	Functional Specification	Generation
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Annexure J

Title: **Medupi Power Station –
Functional Specification for the
Medupi ECSY Coal Disposal
Infrastructure**

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1. INTRODUCTION

Medupi Power Station (hereinafter referred to as Medupi) was commissioned between 2015 and 2020 and is situated in Lephalale Local Municipality, in the Waterberg region of Limpopo Province. Medupi is designed to generate approximately 4 800 Mega Watts (MW) nominal base load for all six units.

Due to delays with the commissioning of the Medupi Power Station units and [the take or pay] coal supply contract with the mine, the Medupi Excess Coal Stockyard (ECSY) project was, at the time, initiated to store surplus coal from the mine in order to avert payment of penalties to the coal supply mine. An environmental authorization for the development of the storage facility was obtained in May 2012 and is expiring around 2025.

The ECSY facility is located on the western side of Eenzaamheid 687 LQ farm on the footprint of the Medupi Ash Disposal Facility. The facility comprises of three phases, namely Phase 1 ,2 and 3. ECSY Phase 1 and 2 were commissioned between 2015 and 2017 while Phase 3 is in part commissioned (during 2022) and some sections under construction finalisation. Mobile plant was utilized for the stacking operations (broadly layering, spreading, compaction) and the current volume of coal stored on Phase 1, 2 and 3 (in part) is circa 14.4 Million tons (Mt).

Medupi Power Station (coal asset owner) has taken a decision to dispose of/sell the coal asset at the Medupi ECSY facility. Suitable logistics, bulk materials handling, and other necessary infrastructure including but not limited to loading and offloading platforms, operations infrastructure and bulk weighing facilities are deemed required to support and enable the coal asset disposal operations at Medupi ECSY facility via existing transportation networks, namely rail and/or road networks.

Against the above background, the Employer's main objective is to appoint a contractor (or potential coal buyer) for, inter alia, the site selection, feasibility studies, social impact studies, traffic management studies, EIA, optioneering, engineering design, construction, procurement, installation, supply, operations of the logistics, bulk materials handling and other required infrastructure to enable and support the coal asset disposal operations.

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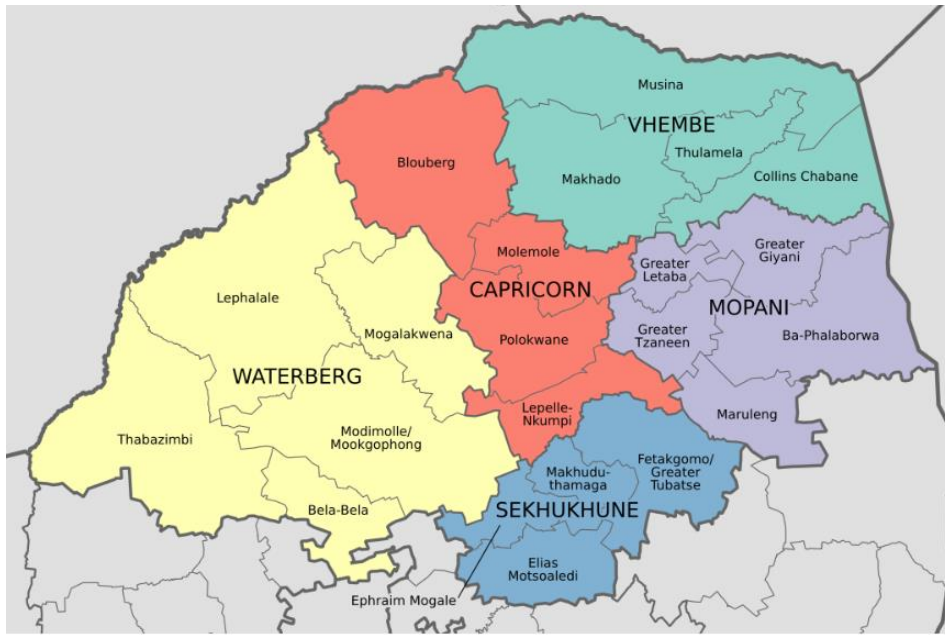


Figure 1: Locality map showing various regions of Limpopo Province (Source: Wikipedia accessed November 2022).



Figure 2: Locality Map showing Medupi ECSY Facility (Source: Google Earth (accessed January 2023)).

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1.1 SCOPE

1.1.1 Purpose

Broadly, the purpose of this document is to outline the functional specification requirements for the logistics, bulk materials handling and other required infrastructure necessary to support and enable the disposal of coal at Medupi ECSY facility.

Medupi Power Station has taken a decision to dispose of/sell the coal asset at the ECSY facility. A contractor or potential coal buyer(s) will be appointed to provide the infrastructure necessary to dispose the coal asset. At this stage, it is envisaged that appointed Contractor(s)/coal buyer(s) will be responsible for, including but not limited to, the following:

- Feasibility, trade-off, site selection traffic management assessment, social & environmental impact and other relevant studies,
- investigations (geotechnical, hydrological, geohydrological and others applicable),
- Development of various alternative to allow for the selection of the best fit solution
- Engagements with authorities, stakeholder and other relevant parties
- Providing cost estimates and costing analysis
- Engineering design and development of details necessary to support Environmental authorizations and approvals from other stakeholders (where applicable)
- Engineering concept and detailed designs,
- Obtaining environmental and other applicable permits, approval and licenses from relevant Authorities and stakeholders
- Execution of the works including but not limited to procurement, supply, management, construction, installation, fabrication, manufacturing, commissioning, safety clearance, relevant and applicable testing, incidental works, and maintenance.
- Quality assurance and control pre-, during and post execution
- Operations including but not limited to materials handling, reclaiming coal, transportation, loading and offloading,
- Provision, construction and supply of all necessary plant, equipment, incidental works, labour, infrastructure, spares, resources deemed required for the logistics, bulk materials

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handling and other reasonably required infrastructure required to support and enable the coal disposal/selling operation from Medupi Power Station ECSY Facility.

- Provision to remove (anticipated after all coal is disposed) all the established infrastructure and rehabilitation.

1.1.2 Applicability

This document applies to Medupi Power Station only.

1.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following, including but not limited to:

1.2.1 Normative References

- [1] The Constitution of South Africa (Act 108 of 1996)
- [2] Occupational Health and Safety Act (Act 85 of 1993) including relevant and applicable regulations and standards.
- [3] Construction Regulations, 2014
- [4] ISO 9001 Quality Management Systems
- [5] Medupi Power Station Environmental permits, relevant and applicable
- [6] SANS 1200 series, standardised specification for Civil Engineering Construction.
- [7] SANS series, relevant and applicable.
- [8] National Building Regulations,
- [9] National Water Act (Act 36 of 1998) and associated relevant and applicable regulations (i.e. GN704, Dam Safety regulations etc).
- [10] National Environmental Management Act (Act 108 of 1998) with associated regulations
- [11] National Environmental Management Waste Act (Act58 of 2008)
- [12] Legislative and regulatory requirements, relevant and applicable.
- [13] Engineering Profession Act(Act 46 of 2000)
- [14] ECSA Overarching Code of Practice for the Performance of Engineering Work
- [15] ECSA Code of Conduct
- [16] Statutes, legislative and regulatory requirements, relevant and applicable.
- [17] SAICE, Code of Practice for Geotechnical Investigation
- [18] 240-105658000: Supplier Quality Management Specification, QM 58

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- [19] 84CIVL036: Medupi Power Station, Stormwater Design Criteria
- [20] 84CIVL053: Medupi Power Station, Specification for Structural Concrete
- [21] 84CIVL007: Concept Architectural Design Specifications for Structures and other Buildings
- [22] 84CIVL028A: Recommendations For Seismic Design At Medupi PS
- [23] 240-55864503: Belt Conveyor Machine Components Standards
- [24] 240-55864503: Belt Conveyor Mechanical Components Standard
- [25] 240-55864504: Belt Conveyor Structural Steelwork and Welding Specification
- [26] 240-55864550: Mass Meters for Coal Measurement in Power Stations Design Standard
- [27] 240-55864553: Magnetic Separators and Metal Detectors Standard
- [28] 240-63236839: On-Line Coal Analysis System Technical Specification Standard
- [29] 240-120532564: Splicing and Repairs of Steel Cord - and Textile/Plied Reinforced Conveyor Belting
- [30] 240-55864434: Storage and Handling of Conveyor Belting in Eskom Guideline
- [31] 240-163146409: Scraper Chain Feeder Standard
- [32] 32-1034 Eskom Procurement and Supply Chain Management Procedure (with reference to Section 14 of Rev 04)
- [33] 240-2022403: Required Operational Capability for Medupi Power Station Excess Coal Disposal

1.2.2 Informative References

- [34] All work shall be conducted in accordance with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) as amended.
- [35] 240-53113685: Design Review Procedure.
- [36] Relevant and applicable SANS
- [37] Best Practice Guidelines (relevant and applicable).
- [38] ISO 9001 Quality management Systems
- [39] ISO 9007 Guidelines for Configuration Management
- [40] 32-421 – Eskom Life Saving Rules
- [41] 240-53113685: Design Review Procedure
- [42] 240-53113953: Manage Engineering Accountability Procedure
- [43] 240-53114002: Engineering Change Management Procedure
- [44] 240-56364545: Structural Design and Engineering Standard

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- [45] 240-57127955: Geotechnical And Foundation Engineering Standard
- [46] 240-84418186: Road Specification Manual
- [47] 240-91244751: Specification for Geotechnical Investigation Standard
- [48] 240-98349953: Check Sheet for Geotechnical Investigations
- [49] 240-8973501 Engineering Drawing Standard and Common Requirements
- [50] 84CIVL096: Medupi Power Station, Stormwater Design Criteria
- [51] 084CIVL028A: Recommendations For Seismic Design At Medupi PS
- [52] 240-53114026 Project Engineering Change Management Procedure
- [53] 240-126468603 Operational Standard for Fire Management in Generation
- [54] 240-54937450 Fire Protection and Life Safety Design Standard
- [55] 240-56356376 On-Site Commissioning for Low Pressure Systems Standard
- [56] 240-105020315, Standard for Low Pressure Valves
- [57] 240-106628253, Standard for Welding Requirements on Eskom Plant
- [58] 240-123801640, Standard for Low Pressure Pipelines
- [59] 240-61227631 Piping and Instrumentation Diagram (PID) Standard
- [60] 240-106680663 Lifts, Escalators, Lifting and Crane Design Guideline

1.3 DEFINITIONS

The following provides broad definitions applicable to this document.

Definition	Description
Asset disposal	Process of/intension to sell coal asset to willing and participating off takers.
Bulk Materials Handling	Refers to the systems used to transport materials from one point to another and includes all conveyors and transfer facilities. The materials transported include coal, ash, limestone and gypsum
Coal Conveyor	A rubber belt used to transport coal.
Excess Coal Stockyard	Long term coal storage facility, located on the western side of the Medupi Ash Disposal Facility (ADF).

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Definition	Description
Off-taking contractor(s)	Contractor(s) responsible for buying, loading and transporting coal from the Excess Coal Stockyard.
Ton	Unit of weight or mass, approximately equal to 1000 kilograms

1.4 ABBREVIATIONS

Abbreviation	Description
ADF	Ash Disposal /Dump Facility
CIDB	Construction Industry Development Board
C&I	Control and Instrumentation
°C	Degrees Celsius
DEFF	Department of Environmental, Forestry and Fisheries
DWS	Department of Water and Sanitation
ECM	Engineering Change Management
ECSA	Engineering Council Of South Africa
ECSY	Excess Coal Stockyard Facility
EDWL	Engineering Design Work Lead
EIA	Environmental Impact Assessment
GCD	Group Capital Division
Gx	Generation
ISO	International Standard Organisation
ITP	Inspection Test Plan
km	Kilometer
LDE	Lead Discipline Engineer
LPS	Low Pressure Services
Mt	Million tons
MV/LV	Medium Voltage/Low Voltage

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Abbreviation	Description
MW	Mega Watt
NKP	National Key Point
O&M	Operating and Maintenance
PEC	Professional Engineering Certificate
PED	Primary Energy Division
PEM	Project Engineering Manager
PLCM	Project Life Cycle Model
PPE	Personal Protective Equipment
ROC	Required Operational Capability
SANS	South African National Standards
SOW	Scope of Work
SRD	Stakeholder Requirement Definition
URS	User Requirement Specification

1.5 DISCLOSURE CLASSIFICATION

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

1.6 ROLES AND RESPONSIBILITY:

Lead Design Engineers (LDEs): The Lead Design Engineers are responsible for compiling their specific sections within this functional specification in line with stakeholder requirements. They must ensure that the Works Information that is derived from this Specification has correctly captured their inputs.

Engineering Design Work Lead (EDWL): The Engineering Design Work Lead is responsible for ensuring the complete integration of this functional specification and ensuring that it meets stakeholder requirements. They must ensure that the necessary reviews to assure the quality translation of this specification to the Works Information takes place and is aligned to necessary Eskom governance.

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Project Engineering Manager (PEM): The Project Engineering Manager is responsible for the delivery of this functional specification to the Project Manager in a timeous manner, within budget and off high quality.

Project Manager: The Project Manager is responsible for translating this functional specification into the Works Information.

1.7 PROCESS FOR MONITORING

All processes will be monitored as per the ECM process and contracts management processes.

2. SITE LOCALITY

2.1 BRIEF DESCRIPTION OF EXISTING ECSY FACILITY

The ECSY Facility is a line coal storage facility (Class C equivalent as per Government Notice Regulation 636 Norms and Standards for Disposal of Waste to landfill), and comprises of three (3) phases, namely ECSY Phase 1, 2 and 3 with associated infrastructure. The facility is currently located on the western side of the Medupi Ash Disposal Facility footprint on the Eenzaamheid 687 LQ Farm.

The main access to the Medupi Power Station is via road D1675 (Steenbokpan Road). Other transportation network in the vicinity of Medupi Power Station include an existing railway line to the south of the Eenzaamheid 687 LQ farm.

The constructed ECSY infrastructure broadly comprises of the following:

- ECSY Phase 1 stockyard with associated leachate collection, coal pilot layer, paddocks, dirty water channels and pollution control dam D5. Single access ramp.
- ECSY Phase 2 stockyard linked to Phase 1 with associated leachate collection system, dirty water channels, coal pilot layer and pollution control dam D4.
- ECSY Phase 3C (cell 1 & 2) and 3D (cell 1 & 2) stockyards with associated leachate collection system, coal pilot layer, paddocks, dirty water channels and pollution control dams D6 and D7. Note: Phase 3D is partially under construction. Single access ramp.
- Phase 1 & 2 access ramp, Phase 3 access ramp, security, and maintenance roads.

Coal from the Exxaro Grootgeluk mine is supplied via circa 5.2km overland coal conveyor and stacked on the Medupi internal (Seasonal, Live, and Strategic) coal stockyards using a combination of mechanical stacker machines and mobile plant.

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Internal haul roads were constructed to facilitate the transportation of coal from the internal coal stockyards to the ECSY Facility using trucks (located circa 7.2km west of the internal coal stockyards). The ECSY Coal stockyard is compacted in layers (as per the ECSY Operating and Maintenance Manual), stacked to a height of 25m, and with the current stored volume of coal is circa 14.4 million tons.

The lined ECSY facility will be rehabilitated to a future Ash Disposal Facility once all the coal has been reclaimed. The appointed Contractor shall therefore exercise the necessary care not to damage the existing infrastructure during the coal reclamation and other activities. Any damage to existing infrastructure due to Contractor’s activities shall be reinstated/repared at the Contractor’s costs.

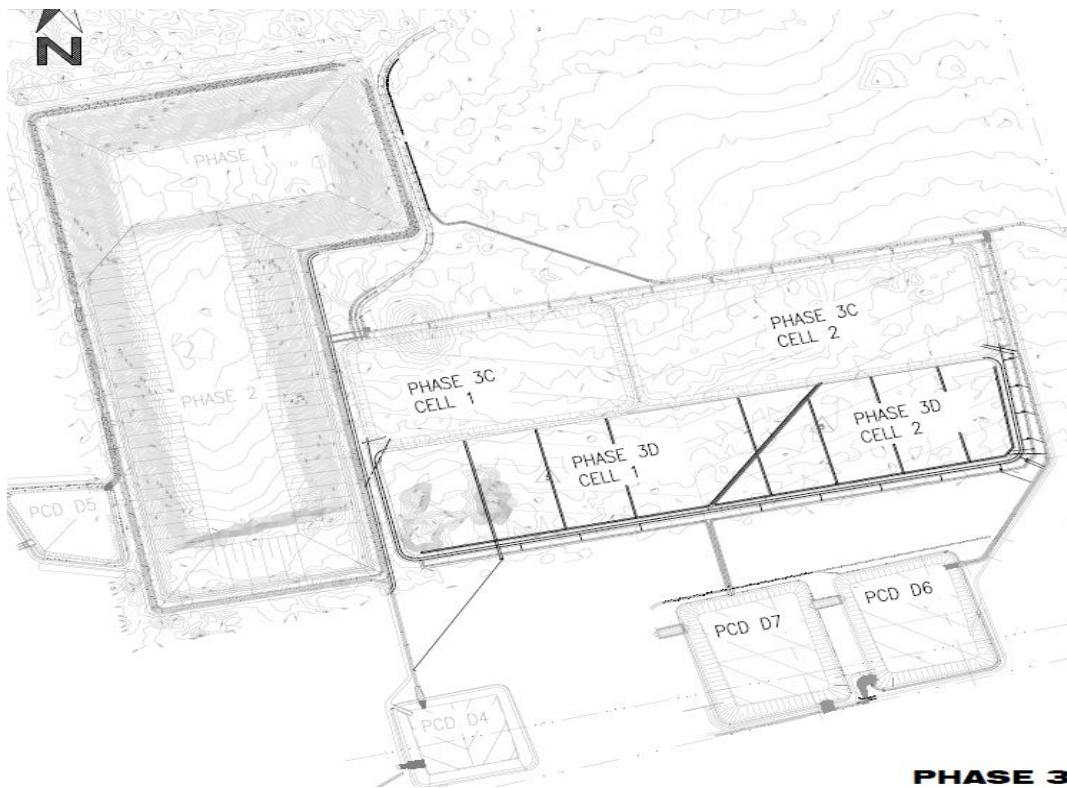


Figure 3: Layout of ECSY Phase 1, Phase 2, and Phase 3 Facilities with associated infrastructure.

Table 1: Volume/tonnage per stockpile as of February 2023 (source ROC)

Stockpile	Volume [m^3]	Density [ton/m^3]	Mass [ton]
ECSY Phase 1 & 2	6 167 020	1.60	9 867 232
ECSY Phase 3C (Cell 1 and Cell 2)	171 055	1.60	273 688
ECSY Phase 3D (Cell 1)	2 654 726	1.60	4 247 562

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Emergency Storage area	Coal	20 306	1.60	32 490
Total		9 013 107	1.60	14 420 972

Caveat: At the time of compiling this document the total volume/tonnage is as per information included in the ROC. Changes to the volume stored will necessitate updates (if applicable) to the above table.

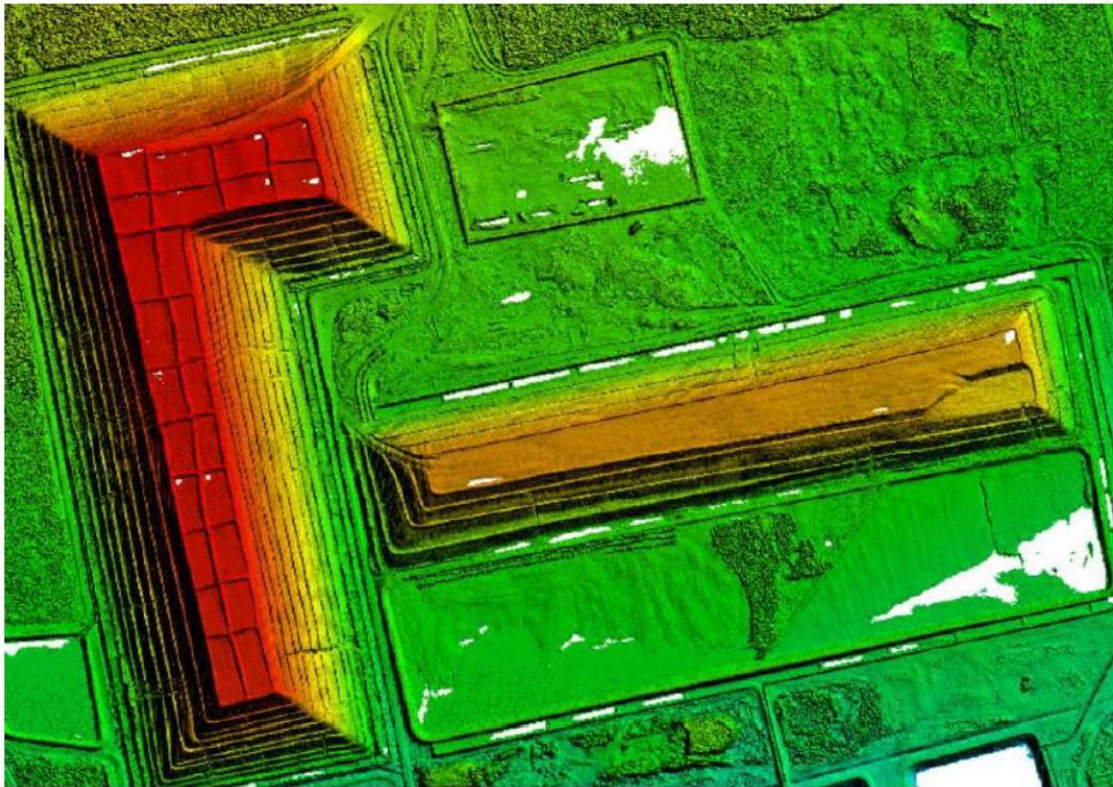


Figure 4: Survey of the ECSY Facility dated February 2023 (source ROC document).

3. FUNCTIONAL SPECIFICATION OVERVIEW

The functional specification outlines the minimum requirements for the bulk material handling, logistics and other applicable/required infrastructure necessary to support and enable coal selling/disposal operations at Medupi Power Station ECSY facility.

This document outlines the following minimum functional requirements:

- Safety, Health, Environmental and Quality
- Engineering and construction
 - Civil and Structural

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- Bulk Materials Handling
- Electrical
- Control & instrumentation
- C&I and CBMS
- Low Pressure Services
- Systems Integration
- All incidental works
- Logistics requirements
- Testing and commissioning requirements
- Infrastructure disposal and rehabilitation requirements

3.1 ASSUMPTIONS & LIMITATIONS OF THE FUNCTIONAL SPECIFICATION:

The following assumption and limitations are noted at the time of compiling this document:

- a) Following the Eskom PLCM standard from inception of projects is mandatory to broadly ensure amongst other things that Eskom derives benefits from the investment and prevent unnecessary risk exposure to the business. As such, it is assumed that the Client (Medupi Generation) will obtain all necessary project governance approvals and/or exemptions from PLCM standard.
- b) In accordance with the ROC document, the appointed Coal offtake contractor(s) shall be responsible to appoint the design consultant and contractor for, amongst other things, feasibility and other applicable studies, investigations, development of alternative, engineering concept and detailed design, construction, supply, manufacturing, operations (including loading, offloading, transportation), maintenance, and rehabilitation of the bulk material handling and other required infrastructure necessary to support and enable the coal asset disposal operations.
- c) The ROC document broadly states that land will be made available to the Contractor for the development of infrastructure required to dispose of the coal. At the time of compiling this document, Medupi had not identified land/site for the infrastructure particularly for the potential rail siding. It is, therefore, envisaged that site selection (including Environmental Impact,

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Traffic Impact) studies might be required to identify suitable land/site within (and/or adjacent to) Medupi Power Station footprint for the rail siding and other infrastructure.

- d) It is assumed that the appointed Contractor will, amongst other things, conduct site selection studies, EIA, investigate and evaluate a wide range of alternatives to ensure the selected solution(s)/option(s) is the best fit and will benefit the organisation.
- e) At the time of compiling this document, the Project complexity assessment was not available. Some of the perceived project complexities such as potential legal, social, reputational and environmental risks will require appropriate risk mitigations measures (i.e. the negative impacts to existing road infrastructure due to coal transportation by trucks are well known).
- f) It is assumed that the coal sampling, testing and analysis before selling operations including applicable quality controls will be addressed in detail separately by Primary Energy Division and/or coal offtake agreement(s).
- g) It is envisaged that the infrastructure to be developed will be required temporarily and the established infrastructure will be removed at a later stage by the appointed Coal offtake Contractor.
- h) At the time of compiling this document the coal stored to date was indicated as circa 14.4 million tons based current available information. Possibility exist of stockpiling additional coal at the ECSY, the volume estimate (as per ROC) will need to be updated to reflect the additional surplus coal stored (if any) from henceforth. Contingencies for additional coal stored exceeding the volumes indicated in the ROC should be considered.
- i) The current Environmental Authorization for the ECSY Facility is expiring around 2025. It is assumed that the necessary Environmental Authorization extensions will be in place. The extensions periods will need to consider the periods required to remove all the coal.
- j) It is assumed that the quality of currently stored coal is within the typical coal quality specification and has not deteriorated/does not vary significantly from the Medupi coal quality specification or “expected quality”. At time of compiling verification sampling or testing was not conducted. Measure to address variations in the coal quality should be addressed in the coal offtake agreements.
- k) It is assumed that the functional design life requirements will take into consideration, inter alia, the minimum coal offtake agreement and/or logistics timelines to remove the coal and/or Employer’s requirements.

- l) Timelines to dispose of the coal shall accordingly consider the Ash dump growth plan. Appropriate alternatives should be considered for any delays with removal of the ECSY to ensure ashing space is available.

4. EMPLOYERS OBJECTIVES

Broadly, the Employer main objective is to dispose/sell the coal commodity at Medupi ECSY. The Employer intends appointing a Contractor(s)/Coal Offtake Contractor(s) for, including but not limited to, the feasibility and other studies, obtain environmental and other applicable permits/licenses, investigations, engineering concept (including optioneering) and detailed design, procurement, supply, manufacturing, construction, all incidental works, commissioning, operations and maintenance of the bulk materials handling, logistics and other applicable and required infrastructure necessary to enable and support the disposal of/selling of the coal asset.

In principle the operations are envisaged as comprising of but not limited to the sourcing, supply of all required plants, equipment, labour and other required resources deemed necessary for all operations relating to coal disposal (such as reclaiming the coal from the existing stockpile, loading, transportation, offloading, delivery of the coal to the buyer's destination and all other necessary operational activities).

The Contractor shall be responsible for operations, maintenance, removal and rehabilitation of the established infrastructure.

The infrastructure developed on Eskom's land will be the property and responsibility of the Contractor however the land will remain the property of Eskom.

5. TYPICAL COAL QUALITY SPECIFICATION

The coal supplied by the mine is required to comply with, amongst other requirements, the Medupi Coal Specification as per the Coal Offtake Agreement. The coal quality characteristics as per Medupi Coal specification is indicated in the below Table 2.

Coal is sampled and periodically tested by Medupi and the mine for compliance as per the Coal Offtake Agreement. Records of the actual analysed coal per shift are kept. Due to storage and preservation broadly by layering and compaction, the Client expects (assumes) the coal qualities to have not changed significantly from the qualities analysed over the period of storage. Available coal analysis results (including trace elements results) can be made available to potential Contractors. However, the Contractor shall as a minimum include provision for coal quality verification sampling and testing.

Coal sampling shall adhere to coal sampling specification and standards.

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CAVEAT: All parameters are measured to 1 (one) decimal place and Sulphur content which shall be measured to 2 (two) decimal places. The Contractor shall take note that there could be instances that the parameters could be lower than the lower limit and higher than the upper limit of the average qualities summarised above. The Contractor shall be responsible for verification sampling and testing of the actual coal stored as required

Table 2: Medupi contractual coal quality specification (source ROC 241-2022403)

Quality Parameter	Unit	Measurement Period	Measurement Basis	Expected Quality	Distress Point	Rejection Point	Impact Coefficient (% per unit)
Calorific Value	MJ/kg	24h	Dry	20.5	19	18	0.474
Ash Content	% by weight	24h	Dry	35	37.5	39	0.169
Abrasive Index	mg Fe/kg	24h	Dry	315	475	625	0.02
Total Moisture (low)	% by weight	8h	AR	11	5	3	0.2
Total Moisture (high)	% by weight	8h	AR	11	12	13.5	0.2
Total Moisture (peak)	% by weight	1h	AR			14	None
Hardgrove Index		24h	Dry	52	45	35	None
Ash Initial Deformation Temp (reducing atmosphere)	° C (Degree Celsius)	24h	Dry	1350	1270	1250	None
Volatile Matter (low)	% by weight	24h	Dry	22-28	20.5	20	None
Volatile Matter (high)	% by weight	24h	Dry	22-28	30	32.5	None
Sulphur Content	% by weight	24h	Dry	1.3	1.8	2.2	None
Size >45mm	% by weight	24h	Dry	5	7	10	None
Size < 6.7mm	% by weight	24h	Dry	60	65	75	None

Element analysis is conducted on an ad hoc basis from time to time (not routinely). Below figure 5 provides typical analysis results of the Medupi Coal.

It must be noted that the excess coal stockyard was stacked over a period of seven (7) years. Records are available of actual coal quality analysed per shift over the period. Only surplus coal was transported to the ECSY whilst the balance was stored at the internal coal stockyards or conveyed to the units for electricity production.

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Analytical Moisture	%	2.0
Ash	%	32.4
Volatile Matter	%	27.0
Fixed Carbon (by difference)	%	38.6
Carbon	%	51.03
Hydrogen	%	3.16
Nitrogen	%	1.11
Total Sulphur	%	1.28
Carbonate	%	2.57
Oxygen (by difference)	%	6.45
Gross Calorific Value	MJ/kg	21.07
Surface Moisture	%	7.8
Total Moisture	%	9.7
Inherent Moisture (as recieved)	%	1.84
Elemental Analysis		
SiO ₂	%	58.1
Al ₂ O ₃	%	23.6
Fe ₂ O ₃	%	7.0
TiO ₂	%	1.5
P ₂ O ₅	%	0.31
CaO	%	2.3
MgO	%	1.6
Na ₂ O	%	0.33
K ₂ O	%	0.9
SO ₃	%	1.68
MnO	%	0.05
Ash Fusion Temperature		
Deformation Temperature	°C	1480
Softening Temperature	°C	1490
Hemisphere Temperature	°C	1500
Flow Temperature	°C	1500

Figure 4: Typical element analysis results of Medupi coal (source: ROC document).

6. LOGISTICAL OPERATIONS FOR COAL COMMODITY

Two modes of transportation are available namely transportation by road or rail or combination of both as per coal offtake Contractor's preference.

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6.1 LOGISTICS BY ROAD TRANSPORTATION

Utilising the interlinks trucks for the pay load transportation from the Medupi CSY to the client delivery point.

There shall be at least two Front End Loaders loading each truck at any given moment, the loading area has to be prepared so that it can take up to two trucks at any given moment. The total of 4 x Front End Loaders with 2 x FELs (966 equivalent, with coal bucket) per truck being loaded.

There shall be a need to also have at Least 2 x Bull dozers (D8 equivalent, with coal blade) working in the area in terms of the dozing of coal into a heap for the FELs to be able to collect and load on the trucks.

The operation will also require at least 2 x Water carts (18000 liters) in order to do dust suppression in the area of the operation and the road that the trucks will be using since it will be a gravel road that is being used at the moment by the ADTs delivering coal to the excess coal area.

The route to be used shall be the excess stockpile and at the station gate turn left to join the road to Steenbokpan and then right at the T-junction until the next T-junction which will be the road that joins the road from Lephalale to Vaal water.

6.2 LOGISTICS BY RAIL TRANSPORTATION

There is an existing railway line that is next to the excess stockpile which can be utilised in terms of rolling stock logistics and there shall only be an establishment of the rail siding.

Utilising the rail network to deliver coal from Medupi to the client delivery point.

There shall be rail siding which will need to be established at the side of the excess stockyard so that the train can be loaded by means of Front-End Loaders which have to be done at least within the 4 hours turnaround time.

There has to be 2 x Front End Loaders loading one carriage at any given moment so that the train can be loaded quicker.

There shall be at least two Front End Loaders loading each rail carriage at any given moment, the loading area has to be prepared so that it can take up to two rail carriages at any given moment. The total of 4 x Front End Loaders with 2 x FELs (966 equivalent, with coal bucket) per carriage being loaded.

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There shall be a need to also have at Least 2 x Bull dozers (D8 equivalent, with coal blade) working in the area in terms of the dozing of coal into a heap for the FELs to be able to collect and load on the rail carriages.

The operation will also require at least 2 x Water carts (18000 litres) to do dust suppression in the area of the operation.

7. APPROVALS, PERMITS, AND LICENSES FROM THE RELEVANT AUTHORITIES AND INTERFACING STAKEHOLDERS (E.G. ROAD AGENCY LIMPOPO, TRANSNET FREIGHT RAIL, GOVERNMENT DEPARTMENTS)

The Contractor shall be responsible for compiling and obtaining all applicable permits, licenses, checklists, way-leave applications and approvals from the relevant Authorities and stakeholders. The Contractor shall include provision for engagements with the relevant Authorities to obtain applicable design and construction approvals. Due to potential interfaces with/connection to the existing road and/or rail networks, the Contractor shall make provision for engagements with interfacing road and rail stakeholder and/or other relevant Authorities.

8. CONTRACTOR'S DESIGN

The Contractor shall be responsible for the engineering design of all required logistics, bulk materials handling, support and other applicable and required infrastructure to support and enable the disposal/selling of the coal asset at Medupi ECSY facility. The Contractor shall be responsible for design integration and interfacing with existing infrastructure and relevant stakeholders.

The Contractor shall be responsible for design, design approvals and execution of all works deemed necessary.

The Contractor shall ensure his designs (temporary or otherwise), as a minimum, complies with the Employer's requirements, relevant and applicable design codes, codes of practice, best practice guidelines, stakeholder requirements, legislative and regulatory requirements including but not limited to Engineering Professions Act (Act 46 of 2000), Engineering Council of South Africa requirements, Occupational health and Safety Act, Construction Regulations etc.

8.1 FUNCTIONAL DESIGN AND SERVICE LIFE REQUIREMENTS

The Contractor shall propose appropriate minimum design life and service life requirements taking into consideration the fit for intended purpose requirements, coal offtake agreement durations, maintainability, Environmental approvals/licenses, logistics and/or duration to dispose of the coal as

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per Employer's Requirements including but not limited to Occupational Health and Safety Act and other relevant regulatory and legislative.

8.2 DESIGN REVIEW PROCEDURE

The Contractor will adhere to the Employers requirements including but not limited to the Employers Design Review Procedure Document No. 240-53113685, Project Engineering Change Management Procedure Document No. 240-53114026, and Engineering Change Management Procedure Document No. 240-53114002.

The Contractors planning and scheduling shall include provisions to accommodate Employers' design review procedure, Employers' review and acceptance of the designs. The Contractor shall ensure that any changes to approved design follow the Employers processes including applicable and relevant legislative and regulatory design change approval processes (where applicable).

8.3 SAFETY ASSESSMENT

The Contractor shall ensure his designs comply with all required safety requirements. The design shall consider (where applicable) Industrial safety assessments, fire safety assessment, operational safety assessment, traffic safety assessment, and other relevant safety assessments.

8.4 REMOVAL OF ESTABLISHED INFRASTRUCTRE AND REHABILITATION:

The Contractor shall include provision to remove/de-establish all established infrastructure and rehabilitate the areas in accordance with Medupi Environmental requirement and other applicable legislative and regulatory requirements.

The Contractor can consider approaching Eskom to sell the infrastructure however, caveat, Eskom is under no obligation to purchase the infrastructure from the Contractor.

8.5 COAL RECLAMATION PLAN

The Contractor shall be responsible for developing a coal reclamation plan, as a minimum, taking into consideration the existing infrastructure and coal stockpiles, logistics plan, Ash dump growth plan, respective ECSY O&M manuals requirements, rate of reclamation, storm water management, safety, prevention of damage to existing infrastructure (and liner system particularly when the coal reclamation reaches the bottom of the stockpile).

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8.6 MAINTENANCE:

The Contractor shall be responsible for the maintenance of the constructed and established infrastructure.

8.7 OPERATIONS:

The Contractor shall be responsible for operations of the infrastructure and all activities relating to (including) coal disposal operations.

8.8 RELIABILITY, MAINTAINABILITY, AVAILABILITY ASSESSMENT

Not applicable. The plant will be operated and maintained by the Contractor.

8.9 HAZARD AND OPERABILITY STUDY (HAZOP)

Not applicable. The plant will be operated and maintained by the Contractor.

8.10 FAILURE MODE EFFECTS AND CRITICALITY ANALYSIS (FMECA)

Not applicable. The plant will be operated and maintained by the Contractor.

9. SITE SELECTION

The Contractor shall be responsible for, as a minimum, investigating, evaluating the feasibility of alternatives sites and selection of the most feasible site for the development of the Rail Siding infrastructure (where applicable), loading and offloading platform and other required infrastructure. The development of the engineering designs will need to consider Employers requirements including relevant municipal by laws, regulatory and legislative requirements The Contractor shall include provision for necessary studies required to support the site selection process.

It is anticipated that Weighbridge facility will be located adjacent to (and within) the Medupi Power Station ECSY Facility. The Contractor shall investigate and evaluate the most feasible site to locate Weighbridge facilities and other required infrastructure.

10. SAFETY REQUIREMENTS

The Contractor shall ensure compliance to the following as a minimum:

- a) A copy of Baseline Risk assessment as per scope
- b) Company Organogram as per the scope of work
- c) A copy of letter of standing or from a mutual federation

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- d) A copy of Medical surveillance and certified copies of medical certificate
- e) Health and Safety Plan as per scope of work
- f) SHE Legal organisational Structure
- g) Health and Safety Costing
- h) SHE/Safety Policy signed by CEO
- i) Covid 19 requirements-Policy, Plan and Risk Assessment

NB: This are only tender returnable and will also be supported by the SHE specifications

11. ENVIRONMENTAL REQUIREMENTS

The contractor shall provide an ISO 14001:2015 certificate or documentation for Environmental Management System (EMS) as indicated below.

- Environmental Policy
- Aspects and Impacts Register
- Environmental Objectives and Targets
- Environmental Roles and Responsibilities procedure including appointment letter of the personnel that will be responsible for implementing the requirements
- Environmental Communication Procedure
- Procedure for Environmental Internal Audits
- Emergency Preparedness for Environmental related emergencies
- Monitoring, measurement, and evaluation of compliance
- Management Review procedure

An Environmental Management Plan (EMP) which include the items indicated below.

- Handling of Hazardous Chemical Substances
- Site Establishment
- Environmental Training
- Procedure for Environmental Incident Reporting
- List of relevant legislations

The contractor will also be expected to submit a Waste Management Plan which must include the following.

- A register of possible waste to be generated by the project
- Waste segregation to be following during the project

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- Waste minimization strategies
- Records of waste quantities disposed (Template)
- Legislation requirements

Contractor must also comply to other environmental requirements from Eskom Medupi Power Station

12. QUALITY REQUIREMENTS

Category 3: Quality Requirements

- The supplier shall complete and sign **Form A** (Enquiry/Contract/Quality Requirements for Supplier Quality Management Specification 240-105658000/ QM 58 and ISO 9001).
- The supplier shall submit objective evidence of a **developed QMS** that complies with **ISO 9001** (or the latest applicable revision). The following documented information (approved/ signed copies) shall be submitted:
 - Quality management system manual or a (documented information) that have defines and describes the QMS and its scope
 - Quality Policy, aligned with the supplier's strategic direction (documented information)
 - Quality Objectives (documented information)
 - Control of documented information (both maintain and retain documented information)
 - Internal audit procedure (documented information)
 - Control of nonconforming outputs (documented information)
 - Nonconformity and Corrective action procedure (documented information)

The QMS should drive all the supplier's business management processes to ensure that all of Eskom's requirements are fully met on a consistent basis.

- The supplier shall submit a **draft contract quality plan** that is specific to the scope of work as described in the tender documents. The plan must address the minimum requirements as per ISO 10005.
- Where applicable; the supplier shall submit an **example inspection and test plan (ITP) or quality control plan (QCP)**.
- The supplier shall submit documented information for Control of Externally Provided Processes, Products and Services.

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- The supplier shall submit a copy of documented information for roles, responsibilities and authorities in relation to the QMS. Examples of relevant documented information are; organization charts, job descriptions, work instructions, duty statements, manuals, procedures.

NB: specific requirements per tender will be selected using the List of Tender Returnables document (240-12248652).

13. ELECTRICAL ENGINEERING

The ECSY is located in an area where there is no closer source of power supply, the following needs to be taken into account for the need of power supply:

- The closest connection point for power supply is a 6.6kv Mini Sub located at the Ash Dump Irrigation pump house.
- The distance to the connection point is estimated to be +/- 4Km away. See figure 3 below
- The potential buyer will need to consider between overhead conductors or buried cables.
- The cable route will need to consider existing roads and other possible services.



Figure 6: Google Earth Image showing nearest source of power supply (source Google earth).

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When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

14. LOW PRESSURE SERVICES ENGINEERING

Fire protection, HVAC, etc:

- a. HVAC system complete with structural supports.
 - o Split Air-conditioning units are recommended for Offices and small buildings
 - o Chiller Systems can be considered to large buildings.
- b. Potable water system.
 - o JoJo Tanks with pressure pumps to installed.
- c. Active fire protection systems
 - o Fire Hydrants to be installed on the yard area
 - JoJo Tanks with pressure tanks to be installed
 - Fire Extinguisher to be installed in buildings
- d. Compressed air system (if required)
 - o To be provided for maintenance workshop area

NOTE: all the above systems to be interfaced with CBMS

15. C&I AND CBMS REQUIREMENTS

The Contractor shall refer to the Appendix A for C&I and CBMS requirements.

16. BULK MATERIALS HANDLING DESIGN

The Contractor shall be responsible for the design, selection, procurement, fabrication, workshop assembly, testing, inspection, labelling, packing, delivery to site, erection, preservation, project management, cold and hot commissioning of a fully functional coal handling system to support and enable the disposal of coal. The Contractor responsibility shall include but not limited to the following.

- a) Conveyor Belts and its associated equipment
- b) Stacking and reclaiming machines
- c) Weight bridges
- d) Mobile Scrapper Chain Feeder
- e) Transfer Houses (if required)

16.1 Belt Conveying Plant

The Contractor shall provide a fully integrated conveyor system that meets the functional requirements as defined in 240-5586450 Belt Conveyor Mechanical Components Standard

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16.2 BELT PROTECTION SYSTEM

The following shall be included as a minimum for a belt conveyor system:

- f) Conveyor start-up warning siren system audible over the entire length of the conveyor.
- g) Trip wire (Pull cord lanyard wire) along the full length of the conveyor.
- h) Non-contact type “Daisy wheel” speed sensors.
- i) Contact type speed sensors.
- j) Take-up travel limit switches.
- k) Holdback devices mounted onto the head end or drive pulley if the conveyor will run back when it trips/stops.
- l) Electromechanical or electronic belt misalignment switches.
- m) Belt tear switches (electromechanical or electronic).
- n) Belt rip detector (electromechanical or electronic).

16.3 Mobile Scraper Chain Feeder

The mobile scraper chain feeder design shall conform to 240-163146409 Scraper Chain Feeder Standard

16.4 Requirements for Drive, Transfer Houses and Conveyor Gantries

The designs for this section shall conform to 240-55864504 Belt Conveyor Structural Steelwork and Welding Specification.

17. MECHANICAL DESIGN REQUIREMENTS:

17.1 General

1. The *Contractor* is required to submit a complete design for all mechanical works. This includes but is not limited to design reports, hydraulic calculations, P&ID and general arrangement drawings.
2. The designs shall be reviewed as detailed in section 5.3.1 of this document and any changes shall follow the design change process as defined in section 5.3.1 of this document.
3. All fire protection and HVAC designs shall be integrated by the *Contractor*.

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17.2 Piping

1. All piping shall comply with the Eskom Standard for Low Pressure Pipelines.
2. Fire water piping and equipment to comply with the requirements of the relevant fire design standard as well as Eskom Fire Protection and Life Safety Design Standard.

17.3 Valves

1. All valves shall comply with the Eskom Standard for Low Pressure Valves.
2. All valves used for fire protection installations to be FM/UL approved.
3. The use of high-volume fire hydrants is not preferred. Should the fire protection design require the use of such hydrants permission should be requested by the *Contractor* from the Medupi Fire Chief prior to design finalization.

17.4 Commissioning requirements

1. All commissioning to be done as per the On-site Commissioning of Low-Pressure Systems Standard.
2. Fire protection systems commissioning to be as per the acceptance criteria of the relevant design standard.

17.5 HVAC

1. The HVAC works for the associated buildings shall comply with 240-70164623 Eskom HVAC Design Guideline and 240-102547991 General Technical Specification for HVAC Systems Standard.

18. CIVIL AND STRUCTURAL ENGINEERING

The design and construction of the civil and structural engineering works (including all incidental works) required infrastructure to support and enable the disposal of the coal asset includes but is not limited to the following:

18.1 SURVEYING

The Contractor shall be responsible for providing surveying works. The Contractor shall make provision for, including but not limited to, pre-development surveys, pre-design topographical surveys, setting out of all works, post construction topographical surveys, surveys during construction, survey verification of existing infrastructure and interfaces, underground and above ground surveys of existing services, and all other required survey studies deemed necessary.

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The Contractor shall be responsible for the responsible for the accuracy, correctness, completeness and appropriate of his surveys. The Contractor shall appoint suitably qualified and competent Lead surveyor(s) registered with South African Council of Registered professionals.

The Contractor shall be responsible for the identification of local trig beacons and obtaining Surveyor General cadastral information which is included on the deliverable survey data

18.1.1 Topographical surveys

The scope of the topographical survey contract shall include but is not limited to the following survey activities:

- a) Topographical survey for all works (as required by Contractor);
- b) Survey shall be conducted at appropriate intervals (or as required by the Designer);
- c) The survey shall be conducted using the WGS 84 coordinate system;
- d) All levels relate to the mean average sea level;
- e) The Contractor shall be responsible for the identification of local trig beacons and obtaining Surveyor General cadastral information which is included on the deliverable survey data; and
- f) The Contractor shall be responsible for the survey and placement of additional control points as required.

18.1.2 Survey Deliverables

The Contractor shall be responsible for the following, including but limited to:

- a) Coordinated electronic survey drawing incorporating all the above in MicroStation format including legend to identify point references and table of all survey beacons and trig beacons
- b) Drawings shall be submitted in native DGN format and PDF; and
- c) An XYZ file, incorporating all reference descriptions, relating to all the above requested survey data is submitted to the Employer
- d) A comprehensive full-scale marked-out survey including level, location, and route of both conductive and non-conductive underground services. All detected services shall be easily identifiable by a legend or suitable description;
- e) Every point of detail shall be fixed in Y, X and Z and shall be presented on the drawings by standard feature descriptions. The density of the survey shall be adhered to so as to enable cross-sections to be extracted from the DTM (also to be provided) at appropriate intervals;

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- f) Include the legend showing the abbreviations of the shots taken

18.2 SITE INSPECTIONS

The Contractor shall conduct a site visit to inspect and visually acquaint themselves with the site, local conditions, accessibility to the site, conditions affecting supply, carriage, unloading, carting, storage, transport networks, access constraints, safe custody of material and other relevant and applicable site conditions and constraints. Claims on the grounds of lack of knowledge in respect of or otherwise will not be entertained.

The contractor is responsible to verify, where accessible, the accuracy of dimensions (from drawings provided) prior to commencing with the works.

18.3 GEOTECHNICAL INVESTIGATIONS

The Contractor shall be responsible for scoping and conducting all geotechnical investigations deemed necessary by the Contractor to complete the Contractor's preliminary or pre-development studies, engineering design, construction, and all other relevant aspects of the works.

The scope of the geotechnical investigations shall be determined by a suitably experienced and competent geotechnical engineer or engineering geologist (i.e. professionally registered with ECSA and/or SACNASP).

The Geotechnical investigations shall be conducted in accordance with and take into consider, as a minimum, Occupational Health and Safety Act (Act 85 of 1993), Construction Regulations, SAICE Code of Practice for Geotechnical Investigations, SANS relevant and applicable, minimum requirements from relevant Authorities (such as Environmental, Road Agency Limpopo, Transnet Freight Rail, etc), 240-5712955 Geotechnical Foundation Engineering Standard and all other relevant codes of practice, regulatory and legislative requirements.

The Contractor ensures that all testing is performed at an accredited laboratory facility (i.e. South African National Accreditation System (SANAS)).

The Contractors geotechnical investigations shall include, but not limited to:

- Desktop studies
- Field works
- Laboratory testing by SANAS accredited laboratory
- Investigation and assessment of available construction material
- Investigations of borrow pit areas
- Identification of geotechnical risks and hazards

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- Surveying (including but not limited to geotechnical and/or geophysical surveys etc.)
- The Contractor shall be responsible for the provision of all required plant, labour and resources to conduct the geotechnical investigations
- Monitoring and supervision during geotechnical investigations field work
- Construction monitoring (as deemed required by the Contractor's Geotechnical Engineer)
- Comprehensive Reporting including but not limited to factual report, interpretation, and analysis report).

18.3.1 Geotechnical Investigations Deliverables

The Contractor shall submit the following, as a minimum, deliverables for the Geotechnical investigations:

- a) Geotechnical investigations proposal outlining all investigations required
- b) Drawing(s) indicating Test pit layout with co-ordinates.
- c) Laboratory and material testing schedule
- d) Comprehensive report on available construction
- e) Comprehensive Geotechnical Investigation report with including but not limited to field work, laboratory testing and results, discussions, evaluations, analysis, recommendations, slope stability, construction material sources, soil and rock logging, geological and geotechnical hazards:
- f) Appendices including all field data (raw data), detailed calculations, laboratory test results
- g) Borrow area licensing (where applicable) including cut/fill material balance

18.4 SITE PREPARATION AND EARTHWORKS

The Contractor shall be responsible for the engineering design and construction of all items including but not limited to earthworks and site preparation in accordance with relevant and applicable SANS, design code of practice, Employers Site Procedures (including but not limited to 200-42826 Criteria for Blasting Vibrations and Excavation Permit Application Procedure), Specifications, Standards, Authorizations, Permits, Licenses, regulatory and legislative requirements.

All materials arising from demolition and site clearance work except materials specified for re-use or as otherwise specified by the Project Manager shall be removed from site as the work progresses and shall be disposed of and/or stockpiled for re-use. Disposal of material shall also align with the existing Medupi Power Station waste disposal plan and environmental requirements. The Contractors' responsibilities shall be aligned with the environmental management plan (EMP).

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All earthworks material shall, as a minimum, comply with approved design, relevant and applicable SANS and other applicable standards.

The Contractor shall make provision for scanning for underground services prior to excavations, design of blasting methodology and design including obtaining blasting design approval from interfacing stakeholders (i.e. Transnet). The Contractor shall ensure his [her] blasting activities do not affect existing infrastructure including stability of the Ash dump.

18.4.1 TERRACE

The Contractor shall include provision for design, construction, and commissioning of appropriate terracing and earthworks and, as far as reasonably practicable, consider site available construction material to ensure economic design and integrate his/her terrace design with existing infrastructure. The terrace design shall, as a minimum, consider appropriate access requirements, stormwater drainage measures, operational logistics, adherence to relevant and applicable Employers requirements, SANS, design codes, regulatory and legislative requirements.

The terrace and earthworks design shall as far as reasonably practicable prevent ponding and flooding and ensure areas are free draining.

18.5 TRAFFIC IMPACT STUDY AND LOGISTICS IMPACT STUDY

The Contractor shall conduct a traffic impact assessment study and other applicable traffic studies to, amongst other things, assess the effect of the proposed logistics infrastructure on the transportation networks. The objective of the study shall include but is not limited to addressing any site development plan, site layout and access requirements, recommendations, queuing and parking analysis, roads and/or intersections improvements and/or rail, road or other transportation infrastructure improvements deemed necessary to accommodate the additional traffic.

The Traffic Impact study shall consider and include provision, as a minimum, for requirements from the relevant road and rail authorities, regulatory and legislative requirements.

The Contractor shall conduct the necessary studies and investigations to decide on the most feasible facility for loading and offloading platforms and bulk material handling.

18.6 SITE LAYOUT & ACCESS REQUIREMENTS

Medupi Power station is a National Key Point with controlled access. The Contractor shall as far as reasonably practicable consider the existing common access point and/or propose [subject to approval by the Project Manager] alternative feasible access points for the proposed logistics

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operations taking into consideration for the ECSY location, existing haul roads, ramps, and tie into existing transportation network. The Contractor shall produce a Site Development Plan, taking into consideration traffic and logistics impact study, addressing access requirements, capacity, queuing and other appropriate analysis, parking requirements.

The Contractor shall include provision to engage with relevant Authorities (Roads, Rail and/or local municipality as deemed applicable) on the site Development plan.

18.7 ROADS & INTERSECTIONS (WHERE APPLICABLE)

The Contractor shall, as a minimum, include provision for the design, procure, supply, commission and construction of all required temporary and permanent access road, temporary construction access roads, haul roads, security and maintenance roads and all other roads deemed necessary by the Contractor.

The roads shall, as a minimum, consider and interface with the drainage design, terrace design, existing as-built roads, services, design of tie in with existing roads, services and structures where necessary. Design and construction of the roads shall consider appropriate storm water management measures (such as appropriate barrier systems and separation of clean and dirty water) compliant with Employers Permits, licenses, relevant design codes, regulatory and legislative requirements.

The Contractor shall, as a minimum, include provision for wayleave application and other applicable applications [including necessary permits, licenses and approvals], engagements with and other applicable relevant authorities where envisaged as required for improvements deemed required to intersections and/or road network to accommodate additional traffic.

All roads shall be designed in accordance with 240-84418186: Road Specification Manual and legislation. The roads shall be designed with a 6m width and 1m shoulders on either side.

18.8 RAIL SIDING (WHERE APPLICABLE)

The Contractor shall include provision for way leave application where envisaged as required for improvements to intersections and/or rail network. The Contractor shall include engagement with the Authorities to obtain necessary (but not limited to) design, construction , commissioning approvals.

The Contractor shall include provision for engagements with Rail Authorities during the feasibility studies to obtain all required information and requirements.

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18.9 COAL LOADING, OFF-LOADING, HANDLING AND WEIGHING PLATFORMS (AS APPLICABLE)

The Excess Coal Stockyard Facility is compacted and stacked to a height of approximately 25m. The Contractor shall include provision for the design, construction, manufacturing, supply, and commissioning of appropriately lined loading and offloading platforms, bulk material weighing platforms, and others as applicable.

The Contractor shall be responsible for the sizing and storage capacity requirements of the loading and offloading platforms. The platforms design shall consider (as a minimum) the proposed road and/or freight rail bulk transportation logistics, bulk material handling and operations, appropriate storm water management, interfaces, the Employers Requirements, relevant freight rail and road authority requirements, environmental authorities requirements and other regulatory and legislative requirements.

The Contractor shall conduct waste classification study of the coal and design appropriate barrier systems and storm water management infrastructure taking into consideration the logistics and operations requirements.

18.10 STORMWATER MANAGEMENT

The Contractor shall be responsible for the for design and construction of the necessary and applicable storm water management infrastructure and systems. The Contractor shall include provision to conduct the necessary studies and investigation including but not limited hydrological studies, perform integrated design, obtain all required/applicable design approvals from relevant Authorities, engagements with stakeholders, authorities and interfacing parties, and ensure compliance to the regulatory and legislation requirements including but limited to the following:

- National Water Act (Act 36 of 1998) with associated regulations
- Government Regulation 704 and Dam Safety Regulations
- National Environmental Management Act (Act 107 of 1998)
- Best Practice Guidelines
- Medupi Power Station Stormwater Design Criteria
- National Environmental Waste Act (Act 59 of 2008)

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The Contractor storm water management studies and design shall propose the most feasible stormwater management infrastructure addressing and considering the following including but not limited to:

- Catchment sizing
- Water balance model
- Suitable barrier system
- Topography constraints and any suitable pumping systems
- Electricity supply constraints
- Appropriately sized and lined dirty water/runoff containment and conveyance infrastructure
- Design input information (weather and climate data from nearest weather station)
- Site specific weather data (where available)
- Erosion protections and attenuation infrastructure
- Others as applicable

18.10.1 Water Balance Model (As applicable)

The Contractor shall be responsible for developing a water balance model (where applicable). The water balance shall take into consideration (and integrate as far as reasonably practicable) the station water balance.

The water balance model shall consider, including but not limited to:

- National Water Act (Act 36 of 1998) and associated regulations (i.e. GN 704, Dam Safety regulations, etc)
- Runoff in/out falls
- Rainfall and climatic data and conditions
- Evaporation rates
- Process/makeup water and recycle and reuse
- Abstraction rates
- Sizing
- Inflows and Outflows for containment structure

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- Total volume of the containment
- P&ID and other visual representation

18.10.2 Clean stormwater management

Clean stormwater design and construction shall consider and comply to [including but not limited to] the environmental requirements, maintainability of the infrastructure, erosion protection, best practice requirements, Employers requirements, including regulatory and legislative requirements.

18.10.3 Dirty water management

Environmental legislation and regulations ordinarily require dirty water to be collected and contained in appropriately lined dirty water containment and conveyance infrastructure to mitigate potential pollution to the environment. The design and construction of dirty water infrastructure shall consider and comply to, including but not limited to, environmental requirements, maintainability of the infrastructure, erosion protection, best practice requirements, waste classification (pre-/post-waste conditioning as applicable), Employers requirements including regulatory and legislative requirements.

18.11 CONTAINMENT BARRIER SYSTEMS (AS APPLICABLE)

The Contractor shall ensure design and construction of appropriately infrastructure to mitigate environmental the environment pollution and contamination. The design and construction shall as a minimum comply with the minimum engineering design requirement, code of practice, minimum construction quality assurances/control, licensing conditions, including relevant and applicable regulatory and legislative requirements. The Contractor shall also include provision for engagements with relevant authorities/stakeholder including obtaining design, pre and post construction approvals, other approvals/licenses form the relevant Authorities and interfacing stakeholders.

It is envisaged that the infrastructure could include but is not limited to:

- Offloading and loading platforms
- Storage platforms/facility
- Civil infrastructure
- Dirty water containment and conveyance infrastructure
- Materials handling areas and storage areas
- Stockpiles, Storage Silos, Surge Bins (where required); and

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- Bunded area for chemical handling and storage

18.12 CIVIL AND STRUCTURAL WORKS

The civil and structural works shall include, as a minimum, all required civil and structural infrastructure to support the logistics infrastructure and operations. The scope includes but is not limited to:

- Concrete structures
- Foundations
- Steel structures
- Ancillary support structures
- Buildings
- Civil structures and support for bulk material handling, LPS and C&I requirements

The design of the civil and structural works shall consider as a minimum sizing and capacity requirements, loading, access, occupancy, operational infrastructure (i.e. cranes, hoist, transfer houses, equipment design, platforms) architectural requirements, suitable foundation design, water management, maintenance requirements, corrosion protection.

All civil engineering design shall as a minimum comply with National Building Regulations, SANS 10400 requirements

The Contractor shall engage a competent qualified Professional Engineer experienced in the design of super structures, support structures and foundations of industrial buildings; conveyor gantries/structures; and heavy machinery to be fully responsible for the design. Professional registration shall be determined by the statutory and legislative bodies of South Africa i.e. Engineering Council of South Africa (ECSA). The competent qualified Professional Engineer shall provide services and perform duties in accordance with Construction Regulations and the ECSA code of conduct. The competent qualified Professional Engineer responsible for certifying the works shall ensure his/her signature is included on all drawings, design reports, calculations, and other relevant design information.

Enclosed buildings and structures shall be provided where required to offer shelter from weather and the environment without undue maintenance and deterioration, ensure security standards are maintained, provide privacy, facilitate storage and to house certain activities.

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All buildings shall comply with the requirements of the latest edition of SANS 10400: National Building Regulations, 240-56364535: Architectural Design and Green Building Compliance and 240-56364545: Structural Design and Engineering Standard.

All civil engineering construction work shall comply with, including but not limited to, the requirements of the design specification, Construction Regulations, SANS relevant and applicable, and applicable legislative and regulatory requirements.

Building and structure design shall include features (e.g. cranes, hoists, monorails etc.) to facilitate removal, replacement and maintenance of major equipment items and to support the operational and maintenance objectives of the infrastructure. The inclusion of such features shall be in accordance with the applicable safety standards and the equipment manufacturers specifications.

Equipment design and layout shall consider ease of access for operational and maintenance activities. Equipment and components shall be accessible from normally provided floors and platforms. Where this cannot be achieved, special access, such as permanently installed ladders and local platforms, shall be provided. Other parameters shall be as required by equipment manufacturers specification.

Building design shall consider the type of occupancy and listed activities and as a result provides all fixtures, fittings and services to levels consistent with OHS Act and applicable standards.

The provision of suitable foundations for all building and structures shall be as required and in accordance with the supporting geotechnical investigation findings.

The provision of suitable access platforms, access doors & windows, stairways and hand railings shall be as required, operating philosophy, maintenance philosophy and in accordance with the National Building Regulations and applicable safety standards.

The provision of suitable sumps and bunds shall be as required, operating philosophy, maintenance philosophy and water management philosophy and in accordance with the applicable safety standards and the equipment manufacturers specification.

The Contractor shall ensure that all infrastructure which are incorporated in the works are functionally and efficiently designed to prevent any ponding around above ground infrastructure and prevents flooding of any underground infrastructure.

The provision of tank and equipment plinths shall be as required. The plinths provided shall meet the requirements for supporting and anchoring the required elements. Other parameters affecting the plinth design shall be as required by tank and equipment manufacturers specifications.

All civil engineering construction work shall comply with the requirements of SANS 1200: Standard Specification for Civil Engineering Construction and the requirements of SANS 2001: South African

National Standard Construction Works. The Contractor is made aware that SANS 2001 takes precedence over SANS 1200.

The Contractor ensures that all testing is performed at an accredited laboratory facility. Only statutory and legislative bodies of South Africa shall be considered therefore South African National Accreditation System (SANAS) accredited laboratory facilities are catered for when delivering the design and related construction specifications. Consider SANAS standards and requirements when producing the testing methodologies when executing these works.

There shall be physical barriers to prevent persons falling into openings in floors, stairwells, staircases, open-sided buildings, and any structure during erection where dangerous openings exist. Danger or demarcation tapes shall not be allowed for the purpose of barricading.

The Contractor shall ensure alignment with respect to degree of accuracy for every interface.

The materials of construction must be fit for purpose and designed accordingly for the input and output materials that are handled and stored within the proposed system. The materials used shall also perform adequately considering both strength and durability requirements.

All steel materials supplied, and the erection of the steelwork shall comply with the requirements of the latest edition of SANS 2001 – CS1. The Employers preference is that all structural steelwork shall be manufactured using grade S355JR steel and all structural bolts shall be of class 8.8. No galvanised bolts shall be allowed. Washers shall be required under all nut and bolt heads on flat surfaces. Flame cutting of holes shall not be permitted. All steel elements shall be marked to be traceable to a specific cast or trace of steel.

All surface protection of steelwork shall comply with the requirements of 240-106365693: Standard for the External Corrosion Protection, where this specification is limited, the Contractor shall use the relevant SANS code of practice.

All structural concrete shall comply with the requirements of the latest edition of SANS 2001-CC1. The Contractor shall ensure that all concrete works are of suitable and appropriate strength, taking into consideration amongst other things appropriate functional, durability, safety, maintenance, economical, operational, disposal and other relevant requirements. The exposure conditions on site for all concrete work shall be considered severe unless otherwise specified. The Contractor shall ensure that all grout used in the Works are of suitable and appropriate strength, taking into consideration amongst other things appropriate functionality, durability, safety, maintenance, economical, operational, relevant SANS, disposal and other relevant requirements. The Contractor shall include the influence of drying shrinkage in his design of the concrete and grout elements to ensure that both strength and durability requirements are met.

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Jointing design and material shall be suitable for the generally high/low temperature conditions on site, to minimize shrinkage and joint failure. Soft board shall not be used as joint filler material. Joint sealants shall be suitable for the prevailing conditions of the site.

The Contractors shall specify the requirements for all chemical tests required to ensure the appropriateness of the Contractors design.

All masonry work shall comply with the requirements of the latest edition of SANS 2001-CM1. All brickforce, rod reinforcement, wall ties and internal steel door frames shall be galvanised.

18.13 CONSTRUCTION MONITORING SERVICES (AS APPLICABLE):

In line with the gazetted ECSA Tariff Fees Guidelines for Professional Fees, the Contractor shall, if deemed required, provide the appropriate level of construction monitoring services (full time or otherwise to the extent deemed appropriate by the Contractor's design) to carry out necessary inspections and monitoring of the works to ensure design intent is achieved and issue professional engineering certification.

The Contractor shall provide suitably qualified and competent persons for construction monitoring services personnel.

18.14 INCIDENTAL WORKS:

The Contractor shall include provision for design, supply, manufacturing and construction of all incident works.

18.15 CONSTRAINTS AND INTERFACES:

The *Contractor* shall be aware of the following existing constraints, including but not limited to:

- a) Site conditions and weather
- b) NKP requirements
- c) Existing Roads, dams and infrastructure
- d) Interfacing with adjacent operations including but not limited to, power station operations.
- e) Existing above ground and underground services.
- f) Travel route existing constraints and conditions including existing services, overhanding branches, wires etc.
- g) Access gate constraints, safe vehicle/truck turning radius.

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- h) Eskom Police clearance requirements for contractor's employees
- i) Topographical constraints
- j) Electricity supply constraints
- k) No installed high-mast lighting at the ECSY facility
- l) Medupi Ash Disposal Facility Are 2 with associated infrastructure.
- m) Ash dump growth plan
- n) Coal offtake agreement
- o) Other contractors working in the area

The Contractor shall, as far as reasonably practicable, take into consideration [and integrate with his design and planning] the above constraints, existing services and infrastructure and resolve conflicts that may arise with existing infrastructure and services.

18.16 CONCEPT AND DETAILED CIVIL DESIGN DELIVERABLES

The Contractor shall ensure the designs adheres to Employers requirements, SANS requirements, and other relevant and applicable code of practice, statutory and regulatory requirements. The Contractor shall submit the following, including but not limited to:

- a) Comprehensive feasibility assessment report
- b) Traffic management plan and route options
- c) concept design calculation file/ report documenting all [as a minimum]:
 - Alternative options considered supplemented by a high-level cost analysis and trade-off study to support the final design solution to be implemented.
 - Assessments and verification of existing systems, where such interface exists;
 - Assumptions made;
 - Calculation methodologies adopted;
 - Design criteria/ parameters used;
 - Design Philosophy;
 - Design results and calculations for all elements;
 - Loads and forces;
 - Materials used;
 - References/ sources of information, data and records of any other information associated with the completed works;

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- Software input and output files incl. design models (all models and calculations etc. must be submitted in their native file format as well as PDF); and
 - References to specifications, codes and standards used in the designs;
- d) Site development plan
- e) Concept drawings
- f) Stormwater Management Plan and Philosophy;
- g) Provide drawings for the full Works, capturing all necessary details;
- h) Investigations reports and construction material analysis
- i) Submit results of all surveys including the raw survey data, detailed contour survey plans, detailed as-built surveys of existing infrastructure, ASCII files, triangular data and a detailed survey report;
- j) Submit results all geotechnical investigations including all raw data and geotechnical report;
- k) Provide Terminal Point Data Sheets for each of the interfaces.
- l) Detailed design report calculation file/ report documenting all:
- Assessments and verification of existing systems, where such interface exists;
 - Assumptions made;
 - Material selections, functionality and durability consideration
 - Calculation methodologies adopted;
 - Design criteria/ parameters/tolerances used;
 - Design Philosophy;
 - Design results and calculations for all elements;
 - Loads and forces;
 - Materials used;
 - References/ sources of information, data and records of any other information associated with the completed works;
 - Software input and output files incl. design models (all models and calculations etc. must be submitted in their native file format as well as PDF); and
 - References to specifications, codes and standards used in the designs;
- m) Detailed design drawings
- n) Design specification(s) and technical data sheet
- o) Operating and maintenance manuals
- p) Detailed Stormwater management plan demarcating dirty and water catchments
- q) Water balance model
- r) Works information describing the works

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- s) Construction quality assurance and control plans
- a) Comprehensive Method statements
- b) construction sequencing plans
- c) risk assessment

18.17 CONSTRUCTION DELIVERABLES

The Contractor shall create and maintain a drawing master document. The Contractor shall submit designs (where applicable) for acceptance by the Project Manager prior to commencement of any construction, installation and fabrication.

The construction related deliverables include but not limited to the following:

- a) Quality Control Plan
- b) Method statement including associated risk assessments
- c) Inspection and Test Plans
- d) Material Quality Assurance records (Material approvals, data sheets, conformance test results approved by the Design Engineer)
- e) Construction Quality Control check sheets, test re
- f) Test results
- g) Submit Data Books including providing sign off, where applicable. Data books shall include but are not limited to the following, as a minimum (where applicable):
 - Approved Design Calculations And Data;
 - Approved Drawings And As Built Data;
 - Approved Non-Destructive Test (NDT) Procedures;
 - Batch Plant Certificates;
 - Bolt Grade Certificates;
 - Calibration Certificates;
 - Corrective Actions and Concessions;
 - Certificates Of Manufacture;
 - Chemical Test Results And Certificates;
 - Compaction Test Results And Certificates;
 - Completion And Handover Certificates;

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- Concrete Mix Designs Including All Required Test Results (E.G. Aggregate Test Results, 7 Day And 28 Day Cube Test Results) And Certificates;
- Construction Completion Reports;
- Corrosion Protection Consumables Certificates;
- Detailed Piping And Valve Lists;
- Document List;
- Equipment Specifications and Certificates;
- Fabrication And Shop Drawings;
- Factory Acceptance Tests;
- Grout Designs Including All Required Test Results (E.G. Material Test Results, 7 Day And 28 Day Cube Test Results Etc.) And Certificates;
- Hydrostatic Test Results For Pipes And Tanks/Pressure Vessels;
- Inspection Reports;
- Instruction For Work/ Purchase Order;
- Internal Release Notes;
- Maintenance Manuals;
- Manufacturing Drawings;
- Material Certificates;
- Material Summary That Gives Full Traceability Between Components Used, Drawings And Material Certificates;
- Method Statements And Specifications Adhered To;
- Modifications / Engineering Changes;
- NDT Contractor Data and Reports/ Results;
- NDT Technician Qualifications;
- Non-Conformance Reports;
- Notifications;
- Operating Philosophy;
- Parts Catalogue;
- Pre-Concrete And Post-Concrete Surveys;
- Pressure Test Procedures, Certificates And The Calibration Certificates Of The Gauges Used;
- Professional Engineering Certificates;
- Risk Assessments;
- Scope Of Work;

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- Site Acceptance Tests;
- Slump Test Results And Certificates;

19. SYSTEM INTEGRATION

All Design change management shall be performed in accordance to the latest revision of the 240-53114026 Project Engineering Change Management Procedure and the *Employer* shall ensure that *Contractor* is provided with latest revisions of this procedure. Any uncertainty regarding this procedure shall be clarified with the *Employer* and clarification updates should be reflected in updated versions of this procedure.

20. DOCUMENT MANAGEMENT REQUIREMENTS

At the time of finalisation of this document, the requirements for document management were not made available. The document management requirements should be finalised by the Cross Functional Team/relevant representatives prior to issuing market enquiry and/or relevant provisions once requirements become available.

21. HANDOVER (WHERE APPLICABLE):

It must be noted that the Employer requires the Contractor to remove all established infrastructure after all the coal has been reclaimed and rehabilitate the area. The Contractor shall ensure provision for the rehabilitation and removal of established infrastructure as per section However the Contractor can approach the Employer to sell the infrastructure. Caveat: the Employer is under no obligation to purchase the established

22. AUTHORISATION

This document has been seen and accepted by:

23. REVISIONS

Date	Rev	Compiler	Remarks
February 2023	0.1		First draft for comments
July 2023	1.0		Issued for Authorization.

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24. DEVELOPMENT TEAM

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

25. ACKNOWLEDGEMENTS

Development Team

26. APPENDIX A – C&I AND CBMS REQUIREMENTS

1. codes and standards

1.1 Informative Standards

- ISO 9001 Quality Management Systems
- Occupational Health and Safety Act 85/1993;

1.2 Normative and applicable standards

- | | | |
|------|-----------------|---|
| [1] | IEC 61508: | Functional Safety of Electrical/Electronic/Programmable Electronic Safety Related Systems |
| [2] | IEC 61511: | Functional Safety – Safety Instrumented Systems for the Process Industry Sector |
| [3] | IEC | IEC 62381 Automation systems in the process industry - Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT) |
| [4] | 240-56356396 | Earthing Standard |
| [5] | 240-56227443 | Requirements For Control And Power Cables For Power Stations |
| [6] | 200-11768 | Station Cabling and Racking standard |
| [7] | SANS 60794-1-1 | Optical fibre cables - Part 1-1: Generic specification – Genera |
| [8] | SANS 61312 | Protection against lightning electromagnetic impulse |
| [9] | ANSI/TIA-942-A: | Telecommunication infrastructure standard for data centres |
| [10] | ANSI/TIA 568: | Telecommunication cabling generic standard and component (fibre optic and twisted pair cabling) specific standards |
| [11] | ANSI/TIA 569: | Communication pathways and spaces (racking, trunking) standard |
| [12] | ANSI/TIA 607: | Grounding and bonding of communication cabling standard |

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1.3 Applicable Eskom standards

[1]	240-56355466	Alarm Management System Standard
[2]	240-56355729	Plant Control Modes Guideline
[3]	240-56355754	Field Instrument Installation Standard
[4]	240-56355815	Junction Boxes and Cable Termination Standard
[5]	240-56355843	Pressure Measurement Systems Installation Standard
[6]	240-56355888	Temperature Measurement Systems Installation Standard
[7]	240-55410927	Cyber Security Standard for Operational Technology
[8]	240-56355731	Environmental Conditions for Process Control Equipment Used at Power Stations Standard
[9]	240-56355808	Ergonomic Design of Power Station Control Suites Guideline
[10]	240-56355728	Human Machine Interface Design Requirements Standard

2. SUMMARY DESCRIPTION OF C&I WORKS

- i. The *Contractor* shall perform engineering, design, procurement, manufacturing, factory acceptance testing, delivery, off-loading at site, storage, installation, testing, commissioning, optimization and as-built documentation for the complete C&I plant and material. The limit of supply is as per Limit of Supply and Services (LoSS) Diagrams.
- ii. The *Contractor* shall supply documentation and information as per the C&I VDSS – clarification of the referenced documents in the C&I VDSS can be found in the C&I Documentation Description document.
- iii. The *Contractor* shall implement the operating and control of the plant in the *Employer's* Distributed Control System (DCS).
- iv. The Plant shall have facilities to be operated from the *Employer's* Outside Plant Control Room with HMI supplied by the *Employer*.
- v. The Plant shall also be operated and controlled by C&I equipment supplied by the *Contractor*.
- vi. The C&I system forming part of the *works* shall provide all information, alarms, protections, process interlocks, control and local control facilities to enable the operator (located in the Outside Plant Control Room) to execute operating tasks safely, reliably and consistently.
- vii. The *Contractor* shall integrate the C&I plant forming part of the *works* to the *Employer's* C&I plant.
- viii. The *Contractor* shall ensure that the C&I plant forming part of the *works* is standardized.
- ix. The *Contractor* shall ensure that the C&I plant forming part of the *works* meets the dynamic and static operation, reliability, availability and safety requirements and does not affect adversely the *Employer's* C&I plant performance.
- x. All C&I, protection system and control components supplied as part of the *works*, shall be supported and maintainable for a minimum of 25 years.
- xi. The *Contractor* is fully responsible for integrating the operation, monitoring, control and process management of the C&I Works with existing installed C&I plant and material.

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- xii. The *Contractor* shall be responsible for obtaining all relevant information of plant and material outside their supply where it affects design or plant and material within the *Contractor's* scope of supply.
- xiii. The *Contractor* shall use only proven technology with references accepted by the *Employer* prior to the commencement of the design phase.

2.1 STANDARDS

- i. The additional standards applicable to the C&I Works are listed in List of Additional Standards Applicable to C&I Works.
- ii. The *Contractor* shall notify the *Employer* of any conflict within this Specification with any referenced standards, specifications or technical guideline.
- iii. Substitutions of any standards in Standards shall be approved by the *Employer*.
- iv. Additional standards proposed by the *Contractor* shall be submitted for approval by the *Employer*.

2.2 BACKGROUND ON EMPLOYER'S CURRENT C&I SYSTEM DESIGN

- i. The *Employer's* control system is based on the Alspa Series 6 Distributed Control System (DCS) supplied by Alstom
- ii. The DCS Input-Output Functional Blocks as implemented by the *Employer* are as per IO Function Blocks.
- iii. MFC3000 Controllers are used throughout the Balance of Plant (BoP).
- iv. The *Employer's* DCS cubicles are distributed throughout the outside plant in C&I equipment rooms adjacent to electrical substations.
- v. All field equipment is HART-enabled to allow for interfacing with *Employer's* Asset Management System.
- vi. Go-switches are used in the place of proximity switches that are hardwired to the DCS.
- vii. Conveyor Protection System of Employer is based on Electrotron system.

2.3 STANDARDIZATION REQUIREMENTS

- i. The *Contractor* shall standardize similar plant components with the rest of the power plant to ensure simplified operation and maintenance, and reduced lifecycle management costs.
- ii. The system shall employ a uniform approach across all plant areas as per the rest of the power plant with respect to design philosophy, basic functional characteristics, system interfaces, documentation, standard function blocks and engineering tools.
- iii. The requirements of standardization shall be applicable to all C&I plant and material including the PLCs. The *Contractor* shall supply a standardization strategy document for the *Employer's* approval during concept engineering design phase.

3. BASIC DESIGN INFORMATION

The following mechanical systems shall form part of the interfaces, control and operation requirements that the PCS will control, operate and interface too.

The PCS will be interfaced to loading, Weighbridge and Medupi power plant balance of plant control system. The onus shall be on all vendors to ensure that both sides provide a working solution and that the LOSS are adhered to. The third party Vendors shall ensure that software drivers and/or signal

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types are compatible to the main PCS system. Should additional programming be required this shall be included in the applicable vendors supply. The limits of supply are as per the LOSS diagrams but the installation and commissioning shall be a collective effort by all parties to ensure integration. Rail yard

3.1.1 Weighbridge

The in-motion weighbridge system detects and weighs each wagon to provide an accurate measurement of the mass and the load distribution within the wagon. The AVI Readers identifies the wagon number as read from the RFID tags on the Transnet wagons.

The Plant control system will provide the monitoring information such as Status, Alarms and events, logs and other information that is necessary to ensure that the operation runs smooth and the operator is equipped to deal will any event timeously. The HMI for this system is located in the Operations room and the PCS shall only monitor and supervise the Weighbridge and no control and interlocking are required.

3.1.2 Signalling

Signalling as per Eskom requirements.

3.1.3 Yard Controls

The Yard Controls are all to be done locally or manually therefore no information will be transferred back to the plant control system

3.2 PROTECTION SYSTEM

The main purpose of protection systems are installed as part of the overall risk reduction measures that deal with a hazardous process. In this instance the following main protection systems are installed:

- Conveyor Protection system.(CPS)

The design principles shall be considered in the design of the Protection Systems. These principles are based on best practice as documented in the IEC 61511 and IEC61508 standards.

3.2.1 Design for Fail-Safe Operation

Applies to sensors, logic solver and final elements of a protection system Implemented through use of negative logic:

- Positive signals will be transmitted when instruments are in a healthy state.
- Wire breaks, short circuits or a fault occurring on an instrument will withdraw the positive signal initiating a trip.
- Similarly the CPS will supply positive signals to all final device elements, which are kept in a healthy state.
- During a trip the CPS removes the positive signal causing the final device element to trip.
- Fire detection shall be part of the protection function to the conveyor system

Where single measurements are used for protection functions, the design needs to consider the diagnostics available on the measurements to avoid spurious trips (In this case protection loops are allowed to be disabled if detected via system diagnostics).

3.2.2 Separating the Protection System from the Control System

The main objectives when interfacing shall be to:

- Avoid common mode failures.

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- Allows for a higher standard of safety integrity to be built into the protection system whilst leaving flexibility to the PCS.
- The following are four areas where separation between Protection system and Control System is to be considered.
 - Field equipment (sensors) – Sharing of field sensors with controls is to be avoided. If it is not practical to avoid the sharing, the sensing device signal is to be wired to the Protection system first, and bus or hardwired to the control system, depending on the functionality, of the signal and whether 3rd party or integrated control systems are used. Where signals are to be used for protection these need to be hardwired.
 - Wiring – Separate wiring and dedicated junction boxes for the protection control systems are provided.
 - Final element – Separate ETRs for the electrical switchgear are provided.
 - Logic solver – Separate controllers for the protection system are provided.

3.2.3 Provide Fault Tolerant Structures

Redundant instruments and logic solvers should be used to ensure that a single hidden dangerous failure in any of the systems should not cause the safety function to fail.

3.2.4 Providing hardware with a proven record of reliability for applications in similar conditions

Field sensors and final elements should have a proven record of reliability in similar protection applications.

3.2.5 Protection hardware to comply with the requirements of IEC 61508

- IEC 61508 standards defines the need for high integrity hardware systems with high levels of diagnostic coverage and fail-safe actions on detection of an internal fault.
- The protection system must have the capability to test the functional readiness of the protection system periodically during normal operation.
- Automatic diagnostics must be included in the design and alarms for the diagnostics must be available on the HMI system for operator action.

3.3 CONTROL SYSTEM

3.3.1 Operation room Assignments

The facility shall have one Rail yard Operations Room (ROR). The ROR is required based on the physical separation of the plant areas.

The primary function of the ROR would be to supervise and monitor the related process plant and shall be continuously manned by plant operators. All control and supervision would be initiated by the Rail yard Operations Room operator.

The loading system and railyard operations are monitored and controlled from the ROR. The LCS for the Uploading HMI allow operation for uploading facility. The Security systems such as CCTV, Access control, Perimeter monitoring, fire detection system and the CBMS are all located in this room.

The ROR layout houses three desks mainly the following:

Desk 1 -CBMS, CCTV,

Desk 2 - PCS HMI,

Desk 3 - loading black box HMI & Weighbridge HMI

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The master fire panel will be wall mounted

The Local Control Stations (LCS) are dedicated local plant floor control station used for operator control of specific equipment. The LCS station would be HMIs connected directly on the PCS network and would contain the same process control interface and graphic screens as similar to the ROR based HMIs. The LCS stations would be housed in suitable environmental enclosures and would be located in strategic process areas for use by plant floor operators. The LCS shall be used as a graphical and control interface by field operators to the Vendor's equipment.

The LCS stations may not include the same hardware as the PCS, but shall retain a similar level of functionality. The LCS stations shall be manned as required by equipment suppliers. The LCS for uploading shall be installed in the ROR and not local at the plant. These control system shall be operated with a panel at the ROR and cameras situated locally at strategic points for visual operation. These control systems shall form part of a package systems and integration to the PCS are specified.

The operations room equipment shall provide the process control supervisor with all the process information and controls essential for efficient plant operation. The information shall be presented in such a way as to enable the control supervisor to fully evaluate process conditions and take the necessary actions. Panel mounted Annunciators may be needed in some plant locations such as in electrical sub-stations

3.3.2 Overview of the control system structure

The plant control hardware and Human Machine Interface terminals (HMI) shall be collectively referred to as the Process Control System (PCS). The PCS shall connect the elements of monitoring and control at remote locations by the plant control network or hardwired directly to the PLC field interface I/O cards.

The major PCS functions shall include:

- Process control, motor controls and alarms
- Process overview displays
- Custom graphic process monitor displays
- Process and maintenance related data acquisition with transfer to business system
- Events and process history functions
- Real time trend recording
- Recording of operator entries
- System diagnostics
- Interface to 3rd party control systems
- Interface to Medupi Power plant balance of plant control system

The control system and instrumentation shall be designed to enable an orderly and safe shutdown sequence of the equipment.

PCS processors shall be allocated based on logical functional areas. This process considers process control requirements and fault handling, isolation and response for one process system with respect to another process system.

All local controls, control panels and other Human Machine Interfaces (HMI) located inside and outside the Rail Operations room, namely in Server room, switchgear rooms or local to the Facility, will in general be regarded as operational facilities and the PCS shall interface to these facilities and monitor all such operations.

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The Network communications between in the PCS and all the Network Interfaces to the Medupi power plant balance of plant control system shall be redundant.

A high-level computer system (HMI) shall be provided and integrated with the Programmable Logic controllers (PLC) system to perform local control and monitoring, and for automatic comprehensive data logging and archiving with detailed analysis and reporting for maintenance management.

Operational Areas of control shall be managed by a security and password protection system, implemented at the operator station level when the operator logs on. This allows operators to have access to control different areas of plant. All operator actions shall be logged and may be interrogated during run-time or historically, by area, operator and console. Supervisors and engineers shall also have higher levels of access to additional PCS functions that are not available to a console operator.

There will be overview screens with dedicated workstation (including keyboard and mouse). The entire workstation shall be positioned at the Rail yard Admin building in the ROR.

This workstation will have monitoring rights only and will be loaded with a licensed thin client software for the plant operator station. The Medupi power plant master clock shall provide millisecond accurate date/time information and the PCS as well as the 3rd party control systems such as (PCS HMI, Weighbridge, Uploading control systems) shall have slaves that synchronise to the Medupi power plant master clock either by means of Irig-B (via co-axial cable) or NTP (Network time protocol via Ethernet).

Devices using their own GPS time input and antenna will also be accepted. Where buildings are more than 50m apart, separate GPS antennas may be used but these control systems will be slaves of the Medupi power plant master clock.

Local indication and alarm indications shall be provided for conveyor control & alarms, analogue values for Weighometers' power measurement as required.

Local control stations for the Weighbridge at the Rail yard, 3rd party Materials handling control systems such as Uploading facility shall be provided with monitoring of the signals by the PCS.

The control systems shall take into account all relevant ICT Standards and will need to manage all interfaces with the client IT departments and their nominated service provider(s).

The PCS shall be located at the Rail yard Operator Building and the HMI will be located in the ROR.

3.3.3 Functions of PCS

3.3.3.1 Process Monitoring and Control

The PCS shall employ modern control strategies and tools to ensure safe, uninterrupted and optimal operations. Details of PCS requirements shall be defined in detailed design and the following are some of the important features:

- Key process variables that impact on production rate, quality or unit cost shall be tightly controlled whereas less important variables shall be allowed to drift within an acceptable operating band. The objectives of each process area shall be identified to enable targeting the correct process variables
- High level process variables shall be calculated and controlled to provide more precise control of the process and reduce the number of variables that the Supervisor must change
- Active control of flows and levels shall be used in plant areas where inventory management is critical
- Process constraint control shall be built into standard control loops

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- Standardisation of controls across the plant to minimise the amount of area specific knowledge required by the operator
- Low level control loops shall be operationally simple and robust as possible
- Automatic start-up and shutdown sequences for major equipment. Sequences shall include process constraint monitoring and control to minimise supervisor intervention. This shall ensure equipment starts the same way regardless of operator and shall allow equipment start-ups over shift changes
- Major equipment may include a duty selector to allow equipment status to be used in control algorithms
- The detrimental effect of poor instrument calibrations shall be reduced by limiting process variables and intermediate calculations to reasonable values
- Control logic shall be designed to handle normal operations including equipment outages for regular cleaning. Abnormal situations may require some manual control
- Control of all field equipment shall be directed by the operator via the PCS
- The process control platform shall support continuous development of advanced controls.

3.3.3.2 Control Actions

All control actions shall have a corresponding minimum feedback. This is required to allow plant equipment and process faults to be detected safely and promptly. For example:

- Motors – start/stop feedback from starters and variable speed drives
- On/Off Control Valves – position feedback from open and closed valve limits
- Modulating Control Valves – position feedback shall be monitored from valve positioner
- Process Control – Instrumentation shall be supplied to monitor process state.

All configurable devices shall be designed with predetermined failure modes. Final element devices shall fail as designated by process design. Instruments shall fail to a predefined fault state, i.e. fail low by default.

Failure of equipment to achieve commanded state shall require related equipment and processes to maintain the highest level of safe and sustainable operation possible. This shall be determined by implementation of sequence and interlocking logic.

3.3.3.3 Interlocks and Start Inhibits

All PCS controlled equipment shall be protected from unsafe or incorrect operation through the use of interlocks. Analogue control loops can be configured to shut down when an interlock condition occurs.

An active drive interlock shall immediately stop driven equipment and prevent the equipment from restarting while the interlock remains active. Similarly, an active control interlock shall immediately set the mode of a controller to MANUAL and the output to a configured safe output (normally 0%).

Driven equipment interlocks can be either hardwired at the MCC panel, or configured in the PCS. Hardwired interlocks are always active regardless of the operating mode of the equipment. Driven equipment process interlocks configured in the PCS are not active when the equipment is selected to for Local operating mode.

Interlocks on Analogue control loops are only configured in the PCS and always active. Interlock functions shall take precedence over manual and sequential operation requests, to ensure that equipment shuts down in a safe manner.

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Operator start inhibits shall also be configured on driven equipment in the PCS where appropriate. This type of signal shall prevent a console operator from starting equipment but shall not shutdown already running equipment.

Interlocking and operator start inhibits shall be reviewed during the detailed design reviews and the HAZOP design detailed phases to ensure that all potential hazards are addressed.

Equipment protective devices that are hardwired shall be monitored at the PCS system. The active interlocks associated with the equipment or loops shall display at HMIs.

An operator's supervisor shall be able to override configured interlocks, where personnel safety or plant integrity is not at risk.

3.3.3.4 Hot Standby Control

The PCS shall control any required Hot Standby operation of motors, fans etc. The HMI shall provide an operator selection for Duty and Standby for each motor in a set which is selected to remote and to hot standby operation. The PCS shall attempt to first operate the Duty motor. A failure in the Duty motor shall automatically start the Standby motor.

3.3.4 PCS Alarm Management

The PCS system shall manage all of the plant alarms. Alarms shall be categorised by priority from highest priority to lowest. The alarm management structure shall be in line with the Alarm Management System Standard.

The operator must acknowledge "Latched" regardless if the alarm source goes back to normal. The highest priority alarms are displayed on a banner on each workstation display. In addition, the Alarm List display shall indicate all alarms. This list can be filtered by tag name, priority, and process area.

The operator can acknowledge:

- An individual alarm and horn, from an equipment faceplate
- A group of alarm, from the primary display
- All alarms, from the Alarm list
- All plant PCS alarms shall be available to be displayed on all PCS HMIs. Specific alarm filtering can be applied to selected HMIs based on process areas, to limit the alarms available to be displayed on the individual stations. Any alarm selected to be displayed on a particular HMI can be acknowledged from that station. Alarms can be viewed and acknowledged from HMI stations located in the ROR or from the plant floor located LCS stations
- Alarms shall be conditioned to eliminate nuisance alarms. When a process area or equipment is not in service, an automated alarm management system shall inhibit nuisance process alarms associated with out-of-service equipment. Alarms generated in vendor-packaged control systems shall be annunciate locally at the equipment panel and communicated to PCS for alarming.

3.3.5 3rd party (Black Box) interfaces to packaged control systems

These types of control systems are used in applications where the system has its own control and supervisory intelligence, but an interface is required to the PCS for either monitoring or control or just monitoring. Each shall have a terminal strip. In certain applications it is required that these interfaces be wired directly to the PLC without the use of junction boxes. The packaged control systems that are considered as black boxes for this plant are :

- Weighbridge control system
- Conveyor Protection system

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- loading facility control system
- Medupi power plant balance of plant control system

The control systems shall interface with the PCS using the Plant Control Network and/or the PCS PLC hardware input /output cards. This architecture shall allow the status and alarm information to be displayed at the Operations room (ROR) HMIs and LCS. The functionality and availability of the plant network shall not have any impact on the integrity or functionality of the 3rd party system operation.

The 3rd party system shall monitor its communications with the PCS. Where communication fails, the system shall continue to operate using the last good set of process values. Communications statistics shall be collected and maintained for collection from the PCS.

Typically all handshake signals such as start and stop commands, running and tripped, between the controller of the packaged plant and the PCS shall be executed through a digital communication interface, Ethernet TCP/IP or Profibus and in some cases whereby minimal critical signals are exchanged for control or protection shall be hardwired between control systems.

The 3rd party systems shall be capable of basic safe operation without communications link interface. The hardwired interface shall be designed to fail safe and potential free contacts or relay terminals.

3.3.5.1 Signal Conditioning

All signals/values passed to the package plant control system from external control systems shall be conditioned at the package system. This shall include range, units, bounce and appropriate value selection. All alarms and trips shall be latched but the details shall be finalised in the Operation and Control Philosophy manual.

3.3.5.2 Medium and Low Voltage Switchgear – PLC Interface

The interface between all LV feeders shall be hardwired from the Electrical equipment's terminal strip to the PLC cubicles. Interposing relays (24V DC) are to be installed on all command signals from the control system to the switching equipment. And LV boards interface with the control system via hardwired alarm panels located in the switchgear room if applicable. No trip or protection signal shall be routed via the control system. The control system will only monitor the status of the protection signals.

3.3.6 Acceptance testing of equipment

A number of tests are required to ensure that the control systems are delivered in an agreed pre determined state as well as be ready for mechanical plant testing this avoiding length commissioning periods on site. The following tests shall be conducted as a minimum:

3.3.6.1 Factory Acceptance Test

The Factory Acceptance Test (FAT) shall be done to test all hardware components of the control system. The FAT shall include all required testing for supplied equipment, software and configuration work. The FAT shall be the responsibility of the Vendor and shall be witnessed by Eskom's Engineer.

3.3.6.2 Site Acceptance Testing (SAT)

Site Acceptance Testing (SAT) shall be performed to enable all control system components to be connected. The objectives being to ensure the control system internal functionality and software stability is achieved prior to the actual SAT tests.

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3.3.6.3 Site Integration Testing (SIT)

Site Integration Testing (SIT) shall be performed to enable all control system components to be simultaneously connected at final location. The objectives being correct performance of control system and safety of personnel and plant. This includes loop checks, hardwired interlock testing, motor bump testing, uncoupled runs, control system sequence.

3.3.6.4 Commissioning Testing

Commissioning is defined as bringing into service all items of the *works*, and meeting the functional requirements and performance criteria of the *Works Information*. Construction verification and Pre-commissioning testing shall be carried out by the project team with the Vendor's assistance.

3.3.6.5 Operation Acceptance Tests

This test shall be conducted after all plant mechanical, electrical and control systems are operational and running continuously. This is the final test done before the plant is handed over

3.3.7 Power Distribution Concept

The requirement for the power supply is an uninterruptible power source. The control system has unitised dual redundant power supplies with two streams of supplies to for 24V DC and 220V.

The distribution of power from the mains supply (380V AC) to the 24V DC control system equipment shall be redundant with no single point of failures between the two streams. Paralleling of the supplies is done at equipment level such that the equipment consumes 50% of current from each stream. In case one supply stream becomes unavailable, the available stream's Battery Charger supplies 100% of the current required by the control system equipment.

The control system design must make provision for the hardwired interface for Battery Charger monitoring and alarming. Battery banks used to supply back-up power are to be located in the battery room.

The redundant 220V AC UPS supply shall have two supply streams from the main supply. The loads for the above mentioned UPS may only be used for Control system, HMI equipment, network equipment and Back-up systems. If the 220V AC equipment has accepting two supply streams, the two supply streams shall be used. If the 220VAC equipment can only take one power cable and its not possible to design a second feed then one stream must be used. The understanding that a redundancy level will be lost needs to be addressed in the risk matrix and mitigated.

The philosophy is depicted in the diagram below:

Power Distribution Concept A:

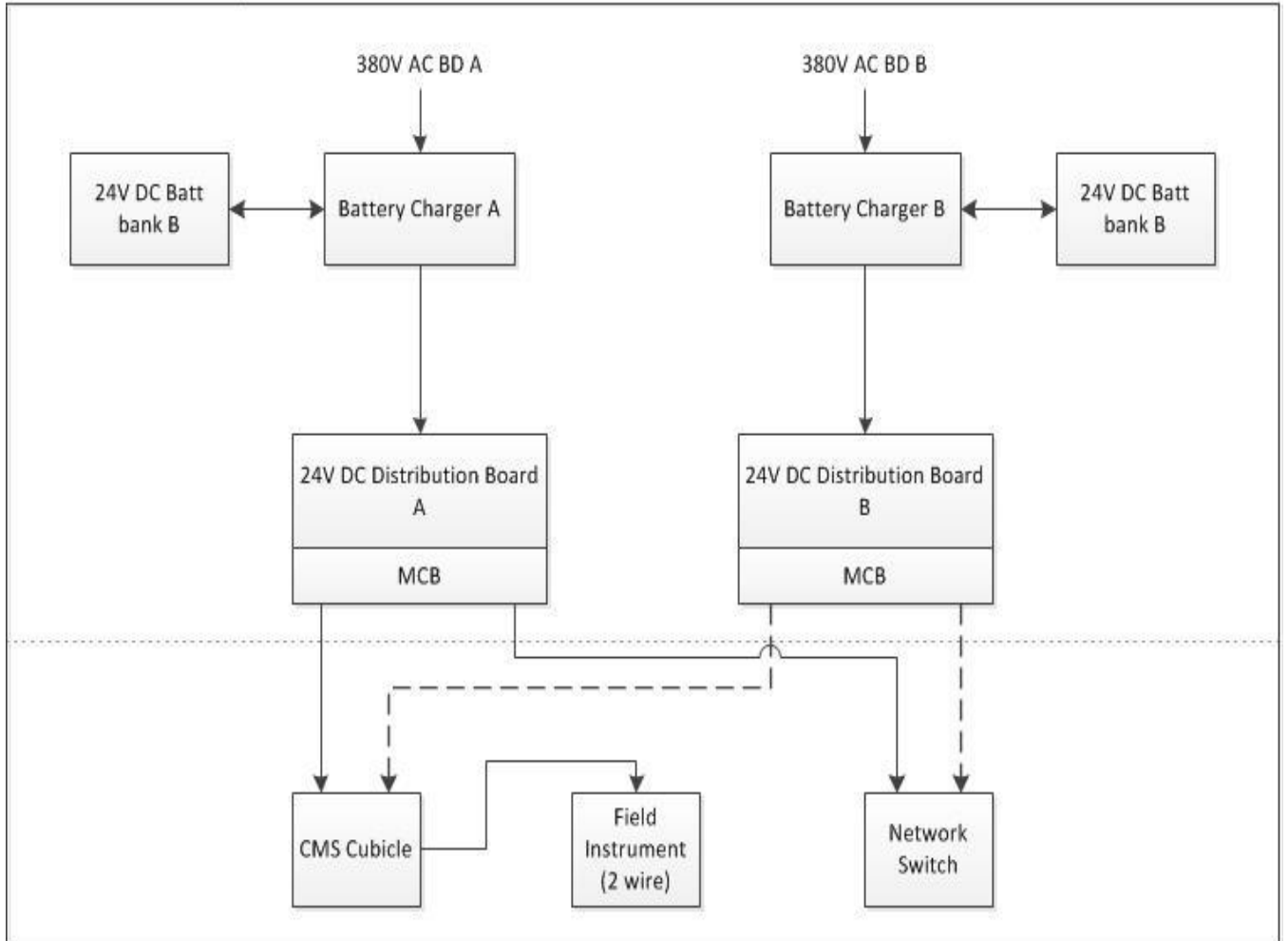


Figure 1

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When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Power Distribution Concept B:

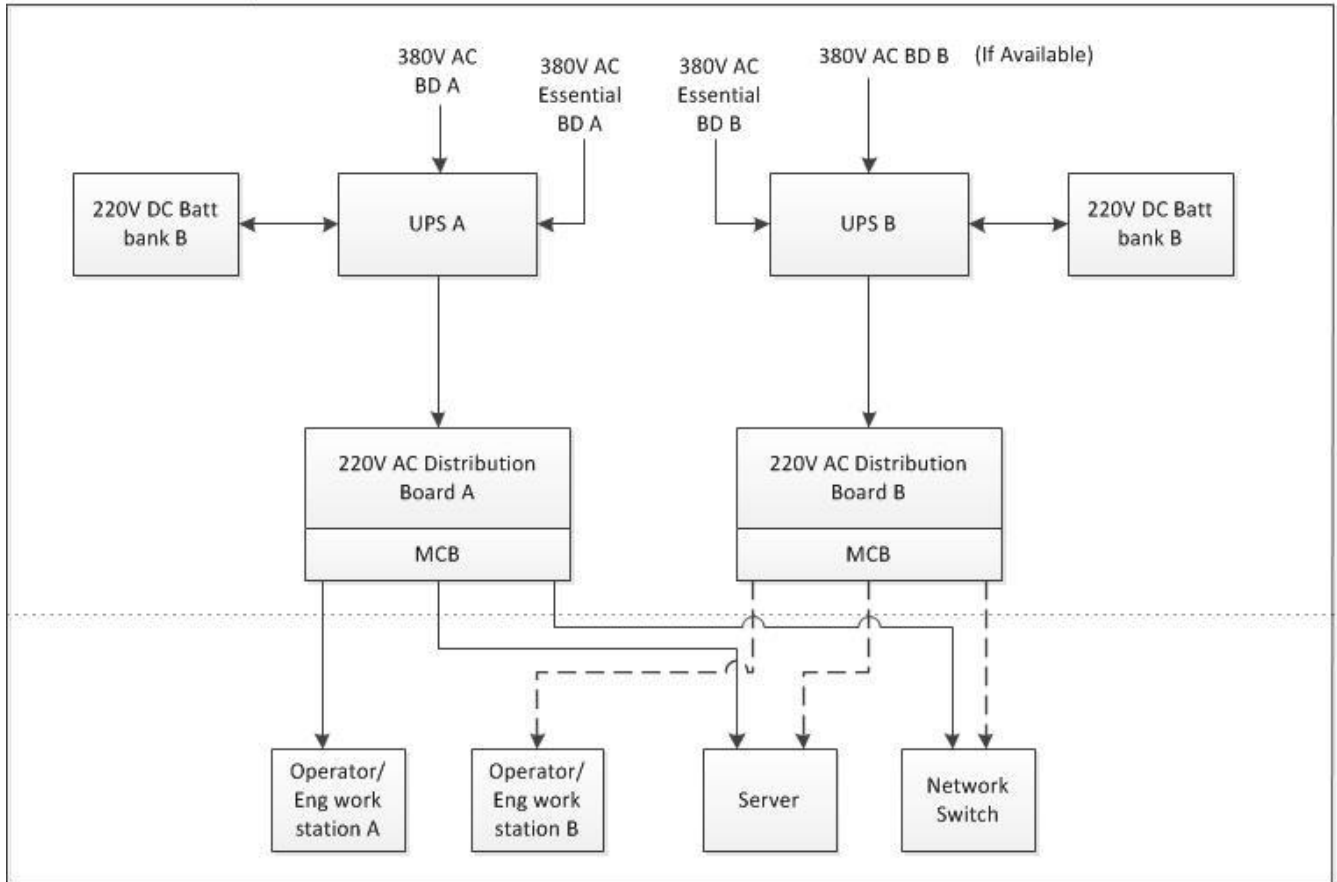


Figure 2

3.4 PCS detailed system DESCRIPTION

3.4.1 General

The design of the PCS shall be based on a hierarchical breakdown of the plant into areas, plant systems and sub-systems representing logical groupings of related equipment which can be controlled and operated as a unit. The system shall be a “state of the art” system designed to provide facilities and data for monitoring, control, scheduling, diagnosis and analysis to meet the needs of the operators, engineers, and maintenance and plant management. It shall be capable of integration to Medupi Outside Plant Control System.

Where required by the process, the PCS shall be dual redundant, designed to withstand any single point of failure to minimise impact of PCS failure on process control. Where the PCS is not redundant, the impact on process shall be considered along with the mean-time-to- repair.

Every critical electronic card shall be designed to comply with the IEC-61000 electromagnetic and immunity standards to be protected against:

- Electrostatic discharge
- Radio frequency
- Switch contact bounce.

Multi-language configuration for PCS shall be based on International Standard IEC 61131 allowing minimal design and configuration time.

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3.4.2 System Architecture

The System Architecture is such that the PCS is integrated to Medupi Outside Plant Control System.

The overall operating philosophy remains with a plant PCS located at the Rail yard Operations Room and a redundant plant bus interfacing to each LCS's in the field. Each bus will follow physically different routes

The Bus and CPU level remains with redundant CPU and redundant and a redundant Bus as well as at the HMI level with 2 Operating stations.

The redundancy at the I/O card level were not considered based on the Process being controlled having no control loops and only sequence starts and/or localised starts. In the event of the IO card failing there would be no emergency being created as the mechanical systems being controlled mainly the conveyor system and some small pumps would not cause any emergency events to happen due to the conveyor systems and 3rd party (Blackbox/ package control systems) having their own localised protection systems which would prevent unsafe situations to happen.

3.4.3 Physical characteristics of Control and Monitoring System

3.4.3.1 Operator Stations

The PCS primary function shall be to monitor and will not be used in protection or control. Further all plant control systems interfaced have local control facilities The Operator desk shall consist of two Operator station.

The LCD screens, keyboard & mouse will be located at the operator desk itself. The operating stations will be located in the ROR.

The operator stations shall consists each of the following components:

- 2 LCD operating screens (24")
- keyboard & mouse
- Operating workstation

3.4.3.1.1 Operating Screens

The minimum size of the operating screens is 24". The operating screens are MVA, PVA or IPS LCD screens. These types of LCD screens provide better viewing angles than a TFT LCD.

3.4.3.1.2 Overview Screens

The minimum size of the plant overview screens is 46". Due to the size of plant and the limited operational requirements it is recommended that Overview screens not be installed.

3.4.3.1.3 Operating Workstations

The operating workstation shall have the following characteristics:

- 19" rack mounted workstation
- Uses dedicated workstation hardware
- Rated for continuous use (24/7)
- Redundant network ports (with redundant connections to the network)
- Hard-drives are redundantly configured via a suitable RAID configuration
- Redundant power supplies
- Remote diagnostics, monitoring & alarming

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Note: The remote functionality described above shall only be available from the engineering workstations within the control system network itself, and not from any PC outside the system boundaries.

3.4.3.2 Engineering Stations

The Rail yard admin building shall have a Server room containing the Engineering Work Stations (EWS), PDH, PCS Communications and Networking equipment cabinet and printers for use by Plant and Control System Engineers. The EWS shall be used by plant maintenance to access and modify all plant processors and HMI's in the PCS. The EWS shall be password protected. The EWS shall connect to the plant PLC communication network and allow access to all of the plant PLC processors. PLC troubleshooting and modifications can be performed at this station.

The engineering stations consists of the following components:

- 1 off LCD engineering screens (24")
- mouse and keyboard
- Engineering workstation

The engineering workstations shall be located on the engineering desks in ROR

3.4.3.2.1 Engineering Screens

Same specifications as in 4.3.2.1.1

3.4.3.2.2 Engineering Workstations

Each engineering workstation shall have the following characteristics:

- Industrial, tower type
- Uses dedicated workstation hardware
- Rated for continuous use (24/7)
- Redundant network ports with redundant connections to every applicable network
- Hard-drives are redundantly configured via a suitable RAID configuration
- Redundant power supplies
- Remote diagnostics, monitoring & alarming

3.4.3.3 Servers

The plant control system (PCS) shall typically consist of the following servers for the following functions:

- PLC servers – via which operating data is routed. Operating data is primarily commands from the operator workstation to the PLC controllers and feedbacks and plant status information from the PLC controllers to the operator workstations
- Engineering servers – for the storage of the plant area's engineering database. The control system logic is created and modified via the engineering server and then downloaded to the relevant controllers
- Historian/PIS servers – for the long term storage of the plant area's information
- Update server – for the centralised management and distribution of antivirus software and security patches updates on all workstations and servers on the network
- Webserver – for view of the PCS operations via the HMI network

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Each of the above servers can share functionality and do not have to be separate individual servers. Typically multiple servers (as described above) may be hosted in one redundant set of hardware. However regardless of how many redundant sets of server hardware are used by the C&I contractor to realise the above server functions, each server machine must have the following physical characteristics:

- Redundant connections to each applicable network
- Redundant power supplies
- Use dedicated server hardware
- Hot swappable redundant hard drives via a suitable RAID configuration
- 19" Rack mounted in network cabinets

3.4.3.4 Network Switches

The housing and functionality requirements for all network switches shall be securely mounted in either the network cabinets or control system cubicle. All network switches shall be managed network switches with the following characteristics:

- Monitoring of the port connections and health of the device remotely
- Remote management, configuration
- All network switches support the backup and restoring of all configuration settings
- Remote network traffic monitoring
- Redundant power input ports
- All network switches are SNMPv3 compatible
- All network switches are IPv6 compatible
- Any network switch not housed in a network cabinet is of industrial Ethernet type and suitable for uncontrolled environmental and harsh conditions.

Note: The Remote functionality described above shall only be available from the engineering workstations within the control system network itself, and not from any PC outside the system boundaries.

Network Cabinets

All servers and operator workstations will be housed in 19" network cabinets. Redundant servers should be mounted in separate network cabinets. Patch panels and network switches may be mounted in the same network cabinets (as opposed to dedicated network switch cabinets). As far as possible, all connectors on rack-mounted components must be rear facing in the network cabinet for easier cable management. Top entry shall be used for network cables and bottom entry for power cables.

The network cabinets must have the following characteristics:

- Fully perforated front and rear server cabinet doors to maximise air flow
- Top panel with grommet holes for cable entry
- Removable solid side panels
- Any cable cut-outs beneath the network cabinet must be sealed to prevent air leakage using raised floor grommets
- There must be no open spaces between the rails and sides of rack enclosure. This ensures the network cabinet air flow is managed correctly

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- Comprehensive internal cable management system (for both horizontal and vertical cable management)
- Blanking panels on all unused slots to manage air flow efficiency and reduce hot spot temperature in the network cabinet
- Redundant Intelligent rack mounted power distribution units for remote management and diagnostics
- Rack mounted environmental monitoring devices for remote monitoring of the network cabinet environment
- Rack mounted LCD & keyboard
- Flexible brushes or shields must be used to prevent air leakage via cable entries
- Network cabinets must have sufficient depth to allow free air around cables in rear
- Cabinets in rows must be grouped together, i.e. no space must be left between the network cabinets.

3.4.3.5 Electronic Security Perimeter

The Electronic Security Perimeter (ESP) serves to secure the PCS from unwanted intrusions. ESP segregates the control system network from “open” system such as the Eskom LAN and other systems external to the control and monitoring system. A standard method of protecting the boundaries of a network is via demilitarized zones (DMZ).

A DMZ which is essentially a buffer zone is created between the outside world and the protected network. Any communication between the C&I system and the outside world occurs via computers in the DMZ only. In this way, direct access to the control system network from the outside world is ruled out.

The plant monitoring system can be configured with all the security protocols required by the client, such as passwords and firewalls.

3.4.3.6 Network Infrastructure

The design and installation of communication and network cabling as well as related telecommunication infrastructure should be done as per the following set of international standards:

- ANSI/TIA-942-A: Telecommunication infrastructure standard for data centres
- ANSI/TIA 568: telecommunication cabling generic standard and component (fibre optic and twisted pair cabling) specific standards
- ANSI/TIA 569: communication pathways and spaces (racking, trunking) standard
- ANSI/TIA 607: grounding and bonding of communication cabling standard

3.4.3.7 Control system cabinets

All trunk cabling into control system cubicles shall be bottom entry. All power cabling into control system cubicles shall be bottom entry. The control system cubicles are designed to be cooled via natural circulation. Grommets are used for all cable entries into the cubicles.

The internal environment of each control system cubicle (including that of non-PLC equipment supplied by the C&I contractor) is monitored and alarmed.

All control system cubicle modules excluding IO modules (CPU, communication modules, and power supply modules) are redundant. All control system cubicle modules are monitored and alarmed for failure. All Analogue input(AI) modules are HART enabled. Where possible, AI modules on non-PLC control systems are also HART enabled.

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3.4.4 Power Supplies and Signal Levels/ types

The power supply to four wire field devices e.g. transmitters, shall be conditioned 220 V, 50 Hz (other than for loop-powered instruments). Critical emergency shutdown devices or panels shall be UPS supported. A dedicated instrument power supply panel board shall be provided. The PCS panels, PCS servers, HMI stations, EWS and networking hardware shall be supplied 240 V AC from a UPS source.

Analog inputs and outputs power supplies shall be 24 V DC. There shall be isolating links on the field wiring terminal strips for each signal at the process control system panels or at any field control panel.

4-20 mA transmitters shall be used for measurement and control everywhere in the plant. Preference shall be given for loop powered instruments wherever possible.

The 220 V, 50 Hz power to instruments shall be individually protected by circuit breakers/fuses.

At 24 V DC, main panel power supplies and distribution shall be circuit breaker protected but individual process control system outputs or instruments shall be fuse protected. Power supplies for 24 V DC instrumentation shall be regulated and filtered. For critical emergency shutdown service the 24 V DC power supply shall be UPS supported and redundant DC supplies supplied as standards or hazard analysis dictates.

Signal	Type
Transmitter/Analog	4-20 mA
Alarms	24/36 V DC
Counters	24/36 V DC
Proximity Switches	24/36 V DC
Solenoid Valves	220 VAC
ON/OFF controls	24/36 V DC
Status signals	24/36 V DC
Local pneumatic control	20 – 100 kPa(g)
Instrument Air Supply (nominal)	690 kPa (g)
Instrument Air Supply (design)	550 – 850 kPa(g)

Discrete inputs to the PCS shall be by means of voltage free contacts suitable for sustained use with 220 VAC. These voltage free dry contacts can handle DC and AC voltages. Contacts shall be self-cleaning (wiping) action or be hermetically sealed.

3.4.5 Sizing of Control system

The I/O cards shall allow for 25% spare capacity for each hardware type after final design has been signed off. The I/O rack and terminations blocks for the PLC shall allow for 25% usable I/O card physical spare capacity. The HMI and PLC CPU's and associated hardware should run at 60% loading when all signals are operational.

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3.4.6 Plant Safety equipment for Conveyors

3.4.6.1 Hardwired Safety Circuit

Momentary stop buttons, pull wire switches, other personnel safety devices and auxiliary contacts of local disconnect switches shall be series connected in a fail-safe hardwired safety circuit.

Note that all electrical protective devices shall be hardwired to the starters or breaker circuits. These circuits shall be wired to de-energise the motor contactor. Additional contacts, arranged to follow the hard-wired contacts shall be provided to signal to the PCS. This shall not preclude the provision, in addition to the safety circuit, of non-latching stop buttons operating through the control system. Such controls may be required, for example, for the routine stopping of variable speed drives where a controlled deceleration to standstill is desired.

Hardwired series safety devices shall be connected into the control circuit of the associated equipment starter or VSD, as well as brought back to the PCS for monitoring. This is important on long conveyors that may have multiple trip switches. Ultimate limits for moving heads and diverter chutes to be hardwired to MCC circuits and auxiliary contacts to be marshalled to the PCS.

3.4.6.2 Intelligent and non-intelligent Conveyor protection Systems

For the intelligent system, all belt protection components as listed below, are wired/connected to a local control unit commonly called the Head End Control Unit (HECU). At the HECU, all signals are collected for a single interface point to the plant control system and/or conveyor drive switchgear.

The HECU allows for each component to be uniquely identifiable and interface to the plant control system is through a combination of hard-wired and "soft" signals where the "soft" signals are in the form of either an industrial type data link such of Profibus, Device Net, etc.

The HECU also provides a single emergency trip circuit for direct integration into the control circuit of the conveyor drive switchgear.

Each typical belt protection system shall as a minimum, consist of the following devices:

- Conveyor start-up warning siren which shall be audible over the entire length of the conveyor. It is desirable that every conveyor belt have a unique start-up warning siren and a strobe or flashing light at the head and tail end to indicate starting of conveyor.
- A trip wire along the full length of the conveyor and around the transfer chute, consisting of a pull key switch for stopping the conveyor at any point in case of emergencies as per the requirements of the Moving Machinery Safety Act (OHS Act). The maximum spacing of the trip switches shall be 100m or as specified by Eskom. Trip switches shall be installed on both sides if the conveyor is accessible from both sides. In this case, the configuration should be intelligent components on both sides and they are to be addressable so that the operators are able to identify location.
- A speed sensor incorporated into the pulley or idler structure at the head end for belt under-speed protection as a result of belt slippage, coupling failure or overloading.
- As an option, a speed sensor incorporated into the pulley or idler structure at the tail end for belt sequencing. This is only required should sequencing not be done by the plant control system or if a live feedback is required.
- Take up travel limit switches to trip the belt in case of take-up tower weight failure.
- Belt misalignment switches (electro-mechanical or electronic) to prevent edge damage to the belt or the conveyor structure as a result of belt running off the idler rollers. Two shall normally be required, one at the head and one at the tail end.

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- Belt tear switches (electro-mechanical or electronic) to detect edge damage to the belt due to contact with the conveyor structure or other components as a result of belt running off the idler rollers. Two shall normally be required, one at the head and one at the tail end.
- Belt rip detector (electro-mechanical or electronic) to detect longitudinal tears in the belt causing material spillage. One shall normally be required installed just after the last loading point of the conveyor.

3.4.6.3 Multi-Position Stop Controls

If more than one location of control is provided for a drive, the “stop” devices at all the locations shall always be operable to stop the equipment. This must include any manual activated ‘stops’ within the plant control system.

3.4.7 Package control Systems (Blackbox)

Package Safety systems shall be used where specific regulatory or certification requirements are required by the process and the same functionality cannot be provided using the plant control systems

Package control systems shall be delivered with all necessary documentation, testing and approvals, and shall follow local codes and standards applicable. .

3.4.7.1 General requirements

All control shall be implemented using PCS standard hardware or where practical Eskom’s approved PLCs.

Where cabinets are installed in field locations with local indications, they shall be supplied with doors having shock resistant glass windows to allow visual monitoring without opening the cabinet doors.

Local indications shall use the same conventions as PCS graphic standards. All local indications shall be clearly visible in full sunlight.

All controls and alarm switches shall be fail-safe, i.e. an abnormal condition shall cause a loss in output signal. Upon loss of power, control circuits and alarms shall go to the fail-safe condition. Solenoid valves and actuating relays shall be normally energised and shall de- energise on protective action or alarm. All alarm contacts shall open to alarm. When a pneumatically loaded device controls contacts, the device shall be normally loaded and shall vent to create the alarm or shutdown condition.

In general, interlock system circuits shall be activated from separate primary instruments. Before initiating a shutdown signal, separate pre-alarm point to indicate that an abnormal condition exists should also be initiated to give the operator ample time to do corrective actions. Failure to take corrective action shall result in a shutdown of the affected equipment. Pre-alarms may be actuated by "normal" instrumentation.

3.4.7.2 Testing Philosophy

The design and construction philosophy is that all possible equipment checks and testing must be completed before equipment is delivered to site.

3.4.7.3 Field Equipment Concept

Instrumentation shall be provided from reputable vendors. Where possible instrumentation will be similar to current specifications installed at the main power plant

Instrumentation shall be provided with the necessary ingress protection for the location. Instrumentation located outdoors shall be protected with sunshades.

Instruments measurement principles will be properly chosen to meet the following requirements:

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- Process Medium
- Servicing without interrupting process
- Installation possibilities and accessibility
- Ambient and process conditions
- Operational ranges and accuracy

For the installation of Control and instrumentation cables they shall be armoured for outdoor applications. All cables will be shielded, with a minimum conductor section of 0.5 mm². Cables above ground are to be laid in trays or on ladder racks and will be segregated from power cables in accordance with Eskom standard for cable installations. Cables will be labelled and conductors will be identified at terminations by ferrule number or suitable proprietary method.

3.4.7.4 Instrumentation

3.4.7.4.1 Belt Scale/Weighing

Where possible, solids flow shall be weighed by gravimetric conveyor belt scales. The scale electronics shall be microprocessor based and belt-speed compensated. The transmitted weight-rate signal shall be 4-20 mA or Profibus DP interface. Steel rollers should be used in the bridge area and ± 2 rollers from the weighbridge

Belt scales shall be designed to provide $\pm 0.5\%$ accuracy for in-plant systems. For plant systems involving product sale, the scales shall be designed to provide $\pm 0.25\%$ accuracy. Load cells shall be used for custody transfer or batch weighing of products and material.

All custody transfer scales shall be located indoors, protected from the elements.

Calibration weights or chains with troughs shall be provided separately for each belt weigher. A suitable access area over the conveyor shall be provided for accessing area with a hoist or crane during a calibration activity.

Impact belt weighers may be considered. Integral to the design shall be a system to divert weighed material to a bin or truck for weighing to check and calibrate the weigher. Idler angle should be kept below 45 degrees in scale.

Load cells shall be used for bin weighing and custody transfer of products and material wherever possible. Strain gauge weighing monitoring systems with sensors bolted on the structural support shall only be considered for coarse weight applications on isolated structures not subject to vibration.

3.4.7.4.2 Under Speed Switches

Non-contacting solid-state type under speed switches shall be used. A time delay, adjustable from 1 to 50 seconds, shall be provided on the speed switch itself (i.e. maintained contact output from switch indicates under speed, not an output pulse train to the control system). Start up time delays shall be done separately in the process control system (PCS). The proximity type switch mentioned above shall be used for speed sensing with any timing function programmed in the PCS.

3.4.7.4.3 Level Instruments

Non-contact level instruments (ultrasonic, laser, radar) shall be the preferred way of measuring solids level in bins, and liquid level in tanks.

For steamy, foamy or agitated applications, radar level devices shall be used instead of ultrasonic level instruments.

Remote flange mounted elements with accessible separate transmitters at ground or walkway level are preferred. Alternately approved integral transmitters shall be mounted adjacent to access walkways as a second option.

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Differential pressure transmitters may be used for level measurement in tanks containing liquids of constant density or dual transmitters with a vertical separation shall be installed to compensate for density.

For wet leg transmitters, consideration is required of pressure and temperature to avoid flashing.

3.4.7.4.4 Level Switches

Where use of a level transmitter is impractical, conductivity type level switches may be used for water, slurries and other conductive, non-flammable liquids.

The switches shall be electronic and of the differential control type which require a minimum of two electrodes and a ground connection. Typical use is on sumps. Vibrating forks are also acceptable in some applications.

Capacitive type switches may also be used for level applications.

For conveyor blocked chutes ultrasonic, infra red or capacitive plate shall be the preferred type of instruments used but these will have to be proven reliable.

Appropriate warning signs and/or approval identification shall be supplied with microwave and nuclear applications as required.

Vibratory wand type level switches shall be used for high-level detection in bins containing non-corrosive liquids, dust or granular material. For bin or tank applications flanged connections are preferred.

3.5 RAILYARD BMS

The BMS for the Medupi Rail yard shall be linked to the CBMS of the Medupi power plant. This solution is to extend the current Medupi power plant CBMS bus to connect and incorporate the Railyard BMS with a local BMS operating station in the Rail yard Operations room.

The sites are to be linked by a fibre cable between facilities and a multimode 12 core fibre cable from equipment room to field devices.

3.5.1 Security Systems

3.5.1.1 Summary of Proposed Security Equipment per Area

3.5.1.1.1 IP Cameras and Surveillance System

The surveillance system will be monitored in the ROR room located at the Railyard Admin building and all equipment will be housed in the Server room also located at the admin building. All outdoor equipment enclosures will be at least IP67 rated.

The proposed solution will consist of below cameras refer to Table below.

Area	Type
General Areas	Pan/Tilt/Zoom
Main Entrance(Security Building)	Pan/Tilt/Zoom Fixed Dome
Admin Building/ Operations Room	Pan/Tilt/Zoom Fixed
Fuel Storage	Pan/Tilt/Zoom Fixed
Parameter Fence	Fixed Camera

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Table 1: Summary of Camera Required

3.5.1.1.2 Access Control System

The proposed access control system will have 1 x Biometric finger print + badge reader at the entrance of the Rail yard admin and operations building.

3.5.1.1.3 Intercoms

There will be intercoms as per list below.

Name of Area	Type of Intercoms
	Boom Gates
	Two-Way Turnstiles
Security control Room/ Rail yard Operations room - ROR (Rail yard Admin Building) Server room and Power room (Rail yard Admin Building)	Slave Intercoms
	Master Intercom
Other general areas – Loading Facility	Slave intercoms
	Master Intercom

Table 2: Summary of Intercom quantities

3.5.1.2 Description of Security System Requirements per Area.

3.5.1.2.1 General Areas

PTZ cameras mounted on 9 m masts will be positioned and installed at a distance of 400 m apart in order to achieve site coverage. The equipment proposed will be linked back to server room in the Rail yard Admin building through Fibre Optic cabling.

3.5.1.2.2 Security system location

The security system will have the following equipment installed in the ROR: two LCD monitors, one Control desk for CBMS workstation, one Surveillance workstations, one Access control workstation, one Perimeter monitoring Fence workstation,

3.5.1.2.3 Main Entrance

The main entrance to the facility will be access controlled using a gate and manually operated traffic barrier. Pan Tilt Zoom (PTZ), fixed cameras and Fixed Dome cameras will be positioned for full surveillance of the area.

The ROR security section shall have the following equipment installed: Two LCD monitors, one Control desk. The Server room shall have, one Surveillance workstations, one Access control workstation, one Fence workstation and network infrastructure.

3.5.1.2.4 Server Room

The proposed server room will have two Fixed Dome Cameras, one Fixed Dome Camera on the outside monitoring entrance into Server room.

The Rail yard CBMS Network interfaces to Medupi Power plant CBMS network

A Network Video Recording System for 30 channels (20% spare channels) with storage assumptions for up 150 days. Including decoder for two LCD Monitors and software.

3.5.1.2.5 IP Fence Intrusion System

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The system will consist of distributed acoustic sensing. The perimeter will also have fixed cameras mounted on 3 m masts at 100 m apart to monitor any unauthorised access through the perimeter.

3.5.1.2.6 Equipment Positions

Final equipment positions will be confirmed during the detailed design phase.

3.5.1.3 Fire Detection System

The system will be centrally monitored in the ROR located at the Admin building of the Railyard. All outdoor equipment enclosures will be at least IP67 rated.

- The new loading conveyors and transfer Houses are to be fitted with a suitable fire detection system and public address system to allow an early warning of a potential fire to be communicated to the Operating Personnel. Visual and audible alarms are to be provided throughout the various areas.
- Up loading Conveyor belt drive motors are to be interlocked with the Fire Detection system so that all respective conveyors are stopped on detection of a fire.
- All Electrical Substations, ROR and Server rooms are to be fitted with a fire detection system to allow an early warning of a potential fire to be communicated to the Operating Personnel. Visual and audible alarms are to be provided throughout the various areas.
- Pump Building are to be fitted with a fire detection system to allow an early warning of a potential fire to be communicated to the Operating Personnel. Visual and audible alarms are to be provided throughout the various areas.
- The diesel storage Fire Protection Foam House is to be fitted with a fire detection system to allow an early warning of a potential fire to be communicated to the Operating Personnel. Visual and audible alarms are to be provided throughout the various areas.
- The system will be centrally monitored in the ROR located at the Rail yard Admin building.
- All outdoor equipment enclosures will be at least IP67 rated.

3.5.2 Internal PCS Interfaces

The interfaces to the other internal security systems shall be the following:

- Profibus/ hardwired signals from each of the Conveyor protection systems
- Ethernet/Hardwired/Profibus/RS232 protocol for Weighbridge System
- Ethernet to Medupi Power plant Fire detection system
- Ethernet/Hardwired/Profibus Signals loading facility
- Hardwired signals to the MCC for Conveyors and pumps start/ stops
- Network infrastructure
- LOSS and Function block diagrams

3.5.3 Multi discipline Integration requirements

3.5.3.1 Civil Requirements

The Rail yard Admin building Server room where the PLC is housed would require civils to create cable route entries and exits and support structures to the Operator room and other rooms including slabs to create a paths for the signals and bus cables to the Operator room and to the outside plant area.

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Further in the field the cable routes would require trenching and support structures for the cable trays housing the cables to the point of interface of all Field equipment. The cable trenches are to be constructed as per the Eskom Instrument cable specifications.

3.5.3.2 HVAC Requirements

The HVAC shall be designed for the Climatic operating conditions of the equipment housed in the Admin building ROR and Server Room. . The estimated heat generated from the equipment in the Server room are as follows:

Equipment	Qty	Kw each	BTU
Servers and network switches	3	3kW	9,000 x 3= 27000
PLC	1	5kW	17,000

In summary requirements are as follows for the server room:

The total of 44,000 BTU is required

The climate conditions shall be maintained between 19C to 27 and average 22C.

Humidity range should be 40% - 60%

There shall be a network card connected to the Aircon system for the BMS system to monitor conditions and failure.

The interface to the Medupi Power plant CBMS network shall apply. Allowance should be made for two independent Aircons for redundancy.

Central and not split Air-conditioning industrial units shall be used

The HVAC systems in the building are interfaced to the CBMS system in order to be controlled for general monitoring as well as in emergency situations such as fire being detected

3.5.3.3 Mechanical Plant

The interfaces to the mechanical plant are as follows:

Rail yard –This interface would be at the Operator room where the Bus for the Weighbridge and Network interface would be located. Allowance shall be made in the Weighbridge system as per the Plant PCS requirements. All driver software and licenses required needs to be included in the Works.

Conveyor System for– The interface to the Conveyors would be via the LCP located at each conveyor for local operation and via the HMI for remote operation and sequence start. The conveyor protection systems (HECU) shall be located at each conveyor motor. There shall be either a Profibus, or and/ Hardwired signals to the PCS. The LCP shall located at be at each drive and connected directly to the PLC for operation. The package control systems such as the up loading LCS shall be either an Ethernet or Profibus or hardwired.

3.5.3.4 Electrical

The electrical system shall provide power requirements of 20 amps from the UPS and Battery Chargers to the PLC small power distribution panels that feed the plant C&I requirements. The localised blackboxes shall be feed with their own localised UPS/ Battery chargers unless they are located in the Admin building. The weighbridge PC and printer shall be fed from the UPS located in the Admin building together with the PLC DB board.

3.5.4 Facilities Required

There shall be sufficient space in the server rooms such that the engineers can work locally on the equipment. There shall be a desk and chair and climate control systems that allow the equipment to operate at their design temperatures.

3.5.5 Maintenance Concept

The PCS system shall include an Engineering station whereby maintenance work can be carried out locally at the Rail yard Admin building. There would be a requirement from Medupi Power plant C&I that remote maintenance from a system perspective should be possible. The intention is to have centralised maintenance facility for all DCS and PLC control systems related to Medupi Power plant be integrated such that maintenance tasks can be executed. The uploading PLC's/ control systems shall include this facility for maintenance.

The spare parts philosophy for commissioning and operations Medupi Power plant philosophy shall apply to this facility. The spares shall form part of the Medupi power plant spares logistic system. It is recommended that some emergency spares are held closer to the operations of the yard such as in the server or equipment room. These spares should allow the local staff to quickly replace equipment to ensure the required availability for this facility is achieved

The recommended 2 year spares for the Uploading facility shall be recommended by the suppliers and shall be in line with the Medupi Power plant operation spares philosophy as well as this facility availability requirements.

3.5.6 Operating Concept

3.5.6.1 Operation Philosophy

The plant is standalone and under normal operating conditions a Rail yard operating room located in the Rail yard Admin building shall be provided from which the entire terminal facility can be supervised, monitored and controlled from dedicated operator workstations.

The operator station software application engineering shall be based on providing a user friendly operator interface to facilitate normal operator selections, such as route selections and starting and stopping of conveyors. The operator interface shall also provide alarm handling and diagnostic information to the operator.

The operator interface shall be interfaced with Rail yard weighbridge, conveyors, loading to view the status and to get diagnostic information and performance data. The Rail yard operations shall be integrated to the Medupi power plant via the Medupi power plant balance of plant control system.

In abnormal conditions the plant can be controlled locally at the local control panels located strategically at each plant area. The conveyor protection systems shall at all times be active during local operation.

The operation shall be monitored from the operators in the Medupi Balance of plant control room. Refer to Eskom Standard on Plant Control Modes with Local Control Facilities

3.6 Requirements for Instrumentation Control and Communication cable

- Where intrinsically safe circuits are used, the specified maximum cable parameters for that respective gas group shall be adhered to, this applies to cable capacitance, inductance or L/R ratios
- For cables defined as instrument signal cables, the following techniques i.e. twisted cores/pairs, individual screens and overall screen shall be incorporated in the construction of such cables to prevent and minimise noise interference. The Vendor data sheets shall indicate the number of twists per meter

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- In cables having multiple pairs or triads each pair or triad shall be individually screened to avoid cross-talk interference between pairs or triads. The screen shall be in the form of helically applied aluminium – Mylar tape. Within each screen a tinned copper drain wire shall be provided
- For above mentioned cables, but also including cables defined as multi-core instrument digital cables (switched potentials) the following shall apply. An overall screen shall be provided to guard against static interference. The screen shall be in the form of a helically applied Aluminium-Mylar tape. A 0.5 mm² tinned copper drain wire shall be provided
- For screened pair cable the capacitance between two conductors of each pair shall not exceed 180 pF/metre for 0.5 mm² conductors, 224 pF/metre for 1.0 mm² conductors and 242 pF/metre for 1.5 mm² conductors having an insulation thickness of 0.40 mm of PVC
- The L/R ratio shall not exceed 25 (the total inductance per unit length measured in micro henries divided by the total resistance per unit length measured in ohms), for cables of
- 0.5 mm² and 1.0 mm² and 40 for 1.5 mm² cable conductors
- All cables and wiring to be tested for insulation (500 volts megger test) continuity tested on the drum prior to cutting and again after installation but before connection to instruments
- All cabling is to be run on, or in, appropriate cable ways. Cables are not to lie on hot or dirty surfaces.
- Flame Retardant cabling is to be used wherever possible.
- All cable terminations are to be checked for hotspots, with the use of thermal imaging equipment, during the commissioning phase
- All cable entries are to be sealed with a 2 hour rated, SABS approved, penetration sealant.
- The electrical reticulation to, and within, all areas of Electrical Substations, C&I rooms housing Equipment and Electrical Equipment areas is to be designed and signed-off by a competent engineer.
- An electrical clearance certificate needs to be issued by the electrical installation contractor.
- All cabling is to be run on, or in, appropriate cable ways. Cables are not to lie on hot or dirty surfaces
- All signal wiring and power wiring associated with instrumentation that enters or leaves a skid or a package system shall be terminated in frame mounted NEMA 4 or 4X junction boxes, as defined by the area classification. Junction boxes shall have hinged lockable doors and bottom entry gland plates and contains numbered, labelled terminal strips. Isolating terminal links shall be provided at the control panel end.
- Similar signal types shall be grouped to avoid electrical interference between signals. All
- entry to and exit from the junction boxes shall be through the bottom entry gland plate only, using approved glands and cables suitable for the application (e.g. hazardous area). Use of
- flexible conduit is permissible where application allows and it is advantageous over rigid
- conduit.
- As a minimum requirement Analog and digital signals shall use UV stabilised individual and overall screened instrument twisted multi-pair cable. Pulse signals shall have individually screened twisted pair cables. Digital or Analog signals shall not share thermocouple mV signal nor pulse signal cables.

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- Screens (shield) shall be continuous through all terminals and panels and only be terminated at the control system end to avoid earth loops. Insulated terminals shall be provided for screens in junction boxes. The screen shield at the instrument end shall be protected with heat shrink insulation.
- In general, all wiring terminations shall be at numbered vibration resistant terminal blocks with no pigtails. Wire splices are not permitted. All wiring and terminations shall be clearly marked and identified with slip on type wire markers. Markers from Weidmueller (Grafoplast plotter type system, c/w slip-on sleeve. (Colour: Black on Yellow or Black on White)) shall be used which shall not be dislodged. The full wire number shall be used on each wire. All cables shall also be numbered at both ends.
- Separate slotted PVC wire ducts with clip on covers shall be provided for local panel internal and field wiring. Labelled, numbered terminal strips shall be provided for connection of all field wiring, and for panel interconnections where required. Terminal strips and wire ducts in panels shall be segregated by voltage levels and function as follows:
 - 220 V AC power and control wiring (shroud and warning label)
 - Profibus DP signals
 - 24 V DC digital signals. (IS signals in separate enclosure in field)
 - Instrument or control system communications
 - 4 to 20 mA Analog signals as required.
- Wire ducts, cable tray, conduits and instrument tubing runs shall not interfere with removal or prevent routine maintenance of instruments.
- Wherever possible all instrument control and power cables shall be armoured, aluminium interlocking, TECK90 cable with PVC outer jacket rated 600 V. All non-armoured instrument cables outside of cable ladders shall be mechanically protected by conduit or similar.
- All instrument cables shall be screened twisted pairs 1.0 mm² complete with overall shield. All shield wires shall be continuous through junction boxes and terminals and grounded at the PCS I/O termination cabinet on an isolated instrument ground bar.
- In general temperature transmitters shall be used. If required, thermocouple extension cable shall be twisted pair wire. The conductor material shall be matched to the thermocouple elements. Resistance Temperature Detector (RTD) extension cable shall be twisted triad copper wires, in cases where a temperature transmitter is remote.

Cables for various PCS communications networks such as Profibus, Ethernet, etc. shall use the appropriate wiring which meets or exceeds specifications required by the associated standard