POWER GENERATION

PROJECT

SUPPLY OF A REFURBISHED

100 MW RATED PULVERISED COAL FIRED ELECTRICITY

GENERATING STATION

TECHNICAL SECTION

03-11-2005

T A B L E O F C O N T E N T

ANNEXURE A

SCOPE OF SUPPLY

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SCOPE OF SUPPLY

POWER GENERATION PROJECT

A - BOILER PLANT

Main Boiler and Boiler House Steel Columns
Main Boiler and Boiler House Steel Beams
Roof Trusses, Purlins and Girts
Roof and Side sheeting including purlins and girts
Platforms & Stairs
Flooring / Grating

Steam Drum and Support Slings / Hardware
Down Comers
Boiler Feed Pumps with Cast-In Frames and Base plates including motor - 2 sets
Finned Tube Economizer Elements and Headers including Bypass
Economizer Gas Bypass
Primary Superheater Elements
Secondary SH Elements
Primary SH Inlet Header
Secondary SH / Main Steam Outlet Header
HP Steam lines complete with spring supports
Boiler Feed lines complete with supports
De-aerator
HP Valves
Feeder Tubes
Riser Tubes

ID Fans with Drives
ID Fan Ducting
ID Fan Dampers
FD Fans with Drives
FD Fan Ducting
FD Fan Dampers
PA Fans with Drives
PA Fan Ducting
PA Fan Dampers

Coal conveyors with Drives and new Belting
Coal Storage Bunkers in Boiler house
Coal Chutes to Coal Feeders and Mills / Pulverizers
Coal Feeders
Coal Mills / Pulverizers with Gearbox and Drives

Combined Coal / Oil Burners including feed systems and new Wind boxes
Hanger Supports for Combustion Chamber
Access Doors
New Thermal Insulation and Cladding for Boiler, Ducting and Piping
Rotary Airheaters with Ducting
Soot Blower Supports and Access Platforms and Stairs
Electrostatic Precipitator - 5 Field
Ash Hoppers with Ash removal system

Structural Steel Design and Foundation Design
Boiler Performance Design
Pressure parts design review and Inspection Authority for Boiler Certification (TUV)
Boiler O & M Manuals
Marking of all components for Erection works
AUTOCAD and original Drawing package

Dismantling, refurbishment and packing of all components

Delivery of Equipment to any Seaport required for Project.

B - TURBINE GENERATOR SET - SCOPE OF SUPPLY - AEG - 3000 rpm / 50 Hz

HP and LP Top and Bottom Casings complete
HP and LP Rotors
Condenser complete with Auxiliary Equipment and Cooling Water Pumps
Cooling Water System
Oil system
Generator
Transformer
Feed Water Heating Station complete with Piping and Valves
Turbine Building including Roof Trusses, Purlins, Girts and OH Crane beams
Performance Review
Turbine Generator O & M Manuals
Marking of all components for Erection works
AUTOCAD and original Drawing package
Dismantling, refurbishment and packing of all components
Delivery FOB South African Port.

C - SUPPLY OF NEW ADDITIONAL EQUIPMENT

New Membrane walled combustion Chamber with new Buckstays
New Lagging and Cladding
New airheater packs
Boiler Furnace cleaning Equipment such as Sootblowers

ANNEXURE B

COAL SPECIFICATION

ANNEXURE B

COAL SPECIFICATION AT PRESENT LOCATION

The fuel shall be an unwashed product having an as used gross calorific value, quality and grading, approximately, as follows (at present location):

Calorific value	10, 380 B.t.u./1b.
Surface moisture	4.0 % (max.)
Total moisture	6.6 %
Volatile matter	18.0 % normal minimum
Ash	18.0 % (maximum)
Sulphur	1.3 % (average)
Grindability	56 Hardgrove index.

Ash Fusion

Initial deformation temperature	1325°C
Softening temperature of ash	1350°C
Fusion temperature of ash	1380-1400°C

Sizing

Coal at the mills will be 100% below 1" cube.

The grading can be adjusted within limits to give the best operating results.

ANNEXURE C

TECHNICAL DETAILS

DOUBLE-CASING CONDENSING TURBINE

Type 11/100 220

AEG-TELEFUNKEN

1.1 TECHNICAL PARTICULARS

General
Rated Turbine Data and Limit Values
Oil Supply System
Governing Equipment
Seal Steam and Drain Equipment
Auxiliary and Safety Equipment
Metering Equipment
Rated Data of Condensing Plant
Motor List
Weights of Some Heavy Components

TECHNICAL PARTICULARS

General

Type of Turbine	11/100 220 AEG Impulse Type Double-casing Condensing Turbine		
	Unit 3	Unit 4	Unit 5
Year of Manufacture	1966	1966	1967
H.P. Rotor Number	T 1073	T 1074	T 1121
L.P. Rotor Number	T 1085	T 1086	T 1122

Rated Turbine Data

Output,	economical	80,000 kW	
	max.	100,000 kW	
Live steam pressure,	normal	1200 psig	(84.4 atg)
	max. cont.	1250 psig	(87.9 atg)
	max. short-time	1380 psig	(97 atg)
Live steam temperature,	normal	950 °F	(510 °C)
	Max. cont.	970 °F	(521 °C)
	Max. short-time	986 °F	(530 °C)
	Max. short-time	1009°F	(543 °C)

1) 1380 psig (97 atg) are permissible for a maximum of 12 hours per year.

2) The max. short-time live steam temperature of 986 °F (530 °C) is permissible for a maximum of 400 hours per year and

3) 1009 °F (543 °C) are permissible for a maximum of 80 hours per year with the duration of an operation limited to 15 minutes at one time.

Pressure and temperature in stage 1 At 80 MW, 1200 psig (84.4 atg), 950 °F (510 °C)	normal	839 psia 873 °F	(59 ata) (467 °C)
	max.	1132 psia	(79.6 ata)
		941 °F	(505 °C)

The pressure in stage 1 should not exceed 1132 psia (79.6 ata)

Steam flow at 80 MW,	Casing I (H.P.) 642,920 lbs/h	(291.6 t/h)
1200 psig (84.4 atg), 950 °F (510 °C)	Casing II (L.P.) 527,560 lbs/h	(239.3 t/h)
Max. steam flow	Casing I (H.P.) 821,640 lbs/h	(372.7 t/h)
	Casing II (L.P.) 736,740 lbs/h	(334.2 t/h)
No-load steam flow (generator excited)	approx. 20,720 lbs/h	(9.4 t/h)
Condenser pressure	norm. 1.82 in. Hg	(0.063 ata)
	max. 3.51 in. Hg	(0.1213 ata)
Condensate flow	norm. 477,740 lbs/h	(216.7 t/h)
	max. 667,120 lbs/h	(302.6 t/h)
C.W. temperature	norm. 75 °F	(24 °C)
	max. 90 °F	(32 °C)
C.W. flow	40,330 imp. gal/min	(11,000 m^3/h)

THREE-PHASE SYNCHRONOUS GENERATOR

WITH HYDROGEN COOLING

Type FKWS 3742 p

AEG - TELEFUNKEN

CONTENTS

1.1. General

Generator type		FKWS 3742p	
Year of Manufacture		Unit 3 :	1966
		Unit 4 :	1966
		Unit 5 :	1967
Stator Nos.		Unit 3 :	G 8133
		Unit 4 :	G 8134
		Unit 5 :	G 8152
Rotor Nos.		Unit 3 :	I 8133
		Unit 4 :	I 8134
		Unit 5 :	I 8152
Main exciter	Type ECT 84/31/8	Unit 3 :	No. 704 384
		Unit 4 :	No. 704 385
		Unit 5 :	No. 710 468
Amplidyne	Type GQC 4546sp1	Unit 3 :	No. 338 990 402
		Unit 4 :	No. 338 990 401
		Unit 5 :	No. 344 426 501
Base exciter	Type 245 sond.	Unit 3 :	No. 705 805
		Unit 4 :	No. 705 806
		Unit 5 :	No. 710 454
Gear unit	Type DSF 20 x	Unit 3 :	5671
		Unit 4 :	5672
		Unit 5 :	5779
Voltage regulator		Type TSA 2	
Field rheostat		R 250	
Hydrogen cooler		Type V 15 x 9 – 3021/2 KF 30 203 No. T 850 429	

1.2 Rated Data

1.2.1 Rated Generator Data

Apparent power	111.1 MVA	Power factor	0.9
Active power	100 MW	H_2 pressure	30 psig (2.11 atg)
Voltage	10.5 kV +/- 5%	Speed	3000 rev/min
Current	6.11 kA	Frequency	50 c/s

Further outputs can be determined from the power chart.

1.2.2 Rated Main Exciter Data

Output	620 kW	Voltage	310 V
Speed	1500 rev/min	Current	2000 A

1.2.3 Rated Amplidyne Data

Output	7.6 kW	Voltage	230 V
Speed	1500 rev/min	Current	33 A

1.2.4 Rated Base Exciter Data

Output	0.09 kW D.C. 0.7 kVA A.C.	Voltage	60 V D.C. 225 V A.C.
Speed	1500 rev/min	Current	1.5 A D.C. 3.1 A A.C

The generators are designed in conformity with BS 2613 and should be operated according to these specifications.

1.3. Electrical Data

1.3.1 Resistances at 20 °C

1.1.1 Stator No. 8133

Phase U_1 X_1	0.00240 ohm	Phase U_2 X_2	0.00238 ohm
Phase V_1 Y_1	0.00236 ohm	Phase V_2 Y_2	0.00237 ohm
Phase W_1 Z_1	0.00239 ohm	Phase W_2 Z_2	0.00237 ohm

1.1.2 Stator No. 8134

Phase U_1 X_1	0.00241 ohm	Phase U_2 X_2	0.00239 ohm
Phase V_1 Y_1	0.00237 ohm	Phase V_2 Y_2	0.00237 ohm
Phase W_1 Z_1	0.00239 ohm	Phase W_2 Z_2	0.00240 ohm

1.1.3 Stator No. 8152

Phase U_1 X_1	0.00239 ohm	Phase U_2 X_2	0.00238 ohm
Phase V_1 Y_1	0.00236 ohm	Phase V_2 Y_2	0.00238 ohm
Phase W_1 Z_1	0.00238 ohm	Phase W_2 Z_2	0.00239 ohm

1.1.4 Field winding, slip ring to slip ring

Rotor No. 8133	0.119 ohm
Rotor No. 8134	0.118 ohm
Rotor No. 8152	0.118 ohm

1.1.5 Main exciter

No. 704 384	Field winding	IK	5.02	ohm
	Compoles	GH	0.00098	ohm

No. 704 385	Field winding	IK	4.98	ohm
	Compoles	GH	0.001	ohm
NO. 710 468	Field winding	IK	5.25	ohm
	Compoles	GH	0.00107	ohm

Amplidyne

No. 338 990 402	Main field	$i_a - k_a$	28.1	ohm
	Control field	$i_b - k_b$	13.2	ohm
	Diff. Field	$i_c - k_c$	43.0	ohm
No. 338 990 401	Main field	$i_a - k_a$	28	ohm
	Control field	$i_b - k_b$	13.15	ohm
	Diff. Field	$i_c - k_c$	43.1	ohm
No. 344 426 501	Main field	$i_a - k_a$	28.6	ohm
	Control field	$i_b - k_b$	13.45	ohm
	Diff. Field	$i_c - k_c$	44	ohm

1.1.6 **Base exciter**

No. 705 805	Field winding CD	16.9	ohm
No. 705 806	Field winding CD	16.9	ohm
No. 710 454	Field winding CD	16.9	ohm

1.3.2 Field Currents

For Maximum output at 30 psig H_2 pressure	approx. 1700 A
For maximum output at 16 psig H_2 pressure	approx. 1540 A
For maximum output at 2.5 psig H_2 pressure	approx. 1280 A
For maximum output at air operation	approx. 1040 A

The field currents are no criterion of the load-carrying capacity of the generator.

ELECTROSTATIC PRECIPITATOR

1. GENERAL

Each boiler will be provided with electrostatic precipitator plant to fit within the space available. The precipitator plant associated with each of the boilers shall comprise one independent shell. The precipitator shall be located in the gas circuit immediately ahead of the induced draught fans.

The precipitator shall be situated outside the boiler house and shall be of weatherproof construction suitable for out-of-doors operation in climatic conditions prevailing at site.

The precipitator shall be complete with all electrical equipment. All collector and discharge electrodes, support frames and insulators, rapping gear, motors, dust hoppers, ducting and casings, thermal insulation and other equipment shall be provided.

All access ports and manholes, galleries and stairways, guttering with all necessary rainwater goods and all ancillaries shall be supplied to make a complete working plant.

The H.V. equipment shall be mounted on the roof of the precipitator, and each transformer/rectifier unit shall be equipped with a drip tray and drain piping leading to a common point on the precipitator floor below each casing.

The design and construction of the precipitator shell shall be such as to ensure that air infiltration is reduced to the minimum amount possible.

A special series of access holes with fittings shall be provided by the precipitator contractor at suitable points in the ducting of each precipitator to enable the inlet and outlet dust burden to be measured.

2. DESIGN

2.1 BASE DESIGN

The precipitator shall have plan dimensions not exceeding 25 m x 12 m and shall have a dust collecting efficiency of not less than 99,6 %.

The performance of the precipitators with one electrical field out of service shall exceed 99,1%. This field may take the form of one complete field over the width of the precipitator, or may be two electrically independent half-sections, making up one total field.

The precipitators shall be capable of handling the flue gas quantity as given in Schedule C1 when the boiler is operating under maximum load. It should be noted that the coal is expected to have an average Sulphur content of 2,0 % and that the average sodium content of the fly ash is 0,6 %.

The design of the induced draught fans serving each boiler is based on the following precipitator performance, which must not be exceeded:

(a) Temperature drop through precipitator at 100% boiler MCR: 6°C.

(b) Pressure drop through precipitator, the inlet and outlet ducts within the precipitator extent of supply, the gas flow straightening and distribution devices and the inlet and outlet losses at 100% boiler MCR: 500 Pa.

Each precipitator shall be subdivided (in direction of the gas flow) into the number of equally sized fields as is required to satisfy the specified collecting efficiency requirement, but the number of fields shall not be less than five. Each field shall be subdivided (in direction perpendicular to the gas flow) into two independent sections and each section shall be energized by an independent H.V. supply.

Adequate insulation shall be provided between attachments of different metals in order to prevent electrolytic action.

2.2. CASINGS AND SUPPORT STRUCTURE

The precipitator casings shall be of welded steel plate construction in accordance with Standard Building Regulations, Chapter 6 – Structural Steelwork as amended and shall comprise all work, including support columns above ground level and dust hoppers.

The casings shall be capable of withstanding a maximum suction of 5 kpa without distortion or distress. The maximum possible dust load on the precipitator internals shall be taken into account in the design of the casing and the support structure, similarly the load of accumulated dust in the inlet and outlet hoods and flues.

The casings shall be arranged to allow a smooth gas flow with no dead pockets or areas where dust may stagnate and cool.

The precipitator support structure shall be of steel construction.

Access shall be provided from the operating floor of the boiler house to the roof or each precipitator.

No welding shall be carried out on steel set in concrete where there is any possibility of the heat of welding being communicated to the concrete.

All columns, walls, floors and roofs shall be of adequate design and construction thickness and strength to ensure gas tightness, to prevent buckling and distortion, and to withstand loads that may reasonably be expected.

The steel casing shall be designed and stiffened to resist the specified loading. The plates used for the construction of the casing shall have a minimum thickness of 6,0mm.

The casing including hoppers, etc., must be carefully and suitably lagged with approved material, protected on the outside by sheeting similar to that used for flues and ducts.

2.3 DUST HOPPERS

The dust will be removed from the precipitators by the continuous wet method.

Dust hoppers of steel plate construction shall be provided underneath the precipitators. The plates shall be suitably stiffened and the minimum thickness of the plate shall be 6,0mm. The internal surfaces of all hoppers shall be smooth and have not projections and bracings of any kind on their inside surface on which dust can hold up.

A valley angle of 60° shall be the minimum permissible.

The dust hoppers shall be of a capacity, calculated on a basis of 640 kg per cubic meter of dust, such that they will be able to contain without causing short-circuiting of the electrodes, or interfering with the efficient and safe operation of any zone of the precipitators, all the dust falling into each of them, when the boiler operates at 100% MGR for a full twenty-four hours, when fired with the basic coal specified in Schedule A.

The mechanical design of each of the hoppers shall be based on a dust load equivalent to a completely filled hopper and a density of the dust of 1000 kg per cubic meter.

Care shall be taken to ensure that cold air and moisture will not infiltrate into the hoppers, thus causing dust removal difficulties due to bridging of the dust.

The casing shall be designed to prevent rainwater from flowing on to lagged hoppers. The hoppers shall terminate at the outlet flange without vertical aided extension pieces above the mouth.

A poke rod agitator or other approved means shall be provided to enable any bridging of dust in the hopper to be broken up.

3.0 CONTROL AND MONITORING EQUIPMENT

3.1 GENERAL

The control and monitoring equipment associated with the precipitators on the boilers shall include control and monitoring consoles, capacity meters, hopper level monitors, chart recorders, alarm panels and all necessary instrumentation to ensure a complete installation.

3.2 PRECIPITATOR CONTROL AND MONITORING CONSOLES

Provision shall be made for the remote control and monitoring of the precipitators associated with the boilers from control consoles to be located either within or adjacent to the existing boiler control desk enclosures on the operating floor level.

A separate console shall be provided for each precipitator and shall contain, as a minimum, the following control and monitoring equipment:

3.2.1 One on/off switch with indication for each electrically independent section of the precipitator.

3.2.2 One meter each for primary voltage, primary amperes, precipitator voltage, precipitator amperes together with a selector switch per meter for switching to any of the electrically independent sections. The signals to these meters shall be 0 to 20 mA and shall be galvanically separate from the quantity being measured with a maximum ripple of 0,5% peak to peak.

3.2.3 Emission monitoring single trace chart recorder with a thirty-day chart and self-inking pen. If more than one trace is required then a second chart recorder shall be provided. Only fault and high level alarm lamps shall be located beneath each recorder.

3.2.4 One alarm lamp per electrically independent section indicating electrical equipment failure, which should cover both the high voltage equipment and hopper meters.

3.2.5 Hopper level high indication for each hopper associated with the precipitator.

TECHNICAL PARTICULARS - POWER STATION

I BOILER TECHNICAL SPECIFICATIONS:

1.	Type and model number	Boilers 1 & 2 I.C.A.L. 100 MW rating Contract No.10931 Boilers 3, 4 & 5 Mitchell Eng. 100 MW rating Contract No. 7298
2.	Steam pressure	Superheater outlet 1271 P.S.I.
3.	Steam temperature	Superheater outlet 965ºF {518,3ºC}
4.	Feed water temperature	Economizer inlet 405ºF {207,2ºC}
5.	Burner type (P.F.)	Boilers 1 & 2 hand tilting, corner mounted Boilers 3, 4 & 5 stationery type, sidewall mounted.
6.	Flame type	Pulverized fuel (profile) flame thrower
7.	Method of lowering temperature	Attemperator
8.	Heat efficiency	Thermal efficiency ±85%
9.	Hot air temperature	Air at air heater outlet 503ºF (261,7ºC)
10.	Method layout	Rotary air heater, gas heated
11.	Method of ash removal	Wet ash removal(hydrovacs and sluice nozzles)
12.	Method of blowing ash	Wet ash removal
13.	Exhaust gas temperature	Gas leaving the air heater 269ºF (131,7ºC)
14.	Operating level height	35 feet
15.	Outside dimensions – Boiler & Turbine House	300 ft long x 150 ft wide x 150 ft high
16.	Country of manufacture	England
17.	Number of Units	Five (4)

II TURBINE TECHNICAL SPECIFICATIONS

1.	Type and model number	Double casing condensing turbine type 11/100220 AEG impulse type
2.	Inlet steam flow (80 MW)	Casing I (H.P.) 642920 lbs/hr (373472kg/hr) Casing II (L.P.)527560 lbs/hr (334881 kg/hr)
3.	Inlet steam temperature	510ºC
4.	R.P.M.	3000 R.P.M.
5.	Power output (maximum), heat rate, steam rate	100MW continuous maximum rating
6.	Exhaust steam pressure	At 100 MW 1,91 ins Hg 0,066 ata
7.	Exhaust steam flow	Through the condenser
8.	Relative internal efficiency	31,1%
9.	Heat consumption rate	± 21 M Joules
10.	Steam consumption rate	113 kg /sec
11.	Number of return stages	6
12.	Extraction pressure at each return stage	See chart below
13.	Temperature flow volume	See chart below
14.	Process steam extraction press. temperature and volume	See chart below
15.	Outside dimensions	H.P. Turbine rotor 10514 kg. 1338 dia. 5205mm long L.P. Turbine rotor 20200 kg. 2520 dia. 5915mm long
16.	Country of manufacture	Germany A.E.G.

The turbine is equipped with 6 non-regulated extraction points for feed water heating:

Extr.	After Stage	Pressure		Temperature		Flow at 80 MW	
		Psia	(ata)	ºF	(ºC)	lbs/h	(t/h)
I	H.P. 9	236,1	(16,6)	577	(303)	31,090	(14,1)
II	H.P. 11	139,4	(9,8)	471	(244)	29,320	(13,3)
III	H.P. 13	76,8	(5,4)	379	(193)	30,200	(13,7)
				Extr. Wetness %			
IV	H.P. 15	38,4	(2,7)	0,57		20,060	(9,1)
V	L.P. 1	16,1	(1,13)	4,22		23,150	(10,5)
VI	L.P. 2	6,3	(0,44)	6,85		28,880	(13,1)

III GENERATOR TECHNICAL SPECIFICATIONS

1. Type and model number — Three phase synchronous generator with hydrogen cooling. Type FKWS 3742 P

2. Electric resistance

Resistances at 20ºC
Stator No. 8133
Phase U_1 X_1 0,00240 ohm Phase U_2 X_2 0,00238 ohm
Phase Y_1 Y_1 0,00235 ohm Phase V_2 Y_2 0,00237 ohm
Phase W_1 Z_1 0,00239 ohm Phase W_2 Z_2 0,00238 ohm

Field winding, slip ring to slip ring
Rotor No. 8133 0,119 ohm

Main Exciter
No. 704 384 Field Winding I K 5,02 ohm
Compoles GH 0,00098 ohm

Amplidyne
No. 338 890 402 Main field $i_a - k_a$ 28,1 ohm
Control field $i_b - k_b$ 13,2 ohm
Diff. field $i_c - k_c$ 43,0 ohm
Base Exciter
No. 705,805 Field winding CO 16,9 ohm

Field Currents
For max. output at 30 psig H 2 pressure approx.
1700 A

3.	Output voltage	10,5 kV ± 5% speed 3000 R.P.M.
4.	output amperage	6,11 KA 50 Hz
5.	Type of cooling	Hydrogen H2 cooler type 4 x V15 x 9-2950/2 KF 30203
6.	Country of manufacture	Germany A.E.G.

IV HEAT SYSTEM

1.	Oxygen Remover Specifications:	Deaerator
	Type and model number	The manufacturer – Carl Spaeter, Hamburg
	Power	N/A
	Working pressure	Full vacuum to 100 P.S.I.S.
	Oxygen removal tank volume	8350 imp. gallons
	Country of manufacture	Germany
	Number of units	1 unit per boiler

2.	Boiler Feed Pump Specifications:	
	Type and model number	K.S.B.
	Flow volume	402 tons/hour
	TDH (HEAD)	Static head at feed pump suction 166 ft.
	Electric motor type and power	A.E.I. 2500 H.P. type H.T.A.S. 158132 D2BEIS
	Country of manufacture	South Africa
	Number of units	2 per boiler

3.	Condenser Pump Specifications:	Extraction pump
	Type and model number	Condensate pump type C250 (3) A.E.G. make
	Flow volume	1503 imp. gal/min
	TDH (head)	328 ft. 1 in. W.G.
	Electric motor type and power	250 KW A.E.G. type AVK 250
	Country of manufacture	Germany
	Number of units	2 per turbine

4.	Turbine heat balance system diagram:	Designed by Hamon – Sobelco
	Type and model of heat exchanger for each return stage	Length 6930 mm Diameter – shell 952mm, Water box 1060 mm
	Area of heat exchanger	Tube volume 1,2 m^3 Refer to drawing No. 035/190 rv.3

V COMBUSTION SYSTEM

1.	Blower Specifications:	F.D. Fan
	Type and model	James Howden 22 size 165 Aerofoil
	Pressure	17,700 lb/min
	Volume	290,000 cu. ft/min.
	Electric motor type and motor	A.E.I. Brush 398 H.P. 5600 volts, 34,7 amps
	Number of units	Two per boiler
2.	Induction Blower Specifications:	I.D. Fan
	Type and model	James Howden TVN3 Radial
	Pressure	20,300 lb/min
	Volume	426,000 cu. ft/min.
	Electric motor type and motor	A.E.I. 48/40 Brush 1180 H.P. 5600 volts, 89 amps
	Number of units	Two per boiler
3.	Pulverized Coal Feeder Specifications:	Feeder
	Type and model	Mitchell table type
	Pressure	Mill internal P.A. pressure
	Volume	25 tonne per hour coal
	Electric motor type and motor	3 H.P. 380V 4,5 amp
	Number of units	3 per boiler
4.	Method of Pulverization :	Mill
	Type and model of pulverizer	P.H.I.
	Degree of pulverization (mesh sizes	80% of C.M.R. – 96% through 100 mesh

	distribution)	300 H.P. 6600 volts, 23,3 amps
	Power consumption	3 per boiler
	Number of units	
5.	Particulate remover specifications:	Classifier
6.	Combustion system diagram:	Refer to drawing Nos. 0,35/7191 Rv. 6, 0,35/886 Rv.4 and 0,35/ 8637

VI FUEL SUPPLY SYSTEM:

1.	Pulverizer specifications:	Mill
	Type and model	P.H.I.
	Power	6,6 kV x 33 amps
	Degree of pulverization	80% of C.M.R. – 96% through 100 mesh
	Power consumption	6,6 kV 300 H.P.
	Acceptable hardness of coal	Hardgrove grindability 55
	Number of units	3 per boiler
2.	Coal Feeder specifications:	
	Type and model	Mitchell table type
	Power	3 H.P. 380V 4,5 amp
	Electricity consumption	380 V
	Number of units	3 per boiler
3.	Coal Conveying Equipment:	
	Type and model	Jeffrey Gallion
	Conveyor width	36 inch
	Conveyor length	various lengths
	Number of conveyors	(10) ten
4.	Screen Analysis Equipment:	
	Type and model	Hand held 12” dia. screen for sample preparation
	Screen capacity	
	Outside dimensions	

	Number of units	

VII WATER TREATMENT SYSTEM:

1.	Method of treatment, treatment of volume	Design capacity 4 ML/day
2.	Major Equipment:	Sedimentation tanks, sandfilters, pumps, Cation, Anion, mixed bed resin tanks.
	Type and model	Dowson & Dobson Ltd
	Power	2 Potable water pumps 380V 58A = 22 kW each 2 Raw water pumps 380V, 12A = 4,5kw each
	Outside dimensions	Sedimentation tanks 29 ft^2
	Number of units	4 Sed. tanks, 4 sand filter, 3 K.B. 2 Cation and 2 Anion
	Country of manufacture	England

VIII WATER SUPPLY SYSTEM

1.	Turbine cooling water inlet and outlet temperature requirements:	Inlet 23 ºC, outlet 33 ºC
2.	Cooling Water Circulating Pump Specifications :	
	Type and model	Vickers Armstrong
	Flow rate	54000 gal/min
	TDH	Hanometric head 56 ft. Static head 27 ft.
	Electric motor type and power	A.E.I. (AIC 63/42) H.P. 1225 6,6kV, 100 amps
	Number of units per turbine	One
3.	Feed Water Method:	Demin. water pumps, Water Plant
	Type and model	A.G.S.A. Type KL
	Flow rate	200 gal/min
	TDH	170 ft. head

	Electric motor type and power	Hawker Siddeley D160L. 25HP 2920 RPM 380V 34 amps
	Number of units per turbine	4 total

IX CONTROL SYSTEM

1.	Method of control	Pneumatic
2.	Instrumentation types	Kent, Bailey, Hannemann

X ASH REMOVAL SYSTEM

1.	Boiler ash removal method:	Wet ashing – Hydrovacs and sluice nozzles
2.	Ash Removal Equipment Specifications:	
	Type and model	Spargo Ash Pump 12" dia. Frame 50
	Capacity	RPM 700, 55m head, 700m^3/ hour (water)
	Country of origin	South Africa
3.	Method of ash removal used by the original plant	No major alterations carried out.

XI ELECTRICAL SYSTEM:

1.	Voltage steps for plant electricity usage:	10,5 kV to 6,6 kV
2.	Principal transformer Specifications:	Unit transformer
	Type and model	3 phase oil cooled 10 000 KVA
	Steps	10,5 to 6,6
	Number of units	5
3.	Plant use transformer specifications:	
	Number of units	20 Auxiliary transformers

4. Other major electrical equipment specifications:

AEG Electrostatic Precipitator
One high voltage transformer
Two low voltage transformers

TECHNICAL DATA
Connection Voltage – 380V single phase
Frequency – 50 C.P.S.
Input – 41,3 KVA
A.C. Current – 109 amps
Rated High Voltage – 78 kV (peak)
Rated output current – 500 MA
Losses - Approx. 3,6 KW

Total weight – 4550 lbs
Oil Weight – 2410 lbs
Oil Quantity – 275 gal

The no-load R.M.S. value of the H.V. transformer is 55 kV
And the peak value 55x2=76kV
with 380 volt primary voltage.

XII OPERATING INDICES:

Boiler heat efficiency — On gross calorific value of fuel 89,3%
On net calorific value of fuel 92,6%

Turbine heat consumption rate — 510 ºC live steam temp. at turbine combined stop and emergency valves

Steam consumption rate — The guaranteed weighted steam consumption including steam to condensate and feed heaters and de-aerator but excluding steam to other auxiliaries and assuming that no water is being circulated between the condenser and the reserve feed tank is:-

Weighted steam consumption
As defined by B.S. 132:1951:

$$\frac{3x1 + 4x2 + 3x3}{10}$$ …….8.1199 lbs/kWh

consumption at test
loads of 60 MW ……..8.003 lbs/kWh
80 MW ….. 8.047 lbs/kWh
100 MW ….. 8.334 lbs/kWh

Standard coal consumption rate per kWhr — 50 ton per hour at 100 MW.

Plant (500 mw) electricity usage rate — ± 35 MW.

POWER STATION – EXISTING DATA

PRESENT CONDITION OF PLANT

At present the plant consists of four 100 MW rated steam turbine generator units complete with boiler plant and auxiliary equipment. The units are in a 'moth-balled' condition.

AGE

DATE FIRST UNIT COMMISSIONED : 31/03/1963
DATE LAST UNIT COMMISSIONED : DECEMBER 1968

COAL

ANNUAL CONSUMPTION: WHEN GENERATING 1,9 MILLION TONES

STOCKPILE VOLUME: WHEN GENERATING 220 000 M3

SILOS/STAITHES: (2) CAPACITY 28 000 TONS

BOILER BUNKERS: (15) CAPACITY 500 TONS EACH

ASH CONTENT: 20 %

MILLING PLANT

MANUFACTURERS: BOILERS 1, 2 &4 PHI ENGINEERING
BOILERS 3 MITCHELL ENGINEERING

MILLS - 3 PER BOILER
TYPE: BOILERS 1, 2 & TRACK AND TYRE MILLS
BOILER 3 TUBE MILLS

OUTPUT: 22,7 TON PER HOUR, PER MILL (MAX. RATING 25 TONS PER HOUR)

BOILERS

MANUFACTURER: BOILERS 1 & 2 I. C. A. L.
BOILERS 3 & 4 MITCHELL ENGINEERING
TYPE: P.F. FIRED, WATER TUBE BOILERS

RATING: 900 000 LBS PER HOUR CONTINUOUS MAXIMUM RATING, AT 1250 PSIG. AND 965 ºF

BURNERS (PER BOILER) 12 UNITS

TURBINES

MANUFACTURER: AEG

TYPE: TURBINE 1 & 2 11/100120
3, 4 & 5 11/100220
RATING 100 MW CONTINUOUS

TURBINE RUNNING HOURS SINCE COMMISSIONING

TURBINE NO 1	155993 HRS	17,80742 YEARS
TURBINE NO 2	163585 HRS	18,674086 YEARS
TURBINE NO 3	154811 HRS	17,672488 YEARS
TURBINE NO 4	144552 HRS	16,501369 YEARS
TURBINE NO 5	144826 HRS	16,532648 YEARS

TURBINE G/O HOURS

TURBINE NO 1	16423 HRS	1,8747716 YEARS
TURBINE NO 2	9681 HRS	1,1051369 YEARS
TURBINE NO 3	32483 HRS	3,7081049 YEARS
TURBINE NO 4	6751 HRS	0,770662 YEARS
TURBINE NO 5	5727 HRS	0,6537671 YEARS

BOILER RUNNING HOURS SINCE COMMISSIONING

BOILER NO 1	158083 HRS	18,046004 YEARS
BOILER NO 2	160604 HRS	18,333789 YEARS
BOILER NO 3	152525 HRS	17,411529 YEARS
BOILER NO 4	144615 HRS	16,508561 YEARS
BOILER NO 5	SOLD	

BOILER G/O HOURS

BOILER NO 1	13748 HRS	1,5694063 YEARS
BOILER NO 2	22535 HRS	2,5724885 YEARS
BOILER NO 3	32483 HRS	3,7081049 YEARS
BOILER NO 4	6751 HRS	0,770662 YEARS
BOILER NO 5	SOLD	

INFORMATION FROM PERFORMANCE MONITORING 31/01/1991

GENERATORS

MANUFACTURER: AEG TYPE FKWS 3742 P
RATED CAPACITY: 100 MW
TERMINAL VOLTAGE: 10,5 KV

ASH PLANT

TYPE: WET SYSTEM (HYDROVAC ASHING SYSTEM)

PRECIPITATORS

MANUFACTURER: BRAND ENGINEERING (PTY) LTD
TYPE: ELECTROSTATIC 5 FIELDS UNITS 1 & 2
3 FIELDS UNITS 3, 4 & 5

GENERATOR TRANSFORMERS

MANUFACTURER: 1 & 2 AEG
3, 4 & 5 OERLIKON
RATE CAPACITY: 110 000 KVA
TERMINAL VOLTAGE: 10,5/275KV

COOLING SYSTEM

WET SYSTEM THROUGHOUT

COOLING TOWERS (4)

TYPE: NATURAL DRAUGHT, CONCRETE
HEIGHT: 93,4 METRES

CHIMNEYS (2)

HEIGHT: 119,48 METRES
TYPE: SINGLE FLUE - CONCRETE

MOTHBALLING DATES

UNIT NO 1 08\01\1987
UNIT NO 2 14\09\1988
UNIT NO 3 18\10\1989
UNIT NO 4 10\09\1990
UNIT NO 5 05\11\1990

RUNNING PARTICULARS AT SITE - ESTIMATED **BOILERS**

	Pounds per hour evaporation		
	720,000	830,000	900,000
		corresponding to 100 MW	113,6kg/hr
	80%	rating	M.C.R.
Temperatures			
Water from economizer (inlet 405 ºF)…….ºF	535	535	537
Steam at superheater inlet……ºF	580	584	588
Primary superheater outlet ….……ºF	833	849	857
Secondary superheater inlet….……ºF	805	806	807
Superheater outlet ……ºF	965	965	965
Air at airheater (minimum)…… …….ºF	90	90	90
Air at airheater outlet……..... ºF	491	503	504
Gas leaving furnace…….ºF	2018	2088	2130
Gas at superheater inlet ……..ºF	1972	2042	2084
Gas at superheater inter-stage …. ……ºF	1725	1782	1824
Gas leaving superheater …….....ºF	1059	1081	1111
Gas at economizer inlet …… …….ºF	1059	1081	1111
Gas leaving economizer (Blr.1……ºF (Blr. 2…….....ºF	813	825	838
Gas leaving airheater (minimum) … …….....ºF	260	269	280
Pressures			
Steam in saturated steam drum lb/ sq. in……	1337	1365	1385

Steam drum (Cont.)

Total discharge capacity saturated steam ……..940,000 lb/hr.

Superheater

Type ……HOPKINSON'S "HYLIF TORSION BAR…….....3

Bore ……2½ ins.

Total area …….. 6.85 sq. in.

Total discharge capacity superheater steam…….. 291,000 lb/hr

(The contractor should note the special requirements of the South African regulations with regard to safety valve areas.)

SAFETY VALVE BLOW-OFF PRESSSURES

DRUM			SUPERHEATER		
NO.	OPEN	CLOSE	NO.	OPEN	CLOSE
1.	1520	1475	1 (Elec: assisted)	1,330	1,290
2.	1530	1485	(unassisted)	1,350	1,290
3.	1530	1485	2	1,350	1,310
4.	1540	1485	3	1,355	1,315

RUNNING PARTICULARS AT SITE (CONT.) **BOILERS**

	Pounds per hour evaporation		
	720,000	830,000 corresponding to 100 MW rating	900,000
B. Th. U. absorbed			
Per sq. ft. boiler surface …….per hour	89,800	103,900	112,900
Per sq. ft. superheater surface ……per hour	5,560	6,440	7,265
Per sq. ft. economizer surface (Blr. 1) per hour	2,170	2,488	3,265
Per sq. ft. airheater surface ……per hour	542	623	676
B. Th. U released per cu.ft. of combustion chamber volume …… per hour	14,530	16,810	18,210
Velocities (average)			
Water through economizer tubes (Blr. 1) f.p.s.	2,2	2,5	2,7
(Blr. 2) f.p.s.	3,7	4,3	4,7
Steam through pipes connecting drum to superheater …….....f.p.s.	43,2	49,8	54,0
Steam through primary S/H tubes ……..f.p.s.	56,2	63,5	70
Steam through secondary S/H tubes …….. f.p.s.	103,9	117,0	120,6
Air through airheater …… f.p.s.	20,6	23,8	25,8
Estimated heat losses			
Drygas……	4,11	4,23	4,55
H_2 plus H_2o in fuel	3,75	3,79	3,79
Unburned combustible……	1,91	1,98	2,03
Radiation …Unaccounted	0,63	0,70	0,73
Total heat loss …….	10,40	10,70	10,90

Overall efficiency (%) of unit before deducting of auxiliary power			
On gross calorific value of fuel…….	89,6	89,3	89,1
On net calorific value of fuel ……	92,9	92,6	92,4