Eskom	Report	Medupi Power Station

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1. EXECUTIVE OVERVIEW

Accurate oxygen measurement assists in achieving efficient combustion in the boiler and also determining the leakage across the GAH. Oxygen content in the exhaust flue gases from the boiler combustion process varies in the duct cross-section due to the effect of stratification creating lower and higher oxygen regions resulting in poor online measurement of oxygen.

Oxygen concentration at boiler loads more than 38% BMCR shall not be less than 2.5% nor more than 9% as per FFFR 3.3.4 section (b). Lower oxygen content results in high concentration of Carbon Monoxide and possible flame instability in the furnace whereas higher oxygen concentration may result in high boiler tubes erosion and dilution of oxygen content and flue gas temperature which in turn affects the downstream plants such as the PJFF, GAH and the ID fans.

Thus having an accurate and reliable measuring instruments across the duct reduces the error caused by the stratification when measuring oxygen concentration, offering a better representation of a reliable combustion performance.

2. GENERAL

2.1 INTERPRETATION AND TERMINOLOGY

2.1.1 Definitions

Definition	Description
Condition Based Maintenance	Predictive maintenance carried out because of findings from analysis of parameters measured under a condition-monitoring regime, or from recommendations from reliability analysis.
Condition Monitoring	Non-intrusive monitoring carried out to determine the physical condition of asset / plant and equipment.
Corrective Maintenance	The process of restoring asset / plant and equipment which have failed or deteriorated to a state which renders it unable to meet the acceptance criteria required for its particular application.
In-service Inspection	All inspection and testing conducted on plant and equipment at regular intervals and prescribed by regulatory and statutory codes or other types of specification throughout its service life.
Inspection	Activities, which by means of examination, observation or measurement, determine the conformance of material, parts, components etc., to predetermined specifications and quality requirements.
Lifecycle Management Plan	This is the plan that details the financial and technical requirements with respect to all planned projects over the life of the plant. This plan covers Capital, R&E, and Routine Maintenance and Planned Maintenance costs.
Maintenance	A combination of all technical, administrative and managerial actions during the lifecycle of an item intended to retain it in, or restore it to, a condition in which it can perform its required function.
Maintenance Philosophy	The principle approach decided upon for performing maintenance, such as pro-active or re-active maintenance.

Definition	Description
Maintenance Plan	• A plan that details the maintenance that needs to be done on a specific asset / plant item or component and the frequency and quality requirements for that maintenance.
Maintenance Schedule	The timing of the Maintenance Plan information stipulating when in the calendar year, work needs to be done.
Maintenance Strategy	The type of maintenance selected for specific asset / plant and equipment, such as time or condition based maintenance, corrective or preventative maintenance.
Preventive Maintenance	Planned time or schedule based maintenance carried out with the explicit objective of preventing functional failures and is directed towards maintaining the physical condition of the asset / plant or equipment. It includes scheduled overhauls and scheduled replacement of worn out parts or failure prone components.
Reliability Centred Maintenance	RCM represents a disciplined decision logic approach that focuses on the consequences of failure to develop the most cost-effective lifetime maintenance programme. The decision logic question is sequenced to those parts of the asset / plant that are maintenance significant. Significant components failure modes are evaluated to identify appropriate maintenance tasks and their costs.
Technical Plan	The technical plan will be the first five years of the Lifecycle Manage Plan (Life of Plant Plan).
Testing	All activities required determining the actual performance or condition of an item.

2.1.2 Abbreviations

Abbreviation & Acronyms	Description
AC	Alternating Current
AFC	Approved for construction
CoC	Certificate of Compliance
DCS	Distributed Control System
DIN	Deutsches Institut für Normung
ECC3	Engineering and Construction Contract (NEC3)
EMS	Environmental Management Systems
ETD	Education and Training Department
FFFR	Fossil Fuel Firing Regulation
FUM	Function Module
GO	General Overhaul
IO	Input Output
KKS	Kraftwerk Kennzeichen System

Abbreviation & Acronyms	Description
NKP	National Key Point
O_2	Oxygen
OBL	Outside battery limits
PSR	Plant Safety Regulations
QA/QC	Quality Assurance/Quality Control
QCP	Quality Control Plan
QIP	Quality Inspection Plan
ROC	Required Operational Capability
SHE	Safety Health and Environment
SHEQ	Safety Health Environment and Quality
SOW	Scope of Work
SPO	Senior Plant Operator
URS	User Requirements Specification
WBS	Work Breakdown Structure

2.1.3 Applicability

i. The requirements defined in this document apply to the whole of the *Works* for the Medupi Power Station Replacement of O2 Analysers.

3. DESCRIPTION OF THE WORKS

3.1 OVERALL SCOPE FOR THE WORKS

The aim of this project is to test the different oxygen analysers on the gas air heater inlet at Medupi Power Station. The currently installed oxygen analysers are not reliable and the spares are also an issue. The *works* will consist of testing only six analysers from a different OEM for the period of six months.

The works is to be performed at Medupi Power Station in the main plant, on the gas air heater landing. The Contractor carries out all the activities such as the supply, delivery, offloading and installation of all the necessary resources to complete the *works* in all respects. Completion of the *works* is only accepted by the Employer upon the commissioning and handover by the Contractor of a fully operational O2 analyser system that complies with all of the statutory and operational requirements, whether stated or not stated in this document, for the gas air heaters that are currently installed at Medupi Power Station. Unless stated otherwise the Contractor supplies all labour as well as plant and materials, equipment, testing, and supervision required for the manufacturing, packaging, delivery to site, offloading, assembly, installation, training of personnel and testing of all the equipment.

It is the responsibility of the Contractor to verify all the information including dimensions, distances given by the Employer in order to ensure the supplied solution complies with all the standards and specifications.

The *works* consists of:

- i. Engineering design proposal, procurement, supply, delivery, offloading, storage, installation, testing, commissioning, optimisation, training of personnel and as built documentation of the new equipment for only one unit.
- ii. The Contractor decommissions and removes the current O2 analysers and keeps them as spares.
- iii. The Contractor uses the current O2 analyser mounting brackets/flanges.
- iv. The Contractor supplies and installs the new integrated (**Compact unit**) O2 analysers.
- v. The Contractor supplies and installs the integrated O2 probe with end cap and filters.
- vi. The Contractor supplies and installs the O2 analysers that have the local display.
- vii. The Contractor supplies and installs all additional equipment and sundries needed for the installation and integration of the different parts of the O2 analyser system.
- viii. The Contractor uses termination lugs for connection.
- ix. The Contractor tests and commissions the O2 analyser system for proper functionality and fail safe, according to statutory and operational requirements as well as industry best practice.
- x. The Contractor supplies all calibration certificates.
- xi. The Contractor proves loop accuracy and integrity.
- xii. The Contractor trains all relevant site personnel.
- xiii. All equipment supplied and installed shall be accompanied by factory acceptance tests, site acceptance tests, equipment specifications, equipment compliance certificate and installation certificate of compliance for the whole system.
- xiv. The Contractor supplies and installs all activities, services or equipment specified.
- xv. The Contractor supplies recommended spares list for the new supplied equipment.

3.2 GENERAL SYSTEM DESCRIPTION

3.2.1 General

- i. The *Contractor's* design in section 4.1 shall address all of the requirements as listed in this *works* information.
- ii. The ROC forms part of the package handed to the *Contractor* by the *Employer*

3.2.2 Description of the current system

GAH inlet oxygen analysers are positioned at 42ml, above the GAH as shown in figure 1.

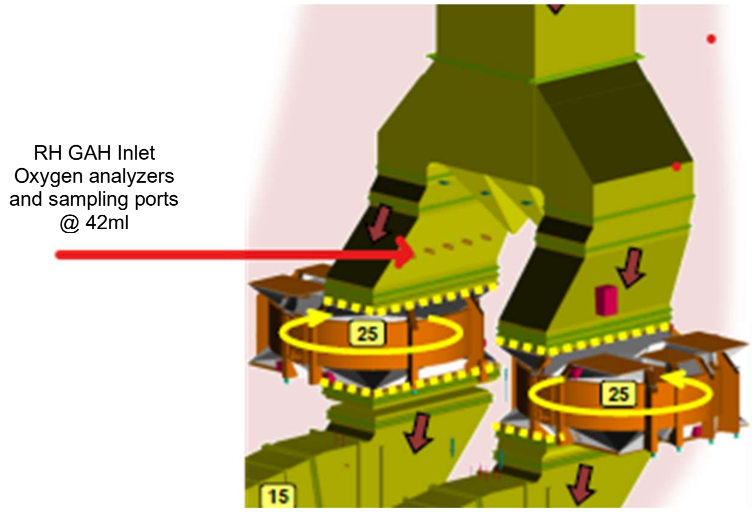


Figure 1: Oxygen analysers' positions on the duct

Medupi Power Station GAHs are equipped with Ametek Thermox WDG 1200 type with a direct insertion probe which goes into the flue gas stream. These analysers are in-situ instruments which measure oxygen on a wet basis.

The design maximum temperature that these analysers can withstand is 600°C. The outer material is made from 310 stainless steel and inner cell from zirconium. The oxygen probes come in three different lengths; 0,457m, 0,9144m and 1,828m. Figure 2 below shows the top view of the analysers' lengths as installed in the plant.

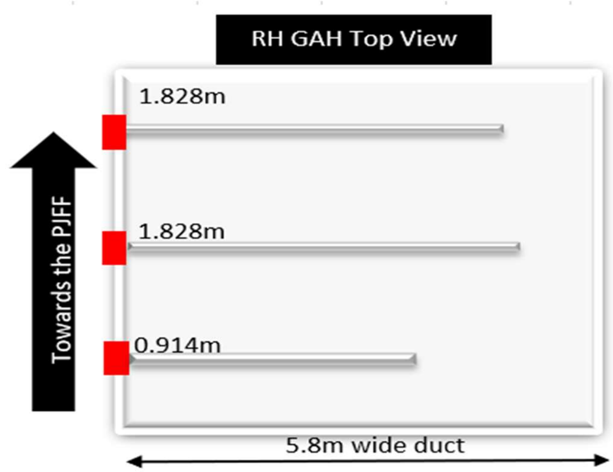


Figure 2: Oxygen analysers Sizes

The current set up of the oxygen analyzers is a 3 single-point measurement using the Ametek InSitu Oxygen Analyzers which are not providing us with the correct representation of oxygen content after combustion.

Therefore it is recommended that this current installation of the Oxygen Analysers be replaced with the different product of the Oxygen Analysers. Figure 3 below shows the mounting and dimensions of the currently installed integrated O2 analyser probe:

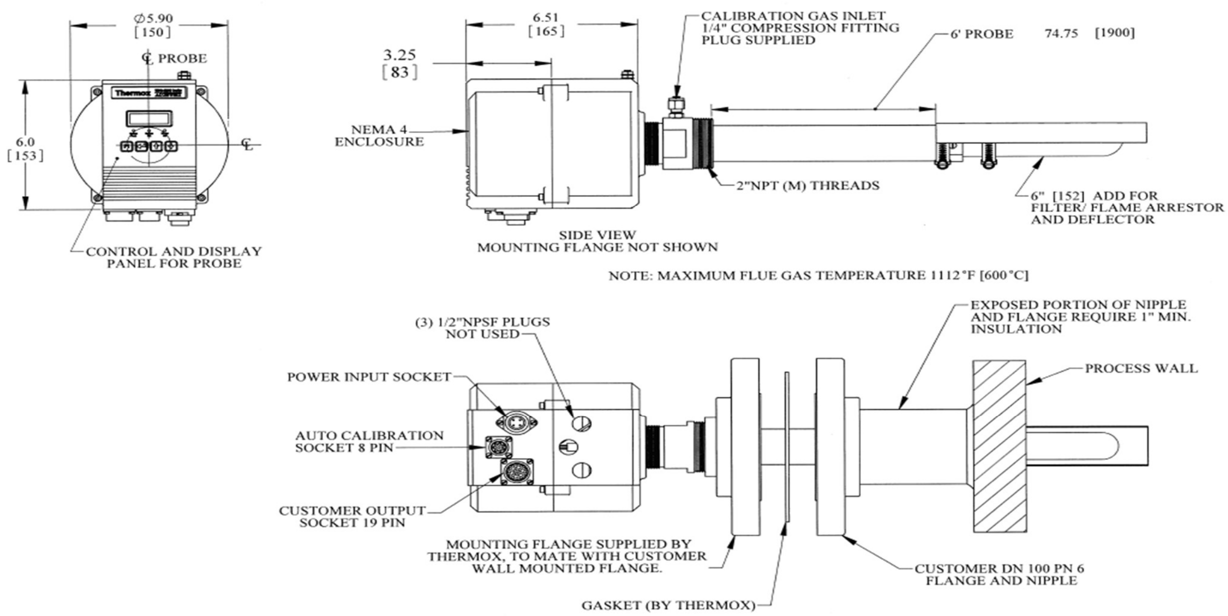
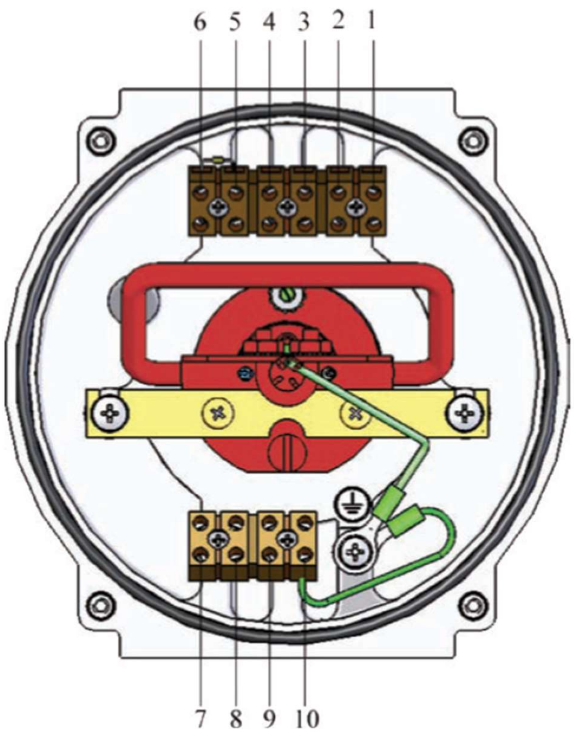


Figure 3: Mounting and dimensions of WDG-1200 InSitu probe



KEY
1. Cell -ve
2. Cell +ve
3. Thermocouple +ve
4. Thermocouple -ve
5. Cold junction +ve
6. Cold junction -ve
7. Heater Live/Line
8. Heater Neutral/Return
9. Not Used
10. Earth/Ground

Figure 4: O2 Analyser – Probe Connections

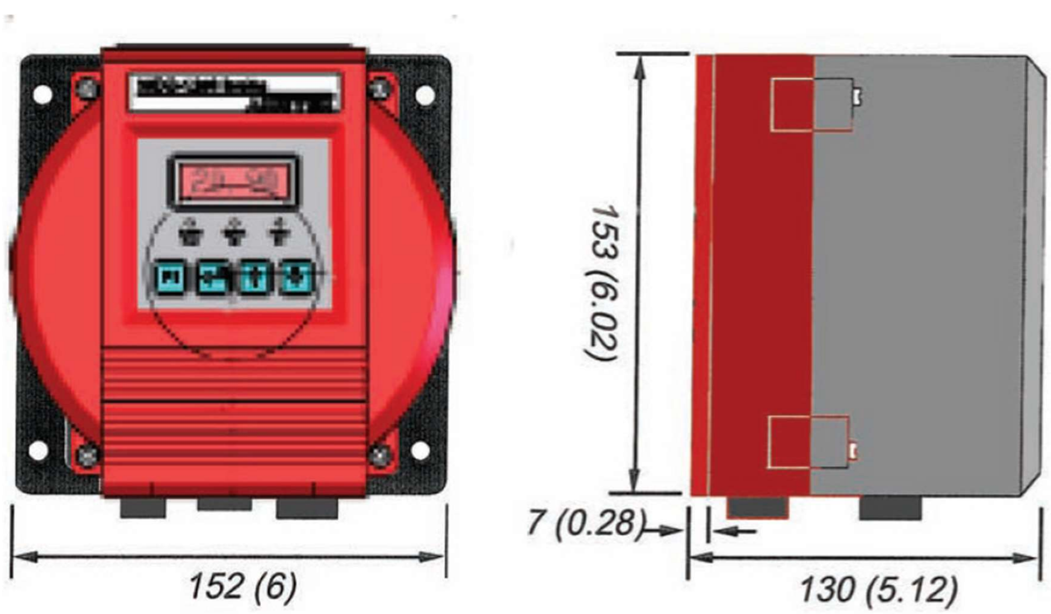


Figure 5: O2 Analyser Dimensional Information

Table 1: The existing WDG 1200 InSitu O2 Analyser - Probe Specifications

General	
Flue gas temperature:	20°C to 600°C
Heater temperature:	700°C ±3°C
Pressure:	±2psig (±13.8kPa)
Probe material:	310 Stainless steel
Case material:	Powder-coated aluminium
Mechanical Data	
WDG 1200/InSitu Probe Length and Weight:	
Overall length of probe:	*Approximate Weight:*
1. 0.9144 m / 36”	11.5 kg
2. 1.828 m / 72”	18.3 kg
3. 1.828 m / 72”	18.3 kg
Environmental Protection	
Probe Head:	IP65/NEMA4 protected
Operating Temperature:	-20°C to +70°C
Relative Humidity:	10% to 90% non-condensing
Performance Data	
Measuring Range:	Selectable range 0 to 1; 0 to 25% v/v O_2
Accuracy:	± 1 % of full scale
Repeatability:	± 0.5 % of full scale on analogue outputs
Response Time:	90% of full scale within 5 seconds (Calibration gas)
Measuring Method:	Zirconia oxide sensor
Warm-up Time:	20 minutes maximum
Electrical Data	
Voltage Range:	100 – 240 VAC
Frequency:	48 – 62 Hz
Power:	250 W
Current Rating:	4 A Peak
Over-voltage Category:	CAT II
Fuse Rating and Characteristics:	3.15A (T)

3.3 DESIGN STANDARDS, GUIDELINES AND CODES

i. The Contractor shall obtain his own copies of International and National standards.
ii. The Contractor shall report any conflict within this specification, with any referenced standards, specifications or technical guideline.
iii. This specification shall take precedence over differences existing between this specification and any document except for statutory requirements.
iv. Substitutions of any standard shall be approved by the Employer. Additional standards proposed by the Contractor shall be submitted to the Employer for approval.
v. Only the most recent versions of the relevant standards, guidelines, or codes shall be used with this Works.

3.4 O2 ANALYSER DETAILED REQUIREMENTS

3.4.1 Overall System Requirements

i. The O2 analyser system shall be configured as fully operational systems, stable, responsive and workable in all respects and are implemented in a consistent and integrated manner.
ii. The O2 analyser system provided shall be configured, designed, engineered, installed and commissioned using this specification, OEM best practices and industry best practices.
iii. O2 analyser system shall have self-diagnostic to detect failure and bring it to attention of maintenance team.
iv. Certification of equipment should include Country of origin and Certificate of Conformity.

3.4.2 Health and safety risk management

i. The *Contractor* shall comply with the latest revision of Eskom Medupi Power Station's Health, Safety and Environmental Specifications.
ii. The *Contractor* shall comply with any other SHE requirements by the *Employer*.

3.4.2.1 General Requirements

i. The *Contractor* complies with the Occupational Health and Safety Act no 85 of 1993 and its regulations, Eskom SHE Policy, Standards, Procedures, Guidelines, Specifications and Regulations.
ii. The *Contractor* ensures safety awareness at all time through continuous training.
iii. The *Contractor* is at all times responsible for the supervision of his employees, agents and Sub-Contractors and takes full responsibility and accountability for ensuring that they are competent, compliant and aware of the legal requirements and other requirements and execute the *works* accordingly.
iv. The *Contractor* ensures that all statutory appointments and appointments required by any Eskom Regulations are made in writing and that all appointees fully understand their responsibilities and are trained and competent to execute their duties.
v. The *Employer*, or any person appointed by the *Employer*, may, at any stage during the term of the contract:
   a. Conduct health and safety audits by a competent person regarding all aspects of compliance with the SHEQ Requirements, at any off-site place of work, or the site establishment of the *Contractor.*
   b. Refuse any employee, Sub-Contractor or agent of the *Contractor* access to the premises if such a person has been found to commit an unsafe act or any unsafe working practice or is found not to be competent or authorised.

c. Issue the *Contractor* with a stop order, should the *Employer* become aware of any unsafe working procedure or condition or any non-compliance.

vi. The *Contractor* immediately reports any incidents, disabling injury, near miss, first aid incident as well as any threat to health and safety of which it becomes aware at the *works* or on the Site to the Project Manager.

vii. The *Contractor* agrees that the *Employer* is relieved of any and all of its responsibilities and liabilities in terms of the Occupational Health and Safety Act no 85 of 1993 in respect of any acts or omissions of the *Contractor*, and the Contractor's employees, agents or Sub-Contractors, to the extent permitted by the Occupational Health and Safety Act no 85 of 1993.

viii. The *Contractor* ensures that all his personnel attend a Health and Safety Induction Course presented by Security Department, Monday to Friday – 09:00 to 11:00, free of charge prior to commencement of any works. This is a two (2) hour course and is valid for the duration of one (1) year at Medupi Power Station.

ix. The *Contractor* works strictly to regularly updated risk assessment.

x. The *Contractor* ensures supervised and authorised entry into the plant.

xi. The *Contractor* barricades the entire perimeter of the site.

xii. The *Contractor* ensures at all times compliance with the safety regulations imposed by any act of parliament, or any regulation or by law of any statutory authority.

xiii. The *Contractor* complies with the Occupational Health and Safety Act and Regulations, 1993 and all regulations made there under as well as the Employer's safety and operating procedures.

xiv. The *Contracto*r acknowledges that he is fully aware of the requirements of all the above and undertakes to employ people who have received sufficient training that they can comply therewith. The *Contractor* undertakes not to do, or not to allow anything to be done which will contravene any provisions of the act, regulations or operating procedures.

xv. All employees of the *Contractor* must attend a safety induction course before they are allowed to work on site.

xvi. It is the responsibility of the *Contractor* to ensure that all employees have attended the safety induction.

xvii. The *Contractor* holds a Toolbox Talk and inspects all PPE before any work commences and keep written proof of such actions.

xviii. The *Contracto*r complies with all of the applicable procedures as required by the *Employer*; Procedures are available from the *Employer's* Documentation Centre on request.

xix. The *Contractor* familiarizes himself with all permit requirements for work to be done on all plant systems and ensures that permits are applied for accordingly.

xx. The following risks are identified by the *Employe*r, and the *Contractor* includes these in his risk assessment:

   a. Injury caused by hand tools.
   b. High noise level.
   c. Falling when working at heights.
   d. Welding which may result in burning.
   e. Movement of stairs while walking.
   f. Falling objects.
   g. Dust

xxi. Any tampering with the *Employer's* fire equipment is strictly forbidden.

xxii. All work done by the *Contractor* shall comply with the latest revision of *Employer's* SHEQ requirement as stated in the Safety, Health and Environmental Specifications and all other *Employer* safety requirements.

xxiii. *Employer* compiles a baseline safety risk assessment to identify all the possible risks during the implementation of the project.

xxiv. The risk assessment includes all the mitigating strategies in order to minimise all the possible risks.

xxv. *Employer* provides the *Contractor* with the baseline risk assessment to use it as a minimum requirement to compile a risk assessment identifying all the risks before the implementation commences, the risk assessment compiled by the *Contractor* will clearly show all the mitigating strategies in order to minimise all the possible risks.

xxvi. No work shall be carried out without the risk assessment identifying all the risks and the mitigating strategies in place in order to address the identified risks.

xxvii. All necessary subsequent removal of existing installations shall form part of Contractor scope.

3.4.3 Safety of workers

i. The *Contractor* ensures the safety of all persons working in the Site. Any hot work, including welding, will be applied for in accordance with the permit to work system. No welding will be allowed on site unless permission is granted in writing by the Project Manager.

ii. All welding, flame cutting and grinding work is properly screened to protect persons from arc flash or eye injuries. Fire blankets are fitted over the scaffolding planks and platforms. Precautions are taken to prevent any objects, welding or grinding splatter from falling.

3.4.4 Plant safety regulations

i. The *Employer*, on request from the *Contractor*, isolates required plant from all sources of danger as described in the Plant Safety Regulations.

ii. The Project Manager, on request, makes available a copy of the latest revision of the Plant Safety Regulations to the *Contractor*.

iii. The *Contractor* complies with all rules and regulations applicable to plant safety and completes the Workman’s Register prior to working on the plant.

iv. The *Contractor* declares any grinding and welding to be carried out on the workers register.

v. At every permit change, the *Contractor* withdraws himself/herself/his staff for that period of permit suspension/revocation and thereafter only proceeds with the *works* after signing onto the new permit.

vi. The *Contractor* ensures that he/she/all Sub-Contractors/personnel/staff/his visitors are medically, physically and psychologically fit to enter Medupi Power Station and especially any confined space.

vii. The *Contractor* is prohibited from entering Restricted Areas.

viii. The responsibility is on the *Contractor* to ensure that the correct confined/hazardous space requirements and tests have been met and done by the *Employer* prior to entry into any confined space or hazardous plant areas.

ix. The *Contractor* ensures that all personnel are competent to carry out the *works*.

x. The *Contractor* provides proof of competency for technical and safety aspects and must be available as and when required on site.

3.4.5 Requirements Related to Availability and Reliability

i. No individual O2 analyser fault shall cause the loss of entire O2 measurement system.

ii. The proposed equipment should have a failure rate of 1% or less over the duration of a calendar year.

iii. The availability excludes hardware upgrades.

iv. The availability of the hardware over its lifetime should be 99% or greater, calculated annually.

3.4.6 Life Expectancy

i. All equipment, protection systems and control components will be supported and maintained for 15 years after the last taken-over system.

3.5 SECURITY REQUIREMENTS

The installed equipment shall be password protected to avoid unauthorised personnel tampering with the settings.

3.6 TRAINING REQUIREMENTS

Training should be provided as per following training requirements:

i. The Provision of detailed training manuals incorporating all aspects of the training that will be provided.
ii. Formal theoretical training to personnel in the maintenance and general running of the *system* and equipment before commencing testing and commissioning is required. The disciplines to be trained are control and instrumentation (C&I) maintenance (10 x personnel), C&I engineering (4 x personnel) and Boiler Engineering (2 x personnel).
iii. The following is considered to be the minimum requirements for training:
    a. System and component description, layout and design;
    b. Calibration;
    c. Replacement of O2 cell;
    d. Replacement of the accessories like temperature measuring device;

a. System operation:
    (1) Normal operating procedures;
    (2) Routine test and inspection procedures;
    (3) Normal and emergency shutdown procedures;
b. Operational problems:
    (1) Troubleshooting;
    (2) Loss of supply (e.g. electrical power);
c. Dangers and precautions
d. Recommended settings:
    (1) Test and inspection plans;
    (2) Inspection and Maintenance Procedures:
        - During plant operation;
        - During shut down periods;

e. Special tools and equipment:
   (1) Requirements;
   (2) Training;
f. Fault Finding:
   (1) Items to inspect;
   (2) Typical observations and/or deviations;
   (3) Recommended corrective actions;
g. Recommended spares:
   (1) Item description;
   (2) Part number/type;
   (3) Supplier;
   (4) Drawing designation;
   (5) Quantity installed on plant;
   (6) Recommended stock;
h. Practical hands-on training for each individual trainee shall form an integral part of all training.

3.7 LIFE-CYCLE COST ASSESSMENT

As part of replacement, a life cycle management functional specification or Report shall describe and define the following points as a minimum:

i. Life cycle costing considerations and total cost of ownership calculations.
ii. System and component replacement strategy.
iii. System and component maintenance strategy.
iv. Spares management strategy.
v. Standardisation strategy.

3.8 EXPANDABILITY ASSESSMENT

Not applicable.

3.9 QUALITY MANAGEMENT

i. The *Contractor* conforms to the following Quality Management requirements:
   a. The quality requirements are as per ISO 9001:2008.
   b. Quality Control Plans shall be in the format of Document Identifier 240-1443182036 "*Medupi Power Station: Quality Control Plan form"*.
ii. Documents submitted for review and acceptance by the Project Manager 30 days after the Contract Date and prior to the commencement of work.
iii. The *Contractor* submits a full detailed Contract Quality Plan for acceptance within 30 days of the Contract Date.
iv. No site work and designs are allowed unless the *Employer* accepts the QCP and QIP's.
v. The *Contractor* utilises the *Employer's* quality documentation forms for requesting access, erection checks etc. These request forms must be submitted to the Supervisor at least 72 hours notification for off-site but local (within the country), 15 days if Offshore and 24 hours for on-site inspections. This will be coordinated by the quality team and the Supervisors.

vi. Apart from any statutory data packages required, the *Contractor* also compiles a data package (books) of the relevant drawings, test certificates etc. for each section of work which must be reviewed and signed off by the Supervisor at erection check phase prior to the commencement of the commissioning phase.
vii. The *Contractor* is responsible for defining the level of QA/QC or inspection to be imposed on his Sub-Contractors and suppliers of material. This level should be based on criticality of equipment and be submitted to the Project Manager for acceptance in the form of a QCP.
viii. The *Contractor* submits a schedule of un-priced orders to be placed that is updated monthly.
ix. The *Contractor* submits a quality report on a monthly basis, including the following:
   a. A list of Defects with those older than 30 days being flagged and an explanation attached.
   b. Monthly updated Site and pre-site programmes.
   c. Foreign inspection dates.
   d. Inspections completed/outstanding.
   e. Register of accepted Defects.
   f. Non-conformance Reports, Corrective Action, Preventative Action and Concessions Reports.
x. Copy of all work instructions and procedures when requested by the Project Manager.
xi. The *Employer* carries out random and scheduled inspections on the plant.

4. ENGINEERING AND *CONTRACTOR'S* DESIGN

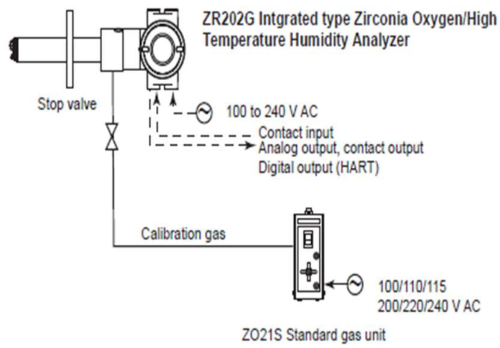
4.1 PARTS OF THE *WORKS* WHICH THE CONTRACTOR IS TO DESIGN

4.1.1 General requirements

i. The *Contractor* provides all equipment and services and executes all *works* to fulfil all requirements specified in this *works* information.
ii. The detailed scope of supply for the *works* is defined by a combination of performance, functional and equipment specifications such that a complete functioning system is provided.
iii. The *Contractor* is to obtain his own copies of National and International standards.

4.1.2 *Employer's* proposed design

i. The new O2 analyser is to be less sensitive to high temperatures and dusty environments. The proposed O2 analyser is used in most of the Power Stations across Eskom and have proven to be reliable for the past decades.
ii. The O2 analyser replacement requires the least amount of changes in the plant. Medupi is known for extreme conditions (dust and heat).
iii. The new system shall be installed such that it consists of the compact unit (Analyser and Probe combined).
iv. Signal cables shall be installed such that they are from the O2 analyser to the existing junction box.
v. The design is such that the current installation will be replaced with the compact unit (O2 probe combined with the display). The existing location of the O2 analyser will be utilised for the new design. Figure below show the proposed new type of O2 analyser:



This analyser consists basically of a probe and a converter that is used as both a Zirconia Oxygen Analyser and High Temperature Humidity Analyser.
This integrated type Zirconia oxygen analyser does not need a sampling device and allows direct installation of the probe in the wall of the flue or furnace to measure the concentration of oxygen in the duct gas.

The integrated O2 analyser integrates both probe and converter to reduce wiring, piping and installation costs.
The ambient air is used as the reference gas. A portable standard gas unit (ZO21S) is used for the calibration. The unit is connected only when the calibration is carried out. This unit is connected only when the calibration is made. Below is the process data to be used during the selection of the O2 analyser:

1	General information	Type of analyzer:: ☑ Oxygen Analyzer ☐ High Temperature Humidity Analyzer
	Customer	☐ Separate type ☑ Integrated type
	Destination of delivery	Object: ☑ indication ☑ record ☑ control ☑ alarm
	Plant name	Fuel: ☐ gas ☐ oil ☑ coal ☐
	Measurement points	Power reuirements 100 - 240 VAC 48 - 62 Hz
2	Process conditions	
2.1	Measurement gas components	
2.2	Oxygen concentration	Nor. Min 0 Max 25 ☐ vol%O_2 ☐
	Moisture contents	Nor. Min. Max. ☐ kg/kg 6 ☐ vol%H_2O
2.3	Temperature	Nor. Min. 20 Max. 600 ☐ Deg C ☐
2.4	Pressure	Nor. Min. Max. +-0.13 ☐ kPa ☐
2.5	Gas flow	Nor. Min. Max. ☐ m/sec ☐
2.6	Dust type, Size	Nor. Min. mm quantitiy ☐ g/Nm³ ☐
2.7	Corrosive gas	☐ No gas ☐ Gas quantity ☐ ppm ☐ / quantity ☐ ppm ☐
2.8	Combustible gas	☐ No gas ☐ Gas quantity ☐ ppm ☐ / quantity ☐ ppm ☐
2.9	Others	
3	Installation site conditions	
3.1	Ambient temperature	1. Around Probe temp. from to °C. 2. Around Converter temp. from to +- 45 °C
3.2	Vibration	☑ No vibration ☐ Vibration
3.3	1 Probe installation location	☐ Vibration ☐ Stack ☑ Others Air Heater Inlet
	2 Probe position	☑ Horizontal ☐ Vertical ☐ Others ☐ Indoor ☐ Outdoor ☑ Covered
	3 Probe insertion length (m) (Note)	☐ 0.4 ☐ 0.7 ☑ 1.0 ☐ 1.5 ☑ 2.0 ☐ 2.5 ☐ 3.0 ☐ 3.6 ☐ 4.2 ☐ 4.8 ☐ 5.4
	4 Flange	☐ DIN ☐ ANSI ☐ Others
3.4	Instrument air supply	☑ Cannot be used. ☐ Can be used. kPa
3.5	Converter location	☐ Indoor ☐ Outdoor ☑ Covered (under roof)
3.6	Cable length between probe and converter	meters
3.7	Calibration method	☑ Manual ☐ Automatic

Table 2: The specifications for the proposed InSitu O2 analyser

General	
Flue gas temperature:	20°C to 600°C
Heater temperature:	700°C ±3°C
Pressure:	±2psig (±13.8kPa)
Probe material:	310 Stainless steel
Case material:	Powder-coated aluminium
Mechanical Data	
InSitu Probe Length and Accessories:	
Overall length of probe:	
1. 0.9144 m / 36” x 2	
2. 1.828 m / 72” x 4	
3. Flange Size	DN100 PN6
4. Filter Type	Mesh Wire and Ceramic
Environmental Protection	
Probe Head:	IP65 protected
Operating Temperature:	-20°C to +70°C
Relative Humidity:	10% to 90% non-condensing
Performance Data	
Measuring Range:	Selectable range 0 to 1; 0 to 25% v/v O_2
Accuracy:	± 1 % of full scale
Repeatability:	± 0.5 % of full scale on analogue outputs
Response Time:	90% of full scale within 5 seconds (Calibration gas)
Measuring Method:	Zirconia oxide sensor
Warm-up Time:	20 minutes maximum
Electrical Data	
Voltage Range:	100 – 240 VAC
Frequency:	48 – 62 Hz
Power:	250 W
Current Rating:	4 A Peak

4.2 BASIC ENGINEERING

4.2.1 General Requirements

i. Basic engineering is defined as being all activities necessary to clearly identify the Contractor's scope and design for the O2 analyser system concerned.
ii. The basic engineering activity shall include the Contractor's interfacing and participation with the Engineer, Employer personnel and Other Project Contractors through clarification meetings in order to reach the basic design freeze (DF) completion.
iii. As a minimum, basic engineering shall consist of the following activities:
    a. Concept designs – during which the rules, philosophies and concepts followed in the various engineering and design activities, are clearly defined, clarified and approved.
    b. Investigation work – during which the Contractor conducts his investigation work.
    c. Scope definition – during which detailed scope definition and clarifications are performed.
iv. During the Contractor's investigation work, the Contractor shall take responsibility for collecting all information from the Employer to enable the Contractor's design to be completed.
v. The Contractor shall identify any discrepancies that would lead to shortcomings and/or deviations in the Works and shall make the Employer aware of such discrepancies and provides recommendations, where applicable. The Contractor takes action on such discrepancies.
vi. Any discrepancies identified are redlined by the Contractor and submitted to the Employer for approval.
vii. Technical clarification is where the Contractor shall clarify with the Employer and Other Project Contractors all the technical issues to permit the Contractor to start detailed engineering.
viii. All equipment having long delivery times shall be planned and technically clarified early in the technical clarification stage to allow early Detailed Engineering to commence in parallel.
ix. The Contractor shall be responsible for maintaining the minutes of the meetings, a deviation schedule and list of open points (LOP) for all engineering activities and shall record all changes to scope during the basic engineering phase.
x. Where the Contractor's system interfaces to 3rd party systems (including electrical and civil interfaces provided by others), the Contractor shall coordinate, through the Employer, with Other Project Contractors and design the interface to ensure the overall design is complete and well-engineered.
xi. The Contractor shall take full responsibility for all technical interfaces between the O2 analyser systems and DCS (including electrical and civil interfaces provided by others).

4.2.2 Specific Requirements

i. A compact oxygen analyzer that comes as probe and display integrated on one unit;
ii. The oxygen probe must come with dust filter fitted on it;
iii. The oxygen probe must come with a dust guard protector fitted on the tip to prevent dust settling on the cell;
iv. Display range of 0 – 25 vol% O2;
v. Output signal of 4 – 20mA;
vi. Tolerance of ±1% maximum value of set range;
vii. List of spares to maintain the system;
viii. The system annual average availability of 100 % is required during the course of the life of the system and a daily reliability> 90%;
ix. Probe head to be IP65 protected.

x. The system should come with operating and maintenance manuals.
xi. The system's installation should be similar to the current installation.

4.3 DETAILED ENGINEERING

4.3.1 General Requirements

i. Detailed engineering is defined as being all activities required to translate the Contractor's scope and design into fully functional O2 analyser system.
ii. As a minimum, detailed engineering shall consist of the development, technical clarification and acceptance of the documents defined in as being required for the Detailed Engineering design.

4.4 MANUFACTURING

4.4.1 General Requirements

i. The O2 analyser system shall undergo Factory Acceptance Testing (FAT) at the factory premises and the results shall be submitted to the Employer for approval.
ii. The Employer has the right to appoint representatives of the Employer and Other Project Contractors, on behalf of the Employer, to inspect all parts during manufacture and to be present at any of the tests specified.
iii. The Employer is free to specify additional 'hold and witness points' during the fabrication and factory testing of the O2 analyser system.
iv. The Contractor shall issue preliminary notification of hold and witness points by giving not less than twenty eight (28) days of advance notice to the Employer.
v. The Contractor shall confirm hold and witness points at least seven (7) days prior to the activity, as shown in the Approved Programme.
vi. Arrangements for witnessing inspections shall be made through the Employer.
vii. A minimum of fifty six (56) days' notice shall be given by the Contractor for inspections and shall be shown in the Approved Programme.

4.5 PROCUREMENT, INSTALLATION & QUALITY

4.5.1 Quality

i. This stage shall consist of the procurement, installation, on-site inspection and testing of all equipment forming part of the Works as well as other items that the Employer has specified such as free issued items.
ii. Quality inspections and tests shall be carried out by the Contractor after erection to prove the compliance of the installation with the Specification and the detailed engineering design freeze documentation.
iii. Erection and installation shall only be considered complete once the quality inspections and tests for the installation concerned have been approved by the Employer.
iv. The Employer reserves the right to appoint representatives, on behalf of the Employer, to inspect all parts during erection and to be present at any of the quality inspections and tests.
v. The Employer is free to specify hold and witness points during the installation and testing stages of the project.
vi. The Contractor shall give twenty one (21) days advance notice to the Employer of holds and witness points.
vii. The Contractor shall confirm hold and witness points at least nine (9) days prior to the test activity.

viii. The Contractor shall provide all test equipment for any inspections and tests.
ix. Damaged or defective structural steelwork and materials shall be set aside for the *Employer* to inspect and to decide whether such items may be rectified, repaired or rejected.
x. The *Employer* to have the right to order the removal from the Works of any defective or damaged material which have not been replaced or certified to his satisfaction, even if the material have been built into the Works.
xi. The *Contractor* to repair and replace all defective materials and rectify all defective workmanship at his own cost.
xii. All work done shall be approved and accepted by the *Employer*.

4.6 SITE INTEGRATION TEST (SIT)

i. The SIT for the O2 measuring system shall only begin once the following has occurred:
   a. The O2 measuring system equipment have been installed in their final locations and connected to permanent power supplies.
ii. The SIT shall be carried out before system commissioning commences to ensure:
   a. Correct performance of the system.
   b. Safety of plant and personnel.
   c. Compliance with the Specification and the detailed engineering design freeze documentation.
iii. As a minimum, the SIT testing and inspection activities provided by the *Contractor* shall consist of site integration and site acceptance activities defined in IEC 62381.
iv. The *Contractor* shall prepare a detailed test procedure in preparation for SIT and submit same to the *Employer* for approval.
v. As a minimum, the proposed SIT procedure shall identify the following:
   a. Major test activities.
   b. Comprehensive list and description of the individual tests to be performed.
   c. How the tests are to be prepared and conducted.
   d. Test dates and durations.
   e. Checklists – how the test results will be documented.
   f. Acceptance Criteria.
   g. How the identified discrepancies will be processed.
vi. A Final SIT Report shall be prepared by the *Contractor* that includes the following as a minimum:
   a. Test procedures used during SIT.
   b. Detailed Test results.
   c. Discrepancies identified during the tests.
   d. Resolution of the discrepancies.
   e. Retests conducted and results thereof.
   f. SIT certificate.
vii. The Contractor shall submit the Final SIT Report to the *Employer* for approval.
viii. When all tests are successful and the Final SIT Report is approved by the *Employer*, the system is classified as 'ready for use'. The system is then deemed ready for cold commissioning.

4.7 COMPLETION, TESTING, COMMISSIONING AND CORRECTION OF DEFECTS

4.7.1 Work to be done by the Completion Date

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

4.7.2 Use of the *works* before Completion has been certified

i. The Employer has the right to make use of the works before completion, should a need arise.

4.7.3 Materials facilities and samples for tests and inspections

i. The *Contractor* provides all necessary testing facilities and samples.

4.7.4 Commissioning

i. Commissioning of the *works* is required before Completion of the *works* is certified by the project manager.
ii. The *Contractor* shall submit a commissioning procedure to the *Employer* one month before the planned date of commissioning. This procedure shall detail all of the steps and procedures to be taken in order to demonstrate the functionality of the system as well as checks which prove that the *Contractor* has done everything required of him to provide the *Works* and fulfil the Purpose of the *Works*.
iii. Commissioning is defined as bringing into service all items of the *Works*, and meeting the functional requirements and performance criteria of the Specification.
iv. The *Contractor* shall commission all O2 measuring system to control equipment provided by the *Employer*.
v. Commissioning shall include all testing and verification of the stated performance criteria.
vi. The *Contractor* shall adhere to the requirements in 200-16714: Medupi Commissioning Procedure.

4.7.5 Optimisation

i. The *Contractor* will assist the *Employer* with the optimisation and customisation of the system in order to conform to the requirements of the end users.
ii. Optimisation will occur at intervals agreed on by the *Contractor* and the *Employer* upon Completion.
iii. The purpose of the optimisation phase will be to tailor the system to the specific requirements of the *Employer*.

4.7.6 Training and technology transfer

i. Refer to Section 3.10 of this document.

4.7.7 Operational maintenance after Completion

i. Maintenance of this system will be performed by C & I maintenance department.

5. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
Selometsi Sehloho	System Engineer: Boiler Engineering
Benji Rahlogo	Chief Technologist: Boiler Engineering
Sithokozile Hlongwa	Manager: Boiler Engineering
Thembi Mukenga	Manager: Performance and Testing
Lesley Baloyi	Group Manager: Operating (Acting)
Zubair Moola	Chief Engineer: COE

6. REVISIONS

Date	Rev.	Compiler	Remarks
November 2022	1	L Mmadihlaba	New Document

7. DEVELOPMENT TEAM

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

- Lucky Mmadihlaba - C & I Engineering

8. ACKNOWLEDGEMENTS

- Not applicable.

APPENDIX A: DESIGN STANDARDS, GUIDELINES AND CODES

#	Type	Number	Name
1	Eskom	240-58552870	Smart Plant for Owner Operators (SPO) Documentation Metadata Standard
2	Eskom	240-86973501	Engineering Drawing Standards
3	Eskom	0.84/3482	Medupi Power Station Earthing Standard
4	ISO	ISO 9001	Quality Management Systems
5	Eskom	237-19-SRM-PC	Medupi Power Station Emergency Preparedness and Response
6	Eskom	240-56227443	Requirements for Control and Power Cables for Power Station Standard
7	Eskom	240-52844017	System Reliability, Availability and Maintainability Analysis Guideline
8	Eskom	240-56355815	Junction Boxes and Cable Termination Standard
10	IEC	IEC 62381	Automation systems in the process industry – Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT)
11	Eskom	240-56355535	Process Calibration Equipment Standard
12	Eskom	240-56356396	Earthing and Lightning Protection Standard
13	Eskom	0.84/3482	Medupi Power Station Earthing Standard
14	SANS	SANS 62305	Protection Against Lightning
15	Eskom	240-56355731	Environmental Conditions for Process Control Equipment Used at Power Stations Standard
16	Eskom	240-56355910	Management of Plant Software Standard
17	Eskom	240-119638133	Control Systems Design for Redundancy and Diversity Standard
18	Eskom	240-72344727	C&I Control System Architecture Guideline
19	Eskom	200-16714	Procedure – Commissioning Procedure
20	Eskom	200-4190	Application for KKS Coding
21	Eskom	240-56355808	Ergonomic Design of Power Station Control Suites Guideline
22	Eskom	PPZ 200-3340	KKS Coding And Labelling Procedure KKS – Procedure
23	Eskom	N.PSZ 45-45	KKS Key Part Fossil Power Station

#	Type	Number	Name
24	Eskom	240-109607332	Eskom Plant Labelling Abbreviation Standard
25	Eskom	240-53114186	Project/Plant Specific Technical Document and Records Management Procedure
26	National Act	Act No. 85 of 1993	Occupational Health and Safety Act