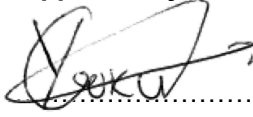


	Scope of Work	Generation Engineering
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Compiled by  Tiyani Malwandla Mechanical Engineer: LPS Date: 02/02/2024	Functional Responsibility  Willie van den Heever Chief Engineer: LPS Date: 02/02/2024	Supported by  Manie van Staden Senior Consultant: Generation Engineering Date: 2024-02-08
Supported by  Yuvir Gokul Kusile EDWL Date: 2024-02-13	Authorised by  T Railo Kusile Project Engineering Manager Date: 13/02/2024	

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1. INTRODUCTION

Westward Electric (Pty) Ltd was contracted to supply Hydrogen Plant and associated equipment for the Kusile Power Station Project. Westward scope also included commissioning and onsite training of the Employer's Operating personnel. The Installation scope was executed by another Contractor. The plant was delivered on in 2012 and due to site access, the installation was delayed and Westward Electric (Pty) Ltd went insolvent before the commissioning and training scope could be completed. ACI Technical Services was appointed to execute commissioning scope, but this could not be fully accomplished snags mostly resulting from the time lapse. These include equipment that need refurbishment or replacement, recalibration of instruments.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document provides a description of *Works* (technical scope of the *Works*) required to refurbish and Commission the Kusile Power Station Hydrogen Plant. This document also covers the following:

- a) All relevant available information
- b) Deliverables required from the successful tenderer (Contractor)

2.1.1 Purpose

The purpose of this document is to clearly define the scope of *Works* with sufficient information to the successful tenderer (*Contractor*) in order to ensure that all requirements are met.

2.1.2 Applicability

This document shall apply to Kusile Power Station.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] ISO 9001 Quality Management Systems
- [2] 36-681 Generation Plant Safety Regulations
- [3] 32-727 SHEQ Policy

2.2.2 Informative

- [4] 366-385227 - Hydrogen Supply Commissioning Procedure for Common and Units 1to 6

2.3 DEFINITIONS

2.3.1 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
BOP	Balance of Plant

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Abbreviation	Description
C&I	Control and Instrumentation
COC	Certificate of Conformance
CWP	Commissioning Working Party
DCS	Distributed Control System
HMI	Human Machine Interface
Hydrogenics	Original Equipment manufacturer of Hystat Units
Hystat	Brand name for Hydrogen Generating Units
KKS	Kraftwerk Kennzeichen System
LCP	Local Control Panel
OEM	Original Equipment Manufacturer
PCR	Pre-Commissioning Review
PLC	Programmable Logic Controller
P&ID	Piping and Instrumentation Diagram
PPE	Personal Protective Equipment
PTW	Permit To Work
QCP	Quality Control Plan

2.5 ROLES AND RESPONSIBILITIES

1. Kusile Project Engineering is responsible for the development of this document
2. The appointed *Contractor* is responsible for the execution of the *Works* in accordance with this document.

2.6 PROCESS FOR MONITORING

Eskom will monitor the compliance to this document.

2.7 RELATED/SUPPORTING DOCUMENTS

None

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3. SCOPE OF WORK

The sections to follow contain the details of the *Works* required to be completed by the Contractor. The Contractor shall provide all equipment, materials, consumables, and services required to complete the Refurbishment and Start-up of the Kusile Power Station Hydrogen Plant. The contractor's scope of *Works* for the Kusile Power Station on the hydrogen plant is as follows:

- a) Complete commissioning of the Hydrogen equipment and Hydrogen Plant. As part of commissioning of the plant full functionality must be proven with all alarms cleared and no production limitations over a 48hrs period. This includes but not limited to:
 - Identifying and fixing any leaks on the Hydrogen Plant, metering panel and associated accessories.
 - Commissioning of metering panel instruments.
 - Repair any defective connections or fittings.
 - Supply of resources (1X Engineer and 2 artisans for 3 days) for nitrogen purging of all hydrogen piping up to the users, hydrogen receiver and subsequent pressurizing of the system with Hydrogen in accordance with approved procedures.
 - All safety valves must be removed, calibrated with gaseous medium and installed before commissioning of the plant.
 - Execute associated Site Acceptance tests (SAT).
 - Supply Commissioning (H3) Databook.
- b) The Contractor shall furnish and install outstanding or defective instruments. List of defects shall include but not limited to items identified on section 3.1 – Hydrogen Plant Snags.
- c) Furnishing and Installation of a permanent potable water 10.0m x 25NB Threaded galvanised SANS62-1 piping to the chiller cooling water system together with an isolation valve and water pressure regulator set at 220kPa.
- d) The Contractor shall furnish and install.
 - Three (3) configured DP-DP Couplers in each Hydrostat and Metering Station Panels to allow the communication between the three PLCs and the Employer's Distributed Control System (ABB 800xA).
 - Profibus cabling between the Hydrostat PLCs and the Metering panel PLC.
- e) The Contractor shall update the PLC software program in each of the Panels and the Virtual Signal List to be free issued to the Employers C&I Contractor for configuration and mapping of signals transfer between the Hydrogen Plant PLCs to the DCS.
- f) Scope specifically excluded from the scope are fixing of any leaks identified during the commissioning which are located downstream of the Hydrogen plant metering panel. This is all piping from the Hydrogen plant to the users at the units. The Employer will be responsible for fixing these leaks if identified.
- g) The integrity of all bulk storage vessels must be verified by performing a Nitrogen purge and pressurization to 2,7MPa and performing a pressure decay test for 12 hours with an acceptable leakage rate of <0,5% over an 12 Hour period. At 2,7MPa a soap test will be performed to identify leaks. After completion of the pressure test the Nitrogen will be transferred to the other bulk storage vessel and the tested vessel isolated with Nitrogen pressure at 510kPa.
- h) All safety valves must be removed, calibrated with gaseous medium and installed before commissioning of the plant.
- i) The contractor will develop and submit hydrogen bulk storage purging and integrity verification procedures for acceptance to the Employer. The procedure shall also cater for the filling of the bulk storage vessel with produced hydrogen from the state of 510kPa Nitrogen pressure to supply hydrogen to the generators at a purity of >96%.

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3.1 HYDROGEN PLANT SNAGS

- a) Calibration/refurbishment i.e., removal, installation, commissioning, and calibration of Dew Point probe in metering panel.
- b) Supply install, commission and calibrate of PANAMETRICS GAS OX-5 STD PPM SENSOR, 0 TO 100 AND 1000 PPM on HyStat A and B.
- c) Supply, install, commission and calibrate of panametrics Gas XMTC-62-22-11-XMTC-CAL-A-1 (H₂ In N₂, 98-100%) in HyStat B.
- d) Supply, install, commission and calibrate of new MICHEL TRANSMET I.S. Dew point probe in HyStat A and B.
- e) Calibration/verification of XMTC required for HyStat A and metering panel.
- f) Supply of 8m ½" stainless steel braided flexible hoses with cable reinforcing across the two ends, fitted with nitrogen regulators from rated 1,5 time max nitrogen MCP operating pressure and quick connector coupling to connect to nitrogen panel.
- g) Supply of 8m ½" stainless steel braided flexible hoses with cable reinforcing across the two ends, fitted with hydrogen regulators from 20MPa hydrogen supply pressure with ¼" valve and quick connector for nitrogen purging. Flexible hose end to be fitted with quick connector nipple to connect to Hydrogen MCP panel. Pressure rating 30MPa.
- h) Supply, install, commission chiller 3-way valve actuator Siemens SAX61.03.
- i) Supply and install hydrogen vent stainless steel tube on the safety valve vent, venting 2m above the roof.
- j) Supply, install and commission (leakage check) receiver flexible connections (inlet and outlet) with stainless steel braided reinforced flexible hoses rated 4,5MPa, 3/4".
- k) Supply, install and commission of KROHNE variable area flowmeter for Hystat B.
- l) Removal and installation and commissioning of hydrogen leak detector, to be relocated inside the Hystat for effective leak detection functionality.
- m) Supply CF Memory Cards to download and Back up Siemens Program SIMATIC S7, Micro Memory Card 2MB(6ES7953-8LL31-0AA0) TRANSCEND CF180 4 GB, Industrial Grade.
- n) All safety valves must be removed, calibrated with gaseous medium and installed before commissioning of the plant.

3.2 OTHER REQUIREMENTS OF THE *WORKS*

3.2.1 General

1. The *Contractor* shall submit a comprehensive Method Statement of the entire *Works* to the *Employer* for acceptance prior to the start of the *Works*.

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2. The *Contractor* shall submit a project specific safety file to the *Employer* for acceptance, prior to the start of the *Works*.
3. The *Contractor* shall manage his access to the working areas and the site to ensure none of the existing plant that is not in the scope is damaged.
4. The *Contractor* is responsible for the *Works* which has not been specifically excluded, including all temporary *Works* and design thereof, and all associated services.

3.2.2 Commissioning

1. The *Contractor* shall be responsible for commissioning and start-up activities for hydrogen generating plant, including planning, all craft labour and supervision.
2. The *Contractor* shall purge with Nitrogen, the hydrogen system including the air receivers, hydrogen generating plant, metering panel and supply piping. Furnish, install and remove all materials, equipment and kit required.
3. The *Contractor* shall energise/fill with hydrogen, the system including the air receivers, hydrogen generating plant, metering panel and supply piping. Furnish, install and remove all materials, equipment and kit required.

3.2.3 Handover

Apart from any statutory data packages required, the *Contractor* also compiles a data package of the relevant drawings, test certificates etc. to the *Employer* for acceptance. These include, but are not limited to:

- As-built and/or Red-line data and drawings of the completed *Works* upon handover. As-built and/or Red-line drawings are submitted in PDF and/or native CAD formats.
- Material certificates

4. SPECIFICATION FOR THE WORKS

The *Contractor* is required to adhere to the latest editions of and the normative references within the following SANS standards and other codes of practice, regulations & standards:

Number	Title
240-86973501	Engineering drawing Standard
240-56227443	Requirements for Control and Power Cables for Power Stations Standard
240-56355815	Junction Boxes and Cable Termination Standard
ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs
ISO 898-5	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 5: Set screws and similar threaded fasteners with specified hardness classes
SANS 1411 (parts 1-7)	Materials of insulated electric cables and flexible cords
SANS 1574	Electric flexible cables with solid extruded dielectric insulation
SANS 60794-1-1	Optical fibre cables Part 1-1: Generic specification - General
IEC 61238-1	Compression and mechanical connectors for power cables
240-56355754	Field Instrument Installation Standard
SANS 1123	Pipe Flanges
SANS 62-1	Steel Pipes Part 1: Pipes suitable for threading and of nominal size not exceeding 150 mm
240-56356376	On-Site Commissioning for Low Pressure Systems Standard
240-145581571	Piping shall be identified as per 240-145581571, Standard for Identification of the Contents of Pipelines and Vessels
240-123801640	Specification for Low Pressure Pipelines Standard
240-106365693	Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings
240-101712128	Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings
240-86973501	Engineering Drawing Standards – Common Requirements
240-54179170	Technical Documentation Classification and Designation Standard
240-71432150	KKS Plant Labelling and Equipment Descriptions Standard
240-53114186	Project / Plant Specific Technical Documents and Records Management Procedure
240-109607332	Abbreviation Standard for Labelling of Plant at Power Stations
240-93576498	Eskom KKS Standard
VGB B105e	KKS Power Plant Classification (B105e) 5th Edition 2003 Published by Verlag VGB PowerTech Service GmbH (Essen)

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5. DRAWINGS ISSUED BY THE EMPLOYER

The following drawings are issued to the *Contractor* to be used for tender. The *Employer* is to provide the *Contractor* with drawings issued for construction after contract award. Drawings for Tender are not used for procurement, fabrication or construction.

Document Number / ID	Document Title	Status
0.90/1236 Sheet 1	Piping & Instrumentation Diagram – Hydrogen Supply	For Information
0.90/1236 Sheet 2	Piping & Instrumentation Diagram – Hydrogen Supply	For Information
203-10500	Kusile Power Station Hydrogen Generating Plant Operations and Maintenance Manual	For Information
203-10193	Hydrogen Storage and metering system operation philosophy	For Information

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6. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Tiyani Malwandla	Mechanical Engineer: Low Pressure Services
Willie van den Heever	Lead Discipline Engineer: Low Pressure Services
Manie van Staden	Senior Consultant: Generation Engineering
Tseliso Msimanga	C&I Engineer: C&I Engineering
Yuvir Gokul	Kusile Power Station - Project Engineering Design Work Lead
Tumiso Railo	Kusile Power Station – Project Engineering Manager

7. REVISIONS

Date	Rev.	Compiler	Remarks
January 2024	0	M. van Staden	For Authorisation

8. DEVELOPMENT TEAM

The following people were involved in the development of this document:

None

9. ACKNOWLEDGEMENTS

None

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10. APPENDIX A – KUSILE HYDROGEN SUPPLY – SYSTEM DESCRIPTION

10.1 SYSTEM IDENTIFICATION

- System Name Hydrogen Supply
- KKS Code MKG

10.2 FUNCTION

The Hydrogen Supply System will generate, store and supply hydrogen gas to the Unit 1-6 turbine generators.

10.3 PROCESS DESCRIPTION

Piping and instrument diagrams of the Hydrogen Supply system are shown on 0.90/1236 Sht. 1&2 [146838-0MKG-M2201A & B].

The Hydrogen Supply System will include the following major equipment and components:

- a) Two 67 percent capacity Hydrogen Generation Skids.
- b) Four 33 percent capacity Hydrogen Receivers.
- c) One 100 percent capacity Metering Station.
- d) Two Chillers for cooling of the Hydrogen Generation Skids.
- e) Two Water Supply Panels for the supply of cooling and process water to the Hydrogen Generation Skids.
- f) Five hydrogen pallet panels for backup hydrogen supply.
- g) Two nitrogen pallet panels for purging.
- h) Associated piping, valves, instruments, controls, and accessories.

The Hydrogen Generation system will generate and supply hydrogen gas to the Hydrogen Receivers. Water electrolysis will be used to produce the required hydrogen supply. The hydrogen receivers will be filled at different rates, but constant pressure, to achieve long term plant health of the cell stack. A deoxidizer and drier will be provided as part of the Hydrogen Generation Skids to remove traces of oxygen and to dry the gas to the required pressure dew point. A transformer, rectifier, controller and programmable logic controller will be supplied with the hydrogen generation plant. Close loop cooling for the Generation Skids is also part of the hydrogen generation system and will be achieved with the use of one chiller per skid. Each skid also has an associated water supply panel that distributes the cooling water from the chiller as well as the demineralized water used for hydrogen production. Hydrogen pallets will also be installed to supply hydrogen to the Metering Station in case the generation plant is out of service. Nitrogen pallets will be supplied to purge the Generation Skids when hydrogen is not being supplied to the hydrogen receivers.

The Hydrogen Receivers will supply the hydrogen gas to each unit's turbine generator via the metering station. The filling of the receivers will be done automatically with a control system to control the inlet

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solenoid valve. The gas will be regulated and controlled by a hydrogen metering station installed downstream of the hydrogen receivers and solenoid valves on the outlet of each receiver. An Inlet Receiver Valve Panel and an Outlet Receiver Valve Panel is supplied for each Hydrogen Receiver.

10.4 BASIS FOR DESIGN

The Hydrogen Generation System is sized to provide the maximum required flow to the four Hydrogen Receivers at the required pressure. The hydrogen produced will be of high purity and quality to ensure safety, limit losses, and ensure turbine generator long term plant health.

Four Hydrogen Receivers will be supplied and sized to cater for one generator fill and to supply normal daily consumption for all generators for 7 days. The hydrogen gas pressure will be measured via pressure transmitters installed on the outlet line for each Hydrogen Receiver. Solenoid valves are located at the inlet and outlet of each Hydrogen Receiver to control which receiver is supplying the units and which receiver is being filled by the hydrogen generation system. The outlet solenoid valves will be automatically controlled from the PLC based on the pressure in the Hydrogen Receivers. Manual control will also be available to the operator. The inlet solenoid valve will be controlled by the PLC to ensure the Hydrogen Receiver filling philosophy is adhered to. Only one receiver will be filled at a time.

The Hydrogen Metering Station will be supplied with a sampling panel located in the same building as the generation system. After the hydrogen has been sampled in the Hydrogen Metering Station, the hydrogen will be supplied to the unitized metering stations inside of the turbine hall.

Hydrogen reticulation to each turbine generator set is provided. The hydrogen reticulation pipe will be protected by double wall piping (hydrogen on the inner wall with a nitrogen blanket on the outer wall) whenever the piping is in a covered trench. Reticulation blanket nitrogen pressure will be monitored by a pressure transmitter and be 100 kPa above the hydrogen reticulation pressure. A hydrogen gas cylinder station with hydrogen gas cylinder pallets will be provided by the turbine contractor as backup for each unit.

Hydrogen piping will be 316L stainless steel pipe and nitrogen piping will be SANS 62-1. Ball valves will be used in all piping and will be constructed of stainless steel. Relief valves will be constructed of stainless steel.

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