *Contractor* is required to submit documents as electronic and hard copies and both copies must be delivered to the *Employers Representative* with a transmittal note.

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

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

Email subject

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

- Electronic copies shall be submitted to Eskom Documentation Centre through generic email address (drmsharingservices@eskom.co.za). The email subject shall as a minimum have the following (Project Name_Discipline_Subject). Electronic copies that are too large for email will be delivered on CD/DVD, large file transfer protocol and/or hard drives to the Project Documentation Centre. A notification email, with the transmittal note attached, shall be sent to the project generic email address. The Representative will be copied on the email as well.
- Hard copies shall be submitted to the Eskom Representative accompanied by the Transmittal note.

4.1.3 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*

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shall ensure that the *Contractor* is provided with the 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).

4.1.4 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 the *Employer* 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 the *Employer* may not be "Right Protected" or encrypted.

4.2 PLANT CODING AND LABELLING

4.2.1 Plant Coding

The Employers AKZ Coding Manual (15ENG MN-676) *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:

Mechanical

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

Civil and structural

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

Electrical

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

Control and Instrumentation

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

Employer will only code the AKZ code defining Documentation listed above. The *Employer* will assign a coding technician who will interact with the Service Provider 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 *Contractor* to consistently apply the AKZ codes throughout the rest of the technical documentation which *shall* include, but not limited to:

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- 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 the *Employer* for review

4.2.2 Plant Labelling

It is the responsibility of *Contractor* to manufacture and install AKZ coded equipment's labels. Labels are manufactured and installed according to Tutuka P S AKZ Plant Labelling Guideline (240-62937990). The *Employer* will label all AKZ coded equipment. 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 (GGS0443) and Abbreviation Standard for Chemistry Related Items for Power Stations (GSER/94/Y0005) *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 Contractor

This project will be conducted within Tutuka P S and will follow all security requirements of the station

4.3 TEST AND COMMISSIONING STRATEGY

The *Contractor shall* prepare and submit a commissioning strategy before the installation phase commences, for approval, to the *Employer*. This strategy *shall* include all commissioning and testing procedures for all the commissioning and testing activities to be performed, detailing the methods, functionality checks, and acceptance criteria that are applicable. Commissioning of the new plant *shall* commence after the plant has been safety cleared

4.3.1 Factory Acceptance Tests (FAT)

All manufactured items *shall* be inspected and accepted at the factory where they are manufactured, the *Contractor* will be responsible for conducting the FATs but the Employer's personnel can also be present during the FATs. The results of the FATs *shall* be presented to Employer by the Contractor

4.3.2 Operation Acceptance Test (OAT)

Commissioning *shall* be concluded with the Operational Acceptance Test (OAT), as a minimum. The *Contractor* submits OAT procedure for acceptance by the *Employer* two months before commissioning can commence

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4.3.3 Instrument Checks

Initial visual and proof checks *shall* be carried out by the Contractor on Site with the Employer present to ensure that instruments are functioning correctly and that they have not sustained damage or deterioration during transit and unpacking. Calibration checks *shall* also be conducted as a minimum by the *Contractor*.

4.3.4 Reliability Test

A 60 days reliability run will be conducted where the *Contractor* proves that the SSC can operate continuously trouble free.

4.4 LIST OF REFERENCES PROCEDURES, STANDARDS AND SPECIFICATIONS

The *Contractor* complies with all standards, specifications and regulations as highlighted within this Works Information.

Table 3 Civil and structural engineering codes and standards

240-56364545	Structural Design and engineering standard
SANS 10160	The general procedures and loadings to be adopted in the design of buildings
SANS 10162-1	The Structural use of Steel Part 1 Limit States design of hot-rolled Steelwork
SANS 10162-2	The Structural use of Steel Part 2 Limit States design of cold-formed steelwork
(OHASA) 85	Occupational Health and Safety act

Table 4 Electrical Engineering Codes and Standards

240-56227443	Requirements for control and power cables for power stations
240-56357346	List of Approved Relays for use on Power Station
240-56357424	Protection Standard
240-56356401	Eskom Generator Protection Philosophy for Large Fossil Fuel Power Stations with Generator circuit breaker
240-56227426	Generation MV and LV protection philosophy for Eskom Power Stations
240-56356396	Earthing and Lightning Protection
240-56227516	Specification for switchboards and associated equipment for AC 1000V and DC 1200V
240-56227573	AC Metal-Enclosed (Metal-Clad) Switchgear and Control Gear for Voltages above 1KV upto and Including 52KV
240-56227573	Metal enclosed switchgear and control gear for voltages above 1 kV up to and including 52 kV

Table 5 C&I Engineering Codes and Standards

240-56355466	Alarm Management System Guideline
240-56355754	Field Instrument Installation Standard

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240-56355815	Junction Boxes and Cable Termination Standard
240-56355843	Pressure Measurement Systems Installation Standard
240-56355888	Temperature Measurement Systems Installation Standard
240-56355729	Plant Control Modes Guideline
240-55714363	Coal Fired Power Stations Lighting and Small Power Installation Standard
240-56356411	Fire Barrier Seals for Electrical Cable Installations at Power Plants Standard
240-56227443	Requirements for control and power cables for power stations
240-56355731	Environmental Conditions for Process Control Equipment Used at Power Stations Standard

Table 6 Mechanical Engineering Codes and Standards

240-83459207	Safe Operation and Maintenance of Submerged Scraper Conveyors Standard
240-87660096	Non-Destructive Testing Inspection Qualification Standard
240-83539806	Manual Ultrasonic Wall Thickness Testing on Eskom Power Plants Standard
240-105453648	Fossil Fuel Firing Regulations Standard
240-123801640	Specification for Low Pressure Pipelines
240-56356376	On-Site Commissioning for Low Pressure Systems Standard
240-83539994	Standard for Non-Destructive (NDT) on Eskom Plant
240-106628253	Standard for Welding Requirements on Eskom Plant
240-105020315	Standard for Low Pressure Valves
240-56030558	Centrifugal Pumps Specification
240-106365693	Standards for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings
240-105658000	Supplier Quality Management Specification
240-138445406	Clinker Prevention and Management in Fossil Fuel Fired Boilers Guideline

5. LIST OF DRAWINGS

Table 7 below provides a list of drawings to be used for Information only, issued by the *Employer* at or before the Contract Date and which apply to this project

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Note Some drawings may contain both Works Information and Site Information

Table 7: Documents related to his works information:

Document No.	Rev.	Document Title	Remarks
0 61-BMH-SSC-001	0 0	Ash Handling Plant SSC Tensioner General Assembly General Arrangement	Proposal Drawing
0 61-BMH-SSC-002	0 0	Ash Handling Plant SSC Drive Assembly General Arrangement	Proposal Drawing
0 61-BMH-SSC-003	0 0	Ash Handling Plant SSC Drive Shaft (Item 1) Detail	Proposal Drawing
0 61-BMH-SSC-004	0 0	Ash Handling Plant SSC Drive Assembly – Drive Unit Location	Proposal Drawing
0 61-BMH-SSC-005	0 0	Ash Handling Plant SSC Structural Head End Modification General Arrangement	Proposal Drawing
0 61-BMH-SSC-006	3	Ash Plant Unit 4 SSC & Water supply System P&I Diagram	Modified Drawing
0 61-BMH-SSC-007	0 0	Ash Handling Plant SSC Structural Head End Modification Torque Arm Mounting	Proposal Drawing
0 61-BMH-SSC-008	0 0	Ash Handling Plant SSC Agitation system	Proposal Drawing
0 61-BMH-SSC-009	0 0	Ash Handling Plant SSC Structural Head End Modification New Shaft Guard (Item 3) General Arrangement	Proposal Drawing
0 61-BMH-SSC-010	0 0	Ash Handling Plant SSC Structural Head End Modification (Items 4 to 10) General Arrangement	Proposal Drawing
0 61-BMH-SSC-011	0 0	Ash Handling Plant SSC Chain & Flight Washing System Arrangement	Proposal Drawing
0 61-BMH-SSC-012	0 0	Ash Handling Plant SSC Modification For PCD 614 8 Teeth Sprockets	Proposal Drawing
0 61-BMH-SSC-013	0 0	Ash Handling Plant SSC Modification To Return Trough Incline Floor – Option 2	Proposal Drawing
0 61-BMH-SSC-014	0 0	Ash Handling Plant SSC Sprocket Position & Chain Profile For 614 8 Teeth Sprockets	Proposal Drawing
0 61-BMH-SSC-015	0 0	Ash Handling Plant SSC Power Pack Maintenance Crawl Beam Arrangement	Proposal Drawing
0 61-BMH-SSC-016	0 0	Ash Handling Plant SSC Agitation Pipework Isometric Layout	Proposal Drawing
0 61-BMH-SSC-017	0 0	Ash Handling Plant SSC Proposed Agitation Pipework General Arrangement	Proposal Drawing
0 61-BMH-SSC-018	0 0	Ash Handling Plant SSC Agitation Pump & Platform Location	Proposal Drawing
0 61-BMH-SSC-019	0 0	Ash Plant SSC Proposed Agitation Pump Platform General Arrangement & Detail	Proposal Drawing
21 61/58017	0 0	Tutuka Power Station HY101- SSC Local POS Panel (sheets 1-18)	Approved Drawing
0 61/10718	0 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheets 1-2)	Approved Drawing

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Document No.	Rev.	Document Title	Remarks
0 61/10719	0 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheet 1)	Approved Drawing
0 61/10720	5 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheet 1)	Approved Drawing
0 61/10721	8 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle	Approved Drawing
0 61/10722	1 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheets 1-2)	Approved Drawing
0 61/10723	2 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheet 1)	Approved Drawing
0 61/10724	1 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheet 1)	Approved Drawing
0 61/10725	1 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheet 1)	Approved Drawing
0 61/10726	6 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle	Approved Drawing
0 61/10727	4 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle	Approved Drawing
0 61/10728	7 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle	Approved Drawing
0 61/10729	1 0	Tutuka Power Station Ash Handling Plant Ash Conveyor Control Cubicle (sheet 1)	Approved Drawing

6. AUTHORISATION

This document has been seen and accepted by

Name	Designation

7. REVISIONS

Date	Rev.	Compiler	Remarks
January 2020	0 1	L Mahlangu	First draft
May 2020	1	L Mahlangu	Final document
June 2020	2	L Mahlangu	Document updated following CCCC comments
November 2021	3	FM Nieuwoudt	Appendix A Updated after pre-enquiry review

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8. DEVELOPMENT TEAM

The following people were involved in the development of this document

- L Mahlangu
- A Matlala
- C Bekker
- R Brayshaw
- M Tshupe
- N Aboobaker
- O Mekingwe
- T Motloutsi
- P. Hoop
- T Mamphogoro
- N Dingaan
- M Reddy

9. ACKNOWLEDGEMENTS

Design Team

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APPENDIX A: TENDER RETURNABLE DOCUMENTS

	Activity	Date
1	General	
1 1	<p>Provide Reference that the Manufacturer/Supplier has successfully built/supplied similar equipment</p> <p>Certificate of completion that includes the description of the completed project, details of the client and the construction dates.</p> <p>The scope previously completed must be relevant to the scope required to be completed as part of this enquiry ie Design and construction of chain conveying system with drive and take up system.</p>	Tender Returnable
1.2	<p>Provide Reference that the Manufacturer/Supplier has successfully built/supplied similar equipment</p> <p>Certificate of completion that includes the description of the completed project, details of the client and the construction dates</p> <p>The scope previously completed must be relevant to the scope required to be completed as part of this enquiry ie Design and construction of chain conveying system with drive and take up system</p>	Tender Returnable
1 3	<p>Tenderer to submit,</p> <p>ECSA registration certificate/ECSA registration number</p> <p>Curriculum Vitea</p> <p>For the Lead Design/mechanical Engineer, Lead Electrical Engineer, and the Lead Structural Engineer</p>	Tender Returnable
1 4	Tenderer to submit a letter stating that they are able to interface with the existing control system at Tutuka Power Station	Tender Returnable
1 5	Input / Output (IO) Block Diagrams	Tender Returnable
1 6	Instrument Schedule	Tender Returnable
1 7	Drive and Actuator list	Tender Returnable
1 8	<p>Tenderer to submit,</p> <p>ISO 3834 Certificate</p>	Tender Returnable
1 9	Milestone Schedule	Tender Returnable
1 10	Prelim Vendor Document Submittal Schedule (VDSS)	Tender Returnable
1.11	Priced Recommended Critical Spare Parts List	Tender Returnable
1 12	Instrument Connection Details	Tender Returnable
1 13	Document/Configuration Management Plan, including (as a minimum) guidelines or procedures for plant labelling, document management and transmittals	Tender Returnable

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1 14	General Arrangement drawings	Tender Returnable
1 15	Catalogue cuts of equipment	Tender Returnable
1 16	Weights of equipment	Tender Returnable
1 17	Outline dimensions of equipment	Tender Returnable
1 18	Detailed Construction Work Method Statement	Tender returnable
1 19	Construction programme	Tender returnable
1 20	List of exceptions/deviations and clarifications	Tender returnable
1 21	Reference list that includes, Projects complete within the last 10 years, Description of the scope completed, Name of the client details	Tender returnable
1 22	The tenderer further submits, Conceptual water recovery system, slurry pump and pipe system drawings Conceptual operating and maintenance procedures Deviation schedule	Tender returnable
1.23	Tenderer submits a letter stating all subcontractors and the scope required to be completed by the subcontractors	Tender returnable
1 24	Provide project methodology document detailing how the Tenderer proposes to execute the electrical Works	Tender returnable
1 25	Conceptual design layout including high-level single line diagrams for electrical scope, showing listed loads	Tender returnable
1 26	Examples of As-Built drawings from previous projects, for electrical scope	Tender returnable
1 27	OEM letter stating previous experience of system integrators CV of proposed engineering professionals indicating years of experience, and previously completed project	Tender returnable
1 28	Field Instrument List that shows the types of field instruments and the quantities required to complete the works Technical specification and data sheet for each instrument to be included Tenderer to include IP rating on field instrument list	Tender returnable
1 29	Design philosophy that demonstrated understanding of the operating and control philosophy, interfacing requirements and standardisation	Tender returnable
1 30	Local Control Station (LCS) Requirement	Tender returnable
1 31	Method statement for the completion of the Civil and Structural works to be competed	Tender returnable

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1 32	The tenderer submits the CV's of the Lead Design/Mechanical Engineer, Lead Electrical and Control Engineer, and the Lead Structural Engineer	Tender returnable
1 33	Outline of the training that will be provided	Tender returnable
1 34	Deviation from LOSS Diagrams (If any)	Tender returnable

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