GUJARAT POWER CORPORATION LTD.

TECHNO-ECONOMIC FEASIBILITY REPORT FOR 2 X 500 MW COAST BASED THERMAL POWER STATION IN GUJARAT

VOLUME - II
POWER PLANT COMPLEX

AUGUST - 1995

DEVELOPMENT CONSULTANTS LIMITED

CONSULTING ENGINEERS

24-B PARK STREET • CALCUTTA-700016

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PROJECT AT A GLANCE

General

The Project	:	2 x 500 MW Coast Based Thermal Power Station near Pipavav in Gujarat.
Owner	:	GUJARAT POWER CORPORATION LIMITED, Ahmedabad, Gujarat
Location	:	The site is located near Pipavav in Amreli District of Gujarat State. Latitude 20° 54′ North and Longitude 71° 26′ East.

Inputs

Main Fuel	:	Coal : About 2.26 MTPY of coal from overseas sources.
Auxiliary Fuel	:	HFO/LDO from nearby depot.
Fuel Transportation	:	Coal would be received in shiploads from South Africa/ Australia/Indonesia at Pipavav Port. From the port, conveyors would be used to transport the coal to the plant. HFO and LDO would be transported to the plant by road tankers.
Water	:	Cooling water requirement for condenser cooling and auxiliary equipment would be drawn from sea (Gulf of Khambat). An intake pump house located beyond high water limit would supply water to the power plant through a 4 Kms long MS, concrete lined pipeline. Sweet water requirement for process and potable use to the tune of 280 M^3/hr may be met from feasible source like Narmada River/Dhatrawadi River. Alternately, the same will have to be generated by sea water desalination.

Land	:	About 300 hectares of land for siting the power station including all related facilities. Another 30 hectares of land is required for residential colony. About 135 hectares of land considered for dumping ash, 4.5 hectares for pipe route and 10 hectares for approach road and other miscellaneous requirement.
Manpower	:	Direct employment of about 800 persons during plant operation.
Rehabilitation	:	Nil

Project Particulars

Unit Size	:	2 x 500 MW Turbine Generator sets fed from two numbers, Steam Generators with steam parameters of 1700 T/hr, 170 $Kg/Cm^2(a)$, 540/540 °C MS/RH.
Cooling System	:	Semi-open recirculating condenser cooling system with wet type natural draft cooling tower using sea water as cooling media.
Consumptive Water	:	About 9535 M^3/hr of sea water to be pumped from the intake pump house through pipeline and clarified before distribution via a clarified sea water reservoir.
Coal Handling System	:	Coal would be imported from South Africa/Australia/ Indonesia by 60,000 DWT vessels upto Pipavav Port. From the port, a twin stream conveyor system would transport coal to the plant site. A storage of 30 days' coal requirement would be maintained at site.
Ash Disposal	:	Dry/semi-dry collection and dry disposal of both the coarse bottom ash and fine fly ash have been proposed. The ash would be collected in bottom ash hoppers and ESP hoppers. The ash collected would be transported by trucks/conveyors to the disposal site. A portion of ash would be utilised in ancillary units. Alternative provision of wet ash disposal under exigency condition considered.

Power Evacuation	:	At 400 kV, by GEB through their grid system. Detail arrangement will be worked out by GEB.
Environmental Aspects	:	Two single-flue stack of 275 M height envisaged for appropriate dispersion of particulate, SO_x and NO_x - • Seven(7) field twin-path electro-static precipitators with efficiency of more than 99.9% is envisaged. • Waste water quality to be maintained as per GPCB standards and the Ministry of Environment and Forest Notification.

Infrastructure and enabling works

Road Access	:	The site is located near the State Highway (SH-34). A double lane access road would connect the site with the above highway. There is no railway connection.
Land Development	:	Plant will be laid at about 20 M level above MSL. The designated area is above highest flood level.
Township	:	640 dwelling units based on 80% satisfaction level will be provided.

Project Cost & Cost of Generation

Capital Cost: • Power Plant	:	Rs. 3333.28 Crores/Rs.33332.81 per installed KW.
• Port Facility	:	Rs. 146.32 Crores
Overall Project Cost	:	Rs. 3479.60 Crores
Project Cost with Interest During Construction and Cost of Generation	:	Rs. 4220.83 Crores or Rs. 42,208 Per KW installed. Tariff Rs.2.76 per kWh.

SECTION – 1

I N T R O D U C T I O N
AND
SYNOPSIS

SECTION - 1

INTRODUCTION AND SYNOPSIS

1.1 Introduction

Lack of sufficient electric power has always been the greatest single deterrent to the growth of industry and agriculture in any region. The responsibility of supplying power to industrial and agricultural sector in Gujarat at present, lies mainly with Gujarat State Electricity Board. The State of Gujarat which was eighth in the list of industrialised state in the country in 1960, now occupies the second position, in terms of value output in the manufacturing sector. Its power supply is thus, unable to keep pace with the increase in power demand due to limited generation capacity. The industrial development till date, has been concentrated mostly in Ahmedabad-Baroda-Bharuch-Surat belt in South Gujarat. But in the past few years new industries are planned and implemented in Saurashtra region as well. It is also found in recent years that more industries are willing to come to this region provided infrastructural facilities are made available. The Government of Gujarat is therefore, taking a number of strategic steps to nurture this trend.

Development Consultants Limited (DCL) was entrusted by the project authorities to study the proposal of setting-up a 1000 MW thermal power station exploiting coal from overseas sources. Long lead distance of indigenous coal to Gujarat and use of natural gas for other essential products have highlighted the importance of setting-up imported fuel based thermal power station in the state. Due to transportation requirement of imported coal, the station is located adjacent to a port. Accordingly, the station has been proposed in the coast of Amreli District of Gujarat where Pipavav Port would be simultaneously augmented to handle requisite capacity vessels. In the event of implementation of coastal shipping of coal as planned by Govt. of India, the viability of using indigenous coal from Ib/Talcher would be considered. The present study is confined to setting-up a TPS with an assumed fuel linkage from South Africa/Australia/Indonesia and is studied in the light of liberalised economic policy of Government of India to establish power plant in private sector.

1.2 Synopsis of Study

The derated installed capacity in the State of Gujarat in year 1993-94 is estimated at 6089.5 MW. As per power planning by the State Electricity Board the total installed capacity would be augmented by about 3075.5 MW by the end of 9th Plan. After above capacity addition a gap of 3188 MW in terms of installed capacity would remain unattended. The proposed station already appears in the list of capacity additions prepared by CEA/GEB. In Section-2 of the report the justification for setting-up the station has been studied.

Among the basic requirements for setting-up thermal power station the fuel requirement would be about 2.26 Million Tonne per annum and would be supplied from overseas sources. Land requirement for plant area, ash disposal area, township and other miscellaneous requirement is estimated at about 530 hectares and have been identified near Pipavav of Amreli District. Alternate sites were also studied to evaluate techno-economic advantage of setting-up the station in most attractive site. Water for the station would be drawn from the sea and used for cooling. A portion of sea water would be desalinated to meet other consumptive requirement. Alternately, if sweet water on year-round basis is available from Narmada or Dhatrawadi River at a reasonable cost the same would be used. The station being located close to the state highway (SH-34) expenses on account of building road access to the plot would be optimum. In Section-3 and 4 of the report the above aspects have been dwelt upon.

In Section-5 of the report the technical features of main plant and equipment, auxiliary equipment, accessories, electrical equipment and instrumentation and control requirements have been studied.

To ensure minimum impact on environment due to solid, liquid and gaseous refuses emitted from the coal based thermal power station necessary measures to be undertaken in the plant have been highlighted in Section-6 of the report.

For this port based grass roots station enough construction facilities need to be developed to ensure smooth and timely execution of construction. In Section-7 of the report stagewise facility development have been outlined. The manpower requirement for the station is estimated at 800 personnel of which 400 persons would be employed in plant operation, 320 personnel would be in maintenance and 80 personnel in administrative work. The study also covers requirement of employee facilities viz. housing, community facilities etc. In planning the township about 80% satisfaction level have been considered along with community facilities viz. school, shopping centre, club, community centre, health centre etc.

The project is planned to be executed under a team of experienced engineers with rigorous monitoring. A time frame of forty-eight(48) months from the zero date (date of ordering of main equipment) has been envisaged for commissioning of 1st 500 MW unit followed by the other unit at an interval of six(6) months.

The estimated capital expenditure of the project (Power Plant) comes to Rs.3333.28 Crores based on the prevailing prices in the 1st quarter of 1995-96. Adding for capital expenses for port facilities the value works out to be Rs. 3479.62 Crores. Assuming debt to equity ratio of 2.33:1 and a financing charge of 18.5% per annum on the estimated cost of the project, the interest during construction comes to Rs.741.21 Crores.

The installed cost thus comes to Rs.34796.20 per KW without financing charges and Rs.42208.28 per installed KW with financing charges for the entire project. No provision for escalation on price has been provided in the estimate. On the basis of the above and other government guidelines the average tariff for first year of operation comes to Rs.2.76 per kWh.

SECTION – 2

NEED FOR THE PROJECT

SECTION - 2

NEED FOR THE PROJECT

2.1 Introduction

Due to the rapid pace of development in Gujarat, the power demand has far outstripped the supply. The state government's concern can be gauged from the urgency with which it is investigating all possible means of augmenting the generation capacity. In the past, capacity addition had been in only two sectors, namely, state and central sectors. Due to change in the Government of India policy, the third option of private sector generating companies is assuming greater importance. This is because of two major advantages in favour of private investors. Firstly, they are in a better position to mobilize finance required for the projects. Secondly, they are often agreeable to arrange for the fuel supply by augmenting the country's supply through additional domestic production or by import. The power scenario in Gujarat may be studied under the backdrop of past and future power demands vis-a-vis, present and future generation capacities planned for bridging the gap. This exercise will help in establishing the saleability of power from the proposed 1000 MW station.

2.2 Power Position in Gujarat

The power position in the state as depicted in terms of peak load, energy requirement and sectorwise demand for power in the past ten years to assess the additional power generating capacity required to meet the need of the state has been discussed hereunder.

2.2.1 Peaking Power

The power position in Gujarat upto 2001-2002 AD, i.e. upto the end of the 9th Plan Period is reproduced in **Table-2.1**. In this table, the estimated demand has been taken from forecast of the State Electricity Board. This is a realistic assessment as the recorded peak demand in the Gujarat Grid system and has already crossed the projected values. It is estimated by the state that under unrestricted condition, the maximum demand catered in Gujarat system during 1993-94 is 4582 MW. Hence, the need for additional 2183 MW peaking power by end of the 8th Plan and 3188 MW at the end of 9th Plan as projected in **Table-2.1** needs suitable redressal. This includes capacity addition of 1916 MW during 8th Plan and 2267 MW during 9th Plan. It is worthwhile to mention that the subject project under study is included in the list of units, to come into operation during 9th Plan Period.

2.2.2 Energy Requirement in Gujarat

Energy requirement forecast of Gujarat is tabulated below :-

Year	Annual Energy Demand (in MkWh)	Remarks
1990-91	15993	Recorded consumption against installed capacity of 5018 MW
1991-92	17319	8th Plan forecast by Working Group on Power, Planning Commission
1992-93	25783.3	
1993-94	27619.7	
1994-95	29497.4	
1995-96	31503	
1996-97	33645	
1997-98	35933	9th Plan forecast by Working Group
1998-99	38376	
99-2000	40986	
2000-01	43691	
2001-02	46487	

The power scenario of Gujarat is shown in **Plate No.2.3.**

2.2.3 Sector-wise Energy Requirement

The energy demand in Gujarat grid from 1981-82 to 1991-92 in the sectors like industrial, domestic, commercial, irrigation, traction etc. have been shown in **Table-2.2**. The same have been displayed in bar-chart form in **Plate No.2.1**. The percentage consumption of energy in the various sectors have been plotted for the years between 1981-82 to 1991-92 in **Plate No.2.2** and in **Plate No.2.4** a pie-chart for 1991-92 is displayed. It may be observed from this graph that during the last decade, the percentage share of industry has gone down from 52% in 1981-82 to 39% in 1991-92. The percentage share of agriculture has, on the other hand, has risen from 18% to 35% in the corresponding years. This phenomenon has introduced a seasonal demand pattern on the state power grid and probably lowered the daily load factor to some extent.

2.3 Power Scenario in Western Region

The installed capacity, peak load, peak availaility, energy availability and energy requirement of the western region upto the end of 9th Plan as depicted by the Working Group on Power of the Planning Commission are as follows :-

Year	Installed Capacity (MW)	Peak Load (MW)	Peak Availability (MW)	Energy Requirement (MkWh)	Energy Availability (MkWh)
1993-94	23873.6	15875	14567.5	98137	100778
1996-97	30250.13	19587	17974.3	121159	117108
2001-02	40520.3	27313	25150.2	169166	167731

The average increase in energy requirement in this region was 9.5% per annum between 1981 to 1990, while for the projection for the nineties and upto 2002 is 7.24% per annum. Though the gap between the energy demand and supply for the region, as projected by the Working Group on Power is not appreciable for the future years, the deficit in peak load ranges between 1500 MW to 2500 MW.

The break-up of installed capacity in the western region as in March, 1992 and the projected capacities at the end of the 8th and 9th Plan are as follows:

Station	March '92	March '97	March 2002
Thermal	18102.33 MW	24052.63 MW	30937.60 MW
Hydel	2720.36 MW	5307.50 MW	7692.50 MW
Nuclear	655.00 MW	890.00 MW	1890.00 MW
Total :	**21478.74 MW**	**30250.13 MW**	**40520.30 MW**

The average annual grwoth rate in the consumption of electricity in the region over the last eight years is estimated at about 15% in the agricultural sector, 5.4% in the industrial sector and 13.4% in the domestic sector.

The percentagewise consumption of energy by different sectors in this region for the year 1990-91 had been as follows :-

Domestic	-	15.60%
Commercial	-	5.88%
Industrial (LT & HT)	-	49.23%
Agricultural	-	22.21%
Public works	-	3.26%
Miscellaneous	-	3.82%

As such a capacity addition plan of 8772 MW in 8th Plan and 10269 MW in 9th Plan has been projected by Working Group on Power to meet the anticipated demand in the western region. Among the capacity additions projected under the 9th Plan, projects of only 2710 MW are sanctioned, 3707 MW are cleared by CEA and the balance are new proposals. Only a few among the above sanctioned projects are financially tied up.

2.4 Justification for the Project

The 1000 MW power plant in Gujarat, proposed to be built in the 9th Plan Period, is justified for the following reasons :

a. Considering the projected energy requirements of 33645 MkWh by 1996-97 and 40986 MkWh by 1999-2000, and the present energy generation of about 17300 MkWh, the additional generation required are about 16345 MkWh by 1996-97 and 23686 MkWh by 1999-2000. Assuming an improved generation from the new projects at the targetted rate of 6000 kWh per KW installed, the deficit can be made up by installation of about 2724 MW of additional generation capacity.

With the capacity addition from the schemes already approved in the 8th Plan to the tune of 1916 MW, theoretically, there is further scope of capacity addition to the tune of 2183 MW by 1996-97 and 3188 MW by 2001-02.

Therefore, considering the past and projected future demand of energy, installation of the proposed 1000 MW capacity green field thermal power station in Gujarat by 2001-02 is well justified. It is needless to mention that the subject project is already included in the proposed capacity addition projected by both GEB and Planning Commission.

b. The trend of growth in energy demand in Gujarat ensures that the plant utilisation factor will be 68% or more.

c. Imported coal transported by sea through a dedicated port will be used to generate power. This will ensure higher plant availability with superior quality of coal.

d. Since captive coal will be transported by sea, there will not be any pressure on the already strained Indian Railway system.

e. The regional grid is capable of handling the additional power from the station. The power map of Gujarat is enclosed in **Plate No.2.5**.

f. The project would be implemented though private sector/joint sector/associate sector company with adequate technical and financial capability to mobilize manpower and resources both from within the country and overseas to meet the corporate target.

2.5 Unit Size Selection

While selecting the unit size for a large power station the most important criteria governing the same are higher efficiency, operating experience of similar size unit elsewhere, grid capability, reliability and cost effectiveness. From general experience in this country as well as overseas, the most frequently used unit sizes and the station configuration may be-

4 x 250 MW

3 x 330 MW

2 x 500 MW

Station comprising smaller unit sizes is normally not recommended in order to take advantage of economy of scale in construction and operation of units and for better heat rate of the larger sets. With higher set sizes the capital cost as well as the cost of generation are comparatively lower and involvement of manpower to operate and maintain the same goes down.

For the 1000 MW station under study installation of two units of 500 MW attracts attention in view of highest cycle efficiency, lowest installation cost per KW and lower operating cost. These sets are available both indigenously and from overseas vendors. The 500 MW sets have been operated with very high plant availability record both in India and abroad. Besides, availability of indigenously developed supporting auxiliaries and skilled operating personnel from super thermal power stations in the country offer definite advantage in favour of the 500 MW sets. Gujarat grid is also capable of handling these large units.

Assuming an annual planned outage of six(6) weeks and unforeseen outage of one week per unit, the station availability may reach about 86.5% (max.). In order to achieve an annual plant load factor of about 68%, the average daily load factor would be of the order of 80 percent in view of planned and non-planned outages. With above advantages in favour, the choice automatically tilts towards 500 MW unit size.

Table - 2.1

Power Position in Gujarat

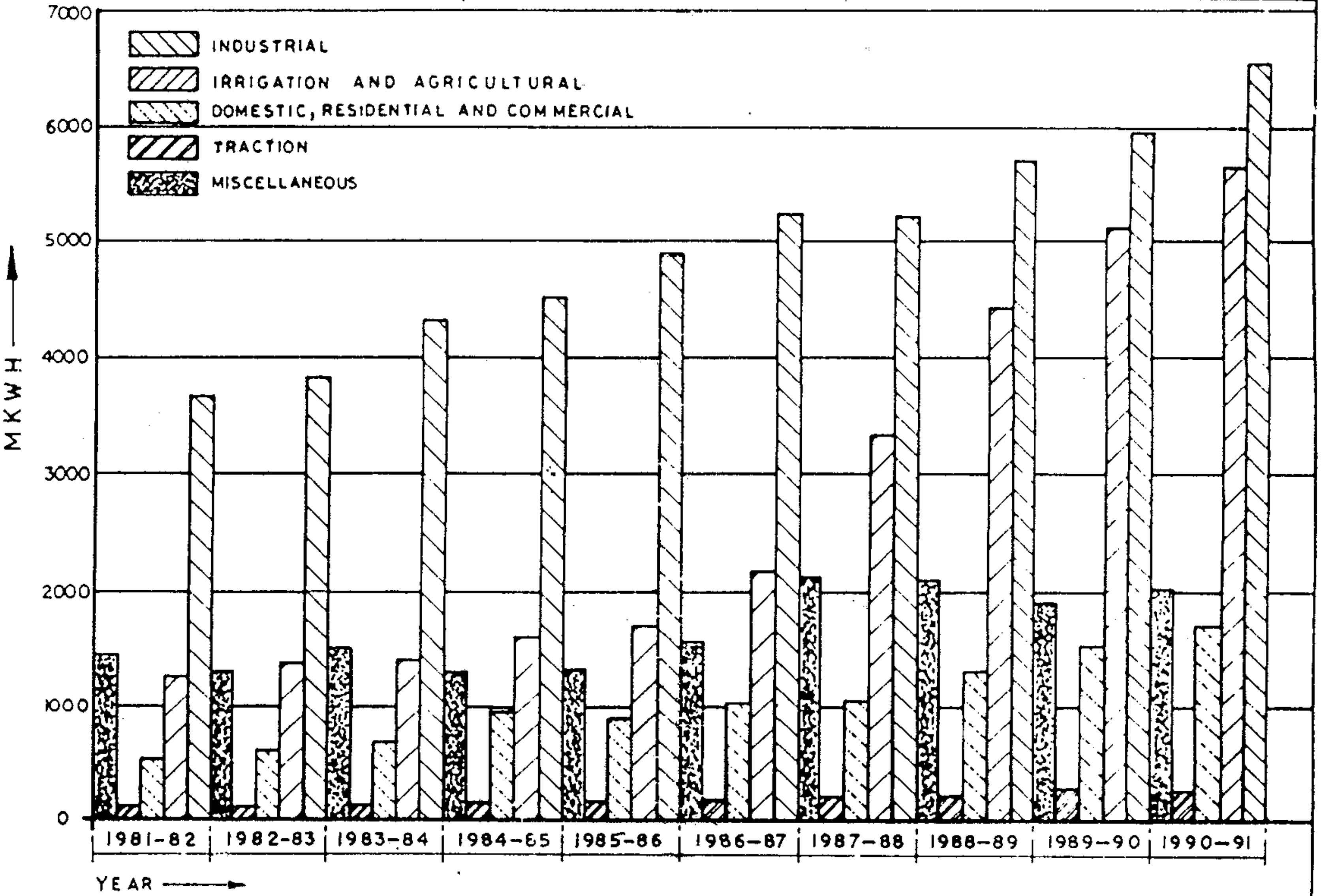
Particulars	Existing Installed Capacity As on 31/03/94 (93-94)	Existing Derated Installed Capacity As on 31/03/94 (93-94)	Capacity Addition During the Year							
			94-95	95-96	96-97	97-98	98-99	99-2000	2000-1	2001-02
Grand Total	6140.5	6089.5	100.5	383	325	460	556	866	135	250
Deration			--	--	110	--	--	--	--	--
Retirement			--	144	254	--	--	--	--	--
Installed Capacity at the start of the year			6089.5	6190	6429	6390	6850	7406	8272	8407
Capacity Addition during the year			100.5	383	325	460	556	865	135	250
Deration & Retirement during year			--	144	364	--	--	--	--	--
Installed Capacity at the end of the year			6190.0	6429	6390	6850	7406	8272	8407	8657
Availability as per 14th EPS		3524.9	3615.5	3833.7	4302.5	4706.3	4756.3	5058.8	5375.6	5692.2
Demand at per 14th EPS		4504	4810	5137	5487	5860	6258	6684	7125	7581
Required installed capacity to meet above demand utilisation factor = 64%		7038	7516	8027	8573	9156	9778	10444	11133	11845
Deficit at the end of the year		948.5	1326	1598	2183	2306	2372	2172	2726	3188

Source : GEB.

Table - 2.2
Sheet 1 of 1

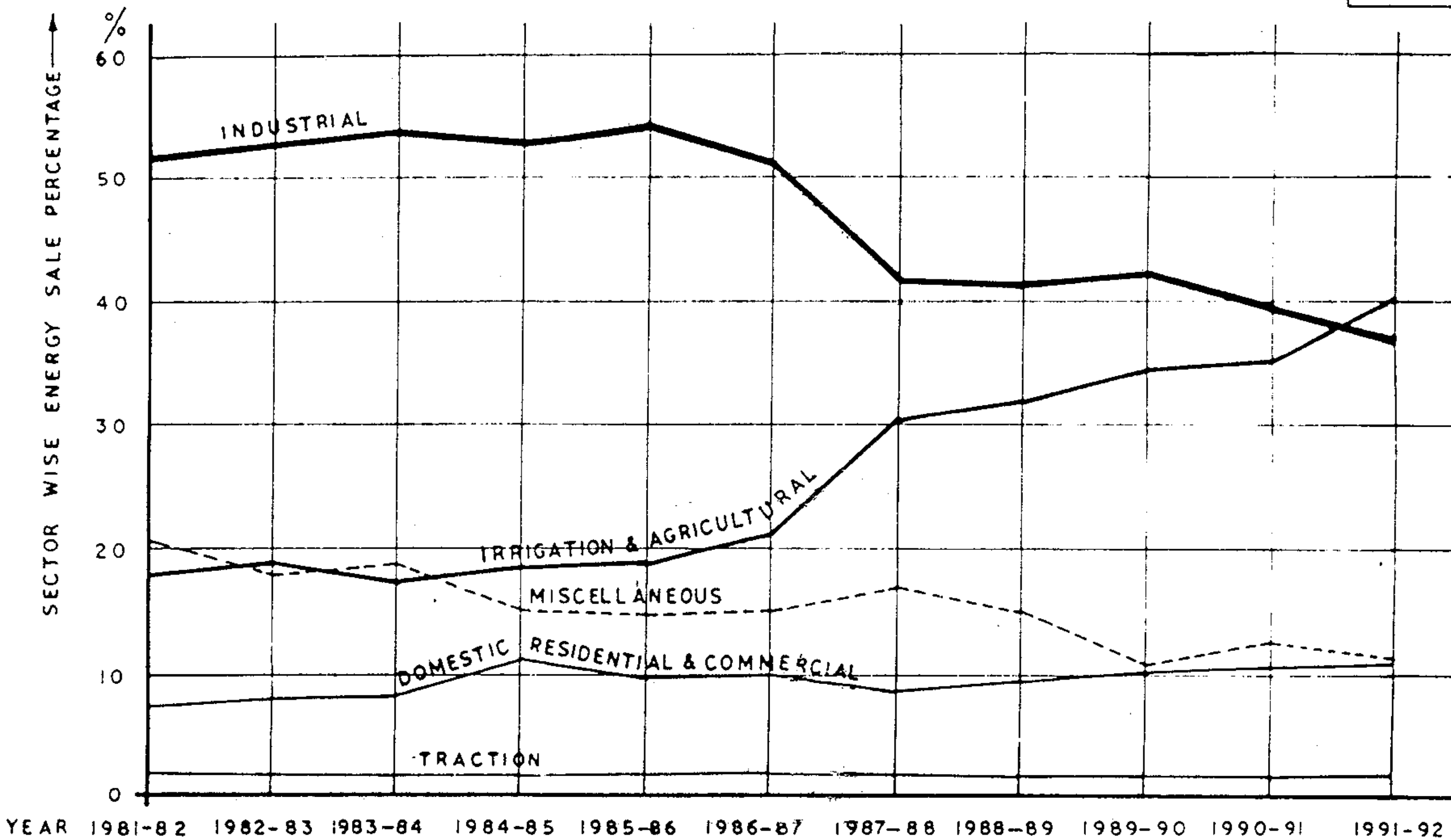
SECTORWISE ENERGY SALES IN GUJARAT

SL. No.	SECTORS	1981-82		1982-83		1983-84		1984-85		1985-86		1986-87		1987-88		1988-89		1989-90		1990-91		1991-92	
		MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%	MkWh	%
1.	INDUSTRIAL	3656.3	51.8	3834.6	52.96	4344.4	53.75	4528.3	52.79	4913.6	54.5	5269.2	51.32	5246.6	41.79	5720.9	41.55	5973.1	42.28	6315.0	39.48	6410.0	37.0
2.	IRRIGATION & AGRICULTURAL	1275.5	18.09	1372.5	18.95	1414.4	17.5	1618.0	18.87	1703.6	18.89	2186.8	21.3	3840.5	30.59	4402.1	31.97	5145.0	34.7	5670.0	35.45	6959.0	40.18
3.	DOMESTIC, RESIDENTIAL & COMMERCIAL	528.5	7.49	600.2	8.289	678.2	8.39	981.0	11.43	890.8	9.88	1044.6	10.17	1113.1	8.86	1319.4	9.58	1549.4	10.45	1718.0	10.74	1888.0	10.9
4.	TRACTION	135.5	1.92	128.4	1.77	129.3	1.6	139.6	1.62	163.1	1.81	190.4	1.85	215.5	1.71	215.7	1.56	242.7	1.63	267.0	1.6	274.0	1.58
5.	MISCELLANEOUS	1451.4	20.7	1304.4	18.031	1514.5	18.76	1310.4	15.29	1344.1	14.92	1576.0	15.36	2138.8	17.05	2110.8	15.34	1916.7	10.94	2033.0	12.73	1788.0	10.34
6.	TOTAL	7047.2	100	7240.1	100	8080.4	100	8578.1	100	9015.2	100	10267.0	100	12554.5	100	13768.9	100	14825.9	100	15993.0	100	17319.0	100



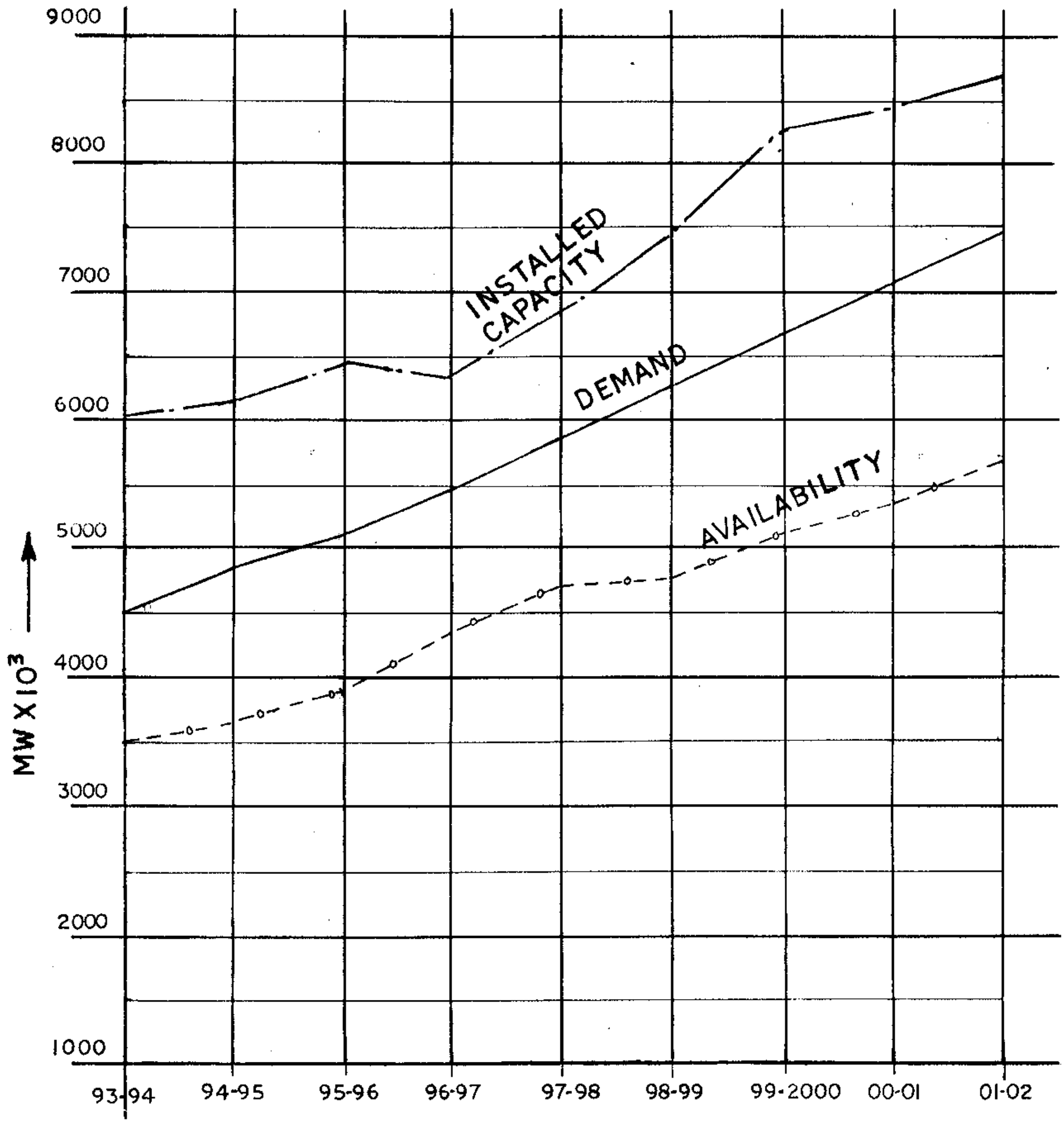
BARCHART OF SECTORWISE ENERGY SALES IN GUJARAT.	GUJARAT POWER CORPORATION LIMITED. 2 X 500 COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAB, GUJARAT	DEVELOPMENT CONSULTANTS LIMITED CONSULTING ENGINEERS

PLATE 2.2



PERCENTAGE SHARE OF DIFFERENT ENERGY SECTORS IN GUJARAT.	GUJARAT POWER CORPORATION LIMITED. 2X 500 MW COAL BASED COASTAL THERMAL POWER STATION. AT PIPAVAV, GUJARAT.	DEVELOPMENT CONSULTANTS LIMITED CONSULTING ENGINEERS

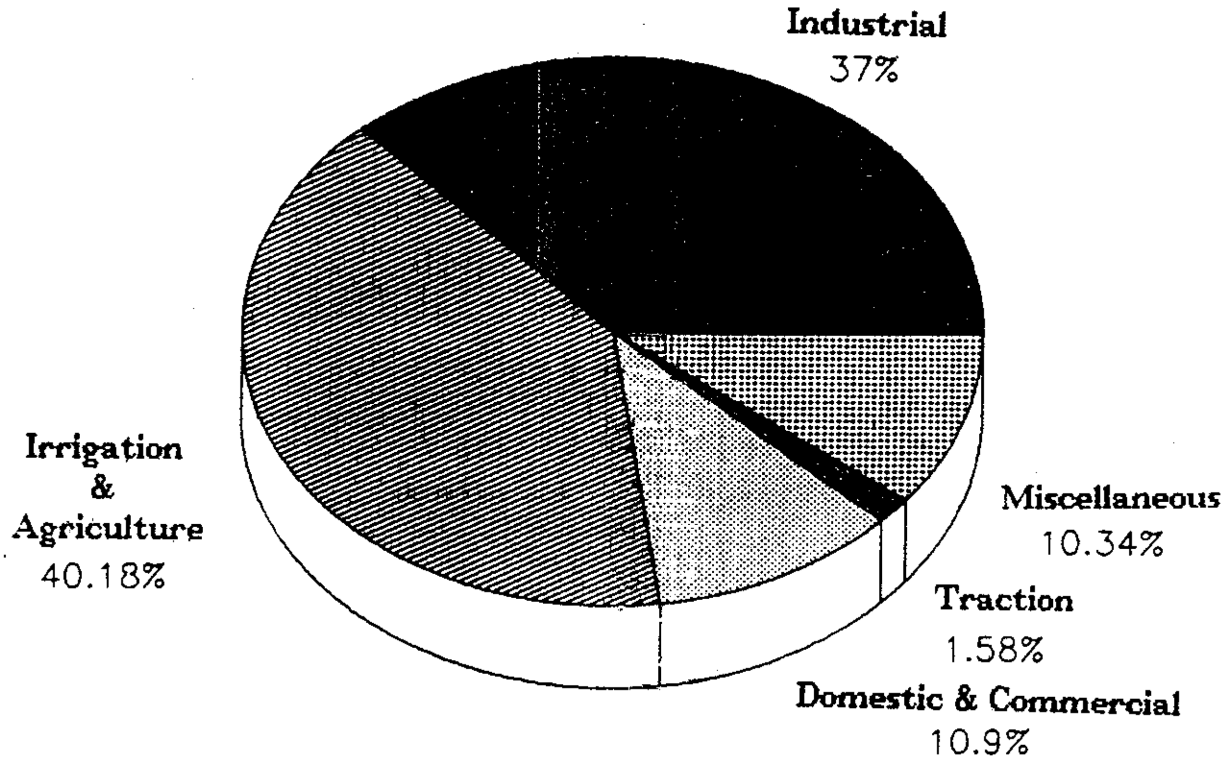
PLATE NO. 2·3



POWER SCENARIO OF GUJARAT

JOB NO.	DATE	GUJARAT POWER CORPORATION LTD.	DEVELOPMENT CONSULTANTS LIMITED CONSULTING ENGINEERS
930Ø5	25.5.95	2 X 500MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.	

CONSUMPTION/DISTRIBUTION OF ENERGY IN GUJARAT



SECTION – 3

BASIC REQUIREMENTS

SECTION - 3

BASIC REQUIREMENTS

3.1 General

The basic requirements for setting-up and operating a large power station are availability of suitable and adequate land, fuel, water, infrastructural facilities like road and rail-head and suitable access for power evacuation. This section discusses the requirements vis-a-vis their availability at the proposed power station site.

3.2 Land

The land requirement for a coal-fired thermal power station can broadly be classified under four basic heads namely, (a) plant area (b) township (c) ash disposal area (d) other requirements such as land for intake water pipe routes, ash disposal route, railway and road access, transmission corridor etc.

Plant Area :

The requirement of land for the plant area with an installed capacity of two units of 500 MW (1000 MW) thermal power station inclusive of space provision for expansion by two more units of identical size is estimated at 300 hectares. The land requirement considers storage of 30 days' coal requirement for the plant, 400 kV station switchyard, provision for semi-open recirculating cooling water system using wet type cooling towers, desalination plant etc.

The proposed site for the station is shown in the site location map (**Plate No.4.2**) enclosed. The land proposed for this station is predominantly private waste land free from any forest.

Ash Disposal Area :

The total quantity of ash generated by a 1000 MW (2 x 500 MW) TPS for a plant life of about 30 years, considering an average ash content of 13% to 14% and wetted bulk density of 1.25 T/M^3 is estimated at 9.3 million tons which would have a volume of 7.4 million cubic meter i.e. 741 hectare metres. This is estimated with an average plant load factor of about 68.49%. Considering an average fill height of 6 M the space requirement inclusive of dyke would be about 135 hectares. Higher dump height, depending on ground contour, allowable bearing pressure of soil and other relevant aspect, may be considered on the basis of detail investigation on the proposed site for ash disposal. The above estimate is based on dry extraction and disposal of ash as discussed in the foregoing section. However, the exact technology to be adopted would be decided in detail engineering stage when adequate information from operating and ongoing projects in the country adopting dry disposal would also be available.

With the dry ash extraction and disposal system proposed, it is expected that a sizable quantity of ash would be utilised gainfully for manufacture of fly ash brick aggregates and as land fill.

Township Area :

The total number of employees for a 1000 MW (2 x 500 MW) TPS is tentatively estimated at 800. The land requirement for residential township for housing the employees assuming a satisfaction level of 80% is estimated at 30 hectares inclusive of the requirement for developing necessary community facilities.

Other Requirement :

Other land requirements for setting-up a grass roots power station are land for access road from nearest highway, right of way for power evacuation, land requirement for raw water intake pipe and waste water disposal, land for ash disposal route, land for compulsory/compensatory afforestation etc.

Total land requirement for the proposed 1000 MW coal-fired TPS can thus be summerized as follows :-

• Plant area	-	300 hectares
• Ash disposal area	-	135 "
• Township area	-	30 "
• Intake pipe route	-	4.5 "
• Other requirement	-	10 "

Total land requirement	-	**479.5 hectares** (Say 480 hectares)

3.3 Water - Requirement and Availability

In a conventional fossil fuel-fired power station, water is used to meet the following consumptive requirements.

a. Cooling water for steam condenser to act as the heat sink for thermodynamic cycle. However, for power stations employing semi-open circuit cooling systems for condenser, only a small percentage of total circulating water flow is required as make-up water.

b. Cooling of electrical and mechanical auxiliary equipment, such as, generators, transformers, large motors, compressors and other heat exchangers through closed circuit auxiliary cooling system using demineralised water as primary coolant and main circulating cooling water as secondary coolant.

The consumptive sweet water requirement for 1000 MW station are of the order of 280 M^3/hr. In case the same is not met by Dhatrawadi River or any other sources like Narmada, an in-house desalination plant has to be built.

c. Make-up water for the power cycle (boiler make-up).

d. Water for miscellaneous services such as -

   i) Fire fighting

   ii) General services viz. airconditioning, ventilation, service water, dust suppression etc.

   iii) Potable water for plant and housing area.

The Pipavav region suffers from acute sweet water scarcity. No sweet water would thus, be available for industrial use. Ground water in this region is also brakish and availability is insufficient to sustain consumptive water requirement for a thermal power station of such magnitude. Hence, in view of acute scarcity of sweet water a two pronged attack is proposed as follows :-

a. Reduce consumption of sweet water to bare minimum and adopt re-cycling wherever possible.

b. Use sea water as primary medium for cooling as far as practicable and provide sea water desalination facility to meet sweet water requirement.

Therefore, it is proposed to draw adequate quantity of sea water from a suitable intake location in the gulf of Khambhat and draw it to site by pipeline. Sea water would be used in semi-open recirculating cooling system for plant cooling utilising cooling towers and heat exchangers. The sea water will also be used as feed stock to the 2 x 237 M^3/hr (2 x 1.5

MGD) nominal capacity desalination plant proposed to be provided inside the power plant to cater consumptive water requirement for the station.

In view of using sea water to meet cooling requirement and desalinated water for other consumptive requirements necessary protections in the form of superior material of construction, cathodic protection as required, additional chemical dozing arrangement to avoid problems of scaling, disposal of waste water etc. would attract special attention.

The estimated break-up of consumptive water requirement for the plant is furnished in **Annexure-3.1** and a typical sea water analysis (tentative) in **Annexure-3.2**.

3.4 Fuel - Requirement, Availability and Transportation

The primary fuel namely, coal for the proposed thermal power station is considered to be supplied in shipload from overseas sources viz. South Africa/Australia/Indonesia. As per the assurance received from Pipavav Port authorities sufficient draught for navigation of 60,000 DWT ships would be available. In **Annexure-3.4**, a letter from Pipavav Port Authorities to this effect is enclosed. As discussed in a separate report on port with dedicated berth for coal at Pipavav, it is envisaged that coal will be unloaded from ship by 1500 tons/hr capacity unloaders. Coal, after unloading will be transported by a set of twin conveyors to a transfer point located on the fringe of the port area complex. At this transfer point coal would be fed to a pair of belt conveyors (1 W + 1 S) leading to the power plant site where it will be stored in a stockyard. As such no provision of coal storage within port area is considered. The battery limit of coal receipt from the port starts from the outlet of this transfer point located near the port. Imported coal transported by ship are normally received in two sizes, namely, (-)40 mm and (-)80 mm. It is customary to specify the limits of both oversized as well as undersized coal including fines in the coal supply contract. For the purpose of the study, (-)50 mm size coal is considered as indicated by one of the coal suppliers. Different reputed overseas coal suppliers were contacted for obtaining necessary data on import of coal. In **Annexure-3.5** letters issued by GPCL to this effect as well as the responses received from overseas suppliers are furnished. In **Annexure-3.6** a comparative study of coal supply from these vendors have been shown. On the basis of composition of coal available from different overseas sources viz. South Africa, Australia, Indonesia, it is estimated that daily coal consumption would be around 8850 MT and a ship load would cater the plant requirement for six(6) to seven(7) days. A typical analysis of coal from an South African supplier is furnished in **Annexure-3.3**. Keeping in view the haulage distance and the turn around time, the stock to be maintained inside the plant should be adequately sized to receive at least three to four shiploads of coal. The stock pile will thus have a provision of holding about 30-days' coal requirement of the power plant. However, depending upon the linkages overseas, turn around time and seasonal requirement, if any, this stock capacity would be reviewed at the time of detail engineering. For the present study, coal from South African sources has been considered. It may be noted that as per projected availability, different mines may have to be linked to supply the required quantity.

Considering a weighted average station heat rate of 2500 KCal/kWh and a plant load factor (PLF) of 90% the average daily coal consumption for the proposed 2 x 500 MW power plant comes to about 8131 TPD or about 2.26 million tons per year. In view of improved plant availability with fuel of superior quality and also high demand in the state grid, actual coal requirement may be even higher.

The start-up and stabilization fuel for this station will be HFO, the daily requirement of which has been estimated to be about 80 KL depending on plant load factor etc. The HFO will be transported to the power plant by road from the nearby depot and stored in tanks. The total HFO storage capacity of about 3000 KL is envisaged for the station which is equivalent to more than a month's stock.

3.5 Power Evacuation

Pipavav substation of Gujarat Electricity Board (GEB) is proposed to be connected by two double circuit 220 kV lines to Jetpur substation and Savarkundla-Kodinar lines. Separate single circuit 220 kV line would connect Pipavav substation to Kodinar and Savarkundla substations. The net power generated from the 2 x 500 MW TPS, after auxiliary consumption, will be supplied entirely to GEB grid and need be evacuated at 400 kV.

This project report covers the installation upto the outgoing bus of the power plant switchyard (400 kV) only. It may be noted that the detail scheme for evacuation of the exportable power about 915 MW would have to be drawn-up by GEB and will be furnished by them. In this context, the power map of Gujarat State is enclosed in **Plate No.2.5** for ready reference.

3.6 Infrastructural Facilities

The proposed plant site is situated at a distance of about 2.5 Kms from the State Highway (SH-34) connecting Jafarabad and Rajula towns. Among the infrastructural facilities, a two-lane common access road of heavy duty class emanating from the highway is proposed to be constructed to connect the proposed plant site.

As stated earlier the site is located about 14 Kms away from the nearest railway station at Rajula R.S. and about 40 Kms from the Pipavav Bandar R.S. on metergauge railway of

Western Railway. However, the railway track would not be extended to the power plant as metergauge track would have limited use for construction and operation of a station of such magnitude.

A staff township would be constructed close to the power plant for housing about 800 employees who will be required to operate and maintain the power station. All associated facilities like market complex, schools, hospital, post office, community centre etc. would be provided in the proposed township.

Annexure-3.1
Sheet 1 of 2

Estimation of Consumptive Water Requirement

(For 2 x 500 MW Coast Based Thermal Power Station in Gujarat)

Sl. No.	Area of Consumption	Passivated Water (M^3/Hr.)	Demineralised Water (M^3/Hr.)	Desalinated Water (M^3/Hr.)	Sea Water (M^3/Hr.)	Remarks
A.	**PASSIVATED WATER SYSTEM :**					
1.	Potable water for plant and colony	45				
2.	Service water	35				
3.	Miscellaneous water requirement including fire water	20 -------				
	Sub-Total	100		100		Considering desalinated water requirement for producing passivated water.
B.	**DEMINERALISED WATER SYSTEM :**					
1.	Heat cycle make-up		136			
2.	Hydrogen generation		5			
3.	Chemical solution preparation		2			
4.	Backwash		7			
	Sub-Total :		150	150		Considering desalination water requirement to produce DM water.

Annexure-3.1
Sheet 2 of 2

Sl. No.	Area of Consumption	Passivated Water (M^3/Hr.)	Demineralised Water (M^3/Hr.)	Desalinated Water (M^3/Hr.)	Sea Water (M^3/Hr.)	Remarks
C.	**DESALINATED WATER SYSTEM :**					
1.	Auxiliary cooling water circuit including sealing/lubrication requirement			30		

	Total :			280		
D.	**SEA WATER SYSTEM :**					
1.	Desal Plant requirement				780	
2.	C.T. make-up				7800	This includes 910 M^3/hr of cooling water from desalination plant.
3.	Pump cooling/hypochlorination requirement				50	
4.	Clarifloculator plant backwash				450	Clarified sea water is used for backwash.

	Sub-Total :				**9080**	
5.	Design Margin @ 5%				455	

	T O T A L :				**9535**	

Annexure - 3.2
Sheet 1 of 1

Tentative Analysis of Raw Sea Water

pH	:	7.8 - 8.3
Suspended Solids (milligramme/litre)	:	23 - 73
Dissolved Oxygen (milligramme/litre)	:	5.6 - 7.3
BOD (milligramme/litre)	:	0.8 - 1.7
Phosphate (PO^4) (microgramme/litre)	:	20 - 48
Nitrate (NO^3) (microgramme/litre)	:	0 - 60
Nitrate (NO^2) (microgramme/litre)	:	2 - 16
Ammonium (NH^4) (mirogramme/litre)	:	35 - 97
Salinity (%)	:	3.74-3.83
Water Temperature (°C)	:	29 - 32.5

Source : National Institute of Oceanography.

Annexure - 3.3
Sheet 1 of 1

Typical Analysis of Imported Coal

Size Range		mm	50 x 0
Total Moisture	a.r.	%	8.0
Air Dried Analysis :-			
Inherent Moisture	a.d.	%	3.0
Ash	a.d.	%	13.0 approx.
Volatile Matter	a.d.	%	27.0 approx
Total Sulphur	a.d.	%	0.6 max.
Gross Calorific Value	a.d.	Kcal/Kg	6850
Ash Fusion Temperatures (Reducing) :		°C	1340
Deformation		°C	1390
Hemisphere		°C	1400
Flow		°C	1400

Source : Ingwe Coal Corporation South Africa (1995).

Gujarat Pipavav Port Limited

GPPL
A Joint Sector of Govt. of Gujarat

RECEIVED D. C.
Date. 30/3/94
BARODA.

Regd. &
Corporate Office
Maharaja Palace
University Road
Navrangpura
Ahmedabad-380 009
India

Phone : 441700, 420168
 21-6853 SARA IN
Fax : 0272-420168

REF : GPPL:GPCL:441:93-94 MARCH 24, 1994

THE MANAGING DIRECTOR
M/S. GUJARAT POWER CORPORATION LTD.,
5TH FLOOR
CENTRE POINT
PANCHVATI
ELLISBRIDGE
AHMEDABAD - 380 006

Dear Madam,

Refer discussion between Consultants from Development Consultants Ltd., and Project Officers of GPPL on March 18, 1994.

The required information as asked by DCL is given here under :

(a) TENTATIVE LOCATION OF BERTHS PROPOSED FOR GPCL

Location is shown in the enclosed sketch.

(b) COST OF BERTH (JETTY)

About Rs. 2000 lacs for 400 mtr. jetty alongwith approach jetty/bund. Cost can be considered proportional for any additional length of berth.

(c) ANNUAL MAINTENANCE COST

Rs. 90,00,000/-.

(d) CONSTRUCTION OF BREAK WATER

The opinion of our Consultant Howe (India) is that Break Water is not required as they had investigated while planning L&T jetty in that area for which also they are the Consultants.

(CONTD .. 2

GPPL
(A joint Sector of Govt. of G

(e) NUMBER OF DAYS OF WORKING PER YEAR

Number of days of working can be considered as 270 to 300 days per year.

(f) PORT CHARGES

Our Charges are comparable to those levied by major ports against the much better services.

Further we are glad to intimate that this port will facilitate berthing of ships upto atleast 60,000 DWT.

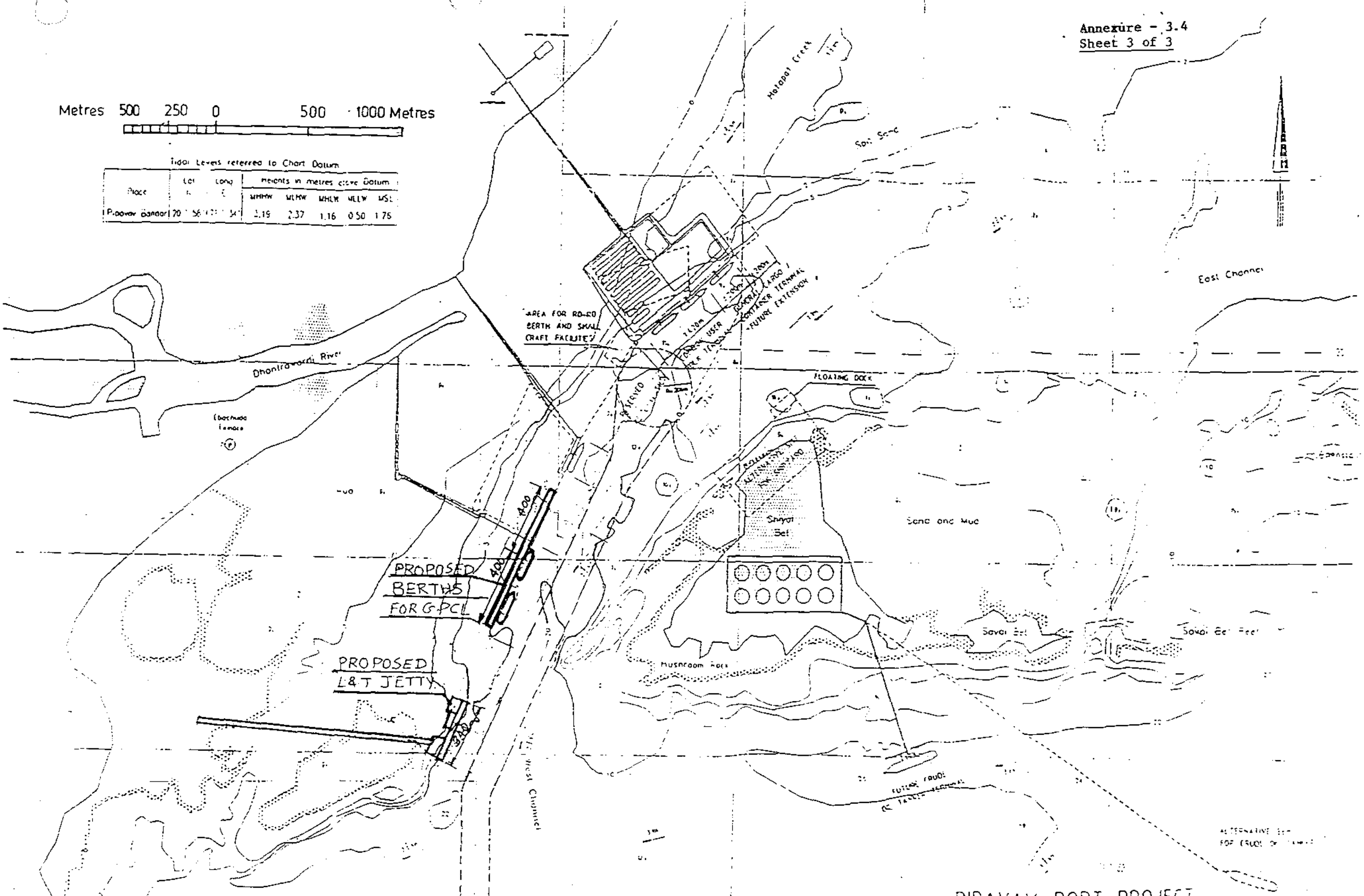
Thanking you,

Yours faithfully,
For GUJARAT PIPAVAV PORT LIMITED

(CMDE. V.G. HONNAVAR)
DIRECTOR (P&A)

CC TO : J.S. TALAULIKAR
DEVELOPMENT CONSULTANTS LTD.,
CONSULTING ENGINEERS
47/2, ARUNODAYA SOCIETY
ALKAPURI
VADODARA - 390 005

Annexure - 3.4
Sheet 3 of 3



PIPAVAV PORT PROJECT

GUJARAT POWER CORPORATION LTD.

GPCL/TECH/319/B/COASTAL TPS/3217 February 5, 1994

To
(As per attached list)

Kind Attn. :

Sub : 2000 MW Coastal TPS in Gujarat (INDIA) - Import of Coal.

Dear Sir,

Gujarat Power Corporation Limited (GPCL), a Government of Gujarat Undertaking, is studying the feasibility of setting up an imported coal based power plant of 2000 MW ultimate installed capacity. The full capacity is proposed to be installed in two stages of 1000 MW each.

Coal requirement for 2000 MW generation will be of the order of 5 million tonnes per year which is proposed to be imported from countries like Australia, South Africa or Indonesia. A dedicated port facility, fully equipped with continuously operating ship unloader and conveyor belt system for transportation to the power station, is envisaged to ensure uninterrupted supply of coal for plant operation.

We are investigating probable port/power plant sites on the coast of Saurashtra and on the northern shore of the Gulf of Kutch. Preliminary investigations indicate that coaliers/bulk carriers of 60000 DWT class would be a good choice for coal transportation with provision for unloading in two days time. Small sized vessels on the other hand, would require larger number of voyages to maintain the desired supply level to the plant, thereby increasing the requirement for number of unloading jetties and corresponding cargo handling systems. Cost of transportation may also go higher.

However, the final selection of vessel size will be guided by more comprehensive study [illegible] of navigational, commercial and operational aspects in addition to the prevailing climatic and site conditions.

..2..

REGD. OFFICE :
5TH FLOOR, CENTER POINT
PANCHVATI, ELLISBRIDGE,
AHMEDABAD-380 006 INDIA
TELEX : 121-6044 GPCL IN
FAX : 91-272-447406
PHONE: 91-272-423957,
446850,51

GUJARAT POWER CORPORATION LTD.

Based on the above, the basic requirements of the project are summarised below :

1.	Nature of Cargo	: Coal of calorific value 6500 KCal/Kg. **(Minimum 6000 Kcal/Kg)**
2.	Volume of Cargo	: 2.5 million tonne/year in Phase-I & 5.0 million tonne/year in Phase-II.
3.	Port Site	: Along the sea coast of Gujarat State, India. Approximate location latitude 23^{o} N, Longitude 70^{o}E.
4.	Expected Delivery	: From mid 2000 AD for Phase - I
5.	No. of Voyages	: 45 per year at regular interval for Phase - I.

To firm up the project details, we need to identify the source of coal for long term supply to the power station. We would, therefore, request you to indicate your interest in this project and furnish the following information :

1) Whether you would be in a position to supply the desired quality and amount of coal on long term basis (say 30 years). Average approximate analysis of coal quality may please be furnished.

2) Estimated current delivered cost of coal with break-up indicating basic cost of coal, freight charges and other incidental cost (purely for budgetory purposes). Any variation with respect to size of carrier may please be indicated, as applicable.

3) Approximate voyage time between the loading port and destination and also return voyage.

4) Size of carrier/s you would prefer to use for the delivery

5) Any other information you would like to give.

..3/-

REGD. OFFICE :
5TH FLOOR, CENTER POINT,
PANCHVATI, ELLISBRIDGE,
AHMEDABAD-380 006. INDIA
TELEX : 121-6044 GPCL IN
FAX : 91-272-447406
PHONE: 91-272-423957,
446850.51

GUJARAT POWER CORPORATION LTD.

An early response would be highly appreciated. In the liberalised economic climate of the country, power generation projects on imported fuel are being actively pursued. We will revert to you on this subject immediately on hearing from you.

Looking forward for an early reply.

Thanking you,

Yours faithfully,

sd/-

(SWATANTRA K. SEKHON)
Managing Director

C.C. to :

1. Mrs. Mazumdar/Mr. R.N. Basu
   M/s. Development Consultants Ltd.
   24- B, Park Street
   Calcutta - 700016

They are requested to follow up with the party.

2. Mr. Talawlikar
   M/s. Development Consultants Ltd.
   47/B Arunodaya Society
   Alkapuri
   Baroda - 390005

(SWATANTRA K. SEKHON)
Managing Director

REGD. OFFICE
[illegible] CENTRE [illegible]
PANCHAYAT [illegible]
AHMEDABAD [illegible]
TELEX [illegible] 6044 [illegible]
FAX [illegible] 272 [illegible]
PHONE 91 272-[illegible]
44685051

BHP

M/s. Australia Coal Ltd.
167 Eague Street
Brisbane Old 4000
Australia

Kind Attn. Mr. L.A. Chalk

M/s. Blaar Athol Coal Pvt. Ltd.
AMP Place
10 Eagle Street
Brisbane Old 4000
Australia

Kind Attn. Mr. Andrew Blackwell

M/s. Bloomfield Collieries Pvt. Ltd
Four Mode creek Road
PO Box 4
East Midland NSW 2323
Australia

Kind Attn. Mr. Geoff Bellamy

M/s. Clutha Ltd.
Level 18
1 York Street
Sydney NSW 2000
Australia

Kind Attn. Mr. W.G. Tweadle

M/s. Coal and Allied Operations Ltd
Royal Insurance Building
1 York Street
Sydney NWS 2000
Australia

Kind Attn. Mr. Trevor M. Bailey

Exxon Coal & Minerals International
PO Box 1439
North Sydney NWS 2059
Australia

Kind Attn. Mr. K.F. Dixon

M/s. Liddell Coal Marktg. Pvt. Ltd.
Level 14 Norwich House
6-10 O Connell St.
Sydney NSW 2000
Australia

Kind Attn. Mr. Stephen Gye

M/s. Metropolitan Collieries Ltd
Level 7 The Denison
65 Berry St.
North Sydney NSW 2060
Australia

Kind Attn. Mr. Graham Wales

M/s. Novacoal Australia Pvt. Ltd.
110 Alfred Street
PO Box 354
Milsons Point NSW 2061
Australia

Kind Attn. Mr. Eric Buller

M/s. Ulan Coal Mines Ltd.
PO Box 1059
North Sydney NSW 2059
Australia

Kind Attn. Marketing Manager

M/s. PT Adaro Indonesia
Sevabudh Building
11 Suite 602C
JL. H.R Rasuna Said 62
Jakarta 12920
Indonesia

Kind Attn. Mr. Graeme Robertson

M/s. PT Allied Indo Coal
3rd Floor Aurum Building
JL Ampera Raya No. 37
Jakarta 12560
Indonesia

Kind Attn. Mr. I.J. Salway

M/s. PT Berau Coal
Gedung Khansma Floor A1
Kelapa Gading Boulevard Block
DB No. 1, Kelapa Gading Boulevard
Jakarta 14240
Indonesia

Kind Attn. Mr. Eddy Sumarsono

M/s. PT Keltim Prima Coal
Kuningan Plaza Suite 403
North Tower
Jalan HR Rasun Said
Jakarta 12940
Indonesia

Kind Attn. Mr. Lindsay Dave

M/s. PT Utah Indonesia
Mid Plaza 11th Floor
JL Jend Sudirman Kav 10-11
Jakarta 10220
Indonesia

Kind Attn. Mr. Bill Zimmerman

M/s. Anglo American Coal Corpn. Ltd
45 Main Street
Johannesburg 2001
South Africa

Kind Attn. Mr. J.W. Campbell

M/s. Dulker Exploration Ltd.
1st Floor
19 Girton Road
Parktown
Johannesburg 2193
South Africa

Kind Attn. Mr. R I Du Preez

M/s. Gold Fields Coal Ltd.
75 Fox Street
Johannesburg 2000
South Africa

Kind Attn. Mr. M. Purvis

M/s. Trana-Natal Coal Corpn. Ltd.
PO. Box 61820
Marshalltown 2107
South Africa

Kind Attn. Mr. Gordon Osterioh

BY: XEROX Telecopier 7033; [illegible] 0062214. 0326→ 0272 4474061#

P.T. Berau Coal

Jakarta Office
Kharisma Building, Floor A1
Jl. Kelapa Gading Boulevard
Blok DB No. 1
Jakarta 14240 - Indonesia
P.O. BOX 1288/JAT
Phone (62) (021) 4512821
4512822
Fax (62) (021) 4510325
4510326
Telex 46959 UTS IA

Field Office
Jl. SM. Aminuddin
Tanjung Redeb, Kab. [illegible]
Kalimantan Timur, Ind[illegible]
Phone (62) (0554) [illegible]
Fax (62) (0554) [illegible]

No.064/XII.3-JO/94

25 March 1994

Mr. Swatantra K. Sakhon
Managing Director
Gujarat Power Corp. Ltd
5th Floor, Center Point
Panchvati, Ellisbridge
Ahmedabad-380 006, India

Dear Mr. Sakhon:

Thank you for your letter No.GPL/TECH/319/B/COASTAL TPS/3217, dated February 5, 1994, stating your interest in PT Berau Coal to become your coal supplier.

As we have vast coal reserves, we believe to be able to supply coal you need. Currently, we have Lati Coal in East Kalimantan, Indonesia, which is produced for domestic consumption as well as for several foreign countries.

In the meantime, we are exploring Binungan area, also in East Kalimantan, which has even better coal quality. The exploration is in the final stage and its first production will be in 1995. We believe the Binungan Coal is suitable for your power plant project.

In answering your queries, we would like to furnish you with the required information:

1. Yes, we are in a position to fullfill your requirement in supplying coal for a long term basis. As the coal you need is still several years ahead (year 2000), we would like to offer you our Binungan Coal. The contract could be established for 30 years as the Binungan area has 90 million tons of coal reserves with 6,200 Kcal/kg (a.d.b.).

2. We still can not furnish you with coal cost break-down this time, as Binungan coal development is still in projecting stage. As for ships to be used, the optimum size is 40,000 tons, however, since the water depth at Berau can accommodate up to cape-sized ships (200,000 DWT), bigger size of ship is possible for this purpose, depending on the economics.

3. Approximate Voyage Time:
   Berau Rivermouth to Ahmedabad - 13 days
   Ahmedabad to Berau Rivermouth - 13 days

0062214571328

P.T. Berau Coal

4. As we can always adjust our production and loading rate to any size of ship, the choice on ship size is up to the capacity of discharging port.

We hope the above information satisfies you, meanwhile, should you need more information please dont hesitate to contact us.

Look forward to doing business with you.

Yours sincerely,

Djoko N. Notodisuryo
Manager - Marketing Dept.

-/FHA

Coal & Allied Operations Pty. Limited

A.C.N. 000 023 656

Attn: Mr. Swatantra K. Sekhon
Managing Director
Gujurat Power Corporation Ltd.
5th Floor, Centre Point
Panchvati, Ellisbridge
Ahmedabad-380 006
INDIA

9 March 1994

G P C L
RECEIVED
Inw. No. 5352
Date 26/3/94
Deptt:
Sign:

Dear Mr. Sekhon,

Thank you for your correspondence dated February 5 1994. We were interested to read of the proposed development of a coal fired power station on the coast of Saurashtra or on the northern shore of the Gulf of Kutch.

To assist you in your research into possible sources of long-term coal supplies we can provide the following information regarding our own operations.

Coal & Allied Operations Pty. Ltd. would be in a position to enter into a long term thermal coal supply agreement (say 30 years) commencing mid 2000. Our current projections indicate the following exportable steaming coal production for the year 2000.

Mount Thorley Brand Steaming Coal	2.7 million tonnes per annum
Hunter Valley Brand Steaming Coal	3.5 million tonnes per annum

The typical specification of coals that we would be able to offer for such an agreement is provided on the attached pages.

Depending on a development option we are currently assessing, we may have a third thermal coal available by that time, Mount Pleasant Brand Steaming Coal. We have not yet published a formal expected typical specification or projected annual production tonnage for this third thermal coal brand. However, from the research done to date, we expect it to be of similar quality to our Mount Thorley Brand Steaming Coal.

The freight component of the cost of supply from Port of Newcastle, Australia to the Gujurat coast (assuming the success of the port project providing continuous discharging facilities able to unload at a rate of approx. 30,000 tonnes per day) would currently vary from around US$11.50/tonne for 60,000 tonne shipments to US$14.00/tonne for 40,000 tonne shipments. The steaming time for this charter would currently be approx. twenty two days.

Level 9 Royal Insurance Building 1 York Street, Sydney, NSW, 2000
Phone (02) 911 0900 Telex AA21226 Fax (02) 911 0962
GPO Box 1354, Sydney, 2001

Our current FOBT price range for our steaming coals is US$35.00/tonne to $37.00/tonne. Although this is only indicative of what we may be able to offer, this would equate to an approx. CFR price of US$46.50 per tonne for 60,000 tonne shipments.

Thank you for your efforts in contacting us about this new business opportunity.

We wish you well in the research and development of this project.

Yours sincerely,

Ian S. MacPhee
Executive General Manager Marketing

Liddell Coal

LIDDELL COAL MARKETING
PTY LIMITED
ACN 003 538 449
LEVEL 15, GOLDFIELDS HOUSE
1 ALFRED STREET
SYDNEY NSW 2000 AUSTRALIA
TELEPHONE +61 2 373 7777
FACSIMILE +61 2 373 7788
TELEX LIDDELL AA 178238

21 March, 1994

Swatantra K. Sekhon
Managing Director
Gujarat Power Corporation Ltd
5th Floor
Center Point
Panchvati
Ellisbridge
AHMEDABAD 380 006 INDIA

Dear Mr Sekhon

Re: 2000 MW Coastal TPS in Gujarat - Import of Coal

Thank you for your letter dated 5 February, 994. We were pleased to receive your letter and wish to express an interest in supplying coal to GPC to the above power station.

In response to your questions:-

1) Our company has coal resources in situ of 372 million tonnes. Enough to last well into the 21st century. Liddell Joint Venture would be in a position to supply coal on a long term basis.

We would counsel against allocating tonange to one suplier - typically a requirement of 2.5 million tonnes would be divided between 5 suppliers to ensure diversity and reliability of supply.

Liddell Joint Venture would certainly wish to be considered as a potential long term supplier.

We attach a copy of our typical steaming coal specification.

2) As a guide current price for 6700 Kcal/kg coal would be about US$34 FOBT. Freight would be about US$13.00 for 60,000 tonne vessel and about US$18.00 for 35,000 tonne vessel. Obviously both coal price and freight are subject to fluctuation.

3) Shipping time is about two and a half weeks each way.

4) The Port of Newcastle can load vessels up ot 140,000 DWT. The size of vessel is not a concern for us but for your company to achieve economies it is my understanding that it is best to use the largest size of vessel possible.

The dollar per tonne rate is generally much lower on larger vessels.

5) We include for your information a booklet giving detail of the Liddell Joint Venture.

To conclude, Liddell Joint Venture produces principally steaming coal and semi soft coal. The coal is used by a number of major companies including:-

- Korea Electric Power Corporation 10 year Contract for up to 400,000 tonnes p.a.
- Posco, Korea 3 year contract 200,000 tonnes p.a.
- EPDC
- Kawasaki Steel
- Kobe Steel
- NKK
- Daio Paper.

The Joint Venture is committed to expansion over the coming years.

We thank you for your enquiry and look forward to the opportunity of developing a good business relationship with you.

Yours sincerely,

Kevin Gallagher

Kevin Gallagher,
GENERAL MANAGER, MARKETING

LIDDELL COAL

TYPICAL STEAMING COAL ANALYSIS

Quality Parameters		Basis		Steaming Coal
Size Range			mm	50 x 0
Total Moisture		a.r.	%	9.0
Air Dried Analysis:	Inherent Moisture	a.d.	%	2.5
	Ash	a.d.	%	14.0 approx.
	Volatile Matter	a.d.	%	33.0 approx.
	Fixed Carbon	a.d.	%	50.5 approx.
	Total Sulphur	a.d.	%	0.6 max.
	Gross Calorific Value	a.d.	Kcal/kg	6850
Indicative Qualities:	Total Sulphur	a.d.	%	0.45-0.55
	Phosphorus	a.d.	%	0.05
	Chlorine	a.d.	%	0.02
	Nitrogen	a.d.	%	1.7
	Hardgrove Grindability Index			50-55 (52 average)
	Abrasion Index		mg Fe/kg	21
	Crucible Swelling Number			3
	Fuel Ratio		FC/VM	1.5
Ultimate Analysis:	Carbon	d.a.f.	%	82.0
	Hydrogen	d.a.f.	%	5.4
	Nitrogen	d.a.f.	%	1.9
	Sulphur	d.a.f.	%	0.5
	Oxygen (By Difference)	d.a.f.	%	10.2
Ash Fusion Temperatures:	Deformation		Deg. C.	>1300
(Reducing)	Spherical		Deg. C.	1440
	Hemisphere		Deg. C.	1460
	Flow		Deg. C.	>1500
Trace Elements:	Arsenic	a.d.	ug/g	0.9
	Barium	a.d.	ug/g	64
	Berylium	a.d.	ug/g	3.1
	Cadmium	a.d.	ug/g	<0.1
	Chromium	a.d.	ug/g	6.5
	Copper	a.d.	ug/g	13
	Lithium	a.d.	ug/g	11
	Manganese	a.d.	ug/g	47
	Mercury	a.d.	ug/g	0.08
	Nickel	a.d.	ug/g	5.6
	Lead	a.d.	ug/g	8.9
	Selenium	a.d.	ug/g	0.3
	Strontium	a.d.	ug/g	178
	Vanadium	a.d.	ug/g	30
	Zinc	a.d.	ug/g	25
	Flourine	a.d.	ug/g	121
Ash Analysis:	SiO_2		%	56.0
	Al_2O_3		%	26.0
	Fe_2O_3		%	6.5
	CaO		%	3.5
	MgO		%	1.3
	TiO_2		%	1.3
	Na_2O		%	0.6
	K_2O		%	0.8
	Mn_3O_4		%	0.08
	SO_3		%	1.6
	P_2O_5		%	1.0

/02 '94 09:53 ☎ 0552831? BLOOMFIELD COLL

Bloomfield Collieries Pty. Limited

FOUR MILE CREEK ROAD, EAST MAITLAND, N.S.W. 2323
A.C.N. 000 106 972

TELEPHONE: (049) 33 7077
33 7805
33 7806
FACSIMILE: (049) 33 8940

P.O. BOX 4
EAST MAITLAND,
N.S.W. 2323

FACSIMILE TRANSMISSION

FACSIMILE NO	:	0015 91 272 447406 DATE: 14 February 1994
COMPANY NAME	:	Gujarat Power Corporation Ltd
ATTENTION	:	Mr S K Sekhon
FROM	:	Mr G Bellamy
SUBJECT	:	**COAL AVAILABILITY**
FAX REF NO	:	1661 NO OF PAGES INCL. THIS HEADER: 1.

Thank you for your letter dated 5 February 1994 outlining your plans for a 2000 MW power plant to be fuelled by imported coal. Bloomfield is very keen to register its interest with your company as a potential supplier from Australia. I will be forwarding to you by an International Courier a summary of our operations. In the meantime I would like to answer some of the questions raised in your letter.

(a) We currently have reserves of saleable coal totalling approximately 90 million and are exporting at the rate of 1.6 million tonne per annum. This gives us sufficient coal to continue to supply at current rate for approximately 60 years. We propose offering to you 500 000 MT per annum.

(b) Bloomfield does not participate in C & F sales. We only sell FOBT Newcastle, New South Wales, Australia. We can however load any size vessel the client desires from handsize (35,000 MT) through to Cape Size (120,000 MT approximately). The approximate sailing time to and from India would be 21 days ie. 42 days sailing for the round voyage.

(c) Our current price idea for 6700 kcals/kg coal (air dried basis) is approximately US$30.00 FOBT Newcastle, New South Wales, Australia.

I look forward to further information from you as your project becomes a reality.

Regards

Geoff Bellamy

Geoff Bellamy
GENERAL MANAGER - MARKETING

NOVACOAL AUSTRALIA

Novacoal Australia Pty Limited
A.C.N. 000 013 990
110 Alfred Street
Milsons Point NSW 2061
PO Box 364 Milsons Point
NSW 2061 Australia
Telephone: (02) 202 8444
Facsimile: (02) 202 8471
Telex: 20311

FACSIMILE TRANSMISSION

TO :	Swatantra K. Sekhon - Managing Director
ORGANISATION :	Gujarat Power Corporation Ltd
FAX NO :	0015 91 272 447406
FROM :	L. Fanshaw
DATE:	17 February 1994
NO. OF PAGES :	2 (including this page)

Re: 2000 MW Coastal TPS in Gujarat

Thankyou for your letter explaining your feasibility study into setting up an imported coal based power station. Novacoal wish you success with this study as we are a coal exporter and are always encouraged to see greater demand for our products.

Novacoal Australia operates three mines in the state of New South Wales producing 5 million tons a year of which 3 million tons is exported mainly to north Asia.

More importantly, Novacoal is part of the CRA group of companies, the largest mining company in Australia. Within the CRA group we produce about 45 million tons a year, most of which is exported. Part of the production is in Indonesia. As most of this coal is steam coal for which the most important market is electricity generation, Novacoal and indeed CRA, is very interested in following the progress of your studies and in time supply coal to your power station.

Novacoal would prefer to supply under long term contracts with stable predictable pricing. Our preferred contract volume would be between 500,000 and 1,000,000 metric tons a year. We produce two steam coal qualities which are provided below:

	A	B
Calorific Value (gross air dried)	6950 kcal/kg	7150 kcal/kg
Total Moisture	9%	10%
Proximate Analysis (adb)		
Moisture	3%	3.5%
Ash	12%	8.5%
Volatiles	34%	34.5%
Fixed Carbon	51%	53.5%
Sulphur	0.7%	0.4%
Hardgrove Grindability Index	48	50

NOVACOAL AUSTRALIA PTY LIMITED
FACSIMILE

Novacoal use the port of Newcastle which can load vessels up to 150,000 DWT. It would take about 16 to 17 days to sail from Newcastle to the Gulf of Kutch. Freight costs in the current weak market would be about US$9.50 to US$10.00 for panamax (65,000 DWT) and US$14.00 to US$14.50 for handysize (39,000 DWT). These rates would apply providing discharge port conditions were normal. That is a port with reasonable discharge rates of about 20,000 metric tons a day, operating 24 hours a day seven days a week, no draft restrictions, and moderate port charges. Novacoal would prefer panamax vessels as this would be the most cost efficient.

Prices can be set in a number of ways. In long-term contracts they could be a base plus yearly escalation by appropriate indexes, or they could be determined each year by negotiation. This latter procedure is common for exports to Japan, Korea and Taiwan, the major Asian markets. Currently the long-term contract price in north Asia for coal type A is US$37.70 FOB and US$38.80 FOB for coal type B.

We hope this information is helpful. We certainly would be pleased to receive information about the progress of your study and would be happy to provide further information as it proceeds.

Best regards,

agmy

per L. Fanshaw
Manager Market Development

BAC

MKA C/R 02P/2M

BLAIR ATHOL COAL PTY. LTD.
A.C.N. 009 738 729

3 March 1994

Mr Swatantra K Sekhon
Managing Director
Gujarat Power Corporation Ltd
5th Floor, Centre Point,
Panchvati
Ellisbridge
AHMEDABAD 380 006
INDIA.

Dear Mr Sekhon

RE: <u>2000 MW COASTAL TPS IN GUJARAT - IMPORT OF COAL</u>

Thank you for your letter dated February 5, 1994 addressed to Mr Blackwell.

Blair Athol Coal is interested in your proposed power project and has the resources necessary to sustain a long term supply source to the plant.

I have attached a copy of our brochure which gives further details on the mine and infrastructure as well as the coal quality.

Our current annual production rate is 10 million tonnes, whilst our recoverable reserves are estimated at 200 million tonnes.

We are in the process of securing an adjoining mining area which will extend our recoverable reserves by a further 170 million tonnes.

Accordingly on the basis of these reserves and our other term commitments we would be able to provide stable long term supply of 0.5 million tonnes per annum.

Our coal is loaded through the Dalrymple Bay Coal Terminal located at the port of Hay Point. The approximate voyage time to your proposed port is 18 days and our preferred vessel size would be 60,000 DWT.

Estimating the delivered cost of coal is very difficult for a project so far into the future. However based on prevailing market prices for term contracts, a figure of US$30 per tonne FOB for 6500 Kcal/kg G.A.D. coal plus ocean freight in Panamax vessels of US$14 per tonne would be appropriate for budgetary purposes. I am not aware of the level of other Indian import costs such as port changes, import taxes/tariffs.

I hope this information is useful for your study. Please contact me if you require further details on our project.

Yours sincerely

M.K. Allen

M.K. ALLEN
Marketing Manager

enc

COAL FROM INDONESIA

PT KALTIM PRIMA COAL

22 February 1994
F5 1020/3443/94

Total page(s): 5

Mr. Swatantra K. Sekhon
Gujarat Power Corporation Ltd.
5th Floor, Center Point
Panchvati, Ellisbridge
Ahmedabad - 380 006
INDIA

Fax: 91 272 447 406

Dear Mr. Sekhon,

2000 MW COASTAL TPS IN GUJARAT - IMPORT OF COAL

Thank you kindly for your letter dated 5 February 1994 (received 18 February) concerning the above.

KPC appreciates the opportunity to indicate an interest in long term coal support for this project. However, with first coal deliveries not expected until the year 2000, we can do no more at this stage than give you a qualified indication of support.

At present, KPC is Indonesia's biggest producer, and one of the world's largest exporters, of thermal coal. We are close to reaching our nominal capacity of 10 Million tonnes per annum. In 1994, for example, we expect to produce and ship 9.5 Mt and of that amount, around 75% is committed under longterm contracts. Background information on KPC and quality data for our two coal brands are attached.

The company is examining the feasibility of expanding to 12 Mtpa within the next three years or so but no decision has been taken on that at this stage -it depends on the capital cost involved of various options and the state of the market. Whatever the capacity of our operations, we do have the coal resources to underpin the company for a very long time. Currently, our measured resource of export quality coal is more than 500 million tonnes. We also have substantial, undeveloped additional coal resources outside but adjacent to our existing operations which are higher in moisture and lower in calorific value then our Prima dr Pinang coal but which could meet your minimum c/v requirements if we proceeded to develop them.

In summary, we can say:

- if KPC stays at its present capacity we could support you for some part of your coal needs, provided it made mutual commercial sense compared with our respective alternatives;

- If KPC expands, we could supply you with a substantial portion of your coal needs, again depending on mutual attractiveness and, in our case, shareholder approval.

For your guidance and without any commitment whatsoever, approximate numbers for coal supply from Indonesia would be, in early 1994 terms:-

around $31.00 FOB Basis 6300 Kcal/kg Gross Air Dried (6% Ash, 13% TM, 0.5% S)
around $37.00 FOB Basis 7100 Kcal/kg GAD (4% Ash, 9% TM, 0.5% Sulphur)

Freight costs would depend very much on port restrictions and guaranteed discharge rates but given a discharge rate of at least 15,000 MT per day SHINC, we would guesstimate on today's rates:

Handysize (35,000 DWT)	$9.00/MT
Panamax (60,000 DWT)	$6.50/MT
Capesize (over 100,000 DWT +)	$5.00/MT

Journey time East Kalimantan/Gujarat would be approx 13 days. KPC loads ships up to 180,000 DWT.

As you know yourself, the international thermal coal and bulk shipping markets experience considerable variations. Over the past two years, for instance, coal contract prices in Japan - the largest Asian importer - have decreased around $4/MT but could go up just as rapidly given continued strong growth in demand and limited supply increases over the next few years.

While it's too early to commit to anything, I hope you find the above information useful as a guide. If you have any further questions please let me know.

Yours Sincerely,

Chris Schrape

Chris Schrape
Manager Marketing

CJS/rs
940221.04

PT KALTIM PRIMA COAL
BRIEFING NOTE

In the mid 1970's PT Rio Tinto Indonesia, which is a wholly owned subsidiary of CRA, entered an agreement with BP to jointly explore for coal in Indonesia on a 50:50 basis. In 1978, the Government of Indonesia invited tenders from foreign companies for the exploration and development of coal resources in eastern and southern Kalimantan.

The BP and CRA joint venture was successful in bidding for an area of 7900 square km in two blocks extending 300 km along the coast of eastern Kalimantan.

Negotiations for an agreement with the Government commenced late in 1978 and were finalised in 1982. On 8th April 1982, PT KALTIM PRIMA COAL (KPC), a company incorporated in Indonesia with CRA and BP each holding 50% of the shares, entered into a 30 year Coal Agreement with Perum Tambang Batubara (now PT Tambang Batubara Bukit Asam or PT TBBA), the Indonesian State Coal Company. This Agreement forms the legal framework under which KPC operates and covers exploration, production and marketing of coal from the Agreement Area in East Kalimantan, Indonesia. PT TBBA receives a royalty of 13.5% on all production.

From 1982 to 1986 detailed exploration of the Agreement Area led to the delineation of several prospects, the most attractive being located near the small town of Sangatta, 200 km north of Balikpapan and less than one degree north of the equator. The climate is typically equatorial with high seasonal rainfall and low wind velocities. Annual rainfall is approximately 2000 mm.

In early 1987, a study team was established in Jakarta by BP and CRA. The team's brief was to prepare a study of the technical and economic feasibility of developing the Pinang deposit.

Following this study, the Boards of CRA and BP decided in 1988 to proceed with the development of an export mine with a design capacity of 7 Million tonnes per annum (Mtpa) capacity. The decision was based on several factors: the substantial quantity of reserves (over 500 million tons of coal have now been measured in the Sangatta deposit); the high quality of the reserves; their close proximity to a part of the regional coast where there is naturally occurring deep water; and the strategically favourable location to service the growing markets of Asia and Europe.

KPC's primary goal is to develop a profitable mining operation which maximizes the advantages of the quality and location of the resource, for the long term mutual benefit of its shareholders and Indonesia. The project is fully integrated and self supporting. It includes a series of open cut pits, coal preparation facilities, 13 km overland conveyor to the coast and a world class marine terminal capable of handling bulk carriers of up to 180,000 tonnes DWT. The remote location necessitates full supporting infrastructure, including a power station, housing, schools, hospitals, water supply and recreational facilities.

Construction started in January 1989 and was completed on schedule on 1 September 1991. The capital budget for the project was US $570 M. All major items, including the crushers, coal preparation plant, conveyor, stacking and reclaiming equipment, and ship loaders were commissioned during 1991 and commercial exports began in the third quarter. Work on the large scale mine development commenced in June 1990 and nine pits are now in production, utilising a fleet of 80 haul trucks, 17 shovels/backhoes and other mobile equipment.

With production and sales reaching 7.3 Mt in 1992, the project's design capacity was exceeded in the first full year of operations. In terms of overburden removed and coal mined, KPC has quickly become Indonesia's and one of the world's largest export coal mines.

KPC produces two products, Prima and Pinang. Prima coal, on which the project is substantially based, is one of the highest quality internationally traded thermal coals. The remaining production is Pinang coal, which is a medium quality thermal coal by international standards, with excellent combustion characteristics.

KPC employs 2100 people, including 125 expatriates. Significant effort is being put into organization structure, recruitment, training and multi skilling as well as a continuous improvement program covering all aspects of the project. In all its activities, KPC recognizes its responsibilities to its employees, the community, the Government and the environment.

KPC's marketing objectives are to establish a secure and diverse revenue base, and to obtain and give full value for its products. Currently, KPC has 30 customers worldwide, with 85% of sales going to major power utilities and 15% to steel mills which use Prima as a PCI coal. The majority of KPC's output is secured under long term sales contracts. About 20% of coal exports is sold in Europe, including the Mediterranean, with the remainder split between Japan (25%), Taiwan (25%), Hong Kong (20%) other Asian markets (5%) and North America (5%).

Production and shipments were 8.7 million tonnes in 1993, comprising 6.4 million tonnes of Prima coal and 2.3 million tonnes of Pinang. In terms of coal mined and overburden removed, KPC has become one of the largest export coal mines in the world.

1993 was a year of consolidation for KPC, with efforts concentrated on continuously improving the performance of all aspects of the operation and strengthening relationships with KPC's customers and suppliers. Significant progress has been made in these respects despite depressed conditions in the international coal market.

KPC aims to increase output to around 9.5 mt in 1994 through further productivity improvements and will be focussing even more closely on a safe and healthy working environment.

KPC
COAL FROM INDONESIA

QUALITY

	PRIMA COAL	PINANG COAL
Total Moisture %	9.0	13.0
Proximate Analysis (ADB)		
Moisture %	5.0	8.0
Ash %	4.0	5.0
Volatiles %	39.0	39.0
Fixed Carbon %	52.0	48.0
Calorific Value Kcal/Kg		
Gross as Received	6800	6200
Gross Air Dried	7100	6550
Net as Received	6500	5900
Hardgrove Grindability Index	50	46
Sulphur	0.5	0.4
Chlorine	< 0.01	< 0.01
Phosphorus	< 0.004	< 0.004
Ultimate Analysis (daf)		
Carbon	80.5	78.5
Hydrogen	5.4	5.2
Nitrogen	1.5	1.5
Sulphur	0.5	0.4
Oxygen (by diff)	12.1	14.4
Ash Fusion Temperature °C (Reducing Atmosphere)		
Deformation	1200	1200
Spherical	1300	1275
Hemisphere	1350	1350
Flow	1450	1400
(Oxidizing Atmosphere)		
Deformation	1250	1250
Spherical	1400	1350
Hemisphere	1450	1400
Flow	1500	1450
Ash Analysis %		
SiO_2	52.0	51.0
Al_2O_3	25.0	25.0
Fe_2O_3	12.6	10.0
CaO	2.2	3.5
MgO	2.2	2.8
TiO_2	1.0	2.5
Na_2O	1.0	1.0
K_2O	1.8	1.0
Mn_3O_4	0.1	0.1
P_2O_5	0.5	0.5
SO_3 and others	1.6	2.6

DUIKER EXPLORATION LIMITED

Our ref: C:\Tenders/AR/0547L/95/gea

Your ref:

Incorporated in the Republic of South Africa
Reg No 85/01401/07

First Floor, 19 Girton Road
Parktown, 2193, Johannesburg
Republic of South Africa

P O Box 1146, Johannesburg, 2000
Republic of South Africa

International Code (+27)
Telephone: (011) 642-7691
Facsimile: (011) 484-2882
Teletex: 450201
Telegrams "Lonrho"

19 July 1995

Gujarat Power Corporation Ltd.
5th Floor, Center point
Panchvati, Ellisbridge
Ahmedabad, 380-006
INDIA

ATTENTION: Mr S K Sekhon
Managing Director

Fax No.: 0991 79 447406

Dear Sir

SUBJECT: **PROPOSAL FOR BITUMINOUS STEAM COAL SUPPLY TO THE GUJARAT POWER CORPORATION LTD**

Thank you for your invitation dated 4 July 1995, to submit a schematic proposal for the supply of bituminous steam coal to the Gujarat Power Corporation Ltd.

We take pleasure in enclosing our proposal together with information on two of our five mines and our current annual report with a detailed brochure on the Richards Bay Coal Terminal (RBCT), a company in which we are a shareholder.

Should there be any details requiring further clarification, please do not hesitate to contact us at your convenience.

Yours sincerely

R I DU PREEZ
MARKETING DIRECTOR

Enclosures ... /

Directors T A Wilkinson (Chairman), E H J Stoyell (Managing Director), (Alternate G D Bartholomew), C J Davies*, J T M de Villiers, R I du Preez (Marketing), D C Harris, I M Hossy, R A Lee*, D C Reeves, W Roux, M Taback, R J Wagner, K P Wilkinson. *British.

GUJARAT POWER CORPORATION LTD

PROPOSAL - BITUMINOUS STEAM COAL
DUIKER EXPLORATION LIMITED

GROUP PROFILE AND COMPANY STRUCTURE

As per enclosed Annual Report for the year ended 30 September 1994.

DETAILS OF TWO PRODUCING COAL MINES

Mine Name / Brand	**SPITZKOP COLLIERY (PTY) LTD**
Mine location	**Ermelo - Transvaal**
General Manager	**P W Schnetler**
Tonnes mined (yr)	**2 400 000 MT**
Reserves (tonnes)	**46 691 000 MT**
Type of mine	**Underground, bord and pillar**
Type of coal mined	**Steam**
Preparation method	**Washed / Sized / PSS**
Export port(s)	(1) **Richards Bay**
	(2) **Durban**
Load rate (mt / day)	(1) **RBCT Scale *(as per enclosed brochure)***
	(2) **3 500 - 8 000**
Max cargo size (mt)	(1) **170 000**
	(2) **30 000 - 45 000**

Mine Name / Brand	**STRATHRAE COLLIERY**
Mine location	**Carolina - Transvaal**
Mine Manager	**J D Du Plessis**
Tonnes mined (yr)	**1 000 000 MT**
Reserves (tonnes)	**19 091 000 MT**
Type of mine	**Underground, bord and pillar**
Type of coal mined	**Steam**
Preparation method	**Washed / Sized / PSS**
Export port(s)	(1) **Richards Bay**
	(2) **Durban**
Load rate (mt / day)	(1) **RBCT Scale *(as per enclosed brochure)***
	(2) **3 500 - 8 000**
Max cargo size (mt)	(1) **170 000**
	(2) **30 000 - 45 000**

COAL QUALITY SPECIFICATION(S)

(See Specification Sheet - Duiker 60"S")

QUALITY CONTROL

1. At Production Point

Sampling:	By hand.
Analysis facilities:	Equipment to I.S.O. specifications.
Frequency of sampling:	
Plant -	hourly sample taken to make a daily composite for Proximates, Sulphur and Calorific Value.
Each train -	as loaded, sample taken for Proximates, Sulphur and Calorific Value.
Blending:	No blending at production point.

2. At final loading Port

Sampling:	Automatic sampler.
Analysis facilities:	Fully equipped laboratory to I.S.O. specifications.
Frequency of sampling:	SABS sample from each **10 000** tons loaded on vessel.
Blending:	If blending is carried out, it is by use of stacker / reclaimers onto and off the stockpiles.

QUANTITY OF COAL OFFERED FOR CONSIDERATION

500 000 metric tons per annum of our **Duiker 60 "S"** product ±10% at Seller's option. The volume contract can be negotiated for any period from 5 years to 30 years, with annual price negotiations.

METHOD OF DELIVERY

We would from an efficiency point of view, prefer to supply the coal on a CIF basis. Please would you therefore furnish discharge data, when these become available, as these are important to secure competitive freight rates.

We can load any vessel between **25 000** tons and **180 000** tons with a slight preference for **60 000** ton cargoes.

PRICE INDICATION

We do not have sufficient information to accurately estimate your future delivered costs, but for the coal indicated and for budget purposes in 1996, we estimate the following:

	US$ / ton
FOB (RBCT) cost of coal	**$38,00**
Freight in 60 000 cargo in vessel	**$12,00**
Freight in 35 000 cargo in vessel	**$16,50**

The above freight rates are for gearless vessels.
Escalation of the FOB price is likely to be at about ±3% per annum, for planning purposes.

VOYAGE TIME AND LOADING CAPACITY

Estimated voyage times are as follows:

Richards Bay to Gujarat	13 days	
Gujarat to Richards Bay	14 days	(allow for bad weather)

DUIKER EXPLORATION LIMITED

PRODUCT : DUIKER 60"S"
LOAD POINT : Richards Bay

TYPICAL ISO COAL QUALITY

TYPICAL	UNITS USED	AS RECEIVED	AIR DRIED	DRY BASIS	RANGE AIR DRIED
Gross Calorific Value	kCal/kg	6200	6600	6800	6500-6700
	MJ/kg	26.0	27.65	28.45	27.2-27.85
	Btu/lb	11180	11900	12250	11700-11900
Net Calorific Value	kCal/kg	6000			5950-6050
	MJ/kg	25.2			
	Btu/lb	10815			
PROXIMATE ANALYSIS					
Ash	%	13.0	13.5	14.0	13.0-14.0
Volatiles	%	25.0	26.0	27.0	25.5-26.5
Fixed Carbon (By Diff.)	%	52.4	55.4	57.6	54.0-56.0
Total Moisture	%	9.0			
Sulphur	%	0.95	1.0	1.05	0.85-1.05
Inherent Moisture	%		3.5		
ULTIMATE ANALYSIS					
Carbon, C	%		67.90	70.58	67.0-70.6
Nitrogen, N	%		1.73	1.80	1.70-1.85
Oxygen, O (Calc)	%		8.28	8.64	8.00-9.00
Hydrogen, H	%		4.14	4.30	4.10-4.40
Sulphur, S	%		0.85	0.88	0.80-0.90
Phosphorous (in coal)	%		0.063		
Chlorine (in coal)	%		0.005		
Fluorine (in coal)	PPM		<100		

TYPICAL SIZE GRADING		TYPICAL	RANGE
+40mm	%	Nil	
25.0 x 40.0 mm	%	1.60	
10.0 x 25.0 mm	%	24.0	
6.0 x 10.0 mm	%	10.0	
3.0 x 6.0 mm	%	10.0	
1.6 x 3.0 mm	%	14.0	
0.1 x 1.6 mm	%	24.7	
0 x 0.1mm	%	1.3	

ASH FUSION TEMPERATURE	TYPICAL	RANGE
Deformation (Reducing)	1250 °C	
Hemispherical (Reducing)	1270 °C	
Flow (Reducing)	1300 °C	
Deformation (Oxidising)	1300 °C	
Hemispherical (Oxidising)	1320 °C	
Flow (Oxidising)	1350 °C	
Grindability Index	46	46-50
Abrasiveness Index mg/kg	18.5	18-19
Swelling Index	1	

TYPICAL ASH CONSTITUENT ANALYSIS

CONSTITUENTS	% IN ASH	RANGE
SiO_2	48.47	46.7-50.25
Al_2O_3	28.50	27.8-29.21
Fe_2O_3	5.13	4.38-5.89
P_2O_5	0.99	0.92-1.07
TiO_2	1.42	1.41-1.43
CaO_2	6.44	5.63-7.24
MgO	1.96	1.71-2.30
K_2O	0.49	0.45-0.52
Na_2O	0.40	0.38-0.42
SO_3	5.14	4.40-5.87
LOI at 1000°C	0.90	

TYPICAL MACERAL ANALYSIS

	%
Vitrinite	34.0
Exinite	5.0
Reactive Semi-Fusinite	16.7
Inertinite	60.9

ref: SPITZ/STRTH-60"S"
DATE JUL 1995(gea)

ANGLO AMERICAN CORPORATION OF SOUTH AFRICA LIMITED
AMCOAL

P.O. BOX 61587, MARSHALLTOWN, 2107
REPUBLIC OF SOUTH AFRICA
FAX (+ 27 11) 638-5428
TEL (+ 27 11) 638-9111
TELEX NO. 4-83732 SA
Registration No. 01/01469/06

PAGE 1 OF 2 DATE: 17 JULY 1995

TO	:	GUJARAT POWER CORPORATION LIMITED
FAX NO	:	0991-79-447406
FOR	:	MR S.K. SEKHON, MANAGING DIRECTOR

FROM	:	R.H. SCHMIDT
COPY	:	RSW

Dear Mr Sekhon,

<u>2000 MW COASTAL TPS IN GUJARAT</u>

We refer to your fax dated 4 July 1995 and our letter dated 15 April 1995, which was in response to your letter dated 5 February 1994, addressed to Mr J.W. Campbell.

Whilst it is important for any producer of coal to find a market for its product, we are currently in the position of having all our production committed for some time. We therefore have no hesitation in indicating our interest in supplying coal to your project, but we cannot guarantee that we will have any coal available when you are ready to receive shipments. Below is a response to the questions posed in your fax, indicating our company's preferred way of conducting business:

1. Amcoal has substantial reserves of coal and will be in operation for a number of years. Typically we contract coal sales for periods of 3 to 5 years, with annual price negotiations. We have a few contracts spanning 10 year periods, but each of these provide for annual price negotiations.

We would appreciate it if you could advise us on your preferred pricing mechanism for such a long term contract and, if possible, provide details of any formula based pricing you might wish to employ.

In our previous correspondence we indicated that typically we contract for 0,5 to 1,0 million tons per annum to a customer.

2. As previously indicated, it is not company policy to discuss any prices with clients, until business is actually concluded. Currently the typical freight cost to India from Richards Bay ranges between US $12 - US $22 per metric ton (handy size vessels). Steam coal is currently being sold for about US $36,00 per metric ton FOB Richards Bay Coal Terminal.

3. The approximate voyage time from Richards Bay to Madras is 12 - 15 days.

4. As previously indicated, Richards Bay Coal Terminal allows for shipments ranging from ± 25000 metric tons to ± 190000 metric tons. We have no specific preference for shipment size, but there are obvious economies of scale advantages in using Cape size vessels.

We will mail a copy of our latest Annual Report to you.

Kind regards.

R.H. SCHMIDT
DIVISIONAL MARKETING MANAGER

AMCOAL / TCOA QUALITIES

		Bank LAC	Witbank LAC	Power Station Smalls (PSS)
ANALYSIS	Units	Typical	Typical	Typical
Calorific Value				
GAD	MJ/kg	30,5	31,0	27,0
GAD	kcal/kg	7300	7400	6450
GAR	kcal/kg	7000	7050	6100
NAR	kcal/kg	6700	6750	5950
Total moisture	%	7,0	7,0	8,5
Proximate Analysis				
Inherent moisture	%	2,9	2,5	2,5
Ash (ad)	%	7,0	7,0	15,5
Volatile matter (ISO)(ad)	%	28,0	32,0	23,0
Volatile matter (ASTM)(ad)	%	29,0	33,0	24,4
Volatile matter (ISO)(ar)	%	26,8	30,5	21,6
Volatile matter (ASTM)(ar)	%	27,8	31,5	22,9
Fixed Carbon (ad) (by diff)	%	62,1	58,5	59,0
Sulphur (ad)	%	0,5	0,65	0,6
Phosphorous in coal	%	0,12	0,1	0,12
Chlorine	%	< 0,01	< 0,01	< 0,01
Physical Properties				
Hardgrove Index (ASTM)	HGI	45	45	50
Abrasive Index	mgFe	55	65	60
Swelling Index	SI	1,0	2.5	
Fuel Ratio	FC/Vols	2,2	1,8	2.6
Size	mm	0 x 50	0 x 50	0 x 50
Ash Fusion Temperature				
(Reducing atmosphere)				
Deformation	°C	1370	1350	1300
Hemispherical	°C	+1400	+1400	+1400
Flow	°C	+1400	+1400	+1400
Ultimate Analysis (ad)				
Inherent moisture	%	2.9	2.5	2.5
Ash	%	7.0	7.0	15.5
Carbon	%	76.6	76.2	67.2
Hydrogen	%	4.3	4.8	3.7
Nitrogen	%	1.8	1.9	1.7
Sulphur	%	0.5	0.7	0.6
Oxygen	%	7,0	7,0	8.8
Ash Analysis				
SiO_2	%	41.6	39.0	45.5
Al_2O_3	%	32.7	33.0	31.8
Fe_2O_3	%	3.3	3.7	3.9
TiO_2	%	2.1	1.9	1.6
CaO	%	7.6	9.0	7.0
MgO	%	1.5	1.2	2.3
Na_2O	%	0.4	0.3	0.3
K_2O	%	0.8	0.7	0.7
P_2O_5	%	2.3	2.7	1.0
SO_3	%	5.5	5.5	5.7

FACSIMILE MESSAGE

DATE:	7 July 1995	FROM:	Ganesh Ramchandani
TO:	Ms Suratantra K.Sekhon (m.a.)	OUR REF:	GR/mo/161/95
FAX :	005-9179-447406	YOUR REF:	
COMPANY:	Gujarat Power Corporation Ltd	NO. OF PAGES:	2 including this page
SUBJECT :	**COAL FOR 2000 MW TPS**		

Your fax dated 4th July 95.

Asia Pacific Resources is the appointed representative of Ingwe Coal Corpn.

Ingwe Coal is the merged company between Trans-Natal and Rand Mines.

Ingwe is the largest exporter of steam coal in the world, 23 million MT and production of 56,000 million MT. In addition, Ingwe also holds 42% shareholding in Richard Bay Coal Terminal, where 56 million MT of coal is exported.

APR have been in contact with other organisation like Reliance Power, Mangalore Power, Jindal Steel etc to meet approx. 15% of their needs of imported coal.

Ingwe have interest to enter into longterm contract for supply of coal, it will be too early to commit what percentage could be made available for GPC.

APR is proposing along with Ingwe to build our own port in Saurashtra to manage upto 2.5 million MT of imported coal, however with additional investment additional 1.5 million MT could be accomodated.

Our Coal Terminal is likely to be operational by 3rd qtr. 1997 if all goes well, ship capacity is 70,000M/T and unloading rate of 20,000M/T PWWD.

Asia-Pacific Resources Pte Ltd

78 SHENTON WAY, #03-01, SINGAPORE 0207 TEL: 2233133 FAX: 2242100 TLX: RS 22118

ASIA PACIFIC RESOURCES PTE LTD. 016 16:03 65 2242100

(2)

The Coal currently produced by Ingwe Coal is with following specification %.

	I	II	III	IV
Calofific Value	6720	6690	6690	6720
Ash	13	14.2	14.1	14.1
T.Mositure	8	8	8.2	8.2
Inherent	3	2.5	2.5	2.5
Sulphur	0.6	0.35	0.55	0.9
Volatiles	27	24	24.5	25
Size	0 - 50			
AFT	1340			
Defo	1390	1400	1330	1298
Hemi	1400	1400	1360	1336
Flow	1400	1400	1400	1376

Current FOB rate is US$34.00 PMT.

I am in Bombay from 11-14 July 95. If convenient a trip could be made to Ahemdabad on 13.7.95 on my way to Baroda.

We await for your kind reply.

Thanks and regards,

Ganesh T.Ramchandani
Vice President

ASIA PACIFIC RESOURCES PTE LTD. 016 P03 '95-07-07 16:04 65 2245100

Date : 26 July 1995

Attn : Mrs Swatantra Sekhon, Managing Director

Company : Gujarat Power Corpn.

Fax : 001-9179-447406

Re : <u>2000MW TPS</u>

2 pages.

As per our fax dated 7/7/95 I did make a visit to Baroda but Mr Talauliker was not available.

I have a proposal which you could consider.

We undertake to build the necessary Jetty fscilities to receive your entire requirement approximately vessel of 50 - 60,000M/T coal.

You sign a irrevocable contract for 20 years, where price formulae can be worked out, your contract must have guarantees to protect us.

We will organise to assure you coal upto 1.5 - 2 million M/T per annum. Source will be South African and Indonesian coal. In addition, we can work out procument plan with coal India to receive some tonnage from Vizag by sea. In fact, I'm already in contact with CIL.

We can setup blending facilities to match your needs.

As for imported coal all payment must be strictly by L/C.

I shall be happy to meet you for preliminery discussion.

Encl. is a fax on some investment commitment for Vietnam.

As you are aware, we are proposing a Joint Investment with Ingwe and Chowgule group to build a dedicated coal Jetty in Saurashtra, South Gujarat.

If your project is serious, then you need reliable associate for a successful venture.

We look forward to hearing from you.

Thanks & regards,

Ganesh T Ramchandani, [illegible]

Annexure - 3.6
Sheet 1 of 2

Comparative Study of Coal Supply from Overseas Sources

(for 2 x 500 MW Coast Based Thermal Power Station in Gujarat)

Sl. No.	Description	P.T. Bereau Coal, Indonesia	Coal & Allied Operations Pty.Limited, Australia	Liddel Coal Marketing Pty. Ltd., Australia	Bloomfield Collieries Pty. Ltd., Australia	Novacoal, Australia	Blair Athol Coal Pty. Ltd., Australia	P.T. Kaltim Prime Coal, Indonesia	Duiker Exploration Limited, South Africa	Amcoal, South Africa	Ingwe Coal Corporation, South Africa
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	Coal Quality :										
	• GCV (KCal/Kg)	6200		6850	6700	6950 & 7150	6500	7100	6200	6450	6720
	• Fixed Carbon (%)			50.5		51 53.5		52	52.4	59.0	49.3
	• Ash Content (%)			14		12 8.5		4	13.0	15.5	14.1
	• Sulphur (%)			0.6 (max.)		0.7 0.4		0.5	0.95	0.6	0.9
	• Volatile Matter (%)			38		34 34.5		39	25.0	23.0	25
	• Moisture (%)			25		12 8.5		5	9.0	2.5	8.2
2.	Type of supply contract offered	30 years contract possible	Long term supply contract (say 30 years) possible	Prefers to be one of a number of suppliers of coal	Can supply 50000 Tons p.a. for 60 years	500,000 to 1,00,000 Tons p.a. long term supply possible	500,000 Tons p.a. long term supply possible	Interested in long term supply contract	500,000 MT p.a. ±10%; 5 to 30 years supply contract	0.5 to 1.0 Million Tons p.a., 3 to 5 years contract with annual price negotiations	1.5 to 2 Million Tons p.a., long term supply contract
3.	Price		FOB US $35 to 37/Ton CFR US $46.5/Ton for 60000 Ton shipment	FOB US $34/Ton	FOB US $30/Ton	FOB US $37.70 & 38.80/Ton	FOB US $30/Ton	FOB US $37/Ton	FOB US $38/Ton	FOB US $36/Metric Ton	FOB US $34/Metric Ton

Annexure - 3.6
Sheet 2 of 2

Sl. No.	Description	P.T. Bereau Coal, Indonesia	Coal & Allied Operations Pty.Limited, Australia	Liddel Coal Marketing Pty. Ltd., Australia	Bloomfield Collieries Pty. Ltd., Australia	Novacoal, Australia	Blair Athol Coal Pty. Ltd., Australia	P.T. Kaltim Prime Coal, Indonesia	Duiker Exploration Limited, South Africa	Amcoal, South Africa	Ingwe Coal Corporation, South Africa
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
4.	Transportation mode and vessel details	Ship upto 200,000 DWT vessels can be used. 40000 Tons ship is optimum	Ship	Ship upto 140,000 DWT vessels can be used.	Ship From 35,000 to 120,000 DWT vessel can be loaded.	Ship, Vessels upto 150,000 DWT can be loaded.	Ship, Preferred vessel size 60,000 DWT	Ship, Vessels upto 180,000 DWT can be loaded.	Ship, 25,000 to 180,000 DWT vessels.	Ship, 25,000 to 190,000 DWT shipments	Ship, Capacity 70,000 DWT.
5.	Transportation Time (one way)	13 days	22 days	18 days	21 days	16 to 17 days	18 days	13 days	13 to 14 days	12 to 15 days to Madras .	12 to 15 days
6.	Cost of Transportation		US $ 11.50/ Ton for 60,000 Ton shipment and US $14/Ton for 40,000 Ton shipment	US $13/Ton for 60,000 Ton vessel, US $18/Ton for 35,000 Ton vessel	No C&F sales	US $9.50 to 10/Ton for Panamax (65,000 DWT) AND us $14 TO 14.50/Ton for handy size (39,000 DWT) vessels.	US $14/Ton in panamax vessels	US $9/Ton for 35,000 DWT US $6.50/ Ton for 60,000 DWT and US $5/Ton for 100,000 DWT + vessels.	US $12/Ton for 60,000 Ton and US $16.50/Ton for 35,000 Ton cargo.	US $12 to US $22/Metric Ton	US $12/Te

SECTION – 4

SITE FEATURES

SECTION - 4

SITE FEATURES

4.1 Site Selection

The basic requirements for the proposed thermal power station have been discussed in great depth in the Section-3 of this Project Report. Based on the basic requirements and the desirable site features several alternative locations were identified and analysed for the proposed thermal power station on the Coast of Saurashtra and Kutch.

A report was earlier prepared on site selection for coal unloading jetty and the proposed 1000 MW thermal power station on the Saurashtra/Kutch Coast in Gujarat. Out of three alternative sites identified one site was identified near Mundra on Kutch Coast, the other two sites were identified on Saurashtra Coast namely Veraval and Pipavav. A detailed discussion on alternate sites was given in the Site Selection Report submitted earlier. The location of these sites are given in **Plate No.4.1**. The comparison of salient features of alternative sites are given in **Table-4.1**. Also, the comparison of indicative cost for alternative sites is given in **Table-4.2**.

4.2 Plant Site

The site location map of the techno-economically selected site near Pipavav as recommended in the Site Selection Report has been shown in **Plate No.4.2**.

The site is located near Pipavav in Amreli District at latitude 20° 54′ north and longitude 71° 26′ east. The site is surrounded by villages Kovya, Bhaktodar to the east, Vand and

Mitiwala to the west and Tulsapur to the north. Nearby towns are Jafarabad and Rajula at a distance of 10 Kms and 18 Kms respectively.

4.3 Water Source and Availability

There is some sweet ground water available in this area round the year. But, the yield from this ground water source is very limited to cater the sweet water requirement of the proposed power plant. Hence the plant sweet water requirement would have to be met from the Desalination Plant to be constructed within the power plant.

Indirect closed cycle cooling system using cooling towers would be adopted considering the site features with respect to the proposed intake location. The location of the sea water intake has been considered at a distance of 3.5 Kms from the plant site with a gravity head of 22 metres.

4.4 Fuel Transportation

The imported coal has been considered to be brought by ship. The unloading of the imported coal will be done at the Pipavav Port which is now under construction and owned by Gujarat Pipavav Port Limited (GPPL). It has already been indicated by GPPL that a dedicated berth will be made available at Pipavav Port for unloading imported coal brought on ship. The location of this unloading berth as indicated by GPPL has been shown in **Plate No.4.2**. This unloading berth is within 7 Kms from the power plant site. A cross country conveyor of 7 Kms length has been considered to deliver coal at the power plant site. The coal conveyors would be supported on a common bridge/access road between the site and unloading jetty. Out of the total length of 7 Kms access road to the jetty, 1.3 Kms stretch would be on the bay area to be supported on bridge and the remaining length of conveyor would be on land.

4.5 Accessibility

The Coastal Highway (CH-6) is running 23 Kms away from this proposed plant site. There is a diversion at Bherai from CH-6 to Jafarabad connected by State Highway (SH-34). The site is accessible from Hitiyala on this highway at a distance of 2.5 Kms. A new White Cement Plant is under construction in this area by Larsen & Toubro Limited (L&T).

4.6 Land

The land for the proposed TPS in this area is private land with scanty cultivation. Because of scanty rain in this region, only single crop is produced in the cultivated land. The land is a flat land at elevation of about 20 Metres above MSL. Recently, there is a steep rise in land price because of implementation of few projects in the vicinity namely, L&T Cement, Copper Wire Complex and Pipavav Port. There is a forest land in the vicinity which will be kept clear from the plant area and its auxiliaries.

4.7 Power Evacuation

Power will be evacuated by GEB through their 400 kV transmission system. The nearby 400 kV substations are at Jetpur and Amreli. The Amreli 400 kV substation is under construction and is at a distance of about 125 Kms from the proposed plant site.

Table - 4.1
Sheet 1 of 4

Comparison of Salient Features of Alternate Sites

Sl. No.	Description	Site - 1 Near Mundra	Site - 2 Near Veraval	Site - 3 Near Pipavav	Remarks, if any
1.	Location : Latitude Longitude	22° 48′ North 69° 39′ East	20° 49′ North 70° 33′ East	20° 54′ North 71° 26′ East	
	Toposheet Nos. & District	41F/9 Kutch	41L/9 Junagarh	41P/5 Amreli	
2.	Nearby Villages & Distance	MUNDRA - 10 Kms. JARPARA - 3 Kms. NAVINAL - 7 Kms. DHRAB - 4 Kms. KAPAYA NANA - 6 Kms.	PASNAWADA - 1 Km. VADODRA - 1 Km. YAWARI - 2 Kms. LODHWA - 2 Kms. MORASA - 2 Kms.	KOVYA - 1 Km. VAND - 1 Km. MITIYALA - 6 Kms. TULSAPUR - 6 Kms. BHAKTODAR - 0.5 Km	
3.	Nearest Town & Distance	BHUJ - 62 Kms. GANDHIDHAM - 82 Kms. KANDLA - 95 Kms.	VERAVAL - 27 Kms. JUNAGARH -112 Kms. RAJKOT -220 Kms.	BHAVNAGAR -131 Kms. JAFRABAD - 8.5 Kms RAJULA - 14 Kms.	
4.	Nearest Highways/Roads	NH-8A - 82 Kms. DISTRICT ROAD - 3 Kms.	NH-8B -144 Kms. SH-31 - 22 Kms. CH-6 - 13 Kms.	CH-6 - 23 Kms. NH-8A -293 Kms. SH-34 - 2.5 Kms	
	Access Road to Site	New Road - 3 Kms. Widening of District - 7 Kms.	New Road form District Road - 1 Km.	New Road - 3.5 Kms Widening of existing road SH-34 to CH-6 - 14 Kms	
	Equipment unloading point for imported items and distances	Kandla Port - 80 Kms.	Porbandar -230 Kms.	Pipavav Port - 40 Kms. (By road)	

Table - 4.1
Sheet 2 of 4

Sl. No.	Description	Site - 1 Near Mundra	Site - 2 Near Veraval	Site - 3 Near Pipavav	Remarks, if any
5.	Berthing Location for Imported Coal and Distance from Power Plant Site	New berth to be constructed at 5 Kms. south-east of Veraval on Arabian Sea 9 Kms	New berth tobe constructed at 16 Kms. south-east of Veraval on Arabian Sea 3 Kms	Pipavav port can provide dedicated berth for this project 7 Kms	
	Coal Conveyor Length to Site	9 Kms	4.8 Kms	7 Kms	
	Natural Water Depth	20 M below Chart datum	18 M below Chart Datum	9-10 M below Chart Datum	Capital dredging would be necessary at Pipavav. Effect on morphology due to capital dredging shall be ascertained by GPPL.
	Wind	Moderate	Moderate	Moderate	Wind and current are not expected to cause navigational, manoeuvring,, mooring or cargo handling difficulties.
	Current	Moderate	Moderate	Moderate	
	Tidal Variation	High	Moderate	Moderate	Adjustment in mooring rope tension would be necessary at Mundra on account of high tidal variation
	Wave Climate	Moderate	Unfavourable	Moderate	At Veraval adequate break-water has to be constructed to ensure tranquility inside the harbour

Table - 4.1
Sheet 3 of 4

Sl. No.	Description	Site - 1 Near Mundra	Site - 2 Near Veraval	Site - 3 Near Pipavav	Remarks, if any
6.	Land Use, Ownership Restrictions, if any	Private Land - Partly barren with marginal cultivation and partly open scrub	Private Land - Marginally cultivated dependent on scanty rainfall	Private Land - Marginally cultivated dependent on scanty rainfall	Information obtained from Dy. Conservator of Forests, Land Revenue Office etc.
	Price of Land per Hectare	Rs. 1.25 Lakh	Rs. 1.50 Lakh	Rs. 2.5 Lakh	
7.	Average Ground Level (MSL)	Undulated land - 5-8 M above MSL	Flat land with mild slope towards sea 4-6 M above MSL	Gently sloping land - 20 M above MSL	Information from toposheets and visual inspection of sites
8.	Highest Sea Water Level	2M above MSL	1 M above MSL	2 M above MSL	
9.	Cooling Water System	Indirect cooling with sea water suing cooling towers	Sea water direct circulation using once through cooling system	Indirect cooling with sea water using cooling towers	Condenser cooling system chosen as applicable to sites
10.	Nearest Intake Location	Near the proposed berth location on Gulf of Kutch	1.5 Kms east of the proposed berth location on Arabian sea	8 Kms west of Pipavav port location on Arabian Sea	
	Route Length of Pipeline/Duct	9 Kms	3 Kms	3.5 Kms	
	Gravity head between intake and plant site	8 M	6 Kms	22 M	

Table - 4.1
Sheet 4 of 4

Sl. No.	Description	Site - 1 Near Mundra	Site - 2 Near Veraval	Site - 3 Near Pipavav	Remarks, if any
11.	Location of Hot Water Outfall	Not Applicable	5 Kms south-east of the proposed port on Arabian sea	Not Applicable	
	Route Length of Hot Channel	Not Applicable	8.5 Kms	Not Applicable	
12.	Sweet Water Source	Desalination plant within power plant premises	Desalination plant within power plant premises	Desalination plant within power plant premises	
13.	Source of Imported Coal	South Africa Indenesia Australia	South Africa Indonesia Australia	South Africa Indonesia Australia	
14.	Nearest 400 kV EHV Sub-station	LIMBDI 400 kV S/S (Proposed)	Jetpur 400 kV S/S (Proposed)	Jetpur 400 kV/ S/S (Proposed)	
15.	Distance of GEB EHV (400 kV) Sub-station	225 Kms	100 Kms	125 Kms	
16.	Transmission Lines envisaged at 400 kV Voltage	2 Double Circuit	2 Double Circuit	2 Double Circuit	
17.	Forest Boundary in Vicinity and Distance :				
	Reserve Forest	Jetpur R.F - 2 Kms	Lodhwa R.F. - 1 Km Dhamrej R.F. - 1 Km	Kovya R.F. - 3 Kms	Information obtained from Dy. Conservator of Forests
	Protected Forest Scrub Land	P.F. - NIL S.L. - 0.5 Km	P. F. - Nil S.L. Nil	P.F. - Nil S.L. - Nil	

Table - 4.2
Sheet 1 of 3

Comparison of Indicative Cost for Alternate Sites

(All Figures are in Rs. Crores)

Sl. No.	Description	Site - 1 Near Mundra	Site - 2 Near Veraval	Site - 3 Near Pipavav	Remarks, if any
1.	Harbour : a) Capital Dredging in Harbour Development	Not Applicable	Not Applicable	Assumed to be covered by Gujarat Pipavav Port Limited (GPPL) under port constn	Not asked for by GPPL
	b) Breakwater	Not required due to available condition	250.00	Not required	As indicated by GPPL
	c) Unloading Berth with Equipment	Same	Same	Same	
	d) Approach to Berth from shore	8 Kms long conveyor, road and pipelines 100.00	1.4 Kms long for connveyor (Road on Breakwater) 14.00	1.7 Kms long for conveyor and road 17.00	
	e) Capitalised Cost of Maintenance Dredging	Not Applicable	Not Applicable	5.00*	* Rs.90 Lakhs / year as indicated by GPPL
	f) Capitalised Cost of Break-water maintenance	Not Applicable	16.00	Not applicable	
	g) Cost of Investigation	0.05	0.05	Covered in GPPl's Port development cost. Nil	Not asked for by GPPL
	h) Port Charges	Same	Same	Same	
	i) **Sub-Total**	100.05	**280.05**	**22.00**	

Table - 4.2
Sheet 2 of 3

(All Figures are in Rs. Crores)

Sl. No.	Description	Site - 1 Near Mundra		Site - 2 Near Veraval		Site - 3 Near Pipavav		Remarks, if any
2.	Cost of Cross country Conveyor from Port to Power Plant, twin conveyor @ 1500 T/hr. @ Rs.6.0 Crore/Km	9.3 Kms	55.80	4.8 Kms.	28.80	7.3 Kms	43.80	
3A.	<u>**Indirect Condenser Cooling System**</u>			Not Applicable				
a.	Offshore Well	Well & P.H.	30.00			1 No. Well	2.00	
b.	Offshore Ducts	2 Nos.1500 dia. 9 Kms. long incl. onshore ducts	58.00			2 Nos. 1500 Dia. 500 M long	10.00	
c.	Make-up Water Pump House onshore		Nil			Civil Cost	5.00	
d.	Make-up Water Pumps with electricals	4 Nos.	1.30			4 Nos.	1.30	
e.	Onshore ducts	Included in (B)				3 Nos. 1500 dia. 3 Kms. long	19.50	
f.	Cooling Towers	2 Nos. Natural Draft	53.60			2 Nos. Natural Draft	53.60	
g.	Sub-Total		143.40	Not Applicable			91.40	

Table - 4.2
Sheet 3 of 3

(All Figures are in Rs. Crores)

Sl. No.	Description	Site - 1 Near Mundra		Site - 2 Near Veraval		Site - 3 Near Pipavav		Remarks, if any
3B.	**Direct Cooling System :**	Not Applicable				Not Applicable		
a.	Offshore Intake Well			2 Nos.	4.00			
b.	Offshore Ducts			4 Nos. 3500 dia. 1 Km long	54.00			
c.	Onshore Pump House			Civil Cost	15.00			
d.	Onsore Ducts			2 Nos. 3500 dia. 2 Kms long	20.00			
e.	Discharge Channel			8.5 Kms. long	7.00			
f.	Annualised Capital Cost due to additional power generation of 5 MW for lower cooling water temperature				(-)33.00			
g.	**Sub-Total**	Not Applicable			67.00	Not Applicable		
4A.	Cost of Road Access to Power Plant @ Rs.0.20 Crore/Km	3 Kms. Modification 7 Kms	0.60 0.70	1 Km	0.20	3.5 Kms. Modification 14 Kms	0.80 1.40	
4B.	Cost of Road Access to Berth @ Rs.0.20 Crore/Km	1 Km	0.20	2 Kms	0.40	5 Kms.	1.00	
5.	Cost of land Acquisition (Total-480 Ha.)	@ Rs.1.25 Lakh/Ha.	6.00	@ Rs.1.5 Lakh/Ha.	7.20	@ Rs.2.5 Lakh/Ha.	12.00	
6.	**Sub-Total of Item 1 to 5**		306.45		383.65		172.40	
7.	Cost of 400 kV Double Circuit Tramission Line (2 D/C lines) upto sub-station @ Rs.2 Crore/Km	225 Kms. at Limbdi Substation	450.00	100 Kms at Jetpur substation	200.00	125 Kms. at Jetpur substation	250.00	
8.	**Total Including Item 7**		756.45		583.65		422.40	

जलवायु सारणी
CLIMATOLOGICAL TABLE

TABLE 4.3
SHEET 1 OF 2

स्टेशन : वेरावल
STATION : Veraval

अक्षांश
LAT. 20° 54′ N.

देशांतर
LONG. 70° 22′ E.

समुद्री तल माध्य से ऊंचाई मीटर
HEIGHT ABOVE M. S. L. 8 METRES.

1931 से 1960 तक के प्रेक्षणों पर आधारित
BASED ON OBSERVATIONS FROM 1931 TO 1960

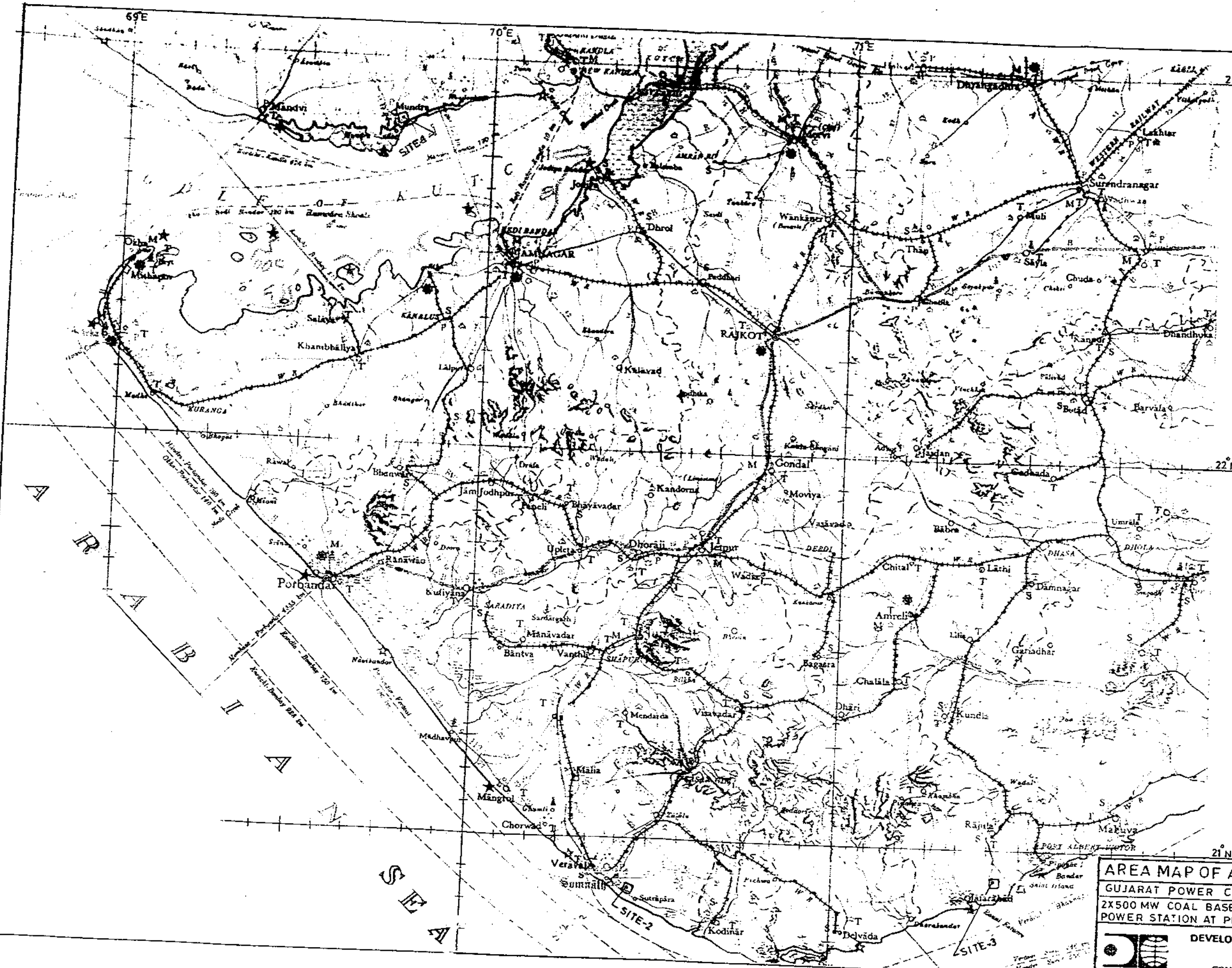
माह MONTH	स्टेशन की सतह दाब STATION LEVEL PRESSURE	वायु-तापमान AIR TEMPERATURE										आर्द्रता HUMIDITY		मेघ की मात्रा CLOUD AMOUNT		वर्षा RAINFALL						माध्य पवन गति MEAN WIND SPEED
		(—के) माध्य MEAN (OF)						चरम EXTREMES														
		शुष्क बल्व DRY BULB	नम बल्व WET BULB	दैनिक अधिक-तम DAILY MAX.	दैनिक न्यून-तम DAILY MIN.	माह में उच्चतम HIGHEST IN THE MONTH	माह में निम्नतम LOWEST IN THE MONTH	उच्चतम HIGHEST	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST	दिनांक और वर्ष DATE AND YEAR	सापेक्ष आर्द्रता RELATIVE HUMIDITY	बाष्प दाब VAPOUR PRESSURE	समस्त मेघ ALL CLOUDS	निम्न मेघ LOW CLOUDS	मासिक योग MONTHLY TOTAL	वर्ष के दिनों की संख्या No. OF RAINY DAYS	वर्ष सहित सबसे नम महिने का योग TOTAL IN WETTEST MONTH WITH YEAR	वर्षा सहित शुष्कतम महिने का योग TOTAL IN DRIEST MONTH WITH YEAR	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष DATE AND YEAR	
	मि० mb.	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C		डि.सें. °C		प्रतिशत %	मि.बा. mb	आकाश के अष्टमांश Oktas of sky		मि०मी० mm		मि०मी० mm	मि०मी० mm.	मि०मी० mm.		कि० मी० प्र० घं० Km. p.h
जनवरी I	1014.6	17.9	12.1	28.6	14.3	32.5	9.7	34.4	13 1933	4.4	24 1905	49	9.9	1.2	0.3	0.7	0.1	14.2 1945	0	12.9	30 1926	12.3
JANUARY I	1011.7	25.0	19.8									59	18.6	1.1	0.2							
फरवरी I	1013.7	19.1	13.8	29.2	15.4	34.7	11.1	38.3	28 1953	4.4	8 1893	56	12.1	1.1	0.2	1.3	0.2	19.1 1923	0	16.8	22 1923	13.2
FEBRUARY II	1010.4	25.2	21.0									68	21.3	0.9	0.1							
मार्च I	1011.9	22.8	17.6	31.1	18.4	38.3	14.0	42.8	26 1945	9.4	4 1892	63	17.0	1.2	0.4	0.2	0	21.6 1911	0	19.1	11 1911	14.9
MARCH II	1008.5	26.6	23.1									73	25.4	0.9	0.2							
अप्रैल I	1009.7	26.4	22.2	31.5	22.0	39.1	18.0	42.8	24 1954	13.9	1 1903	72	23.8	1.7	1.0	4.6	0.1	137.9 1947	0	124.7	17 1947	16.6
APRIL II	1006.5	28.0	25.2									78	29.6	1.1	0.5							
मई I	1006.7	28.6	25.9	31.1	25.9	35.0	22.6	44.2	21 1959	18.9	7 1909	82	31.4	3.0	2.4	5.3	0.2	180.6 1917	0	123.2	31 1917	17.3
MAY II	1003.9	29.3	27.1									82	33.8	1.9	1.3							
जून I	1002.5	29.7	27.1	31.3	27.6	33.3	24.8	37.2	9 1954	20.0	13 1951	83	33.9	4.8	2.9	135.3	4.2	505.5 1940	0.3 1923	221.0	28 1940	22.5
JUNE II	1000.2	29.8	27.7									84	35.3	4.4	2.6							
जुलाई I	1001.5	28.1	26.3	29.5	26.2	31.5	24.1	33.9	8 1902	21.1	12 1892	88	32.9	7.0	3.7	304.8	11.6	719.1 1954	10.2 1899	289.6	16 1945	28.6
JULY II	999.5	27.9	26.6									89	33.5	6.6	3.5							
अगस्त I	1003.6	27.2	25.6	28.8	25.5	30.7	23.8	33.3	31 1932	22.7	16 1960	89	31.6	7.0	3.9	145.8	7.8	696.0 1900	4.6 1941	270.0	2 1933	24.1
AUGUST II	1001.6	27.2	26.0									89	32.3	6.5	3.4							
सितम्बर I	1007.2	27.0	24.9	29.6	24.6	32.4	22.5	36.7	30 1955	20.6	30 1946	86	30.0	4.7	2.5	66.9	4.4	458.2 1926	0	277.4	16 1926	15.3
SEPTEMBER II	1004.5	27.7	25.8									84	31.4	4.0	1.8							
अक्तूबर I	1010.6	26.8	22.0	32.8	22.3	37.3	18.8	39.4	21 1941	13.3	30 1949	68	23.1	2.2	0.6	29.1	1.2	293.3 1959	0	173.7	25 1917	12.1
OCTOBER II	1007.3	29.1	25.7									75	29.9	2.4	0.9							
नवम्बर I	1013.1	24.3	17.6	32.9	18.8	36.2	15.1	37.8	3 1951	10.0	27 1950	51	15.2	1.5	0.2	7.3	0.3	142.2 1948	0	89.9	21 1896	10.3
NOVEMBER II	1009.9	28.3	23.5									65	24.6	1.5	0.3							
दिसम्बर I	1015.0	20.0	13.5	30.4	15.8	33.8	11.5	35.6	10 1953	7.2	25 1950	47	10.9	1.3	0.1	1.1	0.2	27.7 1902	0	25.7	12 1902	11.1
DECEMBER II	1011.7	26.3	21.0									60	20.2	1.2	0.2							
वार्षिक योग या माध्य I	1009.2	24.8	20.7	30.6	21.4	40.1	9.0	44.2		4.4		69	22.7	3.1	1.5	702.4	30.3	1327.2	69.1	289.6		16.5
ANNUAL TOTAL OR MEAN II	1006.3	27.5	24.4									75	28.0	2.7	1.3			1954	1901			
वर्षों की सं० I	30	30	30	30	30	30	30	70		70		30	30	30	20	30	30	70	70	70		30
NUMBER OF YEARS II	28	28	28									28	28	28	20							

स्टेशन : भावनगर हवाईअड्डा—क्रमशः
STATION : Bhaunagar Aerodrome—contd.

माह MONTH	मौसम परिघटना* WEATHER PHENOMENA* — के साथ दिनों की संख्या No. OF DAYS WITH						पवन WIND — पवन की गति के साथ दिनों की संख्या (कि० मी० प्र० घं०) No. OF DAYS WITH WIND SPEED (Km. p. h.)				पवन की दिशा के दिनों की संख्या का प्रतिशत PERCENTAGE No. OF DAYS OF WIND FROM									मेघ CLOUD — मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या अष्टमांश No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS					निम्नस्तरी मेघ मात्रा सहित दिनों की संख्या अष्टमांश No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS						दृश्यता* VISIBILITY* — दृश्यता सहित दिनों की संख्या No. OF DAYS WITH VISIBILITY				
	वर्षण 0.3 मि०मी० या अधिक PRECIPITATION 0·3 mm OR MORE	ओले HAIL	गर्जन THUNDER	कुहरा FOG	धूल० भरी आंधी DUST STORM	चंडवात SQUALL	62 या अधिक 62 OR MORE	20-61	1-19	0	उ N	उपू NE	पू E	दपू SE	द S	दप SW	प	उप NW	शांत CALM	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	कुहरा FOG 8	1 कि० मी० तक UP TO 1 km	1-4 कि० मी० 1-4 kms	4-10 कि० मी० 4-10 kms	10-20 कि० मी० 10-20 kms	20 कि०मी० से अधिक OVER 20 kms
जनवरी JANUARY I	0·3	0	0·1	0	0	0	0	0	24	7	10	2	1	0	1	11	33	20	22	19	5	5	2	0	25	4	1	1	0	0	0	0·1	0·4	2	28
II							0	1	29	1	11	35	29	9	3	2	2	5	4	18	6	5	2	0	24	4	2	1	0	0	0	0	0·7	13	18
फरवरी FABRUARY I	0·1	0	0·1	0·1	0	0	0	0	24	4	8	1	1	1	2	16	39	17	15	19	3	4	2	0	24	3	1	0	0	0	0	0·1	0·1	2	26
II							0	0	27	1	8	29	28	14	5	4	4	6	2	19	4	3	2	0	25	2	1	0	0	0	0	0	0·3	13	15
मार्च MARCH I	0·2	0	0·2	0	0	0	0	0	28	3	10	2	0	1	2	15	36	23	11	22	5	3	1	0	27	3	1	0	0	0	0	0	0·6	2	28
II							0	1	29	1	5	22	26	20	11	4	4	6	2	18	6	4	3	0	26	3	2	0	0	0	0	0	0·8	13	17
अप्रैल APRIL I	0·4	0	0·5	0	0·5	0	0	1	28	1	10	2	2	2	5	17	29	30	3	20	5	3	2	0	24	4	1	1	0	0	0	0	0·3	1·4	28
II							0	2	27	1	3	11	15	27	24	11	3	4	2	14	10	4	2	0	20	7	2	1	0	0	0	0	0·2	11	19
मई MAY I	0·6	0	0·9	0	0·8	0	0	0	31	0	3	0	0	1	7	30	42	16	1	16	5	6	4	0	21	5	4	1	0	0	0	0	0·2	2	29
II							0	7	24	0	2	3	4	14	34	25	12	6	0	11	12	7	1	0	17	10	4	0	0	0	0	0·1	1·0	13	17
जून JUNE I	7	0	4	0	0·4	0·1	0	1	29	0	1	1	0	1	8	39	41	7	2	4	5	8	9	4	9	8	11	2	0	0	0	0·3	2	8	20
II							0	8	22	0	1	1	1	9	29	39	16	4	0	1	7	10	9	3	7	9	11	3	0	0	0	0·1	2	15	13
जुलाई JULY I	15	0	2	0	0	0	0	1	30	0	1	0	0	1	5	45	43	4	1	1	2	4	12	12	4	4	14	9	0	0	0	0·6	6	11	13
II							0	6	25	0	0	1	1	4	14	42	33	4	1	0	1	5	12	13	2	3	14	11	1	0	0	0·6	5	18	8
अगस्त AUGUST I	12	0	1·5	0	0·1	0	0	0	30	1	1	0	0	1	8	42	40	6	2	1	1	5	13	11	5	3	16	7	0	0	0	0·7	4	12	14
II							0	3	27	1	1	1	1	6	15	40	31	4	1	0	1	5	13	12	2	4	16	8	1	0	0	0·4	4	18	9
सितम्बर SEPTEMBER I	9	0	1·9	0	0·1	0	0	0	29	1	2	0	0	1	3	31	44	16	3	3	5	7	10	5	9	7	11	3	0	0	0	0·2	2	7	21
II							0	0	29	1	2	3	4	18	19	26	19	6	3	0	5	9	12	4	4	7	13	5	1	0	0	0·1	2	15	13
अक्तूबर OCTOBER I	1·3	0	1·2	0	0·1	0	0	0	24	7	11	3	2	2	3	9	26	22	22	15	6	6	3	1	22	6	2	1	0	0	0	0·1	0·5	3	27
II							0	0	29	2	7	27	24	21	9	4	2	2	4	8	11	8	3	1	16	10	4	1	0	0	0	0	1·0	14	16
नवम्बर NOVEMBER I	0·5	0	0·3	0	0	0	0	0	22	8	12	4	2	2	1	6	24	19	30	16	6	5	2	1	24	4	1	1	0	0	0	0·3	1·1	2	26
II							0	0	28	2	10	42	24	11	2	0	0	1	10	16	7	4	2	1	23	4	2	1	0	0	0	0·1	1·7	12	16
दिसम्बर DECEMBER I	0·1	0	0	0	0	0	0	0	24	7	10	0	1	0	1	9	33	22	24	18	6	5	2	0	25	4	2	0	0	0	0	0·1	1·3	3	26
II							0	0	11	1	11	43	28	7	2	0	1	3	5	18	6	4	3	0	26	4	1	0	0	0	0	0	1·8	13	16
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN I	47	0	13	0·1	2	0·1	0	3	323	39	6	1	1	1	4	23	36	17	11	154	54	61	62	34	219	55	65	26	0	0	0	3	19	55	286
II							0	28	326	11	5	18	15	13	14	17	11	4	3	123	76	68	64	34	192	67	72	31	3	0	0	1·4	21	168	177
वर्षों की सं० NUMBER OF YEARS I	22						25				27									28					20						28				
II							21				23									23					20						23				

*2 या उससे अधिक दिनों की संख्या पूर्णांकों में दी गई है।
* No. OF DAYS 2 AND ABOVE ARE GIVEN IN WHOLE NUMBERS.

PLATE NO.



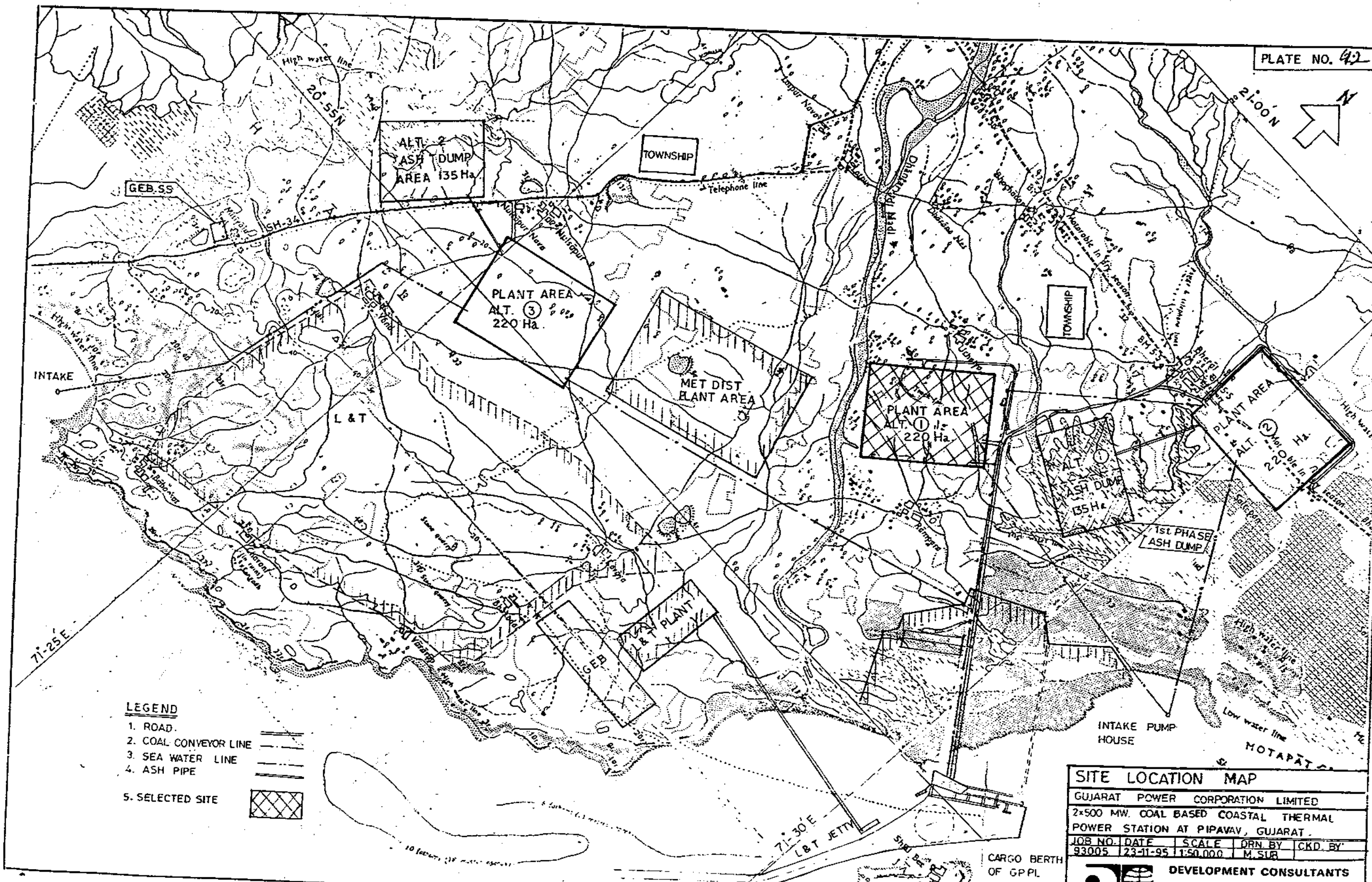
AREA MAP OF ALTERNATE SITES

GUJARAT POWER CORPORATION LIMITED

2X500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

PLATE NO. 42



SITE LOCATION MAP				
GUJARAT POWER CORPORATION LIMITED				
2×500 MW. COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.				
JOB NO. 93005	DATE 23-11-95	SCALE 1:50,000	DRN. BY M.SUB	CKD. BY

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 5

TECHNICAL FEATURES

SECTION - 5

TECHNICAL FEATURES

5.1 General

To achieve efficiency without sacrificing availability, it is considered to limit the choice of steam parameters within the sub-critical range. There is, as yet, no experience in the super-critical range in the power utility sector in India.

The steam parameters have been fixed at 179 $Kg/Cm^2(g)$, 540 °C in line with the established practice of most of the international manufacturers for the 500 MW range. Single reheat is envisaged in the turbine cycle in conformity with the prevailing practice in India and overseas for this range of units. The condenser vacuum i.e. heat sink level is considered to be 76 mm Hg absolute on consideration of circulating water inlet temperature of 33 °C.

For the proposed thermal power station coal will be imported from overseas sources in shiploads and would be unloaded in the port where berth would be specially developed for unloading coal for the proposed TPS. The details of the fuel quality, quantity and availability is mentioned under Section-3.

While deciding on the plant layout, advantages are taken of the existing infrastructure like nearest state highway, prevailing windrose, direction of water supply line and power evacuation. The plant has been laid out in such a way that construction work of later unit do not hamper operation and maintenance of the earlier commissioned unit. Judicious provisions have been kept for spare capacities in various systems and system components both in size and number for high availability of the plant.

A simplified process flow diagram of the proposed plant is shown in **Plate No.5.1.**

5.2 Plant Layout

The proposed power plant site, located 8.5 Kms east of Jafarabad town and 14 Kms south of Rajula town is disposed with the general direction of power evacuation corridor of the plant towards the west. With the switchyard located towards the west followed by the power house, the steam generator, the electrostatic precipitator and the coal stack - the arrangement eminently suits the prevailing wind direction. The plot located 4 Km away from the high water in the south is a waste land without substantial vegetation. Coal imported from overseas sources would be transported by twin-stream conveyors to the plant site and would enter the plant from the east. In absence of topographical survey of the plot, a conceptual layout has been prepared and presented in **Plate No.5.2.**

State Highway (SH-34) connecting Rajula town with Jafarabad is located on the west of the plot. The main access to the plot is considered from this highway covering a length of nearly 3 Kms. The same access road will also be used for the township. Since the plant would not have any railway connection, the access road should be double-lane of apporopriate classification.

Since no storage facility of coal is envisaged at the port end, the entire coal unloaded would be directly transported and stacked in the plant site. Sizing and provision of redundancy considered for the conveying system should be adequate to cater to usual contingency or disruption. The coal stack presently envisaged would be adequate to store four shiploads of coal which amounts to about 30 days' coal requirement for the plant. On confirmation of the source of coal supply, turn around time from source to the plant, seasonal variation in shipping time and other allied factors this aspect may be reviewed in the detail engineering stage.

The fuel oil for the station would also be transported by road. Oil storage and unloading arrangement have been located on the south of the plot. With road transportation of oil, thirty(30) days' fuel oil storage capacity in the plant is considered adequate.

The sea water intake for the station considered from the Gulf of Khambat is about 3 Kms away. The coast facing the open sea at some stretches is lined with limestone cliffs of various heights. In the sheltered coves, there are narrow sandy beaches backed by sand dunes. There are a few salt pans in this zone where sea water enters the landmass through creeks during high tides. A few minor water courses draining rainwater cross the plot of land earmarked for the site. Peripheral draining system would therefore, become necessary to divert these water courses. Raw sea water would be drawn through three RC submarine lines laid on sea bed from the intake structure located suitably at adequate depth and conveyed to the intake pump house forebay. The tidal levels at Pipavav Port are as follows :-

<u>Pipavav</u>

MHHW	-	3.19 M above chart datum
MLHW	-	2.37 M " " "
MHLW	-	1.16 M " " "
MLLW	-	0.50 M " " "
MSL	-	1.76 M " " "

Raw sea water would then be pumped and conveyed through a 1800 mm diameter M.S. buried pipeline to the project site. Adequate protection in the form of guniting the pipeline both inside and outside, galvanic protection etc. would be done. The pipeline would be routed suitably and a maintenance road would be provided alongside. Accordingly land for laying the intake pipe should be acquired. In view of proximity of water source, no in-plant raw water storage is envisaged. Natural draft cooling towers is proposed for the station with sea water as cooling medium and would be located in dust-free zone away from switchyard to safeguard against possible deterioration of steel materials/electrical hardwares by saline moist drift from the cooling tower.

The general plant layout is shown in the plot plan (**Plate No.5.2**) enclosed. The plot of land is predominantly flat with gentle slope towards south and south-east. The layout presently proposed is for two units of 500 MW capacity keeping open space towards the north-west for future expansion. A proven layout with the transmission switchyard in front of the power house block and the boiler, the electrostatic precipitators (ESP), the chimney and the coal handling plant at the rear has been suggested. Space for flue gas desulphurization has also been provided as per the guidelines of statutory authorities.

The cooling circuit envisaged for the station is semi-open recirculating water system using wet type, natural draft cooling towers. Clarified sea water would be used as cooling medium. Each condenser would be connected to a cooling tower of appropriate capacity and cooling range. This system has been considered in view of restriction on temperature of discharge water from the plant by the Department of Environment, Govt. of India, elevation difference of the site from raw water intake and cost of water conveyance to site. The plant water system comprising sea water clariflocculation plant, desalination plant, pump houses etc. are logically located between cooling tower and direction of intake.

The ash handling and disposal facilities will include hydrobins, settling tanks, ash water storage tanks, intermediate surge hoppers, dry ash bins, compressor house and other equipment of ash handling system with approach for truck disposal. The plot for ash disposal is located within 1 Km from the power station. The ash disposal area is segregated and fenced to avoid interference in plant operation by the movement of the fleet of trucks.

The 400 kV switchyard facing south-west of the plot is provided with clear corridor for evacuation.

With the main access to the plant cutting across the water facilities the layout would provide a good view from the administrative building. Adequate green belt encompassing the plot and vacant spaces have been shown in the plot plan.

5.3 Main Plant Equipment Layout

a. **Layout of Steam Generator** :

The general disposition of furnace, PA and FD fans, air preheaters etc., have been taken from boiler layout of standard manufacturers. The mills have been located between the ESP and the air-preheater, following the philosophy of boiler manufacturers in India for similar units. The flue ducts from the ESP have been connected to independent stacks. ESP control room has been located on one side of the ESP. Bottom ash hydrobins, settling tank, ash water storage tanks and pump house are located behind the chimneys with the ash water pumps located nearby and the waste water from process would be conveyed through pipes to this sump. Plan and cross section of the boiler, TG building and its auxiliaries are shown in **Plate Nos.5.3 and 5.4** respectively.

b. **Layout of Turbine Building** :

The Turbine Building comprises the turbine hall of 36 M span, followed by a bay of 10 M span. 3 M wide clear passages have been kept at ground floor all along the length of the turbine hall at 'C' row column line at ground floor interconnect the units for ease of movement. Cross passages have also been provided at convenient locations for ease of movement of men and material.

The reserve switchgears have been located in a 10 M wide bay within Turbine Hall at one side of each unit with 6.6 kV station reserve switchgears and 415 V switchgears at 8.5 metre level floor and control room, DAS room and Unit Control Room have been located at 17.0 metre level floor.

A 3 M clear through passage has been provided in the heater bay at ground level, between 'A' and 'C' row. Sufficient head clearance will be kept for entry of trucks in this passage.

Between the heater bay and the steam generator, the C-D bay houses the electrical and control facilities. Transformers, SWAS chillers and AC Plant have been located at the ground floor level. 11 kV, 6.6 kV and 415 V unit switchgears have been located on the mezzanine floor at 8.5 M level and control room with equipment for control, Data Acquisition System etc. have been placed on the operating floor.

The main equipment erection hatch has been placed at the end of the building with a railtrack under the turbine hall crane. The rail track is meant for handling the transformers. Subsidiary erection hatches have been provided for crane access to equipment located on ground and mezzanine floors. A maintenance bay with road access is provided between the units. HP turbine lay-down area has been provided between 1-1A columns of A-B row. Staircases have been provided for interconnection of all main floors. The main entrance to the power house is provided with passenger elevator.

Air compressors, condensate transfer pumps, boiler filling pumps and DG set have been located at ground floor level in the building annexed to the turbine hall. Unit condensate storage tanks are installed outdoor just beside the annexed building.

Battery, battery chargers, UPS have been installed in the power house building between A - Ao rows at 8.5 M level. Air washers have been provided at two locations, one in the annexed building at roof level and one within C-D bay of the turbine house upper floor.

5.4 Thermodynamic Cycle

Plate No.5.5 shows the single line flow diagram for steam and water for the proposed 500 MW unit. A sub-critical pressure reheat steam cycle with regenerative feed heating arrangement is proposed. A typical heat balance for such cycle based on the commonly used turbine inlet steam parameters of indigenously manufactured set has been presented in **Plate No.5.6.**

As shown in the scheme and the heat balance diagram, the Main Steam from the Boiler, after expansion through the HP Turbine, would be sent back to the boiler for reheating. The reheated steam, after expansion through the double flow IP and LP turbines respectively would be exhausted into the main condenser, where the exhaust steam from the LP turbine would be cooled and condensed by circulation of cooling water and its vacuum would be maintained by two(2) (1 working + 1 standby) 100% capacity vacuum pumps. The feed heating system would consist of three(3) stages of Low Pressure Heaters, one(1) Gland Steam Condenser, one(1) separate Drain Cooler for the Low Pressure Heater, one(1) Deaerator and two(2) 50% capacity parallel trains of High Pressure Heaters arranged in two stages (each train consists of two high pressure heaters in series). The condensate from the hotwell would be extracted by 3 x 50% capacity Condensate Extraction Pumps (2 working + 1 standby) and pumped to the deaerator through condensate polishing unit (when in use), gland steam condenser, Drain Cooler and the LP heaters. The feed water after being deaerated in the Deaerator would be drawn by the Boiler Feed Pumps and pumped to the respective boiler through the High Pressure Heaters. For normal operation two(2) 50% capacity steam turbine driven Boiler Feed Pumps have been envisaged for each unit. This will provide adequate flexibility in addition to increasing net power export from the unit. Besides the steam turbine driven BF Pumps, one(1) 50% capacity motor driven Boiler Feed Pump with variable speed hydraulic coupling will be provided for each unit, which would act as standby to the steam turbine driven Boiler Feed Pumps and will facilitate start-up from cold condition when sufficient auxiliary steam is not available for starting the turbine driven pumps. Feed water would be heated up in the Feed Water Heaters progressively by bled steam drawn from cold reheat line and extraction points of the turbine IP and LP cylinders. Condensate drain from the HP Heaters would be cascaded to the Deaerator feed storage tank and drain from the LP Heaters would be cascaded to the condenser through the Drain Cooler.

The auxiliary steam for the station will be drawn from the boiler from a suitable point and after pressure reduction and desuperheating would be used for various services. The auxiliary steam supply from both the units would be interconnected and this would supply steam to the deaerators, turbine driven Boiler Feed Pumps, turbine gland sealing system (during light load and start-up conditins), fuel oil heating and atomisation system etc. Provision for steam supply to auxiliary steam system from Cold Reheat piping through adequately sized Pressure Reducing and Desuperheating station will also be there. The 500 MW units would also be provided with adequately sized HP and LP Turbine bypass stations for quick hot start and boiler stability with large load rejections.

Salient features and basic parameters of major equipment of the 500 MW unit are indicated later in this section.

5.5 Main Plant and Equipment

Description of the major plant and equipment of a typical indigeneous unit is given hereunder. The detailed design of the unit will, however, vary to some extent depending on its manufacture. The basic parameters are only outlined below.

5.5.1 Turbine Generator Unit

The steam turbine would be standard multi-stage, multi-cylinder, tandem compound, single reheat, condensing type operating at 3000 RPM with six(6)/seven(7) uncontrolled extractions for regenerative feed heating. The turbine is designed for main steam inlet parameters of 170 kg/Cm^2 (a) at 537 °C before emergency stop valves of HP turbine and Reheat steam parameters of 40.5 Kg/Cm^2 (a) and 537 °C at inlet to IP turbine and exhausting against condenser pressure of 76 mm Hg abs. at design condenser cooling water temperature. A typical steam turbine of indigenous manufacturer has a barrel type HP cylinder, a horizontally split double-flow IP cylinder and horizontally split double flow LP cylinder exhausting directly into a spring mounted surface type, two-pass condenser having divided water box. There are six stages of uncontrolled steam extraction, for various HP and LP Feed Water/Condensate Heaters, down stream of the HP turbine exhausts. The Turbo-generator set would be designed for a maximum throttle steam flow of 105% of Turbine MCR flow at Turbine valve wide open (V.W.O) condition. Brief parameter of the turbine generator set is as follows :

Output at MCR	-	500 MW
Steam Inlet Condition :-		
Pressure	-	170 Kg/Cm^2(A)
Temperature	-	537 °C
Flow	-	1530 TPH (approx.)
Turbine Exhaust Conditions :-		
Condenser Pressure	-	76 mm Hg(A)
Exhaust Flow	-	1036 TPH (approx.)
CW Inlet Temperaute	-	33 °C (max.)
Turbine Type	-	3-cylinder, tandem compound, single reheat, condensing type with regenerative feed heating.
No. of Extractions	-	Six(6) (uncontrolled)
Generator	-	500 MW output at 0.85 pf (lagging) 3 pH, 50 Hz, generation at 21000 volts ± 5%.

A quick acting HP and LP Turbine bypass station would be provided as a part of Turbine package. The bypass station would act not only to stabilize boiler condition with sudden load dump/turbine trip out but also as a protection to the turbine during pressure rise resulting from sudden load throw off. In addition, it will enable quick start-up of the unit following a hot trip out by proper matching of boiler steam and turbine metal temperatures. This would reduce thermal shock and help repeated hot start of the unit. The bypass station would be sized for a flow corresponding to about 60% of Turbine MCR.

To prevent undue leakage of air/steam from the turbine rotor glands a fully automatic gland sealing system would be provided for the Turbine, which would have provision for receiving steam from auxiliary steam header or cold reheat steam header during start-up and low load operation. At higher load steam leakage from HP glands is fed to the LP glands so that requirement of external supply is minimum. As per the practice in 500 MW sets the turbo-generators would be equipped with highly sensitive electro-hydraulic governing system backed up by conventional hydro-mechanical system ensuring stable operation under any grid fluctuation and load throw off condition. The turbo-generator would be equipped with an electric motor driven or oil turbine driven rotor turning gear for uniform heating/cooling of the machine at starting/after shut down. The turbo-generator unit would be provided with self-contained lubricating oil system for supplying oil to the Turbine and the Generator bearings and also to the Generator Seal Oil system. The lubricating oil would be cooled by closed circuit cooling water system utilising demineralised water as cooling media. The TG set will be provided with independent non-inflamable control fluid system for hydraulic/electro-hydraulic governing of the TG set through separate fluid tank, 2 x 100% duty motor driven pumps and separate piping system.

The generator would be directly coupled to the steam turbine and would have a nominal rating of 500 MW at 0.85 power factor. The generator would deliver power at 21000 volts (±) 5%, the commonly used voltage for such capacity, 3 phase, 50 Hz.

The generator stator winding would be directly cooled by circulation of DM water thru' hollow conductors and Stator Core and Rotor by circulation of Hydrogen gas filling the air space. The DM water, Hydrogen gas and also Sealing Oil, supplied to Generator shaft seals to prevent Hydrogen gas leakage, would in turn be cooled by closed cooling water system utilising demineralised water as cooling media. The generator excitation system would be brushless type and capable of maintaining steady generator terminal voltage under variable load conditions and also ensure generator stability under transient conditions. The excitation system would be complete with automatic voltage regulator and all necessary metering and supervision equipment.

An Auto-Synchronisation System would be provided for each generator to enable quick and error-free synchronidation with the EHV grid. All necessary protective and supervisory system for turbine run-up, shut down and health of the turbine would be provided to ensure trouble-free, safe and efficient operation of the Turbo-generator. The general description of these protective and turbovisory equipment are outlined in foregoing sections.

5.5.2 Condensing Equipment

Twin double-pass surface condensers capable of maintaining the required vacuum while condensing steam at the maximum rating of the turbine would be provided. The condensers are proposed to be cooled in a semi-open circuit cooling circuit using cooling towers. The condenser arrangement would be such that on-load maintenance of one of the condensers at a time is possible by isolating the same from cooling water inlet and outlet sides. The condenser would be of divided water box design with rolled steel construction of body and water chamber with inside FRP lining. The condensers would be spring mounted type and the neck of the condenser would be welded directly to the LP Turbine exhaust at site. The condensers would be cooled by semi-open circuit cooling system using clarified sea water. As clarified sea water would be the cooling medium Titanium tubes, rolled steel tube sheet with Titanium overlay and titanium/equivalent material of construction for other components coming in contact with sea water as envisaged. Cathodic protection would be provided with Zn or Al sacrificial anode as necessary. This will provide an economic solution to sea water corrossion and will permit steam feed water, condensate cycle feed water to be maintained as desired for internal corrossion control. Intermittent shot chlorination would be adopted to restrict biological growth and consequent fouling of heat exchange surfaces. The condensers would be so designed as to accept full quantity of steam during Turbine HP and LP bypass operation without any undue vibration, thermal stress etc. Condenser axis would be at right angle to turbo-generator axis.

Three(3) vertical condensate pumps each of 50% capacity would be provided to pump condensate from condenser hotwell to deaerator through Drain Cooler, Condensate Polishing Unit (when in use), gland steam condenser and various low pressure heaters. Two(2) 100% capacity vacuum pumps will be provided to maintain the vacuum in the condenser by expelling the non-condensible gases. One vacuum pump would operate during normal plant operation and during start-up both the pumps may be operated such that the desired vacuum can be pulled within a short time.

5.5.3 Boiler Feed Pumps and Drives

Three(3) 50% capacity horizontal multi-stage, barrel casing centrifugal type feed pumps, would be provided for each unit. Two of the feed pumps would be steam turbine driven and normally be in operation while the third feed pump would be electric motor driven through a variable speed hydraulic coupling (with step-up gearing), which, would act as standby to the other feed pumps and also facilitate start-up of the unit. The steam turbine of the feed pumps would receive extraction steam from IP turbine exhaust during normal operation, steam from cold reheat piping at low load and from auxiliary steam header during light load and start-up condition. The exhaust steam from the BFP turbines will go to the main condenser of TG set. Each Turbine driven Boiler Feed Pump would have one(1) matching capacity single stage booster pump. The booster pump would take suction from deaerator and discharge into the suction of corresponding boiler feed pump which in turn, would supply feed water to Boiler through high pressure heaters and feed control station. During operation of the turbine-driven Boiler Feed Pumps, the differential pressure across the feed water regulating station would be regulated automatically by controlling the steam flow to the turbine and consequent variable speed operation of the drive turbine. For the motor driven Boiler Feed Pump variable speed hydraulic coupling provided between the Drive Motor and the main pump will perform the same function. Each feed pump would be provided with an automatic minimum recirculation flow control arrangement to protect the pump under low load operation.

Each turbine driven feed pump would be provided with self-contained forced oil system for supplying lubricating oil for the thrust and shaft bearings, couplings etc. in addition to supply of high pressure oil for the turbine governing system. An oil system integral with the variable speed hydraulic coupling of the motor driven feed pump will supply oil to the feed pump and motor shaft/thrust bearings in addition to serving the hydraulic coupling itself.

The lubricating oil and also gland sealing arrangement of the feed pumps would be cooled by closed cooling water system utilising demineralised water as cooling media. All necessary control, protective and supervisory system would be provided to ensure safe and trouble-free operation of the feed pumps.

5.5.4 Deaerating Heater and Closed Heaters

Each unit would be provided with a variable pressure type deaerating heater with a feed water storage tank of about six(6) minutes storage capacity. The deaerator would be spray or spray-cum-tray type and would be designed to deaerate all the incoming condensate and drain flow to keep the dissolved oxygen content of the feed water below the permissible limit (0.005 ppm). Vent condenser would be provided integral with deaerator to minimise wastage of steam.

The deaerator would normally operate with extraction steam from IP turbine. However, during light load operation and start-up, the deaerator would be pegged with steam drawn from auxiliary steam header. The deaerator would be placed at a suitable elevation to provide sufficient NPSH for the boiler feed pumps without restricting the drain flow from the next HP heater.

The high pressure closed heaters would have both drain cooling and desuperheating zones in addition to the normal condensing zone. The low pressure feed water heaters would be equipped with only drain cooling and condensing zones. The layout considers all horizontal heaters. All the low pressure heaters would be provided with individual bypass to allow isolation and maintenance. For the HP heaters, individual group bypass system, would be provided for each train to bypass the feed flow during emergency high level in HP heaters. The recommendations of ASME standard TDP-1-Part-I for preventing water damage to turbine would be followed.

5.5.5 Steam Generating Unit

The steam generators would be of semi-outdoor type, sub-critical pressure, natural/assisted circulation, reheat, balanced draft, single drum and dry bottom type units, designed for pulverized coal firing using coal from overseas sources as the principal fuel as mentioned in Section-3 of the report. Based on exact source of coal, the design parameters are to be frozen in detail engineering stage. The boiler should be designed for coal with gross calorific value of 6720 Kcal/kg with a variation of 15 to 20% and ash content of 13% ±20%. A single-pass tower type construction or a conventional two-pass design of the boiler may be suitably considered for these 500 MW units on the basis of techno-economic consideration in the detail engineering stage.

The basic parameters of Steam Generating Units are as follows :-

Type	-	Semi-outdoor, natural/controlled circulation pulverized fuel boiler.
Maximum evaporation	-	1700 Tons/hr.
Main steam pressure	-	179 Kg/Cm^2 (g)
Main steam/hot reheat temperature	-	540 °C / 540 °C

Capacity of steam generating units would be so selected as to ensure adequate margin over the requirement of Turbine at 100% MCR in order to cater (a) Auxiliary Steam requirement for soot blowing operation, Fuel Oil system heating and also for start-up of adjacent unit, (b) derating of the steam generating unit after prolonged use. The steam generator would be designed to operate with "the HP Heaters out of service" condition (resulting in lower feed water temperature at Economiser inlet) and deliver steam to meet the Turbo-generator requirement at 100% MCR. The steam generator would also be suitable for operation with HP-LP Turbine bypass system. Economiser section of the boiler would be non-steaming type with provision for recirculation during start-up, chemical cleaning etc. Superheater and Reheater sections would be convection and radiation type and designed so as to maintain rated steam temperature of 540 °C (± 5.5 °C) at superheater and reheater outlet over the control range of 60% to 100% MCR. Superheater and Reheater would be provided with desuperheating stations with provision for spraying water for temperature control. The desuperheating water would be supplied from the Feed Water Heater upstream of the feed control station. Two(2) Regenerative Air preheaters for primary air heating and two(2) regenerative air preheater for secondary air heating, each with duplicate electric motor drive and manual cranking facility for emergency would be provided. Each air preheater would be capable of meeting 60% Boiler MCR load. Steam Coil Air Preheaters (SCAPH) will be provided in each FD Fan discharge duct to maintain cold end temperature above acid dew point during boiler start-up and low load operating conditions. The boiler would be provided with a set of soot blowers, automatic sequential electrically operated type, arranged for on-load cleaning of the heat transfer surfaces e.g. waterwalls, superheaters, reheaters, economisers and air heaters. The boiler furnace and flue gas passages would be designed for appropriate low gas velocities in order to minimise erosion and slagging effect.

Suitable balanced draft system would be provided for the steam generator with two(2) Forced Draft and three(3) Induced Draft fans. Each of the FD fans would be capable of meeting the air requirement at 60% Boiler MCR load. The Forced Draft fans would be axial impulse type with inlet vane control arrangement or axial reaction type with hydraulic blade pitch control arangement for regulation purpose. The 60% capacity Induced Draft fans, two of which will be working and one standby, would be double suction radial type with speed control arrangement through variable speed hydraulic coupling and inlet vane control arrangement for regulation. The Forced Draft fans would control total air flow to boiler and the Induced Draft fans would control furnace draft of the boiler through automatic control loops.

Each steam generator unit would be equipped with suitable pulverized coal firing arrangement comprising crushed coal silos, volumetric or gravimetric raw coal feeders, pulverizing mills, primary air fans and seal air fans, fuel and air pipes, burners etc. as necessary.

Pulverizing of coal is normally associated with high abrasion of system components. This aspect is more relevant in view of uncertainty of coal source for the proposed station. Vertical pulverizing mills which, originally developed in United States, is the most commonly used equipment in utility power plants. They were efficient and perform reasonably well as long as coal quality is reasonably good. From the details of coal quality available, vertical mill is considered suitable for the proposed station. The mills should be suitable for accepting (-)50 mm size coal as fuel, since coal would be received from overseas sources in above sizes. However, the choice of type of mill is kept open and would be reviewed after the linkage is established. Number of pulverizers would be so selected as to have one pulverizer available as standby for maintenance, while the boiler is operated with worst coal at 100% MCR. While operating at 100% Boiler MCR with design coal, one pulverizer would remain standby and another would be available for maintenance. With standard size of mills available from renowned manufacturers, the total number of mills may be suitably chosen.

The mill bay being located between the boiler and ESP separate passenger-cum-goods elevators are envisaged to facilitate approach to the bunker level. The steam generating unit will be provided with a heavy fuel oil/LSHS pressurizing and heating units for supplying fuel oil/LSHS to the oil burners for hot start-up and for stabilization of combustion of pulverized coal. The HFO/LSHS system would be of capacity sufficient to meet minimum 15% of Boiler MCR load. Light oil system would also be provided for cold start-up and warming-up purposes. HFO/LDO facilities will be located near the ash handling plant as shown in the plot plan to utilise separate entry gate meant for ash disposal. A direct ignition pulverized coal (DIPC) fired boiler, eliminating/reducing the requirement of fuel oil may also be adopted in detail engineering stage, depending on the availability and suitability of such boilers. The drum level measurement, in addition to the Yarway Direct Level gauge glass, Bi-colour gauge glass, remote level indication and recording in-plant control room etc. would include Hydrastep water level gauge. The complete boiler would be top supported type and would be provided with all supporting steel platforms, galleries and stairways for easy approach and maintenance of the unit. One passenger-cum-goods elevator will also be provided for each boiler for access to the boiler platforms. Adequate weather protection would be provided for instruments and operating personnel. Necessary lining and insulation alongwith fixing materials to limit outside surface temperature to the safe level would be provided. Monorails and hoists required for handling pulverizers, motors, fans etc. would be supplied alongwith the steam generating unit.

5.5.6 Electrostatic Precipitators

The steam generating units will be provided with four sets of electrostatic precipitators. Each precipitator would have two parallel gas paths, any of which can be isolated for maintenance when required keeping the other path in operation. Each path will comprise seven fields in series for collection of Fly Ash, of which, six fields would be in service and the other one would remain as standby. The ESP would have an efficiency of around 99.9%. Each ESP would be provided with adequate number of ash hoppers having capacity suitable for storing ash collected in at least one(1) shift operation of the Boiler at 100% MCR. Ash handling plant design would ensure auto-sequential extraction of ash from these hoppers once in a shift and subsequent disposal in the silos/bins.

5.5.7 Chimney

For each 500 MW unit an individual concrete chimney is considered. A chimney height of 275 M (minimum) would be required to fulfil the latest requirement of Emission Regulation as specified by the "Central Board for the Prevention and Control of Water Pollution". This will, also satisfy the norms set by Department of Environment, Govt. of India limiting the permissible value on ground level concentration from the station.

5.5.8 Flue Gas Desulphurization System

From the available data on sulphur content in coal, no desulphurization plant is considered necessary. However, after the coal linkage for the proposed station is established this aspect would be re-evaluated and reviewed. The ground level concentration, on the basis of the tentative analysis furnished under Section-3 of the report, would be within the limiting values set by Department of Environment (DOE), Govt. of India.

In the present study, however, space provision has been kept for installing FGD as per the latest guideline of DOE for 500 MW set size.

5.5.9 Limits of NO_x Emission

To reduce the NO_x emission from the steam generator all provisions in the steam generator design and fuel firing system, will be made.

Maximum NO_x emission from the unit will not be more than 400 ppm of NO_x (equivalent NO_2) including thermal NO_x produced during the entire operating range of steam generator. Special provisions in the steam generator design to keep the NO_x emission within the specified limiting values will also be incorporated. Ground level concentration of these are same as those for SO_2 namely 120 micro gram/M^3 for industrial zone, 80 micro gram/M^3

for mixed (Industrial and Residential) zone and 30 micro gram/M^3 for sensitive zone based on annual average.

5.5.10 Noise Level

The Steam Generator and auxiliaries will perform continuously within noise limits as per relevant standard specification but not more than 85 dB at 1 metre from any equipment or sub-equipment.

5.6 Auxiliary Systems

5.6.1 Plant Water System

The region where the power plant has been proposed to be set-up is a region of water scarcity and devoid of any substantial sweet water source, either on surface or underground, on a sustainable basis. So the entire consumptive water requirement of the power plant is proposed to be met by sea water. Sea water would be directly used as cooling water for the condenser cooling circuit in a semi-open recirculating cooling system using wet type Natural Draft Cooling Towers. Apart from the condenser cooling, other auxiliary cooling will be achieved by recirculating desalinated/DM water, which in turn, is cooled by sea water through water/water heat exchangers. For other plant and colony requirements, desalinated water would be used after passivation as per requirement.

As the sea coast nearby does not face any appreciable littoral drift, drawal of water would not face any problem. Sea water level variations at the region is around 2.69 M. However, oceanographic/bathymetric data would be required, for fixing the intake/outfall points, in the detail engineering stage. Preliminary data indicate that the sea water intake would have to be located 1 to 1.5 Km into the sea from the high water line (MHWS) in view of typical sea bed contour in the vicinity. Sea water drawn through submarine pipelines from offshore intake wells will be delivered to the forebay of the intake pump house. The plant is located 3.5 Kms from high water line of sea. The intake pipe location should have about 8 to 10 M below Mean Low Water Spring (MLWS) so that the intake point is about 4 to 5 M above the sea bed and 4 to 5 M below the water level, to minimise ingress of marine life, sand or floating debris.

Total consumptive water requirement including cooling tower make-up is estimated at 9535 M^3/hr of sea water. The break-up is detailed in **Annexure-3.1** and the water balance diagram is given in **Plate No.5.7**. Pumping of the sea water would be done by two(2) of the three(3) sea water intake pumps of 50% capacity each with adequate head. The raw sea water would be transmitted through a mild steel gunited pipe of 1800 mm diameter laid underground with adequate cathodic protection. On entry to the plant site, the incoming sea water would be directly fed to two sets of clariflocculators (2 x 60% capacity each) to remove suspended solids, other debris, marine life etc. before being distributed to the cooling tower basin and the desalination plant. Enclosed **Plate No.5.8** shows the plant sea water system diagrammatically. Sea water from clariflocculation Plant would be distributed to the Desalination Plant and the cooling towers as make-up by separate sets of sea water supply pumps. The total make-up water requirement for the two(2) Natural Draft cooling towers at full load will be around 7800 M^3/hr of which about 910 M^3/hr will come from cooling water used in Desalination Plant. The cooling tower blowdown is expected to be about 5200 M^3/hr.

Sea water would be used as cooling media for both condenser cooling and as secondary coolant of the Auxiliary Cooling Water Circuit. For each unit, it has been estimated that about 74,000 M^3/hr of condenser cooling water and 8,000 M^3/hr of auxiliary cooling water would be in circulation. The total cooling water would be pumped from each of the sea water cooling tower by circulating cooling water pumps. Plate type heat exchanger with water to water heat exchange would be used in the auxiliary cooling water circuit. There would be 4 nos. of 33% capacity plate type heat exchangers per unit. The sea water from the CW headers would be boosted-up and pass through duplex strainers of adequate capacity with one section as standby before entering the plate type heat exchangers. Demineralised or desalinated water would be used as coolant in the primary circuit covering auxiliary coolers like generator gas coolers, turbine lube oil coolers, bearing coolers, DG sets etc. The primary coolant would in turn, be cooled by the circulating sea water through the plate type heat exchangers.

For the plant sweet water requirements, sea water is to be desalinated in a distillation plant. Multi-Effect Distillation (MED) type desalination plant, which has been envisaged for the project, would consist of two(2) chains of about 237 M^3/hr (1.5 MGD) unit each. It would require about 1690 M^3/hr of sea water from the clarified water reservoir to produce about 280 M^3/hr (@ 60% capacity) of desalinated water, generating around 500 M^3/hr of concentrated brine in the process.

The desalinated water produced alongwith condensed steam from the desalination plant would be stored in two(2) nos. desalinated water storage tanks and one(1) no. DM Plant supply tank each of 2000 M^3 capacity. These tanks would be provided with proper lining taking into consideration the nature of the water stored. Water from these tanks would be sent to consumption points like power cycle make-ups through Demineralisation Plant, and to Passivation Plants for other uses. The desalinated and demineralised water system are shown in **Plate No.**5.9.

The Passivation Plant consisting of 3 chains of 50 M^3/hr capacity each would handle about 100 M^3/hr of desalinated water. This passivated water would be stored in two(2) nos. passivated water tanks of 1000 M^3 capacity each. Water from these tanks would be supplied to the plant and the township. The plant and township consumptions are estimated to be 15 and 30 M^3/hr respectively. About 35 M^3/hr of water from these tanks would be distributed through the Service Water Header to various consumption points like air washer unit make-up, various sea water pump gland seals etc. About 20 M^3/hr water from the header would be used for miscellaneous plant uses including replenishment of one(1) no. of fire water tank, of capacity 2000 M^3, as and when required.

The water to the DM Plant supply tank would be passed through a demineralisation plant consisting of 3 chains of mixed bed exchangers of capacity 90 M^3/hr each. This water would be stored in 2 nos. of condensate storage tanks of capacity 1000 M^3 each near each unit. Water from these tanks will be supplied as heat cycle make-up, and 5 M^3/hr for hydrogen generation and 2 M^3/hr chemical solution preparation systems.

About 30 M^3/hr (max.) of desalinated water from the storage tanks would be directly fed to the auxiliary cooling water tanks as auxiliary cooling circuit make-up.

Around 25% to 30% of the service water and the potable water for the plant and township would be lost due to leakage, seepage and evaporation. The waste water run-offs totalling around 50 M^3/hr would be collected from different points and sent to a Waste Water Treatment Plant. Another 68 M^3/hr of waste water from heat cycle blowdown tank would be cooled and fed to the waste water storage facility. Waste sweet water from all the above sources will be collected in a storage pond. This recovered waste water would be reused for ash handling system and in other areas viz. afforestation etc.

Of the saline waste water cooling tower blowdown accounts for about 80% of the total quantity. A portion of this would be used in dust suppression system in coal yard. The balance quantity alongwith concentrated brine solution from Desalination Plant having high salt content and other unrecoverable waste water including clarifier sludge would be collected suitably and disposed in an environment friendly manner. This aspect of waste water disposal is separately discussed in subsequent section.

Sea Water Desalination Plant :

Due to scarcity of sweet water in the region, sea water would be used for catering to the entire consumptive water requirement of the proposed plant. The plant cooling water requirement will be met by using clarified sea water. To meet the sweet water requirement, sea water would be desalinated and then passivated and/or demineralised as per process needs and used for various services and as process make-up.

Two(2) streams of Multi Effect Distillation (MED) type desalination plant of capacity 1.5 MGD each are proposed to be set-up to meet the desalinated water requirement. The total desalinated water requirement is expected to be around 280 M^3/hr which can be met by the two streams, each operating at 60% of the rated capacity. In case of the outage of one(1) stream, the other stream running at 110% of rated capacity would be able to meet the minimum requirements of potable water, process water and service water of the power plant.

Alternatively, a desalination plant based on Reverse Osmosis (RO) process may be used. The RO plant, in this case, will be designed to deliver atleast 280 M^3/hr sweet water with adequate margin on plant capacity. The RO plant will consist of N+2 standard modules where N represents the number of standard modules required to provide the required output at 80% of their rated capacity. In this case, however, a full fledged DM plant will be required to produce the boiler make-up water in view of comperatively higher salt content in the desalinated water produced.

Actual selection of desal process viz. Distillation or RO may be made in detail engineering stage.

The MED Process :

The MED plant consists of horizontal tube, falling-film evaporative condensers in a series arrangement. The basic scheme of the MED desalination plant are illustrated in Plate No.5.10.

The basic idea of the MED process is to produce desalinated water from sea water with the help of low grade input steam through repeatative steps of evaporation and condensation.

The sea water, before being supplied to the desalination plant, is passed through clariflocculation plant. A portion of the clarified water input to the desalination plant is used as the coolant and is returned from the cold end of the desalination plant. The balance of the intake sea water is the feed water for the process.

After the first effect the feed water is injected with scale inhibiting additives. In each effect the feed water is distributed over rows of tubes through spray nozzles. The steam in the tube condenses while a part of the feed water vapourises. The remaining feed water is sprayed onto the next effect, which operate at increasingly higher temperatures. This spray and evaporation procedure is repeated through all the effects.

The input steam is fed into the tubes of the hottest effect at the hot end of the plant. Here it condenses and is returned to the DM water storage tank. The feed water, on the other hand, partially vapourises and is carried into the system towards the initial effects.

The condensate product of all the stages is pumped out together to desalinated water storage tanks for different plant services.

Based on the plant capacity selected and the Gain Output Ratio usually available an auxiliary boiler capable of delivering about 40 TPH steam at 8 $Kg/Cm^2(g)$ pressure and 250-300 °C temperature would be provided to meet the minimum sweet water requirement with the main boilers out of operation. A completely automatic, oil-fired, skid mounted package type boiler is considered for this purpose.

When any of the main power plant boilers start generating and steam becomes available in the station Auxiliary Steam Header, the Auxiliary Boiler will be shut down and desalination continued with steam supply from the main plant. It may be possible to draw steam from a suitable extraction point (IP turbine cross over) of the TG sets for maximum cycle efficiency. This may, however, be decided in the detail engineering stage.

The desalinated water will be taken into a DM plant supply tank and two(2) desal water storage tanks for supply to various points for consumption.

The RO Process :

The Reverse Osmosis (RO) process utilises the physical property of some membranes, by which they allow water to pass quite easily, through the membrane but strongly resists passage of dissolved salts. In this process water containing dissolved salts is passed through a bunch of special composite membrane wall tubes under pressure. The membrane wall tubes, by virtue of their salt rejecting property, allow the clear water to flow out of the membrane wall while retaining the salts within it, thereby delivering salt-free water. The pressure, to which the salt solution is required to be subjected to make clear water just about to flow out of the membrane wall is called the Osmotic Pressure. The Osmotic pressure depends on the salt concentration. For example the Osmotic pressures for brackish water with 2000 ppm, open sea water with 35000 ppm and gulf water with 42000 ppm salt concentrations have osmotic pressures of 1.6 Kg/cm^2, 26.7 Kg/cm^2 and 32.7 Kg/cm^2 respectively at about 25°-30°C temperature. Since, it is not possible to obtain membranes with 100% salt rejection properties, the fresh water coming out will still have some salt left in it. For drinking purposes TDS of 300 to 600 ppm may be acceptable and a single pass RO stream is adequate. For higher purity water required in boiler make-up and other process use two or even three-pass arrangement may be necessary.

Reverse Osmosis membranes are sensitive to even small amounts of contaminants and impurities in the feed water. Also to prevent scaling inside the membrane tubes pH conditioning is required. The RO system thus consists of a pre-treatment section to filter and condition the raw water both physically and chemically to a high drgree of purity, followed by the RO modules which produce the desalted water.

Plate No.5.10 enclosed shows a Typical Packaged Sea Water RO Flow Diagram.

The present report is, however, based on the MED process.

Demineralisation Plant & Heat Cycle Make-up System :

The basic scheme of Demineralisation Plant and Heat Cycle Make-up System is shown in **Plate No.5.9**.

Since the desalination plant produces distilled water of good quality an elaborate DM plant is not required. Therefore, three(3) streams of Mixed Bed Polisher Units of adequate capacity has been proposed for this plant. Considering a maximum power cycle make-up requirement of 136 M^3/hr three MB exchangers of capacity 90 M^3/hr each is proposed.

It may be noted here, that the desalination plant heating steam condensate will be taken back to the DM plant supply water tank and recycled through the ion-exchanger to minimise chances of contamination. It may be possible to collect and recycle the boiler blowdown water in a similar way to minimise desalinated water consumption. This will, however, be looked into in the detail engineering stage.

The DM water produced in the plant would be taken to the two(2) make-up water storage tanks, each of 1000 M^3 capacity. The make-up water tanks would be located outside the turbine hall. These two tanks will supply DM water to the two units directly but there would be provision for interconnection of supply lines during actual usage. Two(2) nos. 200 M^3/hr capacity 20 MWC head make-up water pumps would be provided for each unit to supply make-up water, besides provision of gravity make-up to the condenser hotwell.

Condensate Polishing System :

The proposed 2 x 500 MW units will be provided with 100% capacity condensate polishing system. Each condensate polisher unit will contain four(4) ion exchange mixed bed units operating in parallel. Any three(3) of the ion exchange mixed bed units will be capable of treating the full condensate flow even at boiler MCR condition. During normal operation, three(3) of the exchanger vessels will be working in parallel with the fourth one isolated from the system. The fourth vessel will act as standby and will be brought into operation when a regeneration is required or during any emergency period. The operation of the condensate polishing system will be semi-automatic, that is remote manual.

The regeneration system will be external. For regeneration resin from the exhausted exchanger vessel will be transferred hydraulically to this facility. The regeneration facility is proposed to be located in the DM plant area.

5.6.2 Coal Handling Plant (CHP)

The coal handling plant envisaged for the station would be designed on the basis of receipt of coal from overseas sources by sea transportation. The system design should be capable of ensuring uninterrupted operation of the station under any adverse condition in supply of fuel.

The scheme of the proposed coal handling system is outlined in **Plate No.5.11**. The following are the salient points of design basis :-

i)	Gross calorific value	:	6720 KCal/Kg
ii)	Hourly coal consumption	:	367.26 Te
iii)	Daily consumption of coal with 0.9 load factor and 2.5% handling loss (in MT)	:	8131 Te
iv)	Annual coal requirement for proposed 1000 MW unit in Million Tes with 6000 hours operation per year	:	2.26 Million Te
v)	Maximum size of coal delivered	:	(-) 50 mm
vi)	Mode of coal transportation	:	By sea to Pipavav Port and thereafter by conveyor upto plant.

To meet the estimated weekly requirement of coal one ship-load of coal of 60,000 DWT would have to be received. With 1500 TPH unloading capability to be provided at the port, dedicated for the power station, and 1600 TPH conveying capacity from port to plant about two days operation would be involved to unload a shipload. Plant being located within a reasonable distance from the port no storage facility is envisaged at port end. As indicated under Section-3 of the report, the voyage time ranges from two to three weeks. Taking into consideration possible disruption in supply viz. bad weather, mining problem during heavy rain or snowfall, disruption of port facility either at loading end or at receiving end, four weeks coal storage facility is considered in the plant.

As discussed earlier, coal from overseas sources are normally received in specific sizes of 40 mm and 80 mm as per the agreement between supplier and purchaser. It is also customary to incorporate penalty clause for deviation in size including the fines. In the quotations received, it is noted that one of the Australian suppliers has offered (-)50 mm size. As per the requirement of boiler supplier, coal supplier may be requested to match the feed size required by the mills. In view of above no crusher is envisaged for the station. The layout, however, considers space provision of retrofitting crusher house in future.

The coal conveying system from port to the stackyard considers twin-stream conveyor with a design capacity of 1600 TPH each and from stockyard to bunker 800 TPH each. The system design considers two-shift operation of the coal handling plant. However, unloading from ship would be done on three(3) shift basis to reduce berthing time. Coal from port conveyor 1A/1B would be received in conveyor 2A/2B at TP-1. Battery limit of power station Coal Handling System is considered from TP-1. Cross country conveyor no.2A/2B emanating from TP-1 would terminate at transfer point TP-2 located inside the plant where it would be fed to conveyor no.3A/3B. Conveyor no.3A/3B would in turn feed conveyor no.4 leading to coal stack. The reversible stacker-cum-reclaimer would have a capacity of 1600 TPH stacking and 800 TPH reclaiming. Arrangement is also provided for distribution of about 50% of the coal receipt from port end directly to the power house through bifurcation chute to be provided at TP-3 and the balance to be directed to the stack. The reversible stacker-cum-reclaimer would be rail-mounted, self-propelled unit with 48 M boom length having 270° slewing and adequate luffing provision to stack coal upto a height of 9 M and reclaiming the same afterwards. For the presently proposed station one stacker-cum-reclaimer is considered. A provision for stacking coal by a separate emergency stacker conveyor (conveyor no.5) is kept to take care of exigency condition of outage of stacker-cum-reclaimer. Provision of ground hoppers with bulldozers/payloader would be made to temporarily feed the station during such disruption. Coal from the stack would, thereafter, be fed to the bunkers. Bunkers would have a storage capacity of 14 hours coal requirement for the boiler. The bunkers will be provided with rod and slide gates, arch breakers, etc. to facilitate operation. Necessary belt weighing at bunker level conveyors, electro-mechanical and capacitance type level indicators, coal sampling units, flap gates etc. would be provided in the system as required.

Special precautions will be taken for pollution control by providing dust extraction and dust suppression systems in different transfer points and stockpile areas and ventilation system for underground tunnels. In addition roof extraction fans will be provided in key areas like boiler bunker floors. Pressurized ventilation system with unitary air filtration unit will be provided for control room and MCC buildings.

Necessary water distribution network for drinking and service water with pumps, piping, tanks, valves etc. will be provided for distributing water at all transfer points, control rooms etc.

A centralised control room with microprocessor based control system is envisaged for operation of the coal handling plant. This will be located near the transfer house no.3. Except locally controlled equipment like travelling chutes, dust extraction/dust suppression/ventilation equipment, sump pumps, water distribution systems etc. all other in line equipment would have provision of remote control. However, provision of local control would also be provided. All necessary interlocks, control panels, MCC's, mimic diagrams etc. will be provided in the control room for safe and reliable operation of the Coal Handling Plant.

The number and ratings of major equipment is listed below :-

1.	Belt conveyors	-	2 parallel lines of 1600 TPH upto stack and 2 parallel lines of 800 TPH upto bunker.
2.	Reversible stacker-cum-reclaimer	-	One(1) No. of 1600/800 TPH capacity
3.	Vibrating feeders	-	Eight(8) Nos. of 800 TPH
4.	Flap gates	-	Two(2) Nos.
5.	Rack and pinion gates	-	Six(6) Nos.
6.	In-line magnetic separators	-	Two(2) Nos.
7.	Travelling chutes	-	One(1) set
8.	Metal detectors	-	Two(2) Nos.
9.	Belt weighers	-	Four(4) Nos.
10.	Coal sampling unit	-	Two(2) Nos.
11.	Level indicators	-	Twelve(12) nos. electro-mechanical type and 12 nos. capacitance type.
12.	Chute liners and chute supporting structures	-	One lot

13.	Manual/electric hoists	-	12/6 Nos.
14.	Sump pumps	-	Four(4) Nos.
15.	Dust extraction/dust suppression ventilation equipment	-	One lot
16.	Water supply system	-	One lot
17.	Belt vulcanizer	-	One No.
18.	Bulldozers	-	Two(2) nos.

5.6.3 Ash Handling Plant (AHP)

The Ash Handling System to be implemented for the proposed 2 x 500 MW units would serve the purpose of extracting the fly ash as also the furnace bottom ash from the units and disposing off the same to the ash disposal area. The system designed would be based on 26 Te/hr per unit ash generation with coal having 14% ash content. Furnace bottom ash would be about 20% and fly ash collection in air heater hoppers, ESP hopper and chimney would account for about 80% of total ash generated. Accordingly the ash generation per 8 hours shift per unit would be approximately 41 Te of bottom ash and 165 Te of fly ash. The system meant for fly ash removal is being designated as pneumatic pressure conveying system with conveying air blower/compressor in which fly ash will be extracted and conveyed by compressed air. This system will be designed for removal of ash from the hoppers in a sequential mode and would be intermitent. Accordingly the fly ash hoppers would be sized for 8-hours storage. The scheme is also shown in **Plate No.**5.12 enclosed.

Furnace Bottom Ash System :

Dry ash from furnace bottom will be collected in the water impounded bottom ash hopper located below each hopper and would get quenched. The hoppers will have storage capacity of at least ten(10) hours. Once in a shift, the ash collected in the hopper will be conveyed to the dewatering bins through clinker grinder, jet pump and pipeline assembly. The bins would have dewatering facility where excess water would be removed, treated in two(2) settling tanks and then sent back to the system via surge tank. Dewatered clinker would be directly loaded in trucks for disposal. The bins would have a total holding capacity of 24 hours.

Fly Ash System :

Fly ash will be separated from the flue gas and would be collected in air-heater hoppers, electrostatic precipitator hoppers and stack hopper. The fly ash collection hoppers would be connected through a network of fly ash conveying pipline with isolation valves, nuovo feeders etc. below each hopper. The conveyor piping is connected with the air compressor where necessary pressure would be maintained to ensure necessary conveying air flow through the system.

The ash is discharged into this fly ash piping in a pre-determined sequence from various hoppers by auto-sequencing or in random by natural selection. Capacity of ash removal for each stream would be 50 Te/hr per stream considering worst coal. The pressurised conveying system will deliver the fly ash to an intermediate surge hopper. Two such surge hoppers would be provided per unit.

Ash from the intermediate surge hoppers would thereafter be conveyed to the fly ash silos by blow vessels. Total four(4) nos. each of plate valves, expansion joints, inlet isolation valves and other accessories. Three(3) nos. of silos each of 1250 Te storage capacity is considered adequate for the station. The silo would be complete with rotary dustless unloader, vent filter and other accessories required for loading of conditioned ash in covered truck for disposal. Under emergency condition, provision for disposal by pressurized water jet upto a distance of 2.3 Kms from the silo would be provided. Motive water for the system would be tapped from cooling tower blowdown. Provision to recirculate ash water from the pond would be made, if considered necessary during operation.

Ash Water System :

Ash handling system envisaged for the proposed thermal power station being dry, nominal quantity of ash water is required in the form of sealing water, bottom ash hopper make-up, clinker grinder cooling water, bearing cooling water for blowers, compressors etc.

Fluidized Air System :

Continuous supply of fluidized air has been envisaged in all the ESP hoppers to facilitate smooth and effective ash flow from hoppers. For this purpose, fluidized blowers of required capacity and pressure will be provided. The fluidized air system will be complete in all respects with necessary piping, valves and instruments to ensure satisfactory system operation.

Compressed Air System :

Compressed air system for operation of various equipment and control instruments will be complete in all respects with necessary piping, valves and instruments.

MCC & Control Panel :

415 V MCC and control panel for the ash handling plant will be located inside a separate room annexed to the ash slurry pump house.

Disposal and Utilisation of Ash :

With annual ash generation from the plant to the tune of 0.31 Million Te, of which about 15 to 20% would be bottom ash and balance 80 to 85% fly ash, ash disposal in an environmentally acceptable manner employing cost effective and apt methods would be engaging attention of the project authorities during plant operation. In the proposed station, it is considered that a sizable quantity of ash would find a suitable end use. The technology of manufacture of bricks, aggregates and mixing fly ash in production of cement has already been received with enthusiasm by entrepreneurs in the country. Ancilliary units manufacturing fly ash bricks, tiles and aggregates are already gaining ample encouragement from Govt. of India in terms of exemption of excise duty and reduction of customs duty on imported press machines etc. Bottom ash from most of the power stations in the country find a ready market as a replacement of cinders and some private power stations sell these clinkers at a suitable price. Bottom ash is mostly used as land fill and construction of road.

Ash from the proposed power station is also expected to be utilised with active encouragement from Project Authorities. The redeeming feature of the proposed thermal power station is low ash generation (only 14%) compared to the plants using Indian coal with 40 to 45% ash. Again Pipavav area is expected to be developed at a fast pace with development of infrastructure for major industries including coming-up of a port, ONGC installation etc. Thus bricks, tiles and other construction material which are not abundantly available would necessitate development of fly ash based construction material manufacturing plant. Commercial utilisation of ash from the station is separately discussed under Section-6 of the report.

However, a clear space of 135 Hectare has been earmarked on the north of the plant site for dumping ash during initial years and also to cater to any disruption in ash disposal process during plant operation.

5.6.4 Fuel Oil System

Fuel oil has been considered to be transported by road. The station would have an average oil consumption of 80-100 KL per day and storage tank sizes would be selected accordingly. Two LDO tanks of 500 KL and two HFO tanks of 1500 KL capacity are considered. Three unloading and transfer pumps would be used for unloading and transfer to day oil tanks near the boilers. From the day oil tanks, heavy oil would be pumped by high pressure pumps through strainers and heater sets to the oil burners. HFO lines would be steam traced/electric coil heated to ensure flowability. The recirculated oil would be returned to the day tanks. The heavy oil storage tanks and oil feed lines would be steam traced or electrically heated and insulated to maintain fluidity. A single line diagram for the fuel oil system proposed is furnished in **Plate No.5.13** enclosed.

5.6.5 Compressed Air System

It is proposed to install two instrument air compressors per unit having adequate capacity margin to take care of constant and intermitent demand. Accordingly, four(4) instrument air compressors each having capacity 55 Nm^3/min. would be provided. The instrument air compressors would be oil-free type, complete with dessicant/refrigerant type dryers and individual air receivers for acting as reserve supply of compressed air to permit continued operation following failure of the operating compressor until the standby one is put into service.

The station service air requirement, for normal cleaning purposes, atomising air medium for warm-up guns and ignitors, motive power for burner drive mechanism and emergency air for air drive motors of air-preheaters would be met from separate plant air compressors. It is proposed to install a centralised service compressor station comprising four(4) 55 $Nm^3/min.$ plant air compressors for two units (two working and two standby). Independent air receivers would be provided. Plant service air compressors would have suitable interconnection with the instrument air header. A single line diagram of the proposed compressed air system is shown in **Plate No.5.14**.

5.6.6 Ventilation and Airconditioning System

Right environment for operation and maintenance of the plant as well as for proper functioning of the equipment, controls and accessories is an important aspect which has been given due consideration in the proposed Ventilation and Airconditioning System.

Ventilation System :

Adequate ventilation system has been considered for the power house building, ESP control building and other areas like DG set room, air compressor room, A/C plant room, Desalination plant building, DM plant building, elevator machine rooms and various pump houses like fuel oil pump house, desalinated water and DM water pump house etc. to achieve the following :

i) Dust-free comfortable working environment.

ii) Scavenging out structural heat gain and heat load from various equipment, hot pipes, lighting etc.

iii) Dilution of polluted air due to generation of abnoxious gaseous/aerosol contaminants like acid fumes, dusts etc.

Ventilation system proposed for important areas are described below :

a. **Power House**

Supply/exhaust ventilation system with cooling provided by a set of coils conveying chilled water has been recommended for the power house building. Ambient air would be drawn through automatic viscous filters and will pass through the coils permitting a drop in air temperature fed to some areas. Air will be supplied by means of centrifugal fans to power house through ducting and grilles to achieve proper distribution. The chilled water will be recirculated after cooling in a dry type air cooler by means of centrifugal pumps, piping, valves and other accessories. Exhaust system consists of axial flow wall/roof mounted exhaust fans with rain protection cowl/hood, short duct work etc. Part of the supplied air will be exhausted and the rest will exfiltrate through the various openings in the structure, preventing infiltration of dusty air. This arrangement also ensures more or less ambient dry bulb temperature inside power house.

Various rooms in power house e.g., cable spreader room, switchgear room etc. will be ventilated by means of transfer fans or by extending duct as required and found suitable.

The crusher houses will have adequate louvres for natural ventilation. Coal tripper floors are proposed to be provided with exhaust system to eliminate building-up of hazardous gases.

b. **ESP Control Building (Excepting Control Room)**

For ventilation of this building, ambient air will be drawn through unitary air filtration unit comprising fresh air intake louvre, dry type filter and cooling coils conveying chilled water and supplied to the space by means of centrifugal fans through ducting, grilles etc. The chilled water circuit would have aircooling system as described above.

The supplied air will be exhausted through wall mounted gravity operated dampers to maintain an over-pressure of 1-2 mm of water column to reduce dust.

c. **Other Buildings**

Other areas like DG set room, air compressor room, A/C plant room etc. will be ventilated by means of dry system comprising axial flow fan, dry filter wherever required, cowls, ducting etc. Inside dry bulb temperature may be higher than ambient by about 5 °C. Fire dampers will be provided wherever there is electrical installation. Ventilation system of respective areas will be suitably interlocked with fire detection system to minimise spreading of fire.

Air Conditioning System :

Various control rooms in power station, housing a group of sophisticated and precision control and protection devices calls for controlled environment for proper functioning and for personnel comfort.

The following areas are proposed to be airconditioned :-

a. Control room, DAS room, control equipment room/UPS room located at 17.0 M floor in C-D bay of power house

b. Electrostatic Precipitator Control Room

c. Coal Handling Plant Control Room

d. Desalination Plant Control Room

e. DM Plant Control Room

f. Office area, Laboratory, Lecture Room etc. in Service Building

g. Switchyard Control Room

In view of acute water shortage in this area, air cooled refrigerant circuit have been considered as far as practicable instead of conventional water cooled units. To cater to the above requirement the following systems is proposed :

i) A central chilled water system for the control rooms etc. mentioned under (a), (e) & (f), comprising compressor, aircooled condenser, direct expansion/flooded type evaporator, chilled water circulating pumps, cooling water piping with valves, accessories, fittings etc. has been envisaged. The chilled water produced will be circulated through the coil of air handling units located near respective control room.

ii) Separate direct expansion plant will be provided for ESP control room, Coal Handling Plant control room, Desalination Plant control room and DM Plant control room. Each direct expansion plant will be complete with aircooled condensing units, air handling units, piping with valves, fittings etc.

iii) Aircooled packaged air conditioners will be provided adjacent to respective isolated area.

5.6.7 Fire Protection System

For protection of the plant against fire, all yards and plant would be protected by any one or a combination of the following systems :-

a. Hydrant system

b. Automatic high velocity and medium velocity sprinkler system

c. Water Spray (Emulsifier system)

d. Portable and mobile chemical extinguishers

e. Foam system type)
) for control room
f. Auto-modular CO_2 system)

The system will be designed as per the recommendation of Tariff Advisory Committee of Insurance Association of India. Applicable Codes and Standards of National Fire Prevention Association (NFPA), USA, would also be followed.

In view of vulnerability to fire and it's importance in the running of the power station, effective measures are to be taken to tackle fire in the following particularly susceptible areas :

i) The cable galleries, and

ii) Fuel handling areas, mainly coal conveyors, transfer points and tunnels.

For containment of fire and preventing it from spreading in cable galleries, unitwise fire barriers with self-closing fire resistant doors are to be provided. The ventilation systems, if any, provided in cable galleries should be so interlocked with the fire alarm system that in the event of a fire the ventilation system would be automatically switched off. Also to avoid spreading of fire, all cable entries/openings in cable galleries, tunnels, channels, floors, barriers etc. would be sealed with non-inflammable/fire resistant sealing material.

The source of water for fire water pumps of hydrant system, water spray and sprinkler system etc. will be desalinated/service water as explained earlier under Plant Water System. Three(3) electric motor driven fire water pumps with two(2) diesel engine driven pumps as back-up for sprinkler system will be provided in the fire water pump house. One set of pumps would be connected to the emergency diesel bus to ensure power supply to the pump sets, during total power failure. In addition to these, jockey pump sets, hydro-pneumatic tanks, compressors, pipes and fittings as required will be provided. These pumps will draw water from the 2000 M^3 capacity fire water tank. The hydrant system will feed pressurized water to hydrant valves located throughout the plant and also at strategic locations within the power house.

Automatic high velocity sprinkler protection system will be provided for cable gallery, cable trenches/vaults, coal conveyors etc. Automatic medium velocity sprinklers will be used for protection of burner zone of boiler.

Automatic type water spray (emulsifer) protection system would be provided for the following equipment -

a. Generator Transformers

b. Unit Auxiliary Transformers

c. Station Reserve Transformers

d. Turbine Oil Storage Tanks

Suitable fire detection system as necessary for all the above mentioned fire fighting system with adequate supervisory circuitry will be provided.

In addition to these, adequate number of portable and mobile (wheel mounted) chemical fire extinguishers of foam, soda acid type and carbon-dioxide type will be provided at suitable locations throughout the plant area. The extinguishers may be used during the early stages of fire to prevent spreading.

The fire safety office will be integrated with the plant gate house complex where adequate fire monitoring facility will be provided for round the clock supervision. The monitoring facility will include computerised scanning and alarm system covering all the fire detectors provided in the complex.

Besides fire tenders, foam tenders are also proposed to be procured for station.

5.6.8 Piping, Valves, Fittings and Specialties

Piping, valves, fittings, hangers, anchors, supports and guides of various systems like steam, condensate, water, oil and air would be provided as required. All high pressure, medium pressure and low pressure lines would be of proven quality and suitable for conditions of operation encountered at the specific points. Pipelines running outside the power house would be routed over trestles and pipelines in trenches or buried pipes would be avoided as far as practicable in order to avoid maintenance and other problems encountered with trench piping and buried piping. However, large diameter water pipes would be buried underground with proper external protection measure.

5.7 Miscellaneous Auxiliaries

5.7.1 Hydrogen Supply System

To meet the requirement of hydrogen gas for the station, bottled hydrogen would be brought to site and connected to a manifold to make-up hydrogen supply to the circuit.

5.7.2 Turbine Oil Purification System

A suitable centrifuge or other type of turbine oil purification plant will be provided as an auxiliary of the turbo-generator to condition the turbine oil continuously, in order to remove the water and other impurities from the system to maintain the turbine oil at the optimum condition. In addition to the above unit system, a central turbine oil storage unit comprising of one clean oil tank, one dirty oil tank, one purifier unit and necessary pumps, vent fans will be kept. This would also receive the refill of turbine oil from outside. The purification plant to be provided with the unit system will be complete with oil purifiers, storge tanks, filters, necessary pumping sets and vent fans.

5.7.3 Chemical Feed System

Chemical feed system will be provided for feeding trisodium phosphate in the boiler drum and neutralising amines such as ammonia, morpholine, cyclohexylmine and hydrazine in the condensate pump discharge/boiler feed suction line to maintain the chemical concentration in the drum water and feed water within permissible limits for trouble-free operation of the plant.

The Low Pressure chemical dosing system of each unit will consist of :-

i) A mixing tank provided with stirrer and a metering tank

ii) Two(2) full capacity, variable volume metering pumps, complete with suction filters and other accessories and fittings as necessary. These LP Pump will inject hydrazine or other chemicals into the condensate pump discharge/boiler feed suction. Normally one pump will be running and the other will be on standby duty.

iii) Necessary piping, valves, fittings and instruments.

The high pressure chemical dosing system will consist of :-

i) A mixing tank provided with stirrer and a metering tank

ii) Two(2) full capacity (one standby) metering pumps will be provided for injecting trisodium phosphate to the boiler.

5.7.4 Elevators

As mentioned earlier, one goods-cum-passenger elevator will be provided for each boiler. In addition, two passenger elevator will be installed in the power house building and two goods-cum-passenger elevator is considered for the mill bay.

5.7.5 Cranes and Hoisting Equipment

EOT crane in the turbine-hall will be used for lifting/unloading of heavy equipment at the unloading bay and also for erection and maintenance of equipment.

For 500 MW unit the heaviest piece to be handled will be the generator stator of about 270 Tonnes, while the weight of next heaviest item, (besides single phase Generator Transformers) is LP turbine rotor weighing about 80 Tonnes. In view of this, the Generator is proposed to be lifted by jacking operation for which stator lifting rig will be deployed. One EOT Crane having capacity of 115/25 Tonnes will be installed in the turbine building.

Conventional and special type of cranes required for maintenance of certain SG and TG equipment such as mills, FD/ PA/ID fans, condenser water box, ESP transformer rectifier sets etc. will be supplied by the respective equipment supplier. For clarified sea water pump houses cranes of 7.5 Tonnes (pendant operated) and for circulating water pump house a pendant operated 25 Tonnes electric travelling overhead crane have been considered.

Maintenance cranes/handling devices of suitable capacities have been considered for all other pump houses, other places such as coal handling plant transfer points, desalination plant, DM plant etc. Monorails for lifting heavy motors and other equipment within the power house not covered by EOT crane such as air compressors, miscellaneous pumps, heat exchangers etc. will also be provided. Suitable rails will be provided on floor for bringing the horizontal feed water heaters under the approach of EOT crane.

5.7.6 Thermal Insulation

Insulation would be provided wherever necessary to minimise heat losses from the equipment, piping and ducts and to ensure protection to personnel. Insulation would be held by adequate cleats, wire nets, jackets, etc. to avoid loosening. Insulation thickness would be selected so that the covering jacket surface temperature does not exceed the surrounding ambient temperature by more than 15 °C. The turbine proper would be spray insulated as normally recommended by the turbine supplier.

5.7.7 Painting

All mechanical and electrical equipment including piping system and structural steel would be painted and suitably colour coded for easy identification during normal operation and emergencies. DM plant equipment would be of acid/alkali-proof variety.

5.7.8 Pollution Monitoring System

Monitoring of various environmental aspects is of prime importance in setting-up a thermal power station for the following reasons :-

- to keep an watch on the state of pollution
- to generate data for predictive and corrective measures
- to quantify environmental impacts

The important areas requiring periodic/continuous monitoring are :

- Stack emission
- Ambient air quality
- Disposed water quality

Electronic smoke density analyser and gas analyser equipment is proposed to be provided for continuous monitoring of particulate matters at the outlet of ESP. Sample analysis of SO_2 and other pollutants from chimney would be carried out.

An oil/water separation unit has been envisaged near the fuel oil unloading area in order to keep the plant drains free from oil and to reclaim the waste oil as far as practicable. This would consist of necessary stilling chambers, oil pits, pumps etc. Oil thus separated would be returned to the heavy fuel oil tank and used or disposed of by incineration. Waste water would be checked for pH analysis and other harmful pollutants. The environmental aspects have been separately dealt in a separate section later.

5.7.9 Associated Facilities

Repair Workshop :

For achieving higher availability of the plant, the plant maintenance would be done following a concept of unit exchange system for repair and maintenance.

Under this system, the defective components would be replaced immediately by sound ones from the stores. The defective components would thereafter be repaired in the workshop and sent back to the stores. Following this system, two types of activities namely maintenance and reconditioning would be physically separated thereby speeding up maintenance activity.

In order to carry out the repair activities, it is envisaged to provide the following shops :-

a. Main workshop near the main power house building.

b. Instrument repair shop housed within the power house building or in the workshop.

c. A repair shop for mobile equipment would be located near the coal storage yard.

d. Motor vehicle repair shop

Necessary machinery, tools and tackle required for the nature of repair involved would be provided at all the above shops.

General Stores :

Both covered and open space would be required for storage of various materials required for construction as well as operation and maintenance of the plant. While the construction stores would be temporary, the other stores would be permanent.

The permanent stores would broadly have the following divisions to house material of different categories :-

a. Heavy materials stores

b. Mechanical, Electrical and Instrument small spare part stores

c. Fast moving spare stores for consumable items

d. Chemical stores

e. Civil engineering stores

f. Open storage yard

g. Refractories and lubricants stores

Suitable enclosures would be provided for storing the insurance spares. Arrangements would be made for storing items like relays, motors, instruments, electronic cards and components under controlled atmospheric conditions. For organising and managing the inventory an office space would be provided within the stores complex. Computerised systems of inventory would be provided.

Chemical Laboratory :

A central chemical laboratory is envisaged for the station. This would have necessary equipment and facilities to test and analyse steam, water, oil, fuel etc. required to ensure satisfactory operation and maintenance of the station. A field metallurgical laboratory is also envisaged in the station to carry out necessary testing.

Diesel and Petrol Filling Stations :

Oil filling station would be provided with road tanker unloading facility. Diesel filling arrangement would be kept for the plant locomotives as well as for heavy mobile equipment. Diesel pumps would also transfer oil to storage tanks in diesel generating station.

5.8 Electrical System and Equipment

5.8.1 Electrical System

The proposed 2 x 500 MW thermal power station as envisaged will have two(2) generating units, each of 500 MW capacity.

Considering the load growth and planning of transmission system, it is proposed that this TPS will have 400 kV switchyard to evacuate the generated power. Cost for these overhead transmission lines, towers and all associated works has not been included in the project cost.

The generator will be directly coupled to the steam turbine and will have a nominal rating of 500 MW at 0.85 p.f. (lag). Generation voltage will be about 21 kV with variation of ±5%, 3 ph, 50 Hz and will be connected directly to the 400 kV switchyard bus through 600 MVA, 21/420 kV, 50 Hz generator transformers consisting of three single phase units each rated for 200 MVA.

Three voltage system viz. 11000 volt, 6600 volt and 415 volt have been selected to supply power to unit and station auxiliaries. Schemes of the auxiliary unit and reserve power distribution system have been shown in **Plate Nos.5.17**.

Unit auxiliaries like ID fan, FD fan, PA fan, coal mills etc. will be fed from unit auxiliary transformers. Four(4) unit auxiliary transformers will be provided to feed the unit auxiliaries of each 500 MW generator. Two(2) station reserve transformers will be provided to feed the station auxiliaries and station start-up facilities. For each of the proposed 500 MW set three(3) boiler feed pumps, each of 50% full load capacity will be provided of which two(2) will be turbine driven and one will be motor driven. This electrically driven boiler feed pump will only be used for start-up and standby to steam turbine driven BF pumps, and will be fed from station reserve buses.

The power station complex will have a number of auxiliary systems viz. coal handling, ash handling, fuel oil handling, water treatment, cooling water, fire-fightng, station lighting system, etc. These systems will be fed from the station transformers through adequate numbers of 11 kV/6.6 kV circuit breakers, 11 kV/6.6 kV/433 V transformers and 415 V switchgears/MCCs. In addition to the above, each of the above mentioned systems will have its own requirement of electrical equipment/devices e.g. motors, power control centres and/or MCC for further distribution of power wherever necessary, control panels/ desks, limit switches, power and control cables for distribution within the system itself, local control stations etc.

5.8.2 Generator

The generator will be a two-pole direct connected three phase unit rated for 500 MW at 0.85 pf. lag, 50 Hz. The nominal voltage rating will be in the order of 21 kV with variations of ±5%. The generator neutral will be grounded through a distribution transformer having the secondary loaded by resistor or reactor to limit the ground fault current.

The generator will be cooled by a combined system - stator winding directly cooled by demineralised water and the rotor by hydrogen. The generator excitation system will be selected to provide the following basic requirements.

a. Maintain the generator terminal voltage constant within 5% of the preset value over the entire load range of the machine.

b. The response time must be short so that the automatic voltage regulator (AVR) can control the generator during system disturbances or transients in which rapid changes in excitation are required to maintain system stability margins both in steady state and transient condition.

Considering the commutation problem, sparking in slipring brushes, perference will be given to brushless excitation system. The ultimate aim of the excitation system selection will be to achieve an ideal in rate of response, simplicity, reliability, accuracy and sensibility.

5.8.3 Generator Transformer

The generated voltage of 21 kV will be stepped up and fed to 400 kV switchyard by a step-up transformer connected directly to the generator terminals through isolated phase bus duct. The transformer will be a bank of three single phase units each rated for 200 MVA, 21 kV/420 by square root of 3 kV (Nominal), 50 Hz, suitable for maximum utilisation of generator capacity. The total capacity of generator transformer will thus be 600 MVA. The transformer would have preferably OFWF type of cooling. It will be provided with off circuit tap change system having range of tap of -5% to +5% of nominal voltage @ 2.5% per tap. One spare 200 MVA, 21 kV/420 by square root of 3 kV single phase, 50 Hz generator transformer will be provided. This spare unit will be located in the transformer yard and will be kept charged at no-load. The high voltage terminals of the Transformer will be connected to the 400 kV outdoor switchyard by overhead conductors. To protect the transformer against disturbances, lightning arrestors will be provided near HV terminals of the transformer.

5.8.4 Bus Duct

a. **Generator Bus-Duct (Isolated Phase)** :

The generator will be directly connected with its step-up transformer and Unit Auxiliary Transformers through bus-duct. The busduct will be of isolated phase, continuous type with aluminium conductor in aluminium enclosure. Lightning arresters and surge absorbers (if recommended by generator manufacturer) of proper rating will be provided at a location as close as practicable to the generator terminals.

The main section of bus from Generator to Generator Transformers will be suitable for 20,000 Amp and that for Unit Auxiliary Transformers will be 2000 A for 11 kV and 3000 A for 6.6 kV systems. The maximum temperature of the bus conductor and enclosure will be limited to 105 °C and 70 °C respectively.

b. **11 kV/6.6 kV Bus-Duct (Phase-segregated)** :

The 11 kV/6.6 kV side of Unit Auxiliary Transformers and Station Transformers will be connected with the associated switchgears through phase segregated bus duct. The continuous rating of the aluminium bus bar will be in the range of 4000 A and so designed that the maximum temperature of bus conductor is limited to 90 °C. In case of enclosure the maximum temperature will be limited to 70 °C.

5.8.5 Power Supply Arrangement to Unit Auxiliaries (HT)

During normal operating condition of generator under unit concept, the power supply to unit auxiliaries will be given from the generator terminals through the Unit Auxiliary Transformers. These transformers will be directly connected to the generator busduct.

Four numbers of identical Unit Auxiliary Transformers for stepping down the voltage from 21 kV to 11 kV/6.9 kV have been envisaged for each unit. These Unit Auxiliary Transformers will be rated 22.5 MVA and 12.5 MVA of voltage ratio 21/11.5 kV and 21/6.9 kV respectively, ONAN/ONAF cooled, 3 phase, 50 Hz, provided with ON load tap change system on the high voltage side to take care of voltage variation to the extent of ± 10% @ 1.25% per tap. The capacity of the Unit Auxiliary Transformers has been selected on the basis of the unit auxiliary load with due consideration to the starting of the largest motor, available breaker capacity and voltage regulation requirement.

5.8.6 Unit Auxiliary Transformer (LT) for Medium Voltage Auxiliary Power

The motors rated 160 KW and below with other auxiliary loads will be connected to 415 Volts system. For this purpose, an adequate number of Unit Auxiliary Transformers (LT) rated, 2000 kVA, 1600 kVA, 1250 kVA, and 1000 kVA, 11 kV/6.9 kV/433 Volts, 3 phase, 50 Hz, Dry type/ONAN cooled, will be used as shown in **Plate No.5.13**. Each of these transformers will be connected to the 11 kV/6.6 kV unit buses. These transformers will be provided with OFF circuit tap changing device in five(5) equal steps to take care of voltage variation to the extent of ± 5% @ 2.5% per tap.

5.8.7 Power Supply Arrangement to Station Reserve Service

a. During start-up or shutdown, auxiliary power both at HT and LT will be drawn from 400 kV source through two(2) station transformers to supply power to the station service and cooling water system. These station transformers will have three winding, rated for 90/45/45 MVA, 400 kV/11.5 kV/11.5 kV, and with ONAN/ONAF/OFAF cooling. The 11 kV station system is further stepped down to 6.6 kV by suitable 11 kV/6.9 kV transformers.

In order to take care of Grid voltage variation, these transformers will be provided with ON-LOAD tap changer to accommodate voltage variation of ±10% @ 1.25% per tap. The transformer will be connected by overhead lines to 400 kV system and on the L.V. side suitable busduct will be connected to 11 kV and 6.6 kV indoor switchgear installed in the main plant.

b. After the unit is synchronised, the unit auxiliary load will be transferred from the reserve system to the unit system with the two systems momentarily operating in parallel. In the event of loss of power from unit source, a fast automatic changeover followed by slow changeover of the auxiliary power from the unit system to the reserve system will be ensured to maintain continuity of power to the auxiliary equipment, particularly the vital ones.

For power supply to station, adequate number of LT auxiliaries, transformers rated 2000 kVA, 1250 kVA and 1000 kVA, 11000/433 volts and 6600/433 volts, 3 phase, 50 Hz will be used. These transformers will be provided with off-circuit tap changer to accommodate voltage variation of ±5% @ 2.5% per tap.

5.8.8 Switchgears

The drives for auxiliary equipment, having capacity higher than 160 KW, will be rated for 11 kV/6.6 kV and those having capacity 160 KW and lower will be rated for 415 V, 3 phase, 3 wire system. Suitable HT and LT Switchgears, as described below, will be provided for operation of these motors. The distribution system for HT Switchgears has been indicated in **Plate Nos.5.17**.

a. **11 kV/6.6 kV Switchgears** :

Power received at 11 kV/6.6 kV, either from Unit Auxiliary Transformer or Station Reserve Transformer will be connected to the respective 11 kV/6.6 kV switchgear banks through suitable breakers for further distribution to high voltage motors and to the Transformers intended to step down this voltage to 415 volts. These feeders will be controlled by breakers provided with protection as required for the individual motor, transformer and feeder circuits. The 40 KA interrupting capacity of 11 kV and 6.6 kV breakers has been selected after considering maximum possible fault contribution from the system as well as from the motors under the most severe fault condition. The current rating of the breakers will be of two categories. Incomer, bus coupler and tie breaker will be of one rating while all other breakers will be of another rating. Interchangibility of breakers will be possible between the respective type of breakers. Duplicate feed will be provided as may be necessary.

b. **415 V Switchgears** :

415 Volts supply from Unit Auxiliary Transformer (LT) and Station Auxiliary Transformer (LT) will be connected to their respective bus through breakers to facilitate distribution for different motors and other electrical loads. Motors with capacity higher than 110 KW will be controlled by 415 Volts circuit breaker and those with capacity 110 KW or lower by magnetic contactor having required protection. The rupturing capacity of all 415 volt circuit breakers will be 50 KA. Duplicate feed will be provided for 415 V switchgears where necessary.

Motor Control Centres (MCCs) will be provided by grouping of starters of different motors together in sheet metal cubicle and located suitably in the load centres to the extent possible considering the space availability and operational advantages.

Protection and control for individual motors will be provided. Same principle will be applied for power supply to the plant service systems like raw/filter water booster pumps, fire water system, water treatment system etc. Depending on the location and requirement, switchgear and LT Transformers will be located near such stations.

5.8.9 Plant DC System

A reliable DC power source will be provided to supply those loads which are required to function on a loss of AC power for security, protection and safe shutdown of plant. The DC power supply system comprises :

- 220 Volt DC Battery
- Battery Charger (Float and Boost Charger)
- DC distribution and sub-distribution boards

Basis of selection of the above items will be as follows :

a. <u>Battery</u> :

Normal requirement of the battery is to supply power for the following :

- Control and monitoring of the entire operation
- Alarm and annunciation of plant condition under emergency. During the first one minute after occurrence of emergency the battery will be called on to supply the following loads :
  - Tripping power for all major circuit breakers simultaneously
  - Starting of emergency drives to protect the machines from damage
  - Plant emergency DC illumination system
  - Indication, alarm and annunciation
  - Other miscellaneous loads

The storage battery sets at ten hour discharge rate having 110 cells for 220 volts would be selected.

Six(6) 220 V battery sets of adequate capacity will cater to the need of the power plant complex. Since the proposed 400 kV substation will be of considerable magnitude, a separate 220 V battery set of adequate capacity is proposed to be used for control and supervision of 400 kV switchyard equipment/system.

A 48 V battery set of adequate capacity may be installed in the switchyard relay and metering annex room for PLCC system.

A 24 V battery set of adequate capacity will be installed to cater to the needs of ATRS, FSSS and other systems requiring 24 V DC supply.

b. **Battery Charger** :

Battery chargers of suitable capacity will be provided with quick boost and trickle charging facility for each of the aforesaid battery sets. Completely automatic and self regulating type of battery charger will comprise one float charger and one float charger-cum-boost charger for each of the battery set.

The float charger will be capable of floating the battery at 2.15 volts per cell and at the same time supply a normal DC load.

The boost charger will be capable of quick charging the battery at 2.75 volts per cell and the capacity to restore a fully discharged battery to a state of fully charged condition in 8 hours with 25% spare margin over the maximum charging rate will be considered.

Total number of chargers will be as per the quantity of the battery sets.

c. <u>DC Distribution Board</u> :

One main DC distribution board for each of the battery sets will be provided with DC sub-distribution boards as required. The DC distribution board will have two incomer DC circuit breakers and required number of outgoing switchfuse units which will be selected to have a continuous current rating of not less than 125% of the nominal load current.

d. <u>Standby D.C. Battery Charger & Board</u> :

One set D.C. battery, charger and D.C. board shall be provided and used as a common standby for all the D.C. battery and charger system. Each of the main D.C. board will connect with this standby D.C. board so that D.C. power is available during maintenance/replacement of its own battery.

5.8.10 Control and Relaying

The power house control room will have number of control and relay panels for the generator, its auxiliaries, 11 kV/6.6 kV switchgear and 415 V switchgears. All required control, protective relays and metering for generator including excitation system, unit and reserve transformers to safeguard against abnormal system conditions will be provided in this control room. Control elements for drives will be located in Boiler-Turbine control desks.

Synchronisation for generator will be done from the power house control room which will be provided with measuring instruments like ammeter, voltmeter, wattmeter, VAR meter, frequency meter, synchroscope etc. and mimic with switch position indication. Audio-visual annunciation with discrimination will be provided in the control room to draw operator's attention for abnormal operating condition and tripped condition. The annunciation system will include all necessary flasher, acknowledge, test, reset devices and other accessories as may be required. All important points will be monitored in DAS and important events will be connected to Sequence of Event recorder.

In view of the magnitude of the extension of the switch yard it is proposed that a new switchyard control room may be constructed in 400 kV switchyard. The EHV switchyard control room will be provided with necessary relays, control and metering panels to enable control and supervision of the 400 kV substation equipment. It will also be provided with duplicate metering and indication for generator, generator transformer and station transformers.

5.8.11 Protective System

For protection of equipment against abnormal system conditions, adequate protective devices will be installed in the respective switchgears and/or control and relay panels. A group of such protective devices may be necessary to protect the equipment under different abnormal conditions arising in the system.

For equipment exposed to atmosphere, protection against lightning surges and switching surges will be provided with lightning arrestors at suitable locations, over and above the shielding wires and lightning masts to safeguard the equipment.

In all cases, proper discrimination would be achieved so as to isolate the faulty elements only, keeping the healthy part of the system in service.

5.8.12 400 kV Switchyard

The Electrical Single Line Diagram is shown in **Plate Nos.5.16** indicates the arrangement of evacuation of power from the proposed 2 x 500 MW units.

The outdoor substation switchyard of this TPS will be of 400 kV class. The substations will have two main buses and one transfer bus scheme. The substation will comprise the following bays :

a.	Generator Transformer	-	2 Nos.
b.	Station Transformer bay	-	2 Nos.
c.	Feeder line	-	3 Nos.
d.	Bus Coupler and Bus PT bay	-	1 No.
e.	Bus Tie bay	-	1 No.

The switchyard will have a separate control room building for control and supervision of the equipment in line feeders, buses etc. as stated earlier. Metering protection and control of these circuits will enable feeder synchronisation from the control room in this building. There will be a separate room in this building for the DC system consisting of battery, battery charger and DC distribution boards for the 400 kV switchyard.

PLCC Equipment :

Power line carrier communication equipment and wave traps are envisaged at the 400 kV feeders to provide for speech communication between different substations. The equipment will be designed to work on 48 Volt DC system for which suitable DC battery with battery charger and DC feeders of adequate capacity will be provided in the proposed control room in the switchyard.

5.8.13 Inter-communication System

An inter-communication system will be provided to facilitate plant operations by establishing quick communication among the operating personnel at various location of the plant.

Two-channel voice communication system with 'Paging' mode as well as 'Private' mode is envisaged. Speaking in 'Paging' mode will be heard all over the plant on selective basis while the 'Private' mode will facilitate conversation between two or more stations through close talk channel with discrimination against background noise.

Hand sets for transmitting or acknowledging message would be installed at all important locations. The sound level throughout the area covered by a TG unit varies from place to place. Each unit will be divided on the basis of sound level and adequate power amplifiers will be used to cover these zones. Each handset/loudspeaker station will have its own pre-amplifier, line amplifier suitable for long line signal transmission and power amplifier to suit loudspeaker capacity. Provision for spare power amplifier will be made to serve as standby.

A communication facility between power house with the intake pump house which is located about 40 Kms away would be established for smooth and uninterrupted operation of the plant.

5.8.14 Illumination System

Suitable illumination is necessary to facilitate normal operation and maintenance activities and to ensure safety of working personnel. This will be achieved by artificial lighting.

For outdoor yard illumination, flood lights will be installed at suitable locations to provide requisite level of illumination. Pole mounted high pressure sodium vapour lamp fixtures will be used for approach and work roads.

Generally fluorescent fixtures will be used for indoor illumination. Combination of sodium vapour, fluorescent and incandescent fixtures will be used for Turbine Hall and Boiler Platforms/Galleries as may be necessary.

The illumination levels at various places will be maintained as per internationally accepted codes. The lighting system design will ensure uniform illumination at working levels.

Power for the illumination system will be supplied from 415 V bus through lighting distribution switchgear. The power for the lighting distribution switchgear will be obtained from the 415 V bus through 415 V/415 V step down transformers at a lower fault level of suitable rating. Lighting distribution boards with 415 V/415 V dry type transformers will be located in the ancillary buildings for providing illumination in ancillary locations.

Suitable number of lighting panels will be located in each area, power to which will be supplied from main lighting distribution boards. The lighting panels will be installed at convenient locations for ease of operation. In addition to normal illumination scheme, emergency AC and DC lighting scheme will be provided in the power station complex. The emergency AC lighting will be supplied from AC emergency lighting boards which are connected to the AC emergency MCC. The AC emergency MCC will be energised from diesel generator during emergencies. The station emergency DC lighting will be fed from station 220 Volt DC distribution system during extreme emergencies. On failure of the AC supply, these lights will glow from DC system. For isolated buildings in remote areas where station 220 V DC is not available, DC lighting will be derived from self-contained battery with charger/flood lamp units, energised upon loss of normal AC supply to such isolated areas.

5.8.15 Power and Control Cables

Main factors which are considered for selection for power cable sizes are as follows :

- System short circuit current
- Derating factors due to higher ambient temperature and grouping of cables.
- Continuous current rating.
- Voltage drop during starting and under continuous operation.
- Standardisation of the cable sizes to avoid too many sizes of cables.

All 11 kV/6.6 kV cables will be of stranded aluminium conductor, heavy duty XLPE insulated, extruded PVC inner sheathed, each core screened on conductor as well as on insulation, single round galvanized steel wire armoured (for multicore cables only) and with fire resistant low smoke (FRLS) PVC outer sheathed. The cables will be suitable for unearthed system. For single core cables, single round aluminium armour wire will be used.

All LT power cables will be 1100 V grade with stranded aluminium conductor, XLPE or PVC insulated, extruded PVC inner sheathed, single round galvanized steel wire armoured (for multicore cables only) and with FRLS PVC outer sheath. The cables would be suitable for earthed system.

Control cables will be multicore 1100 V grade PVC insulated, PVC sheathed, round steel wire armoured and with FRLS PVC outer sheath with 2.5/1.5/0.5 Sq.mm stranded copper conductors.

Fire survival cables (FS) will be used for system which are necessary for protection and safe shutdown of plant in case of fire.

5.8.16 Grounding & Lightning Protection

The grounding requirement of a power station complex could be divided into the following two main categories :

- System Grounding
- Equipment Body Grounding

The system grounding is adopted to facilitate ground fault relaying and to reduce the magnitude of transient over voltage. The system grounding involves primarily the grounding of the Generator and Transformer neutrals. High resistance grounding is envisaged for generator neutral which would be achieved through a distribution transformer shunted by a resistor or reactor in the secondary.

For 11 kV/6.6 kV system for the proposed 500 MW unit it is envisaged to have low resistance grounding with fault current limited to 300 Amps. 415 V power supply system will be solidly grounded. DC system will be ungrounded. The equipment body grounding is adopted to provide protection to personnel from potential hazard caused by ground faults and lightning discharges by providing a low resistance conducting path to the ground. A stable ground grid will be provided for grounding of equipment and structures maintaining the step and touch potentials within safe limits. An earth mat will be laid in and around the power station and also in other hazardous areas as necessary.

This mat will be buried at a suitable depth below the ground and provided with ground electrodes at suitable intervals. All metallic parts of equipment supposed to be at earth potential will be connected to the ground mat including structures, buildings, transmission towers, plant rail-road tracks, the perimeter fencings etc. Lightning protection system will be installed for protecting the buildings/structures against lightning discharge. This would be achieved by providing lightning masts on stacks, power house building, towers in switchyard, floodlight towers etc. and connecting them with the Ground Grid.

5.8.17 Emergency Power Supply System

The emergency power system provides power to essential auxiliary loads required to permit a safe shutdown of the unit in the event of a plant blackout (i.e. loss of station and unit auxiliary transformers). In addition, power is provided for auxiliaries and services required for personnel safety and minimum plant maintenance during the blackout.

In order to meet the above requirement two diesel generators will be installed.

Three (2 running + 1 standby) 1000 kVA, 415 V, 3 phase, 4 wire, 50 Hz DG sets have been envisaged. However, exact rating of DG sets may be fixed during the detail design for the power station.

5.8.18 Uninterruptible Power Supply (UPS) System

Two sets of uninterruptible power supply systems of continuous duty have been envisaged to supply regulated, filtered and uninterrupted 240 V, 50 Hz, single phase power within acceptable tolerances to critical AC loads like computerised Data Acquisition System; microprocessor based Control and Instrumentation System, Analog Control System, Burner Management System, Annunciation System, indicators/recorders mounted on unit control boards and other critical loads of such nature. The system would comprise static inverters, static transfer switches, UPS system battery, float-cum-boost chargers for the battery, step down transformer, voltage stabilizer, DC distribution board, AC distribution boards etc. Both automatic and mannual mode of operation will be provided.

5.9 Instrumentation And Controls

Fluctuation of load within wide limits, high speed of load fluctuation and frequent run-up and run-down operations particularly during peak load in power plants call for a sensitive, accurate and safe Instrumentation and Control System. So a state-of-the-art microprocessor based Distributed Control System (DCS) is recommended for this power station. This is intended to provide reliability of power supply, economy of operation, reduction in cable cost and complexity due to hardware connection, inherent safety system i.e. safety relating to plant itself and safety of operator, better maintenance and monitoring of boilers, turbines and associated systems.

The plant automation will be achieved mainly using a functionally distributed, microprocessor based Distributed Control System (DCS), incorporating data acquisition as well as approriate redundant measurement and control, for each unit, in conjunction with the Burner Management System (BMS) of the SG and Turbine Stress Evaluator, Electrohydraulic Governing System (EHG), Automatic Turbine Run-up System (ATRS), Automatic Turbine Tester (ATT) and other control systems of the TG. The plant start-up and shutdown will be automated with provision for plant cold/warm/hot start conditions.

In addition to open loop and closed loop controls associated with the SG plant fuel, draft, feed and steam systems and also the TG auxiliary systems, each DCS will incorporate a Unit Load Control (ULC) scheme to operate the TG and SG in a coordinated mode to accommodate both constant and variable pressure operation, and with the ability to operate in constrained modes i.e. Boiler Follow Turbine (BFT) or Turbine Follow Boiler (TFB).

The HP-LP steam bypass system will also be interfaced to the ULC to form an overall co-ordinated control system to achieve target load set at the Unit Control Desk (UCD) by the operator.

An additional DCS, primarily for monitoring and some start/stop initiation functions, will be provided for non-unitised auxiliary plant systems. This DCS will be appropriately coupled to each Unit DCS.

The Instrumentation and Control System for the plant shall be configured to provide centralised control with the ability for manual control, for reliable, safe and efficient operation of the steam generators, turbine generators and associated auxiliary equipment - under all operational conditions - automatically and remotely from each unit control room except for those plant peripheral systems like Coal Handling, Ash Handling, DM Plants etc. which have their own control rooms.

All necessary process and equipment parameters will be measured to enable the operator(s) to supervise and control the plant. Each SG-TG shall be started, controlled and shutdown from the unit control desk. Each SG and TG will be equipped with a protection system which trips the plant, by automatic means, in the event of critical process variables exceeding permissible values. Trip and reset push-buttons will also be provided at each UCD to enable operator initiation of plant trip.

Data acquisition information systems will be incorporated to carry out supervisory monitoring, data logging, event logging and operational performance and efficiency calculations.

The operator's primary interface to the plant will be through the Man Machine Interface (MMI) of the DCS consisting of colour VDUs, keyboards and Track Balls/Touch Screen supported by associated peripheral devices.

Unit Control Panel (UCP) will be provided for each unit, to accommodate selective back-up instrumentation comprising hardwired alarm annunciation, continuous indication and recording of fuel, air, water and steam process variables, status of the major plant items etc. Additionally, the UCP will contain a generator control section to display the electrical status and provide a manual synchronising facility.

For hardware configuration, the following guidelines shall be adopted :-

a. For protection of Boiler, Turbine and Generator, triple modular redundant hardware will be considered.

b. For balance protection, all control loops and sequential logic and related measurement, dual redundant hardware shall be considered.

c. For balance measurement, non-redundant hardware shall be considered.

The overall system may be mainly subdivided as (a) Control Systems (DCS) (b) Measuring Instruments (c) Final Control Elements (d) Analysers (e) Panels & Cubicles and (f) Erection hardwares which are briefly discussed below :

a. <u>Distributed Control System</u>

This system would cover closed loop control systems, open loop control systems and acquisition of important information from Boiler/Turbine integral control system, HP/LP bypass, seal steam pressure control, Burner Management System, Soot Blower Control, ATRS (Automatic Turbine Run-up System), ATT (Automatic Turbine Testing) etc. Functionally distributed control with dual redundant data highway has been envisaged. Manual back-up stations would be provided for critical drives connected with automatic modulating control system. Operator interface stations would have redundancy and fall back feature.

Sub-systems would communicate with each other via data highway. Diagnostic processors of individual sub-systems would be provided. The operator station or CRT-Keyboard-printer unit would complete the man-machine interface. All diagnostic display/print shall be displayed and printed by CRT and printer respectively. Historical storage unit would also be supported with the system and would have built-in redundancy. The function at unit level would be centralised and at group level and individual levels would be decentralised. The overview display, group display, trend display and graphic display would be available with DAS. The system would have separate Engineer's and Operator's console to enable the respective person to interact with the system. In addition, a separate console for the system engineering would be provided for fault diagnostic system checking/timing etc. The MIS (Master Information Service) would communicate with the main system data highway via suitable gateway.

Apart from normal data logging and display functions the DAS would also support the performance calculations like boiler performance, turbine stress evaluation, turbine heat rate, condenser performance etc. Normal display would include periodic display, on-demand display, alarm display, operator's guide message display, graphic display etc.

Periodic Log (hourly, daily, monthly), on-demand log, start-up and shut down operator's guidance message, alarm printing etc. would be incorporated in the DAS. The system would have self-diagnostic features. SOE (Sequence of Events) monitoring would be done by the system. The SOE will include electrical generator and electrical systems and will monitor electrical faults.

One(1) separate switchyard control room shall be offered for the power station. Switchyard control room shall have its own SCADA system (Supervisory Control and Data Acquisition). It will have standard communication links with DCS for monitoring the status in Unit Control Rooms.

b. <u>Measuring Instruments</u>

Primary sensors would be selected from reputed makes with proven performance. Transmitters would be electronic in nature, having high degree of accuracy and reliability. Smart transmitters which conform to standard field bus have been envisaged. These will help in remote testing and cable reductions. Also they provide the facilities for digital communication within the system. The indicator, recorder and other instruments would also have optimum response time with high accuracy. The transmitters would be grouped together and would be placed on different racks at suitable locations. Measurement gauges would be provided locally.

c. <u>Final Control Elements</u>

Control valves would have wide range of controllability and less noise. All of them would have adequate fail-safe feature. For isolating/on-off/inching services advanced electrical type actuator would be selected. For modulating control loops, pneumatic actuators will be used.

d. **Analysers**

Gas analysers for the measurement of O_2 & CO in the flue gas have been envisaged. SO_2 smoke density/particulate emission meters would be used to check pollution. The steam and water analysis system (SWAS) would consist of measurement of dissolved oxygen, conductivity, pH, silica at different points of the steam-water cycle to ensure proper quality of water and steam in boiler and turbine. To fulfil the requirements of environmental protection, all necessary instrumentation to monitor the stack discharge and other effluents of the plant would also be provided. For steam and water analysis, a central analyser room is also envisaged. The SWAS panel would consist of dry and wet sections. For LP dosing automatic stroke control of dosing pumps has also been envisaged. This shall be done via DCS where all SWAS points shall be connected for monitoring.

e. **Panels and Cubicles**

For the two unit station, unitwise control room has been envisaged. Back-up combined panel/desk would be provided in the unit control room in addition to operator's console consisting of CRT & Keyboard. The annunciation system (Hardwared) would be of split-architecture type for every important services. A few number of back up display instruments like indicators, recorders etc. would be located on the back-up panel, whereas few back-up switches, push buttons, lamps etc. for very important services would be accommodated in the back-up section. The back-up panel instrumentation shall be applicable for very critical application only. The layout would be as per the latest ergonomic practices. The system cabinets containing hardwares would be placed in the control equipment room. Local panels would be provided for local monitoring and interfacing of operators when needed. For operation, operator's control consoles would be provided. This control console will house the CRTs in the panel part and keyboards, trackball/mouse etc. in the desk part.

For each Unit Control Room the operator station configuration has been envisaged as follows :

i) Two number stations for boiler controls

ii) One number for TG control

iii) One number for balance of plant (BOP) control

iv) Two number of alarm monitors

v) One number of utility monitor

There will be three printers one dedicated for alarm functions, one for logging and the other for diagnostic purposes.

f. <u>Erection Hardwares</u>

The package would include all the erection hardwares required for the plant.

The Desalination Plant would be complete with its own Instrumentation and Control. However, all critical parameters of the plant would be monitored in central control room through the 'SCADA' (Supervisory Control and Data Acquisition) System.

5.10 Civil & Structural Engineering Aspects

5.10.1 Plant Levels

The general grade level of the plot is apprixmately 20 M above MSL with a gentle slope from North to South. The exact grade level can be decided on completion of site survey. For the purpose of this report, a single terraced level land of the power plant has been considered at an elevation of 20 M above MSL. An average depth of 0.5 M cutting/filling has been considered for grading.

5.10.2 Soil Characteristics

Soil investigation at the plant site has not been done as yet. Based on the soil characteristics of adjacent areas in raft/spread footing in foundation have been considered for major plant and equipment and the project cost estimate is prepared based on this assumption. However, during project implementation, detailed geo-technical investigation would be required to ascertain appropriate type of foundation of heavy equipment and structures.

5.10.3 Seismic Considerations

The power station is located under Zone-IV as per IS:1893, for which the basic horizontal seismic co-efficient is 0.05. Analysis and design of structures to resist the seismic forces are to be carried out as per the provisions of IS:1893. The applicable importance factors would be duly considered in the detail design.

5.10.4 Wind Loading

The maximum wind pressure including winds of short duration as specified in Indian Standard Code No.875 - 1987, for the zone where the proposed power station is located, while designing buildings and structures, will be adopted. The site is located in the red zone as per above standard with wind speed of 50 M/sec. and the basic wind pressure for short duration is 150 Kg/m^2. The basic wind pressure along with its variation with heights and with appropriate co-efficients for shape of the structures will be considered for design.

5.10.5 Power House Building Superstructure

The superstructure of the power house building will be in fabricated structural steelwork. All components will be of welded fabrication and the field connections will be with high-tensile bolts or welding as determined in design stage. The transverse frames will be of rigid type. In the longitudinal direction these rigid transverse frames will be braced to resist horizontal forces. Floors and roofs, except the turbine hall roof, will have cast-in-situ RC slabs. The turbine hall roof will be made of precast RC planks in order to reduce the period of construction. Side cladding will be of plastered brickwork supported on steel wall beams.

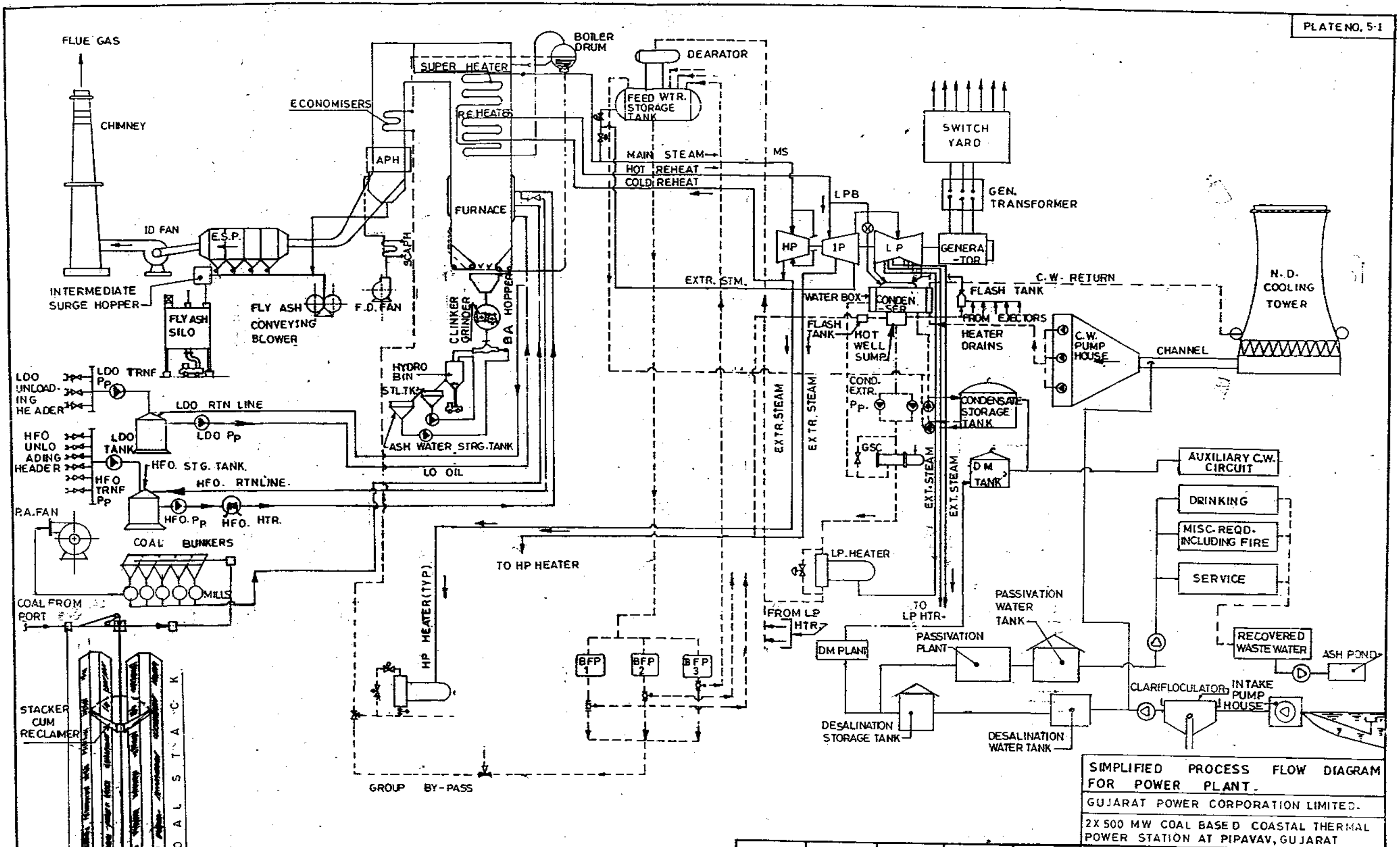
5.10.6 Civil Works for Plant Water System

Circulating cooling water system using cooling tower is considered for condenser as well as auxiliary cooling of the proposed station using sea water from the gulf of Khambat. The sea water intake structure will be located about 3.5 Kms South of plant site above HFL. The pump house forebay will be fed by a set of RCC submarine pipe laid on sea bed. The intake point would be 4/5 m above sea bed level and 4/5 M below MLLW to ensure receipt of comparative clean water. The submarine pipe would be suitably covered with ballasts. The intake point for water (in sea) should be complete with marking buoys. The intake structure shall be of RCC construction and will house forebay sump chamber, a suitable sand trap, pump room and electrical room. The discharge line from intake pump house will be buried mild steel gunited line upto the plant.

The sea water discharge line shall be terminated further into the sea to avoid recirculation. The discharge pipe will follow the same route on the land but shall take a rightward turn at the shore line. On bay the discharge pipe shall be laid on the sea bed duly dredged/levelled and covered with crushed stone. The discharge line shall also have a pressurised flow in order to achieve a minimum velocity of 1.2 m/sec to prevent marine growth. The discharge pipe shall have a diffuser system at the end.

5.10.7 Civil Works for Coal Handling Plant

Coal from the port would be transported by conveyor. This conveyor would be constructed, owned and operated by the station. Conveyor galleries, supporting trestles, superstructures of transfer houses shall be of fabricated structural steelwork. All components will be of welded fabrication with bolted/welded joints for erection and assembly in the field. Roofing will be of AC sheets. Intermediate floors in transfer houses will be of reinforced concrete supported on structural steel framing. Side cladding will be of AC sheets and necessary windows/louvres will be provided for natural lighting and ventilation.



SIMPLIFIED PROCESS FLOW DIAGRAM FOR POWER PLANT.

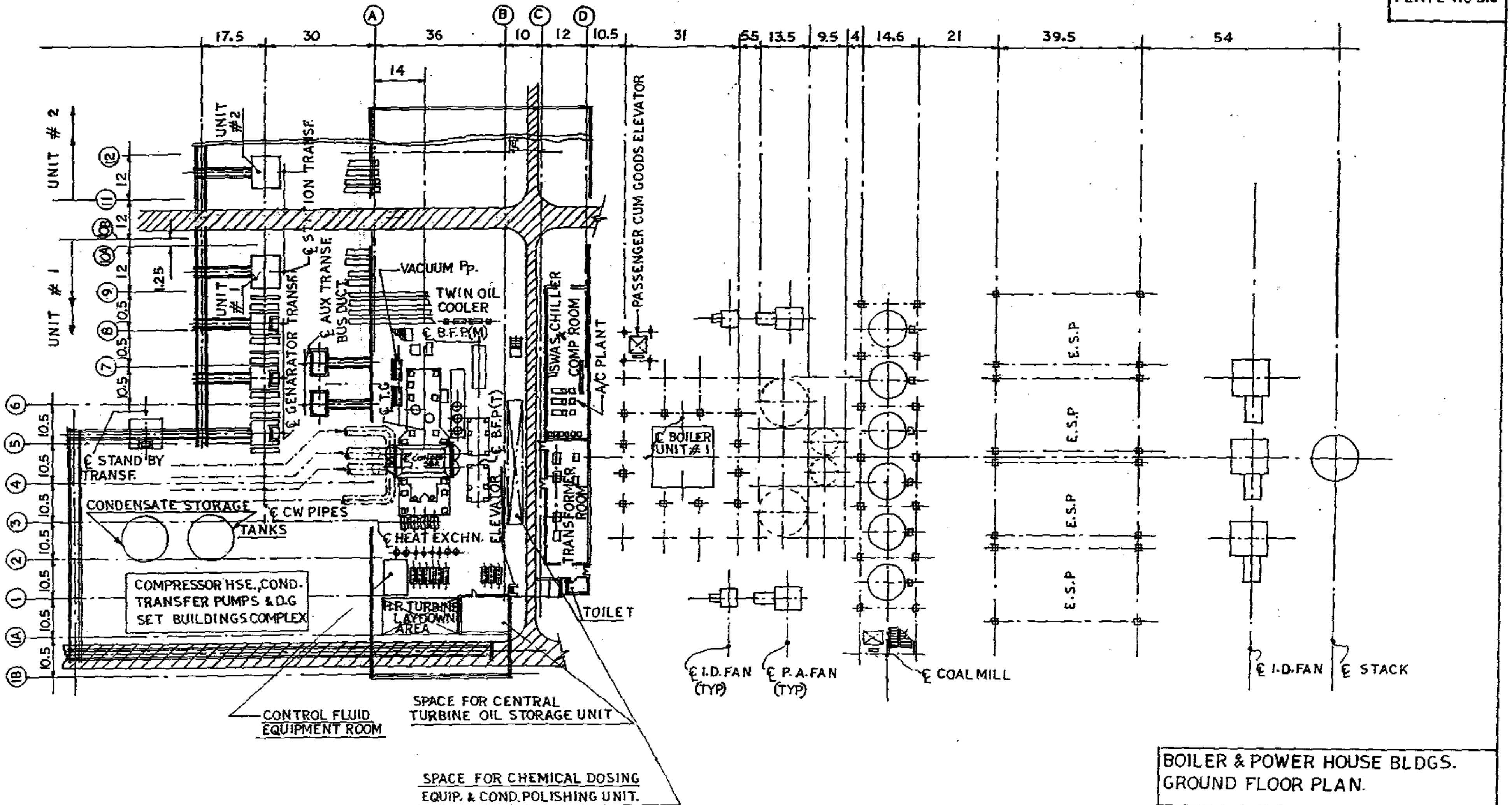
GUJARAT POWER CORPORATION LIMITED.

2X500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT

DRN. BY	CKD. BY	JOB NO.	SCALE	DATE
M. Ghosh.	[signature]	93005	N.T.S	18.11.94

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

PLATE NO 5.3



BOILER & POWER HOUSE BLDGS.
GROUND FLOOR PLAN.

GUJARAT POWER CORPN LIMITED.

2X500 MW COAL BASED COASTAL TPS
AT PIPAVAV, GUJRAT.

DRN BY	CKD BY	JOB NO	SCALE	DATE
B.RUDRA	T.S.	93005	N.T.S	8.11.94

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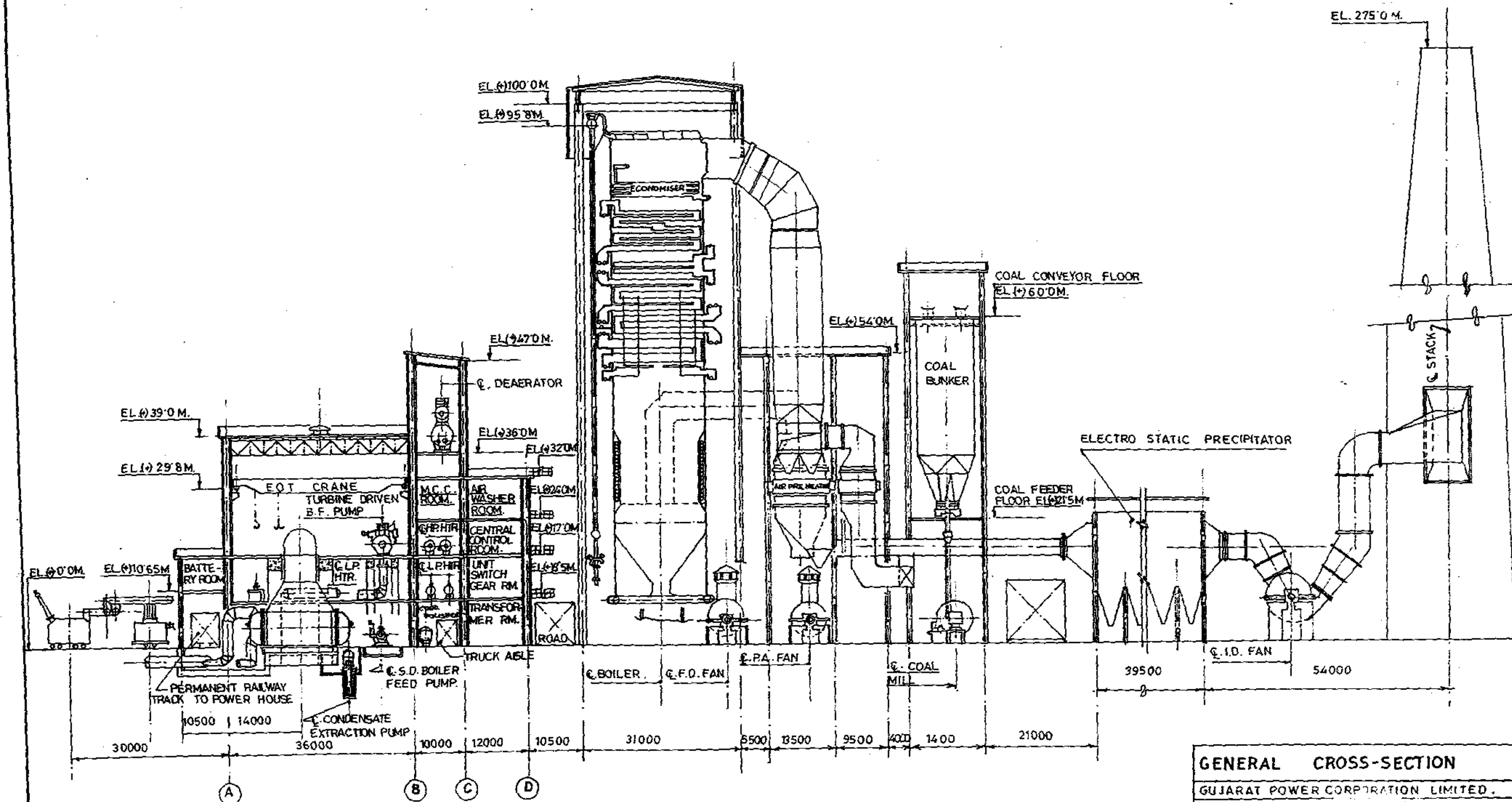
CONSULTING ENGINEERS

PLATE NO. 5.4



DRN BY	CKD BY	JOB NO	SCALE	DATE
M. Ghosh.		93005		12.11.94

GENERAL CROSS-SECTION

GUJARAT POWER CORPORATION LIMITED.

2 X 500 MW. COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

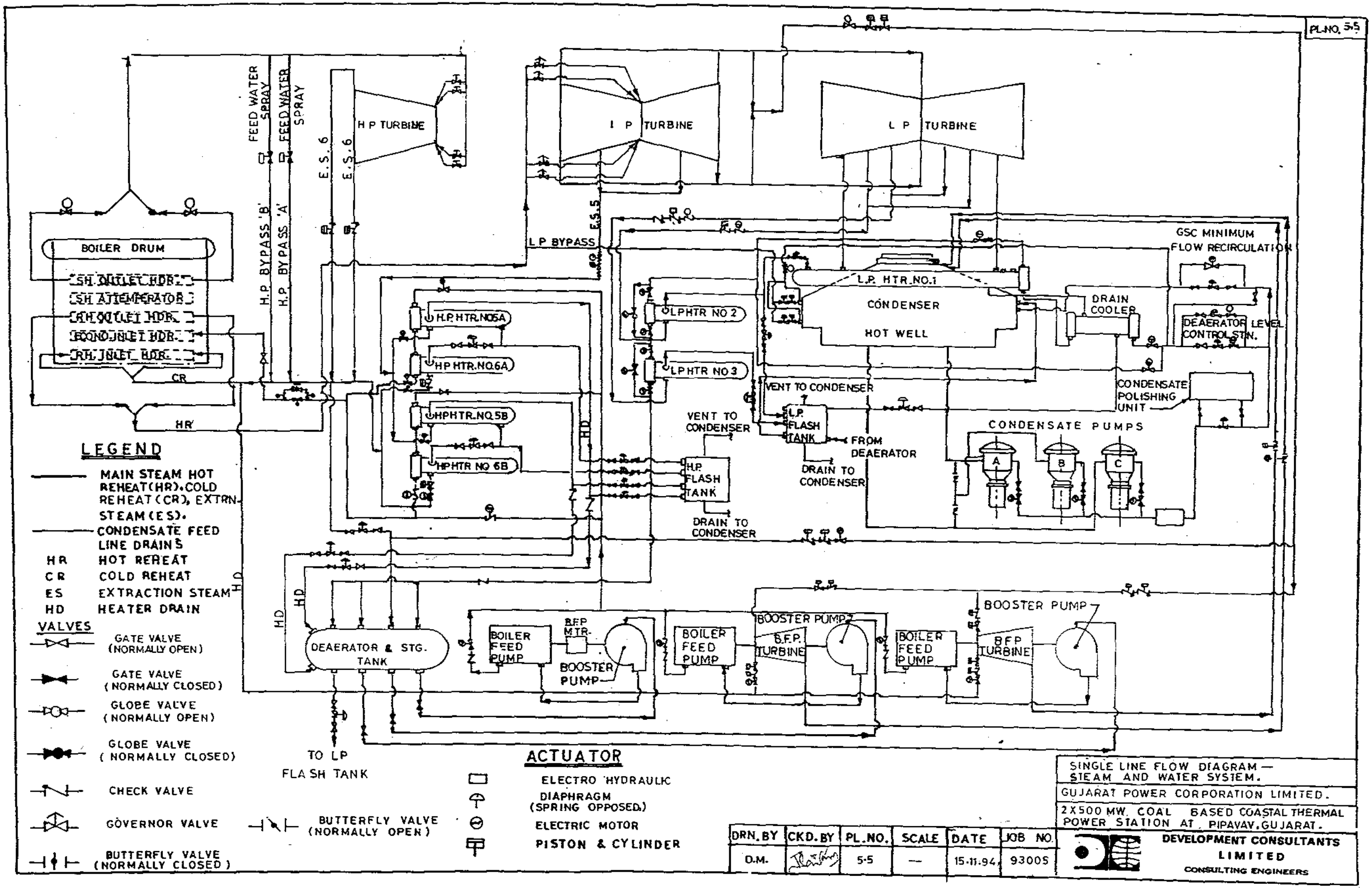

PL.NO. 5.5
H P TURBINE
I P TURBINE
L P TURBINE
FEED WATER SPRAY
FEED WATER SPRAY
E.S. 6
E.S. 6
E.S. 5
H.P. BYPASS 'B'
H.P. BYPASS 'A'
L P BYPASS
BOILER DRUM
SH OUTLET HDR.
SH ATTEMPERATOR
RH OUTLET HDR.
ECO INLET HDR.
RH INLET HDR.
CR
HR
H.P. HTR. NO.5A
HP HTR. NO.6A
HP HTR. NO.5B
HP HTR NO 6B
HD
L.P. HTR. NO.1
CONDENSER
HOT WELL
LP HTR NO 2
LP HTR NO 3
VENT TO CONDENSER
VENT TO CONDENSER
L.P. FLASH TANK
FROM DEAERATOR
DRAIN TO CONDENSER
H.P. FLASH TANK
DRAIN TO CONDENSER
DRAIN COOLER
GSC MINIMUM FLOW RECIRCULATION
DEAERATOR LEVEL CONTROL STN.
CONDENSATE POLISHING UNIT
CONDENSATE PUMPS
A
B
C
DEAERATOR & STG. TANK
BOILER FEED PUMP
BFP MTR.
BOOSTER PUMP
BOILER FEED PUMP
BOOSTER PUMP
B.F.P. TURBINE
BOILER FEED PUMP
BOOSTER PUMP
BFP TURBINE
TO LP FLASH TANK
LEGEND
MAIN STEAM HOT REHEAT (HR), COLD REHEAT (CR), EXTRN. STEAM (ES).
CONDENSATE FEED LINE DRAINS
HR HOT REHEAT
CR COLD REHEAT
ES EXTRACTION STEAM
HD HEATER DRAIN
VALVES
GATE VALVE (NORMALLY OPEN)
GATE VALVE (NORMALLY CLOSED)
GLOBE VALVE (NORMALLY OPEN)
GLOBE VALVE (NORMALLY CLOSED)
CHECK VALVE
GOVERNOR VALVE
BUTTERFLY VALVE (NORMALLY OPEN)
BUTTERFLY VALVE (NORMALLY CLOSED)
ACTUATOR
ELECTRO HYDRAULIC
DIAPHRAGM (SPRING OPPOSED)
ELECTRIC MOTOR
PISTON & CYLINDER
SINGLE LINE FLOW DIAGRAM — STEAM AND WATER SYSTEM.
GUJARAT POWER CORPORATION LIMITED.
2X500 MW. COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.
DRN. BY D.M.
CKD. BY
PL. NO. 5.5
SCALE —
DATE 15.11.94
JOB NO. 93005
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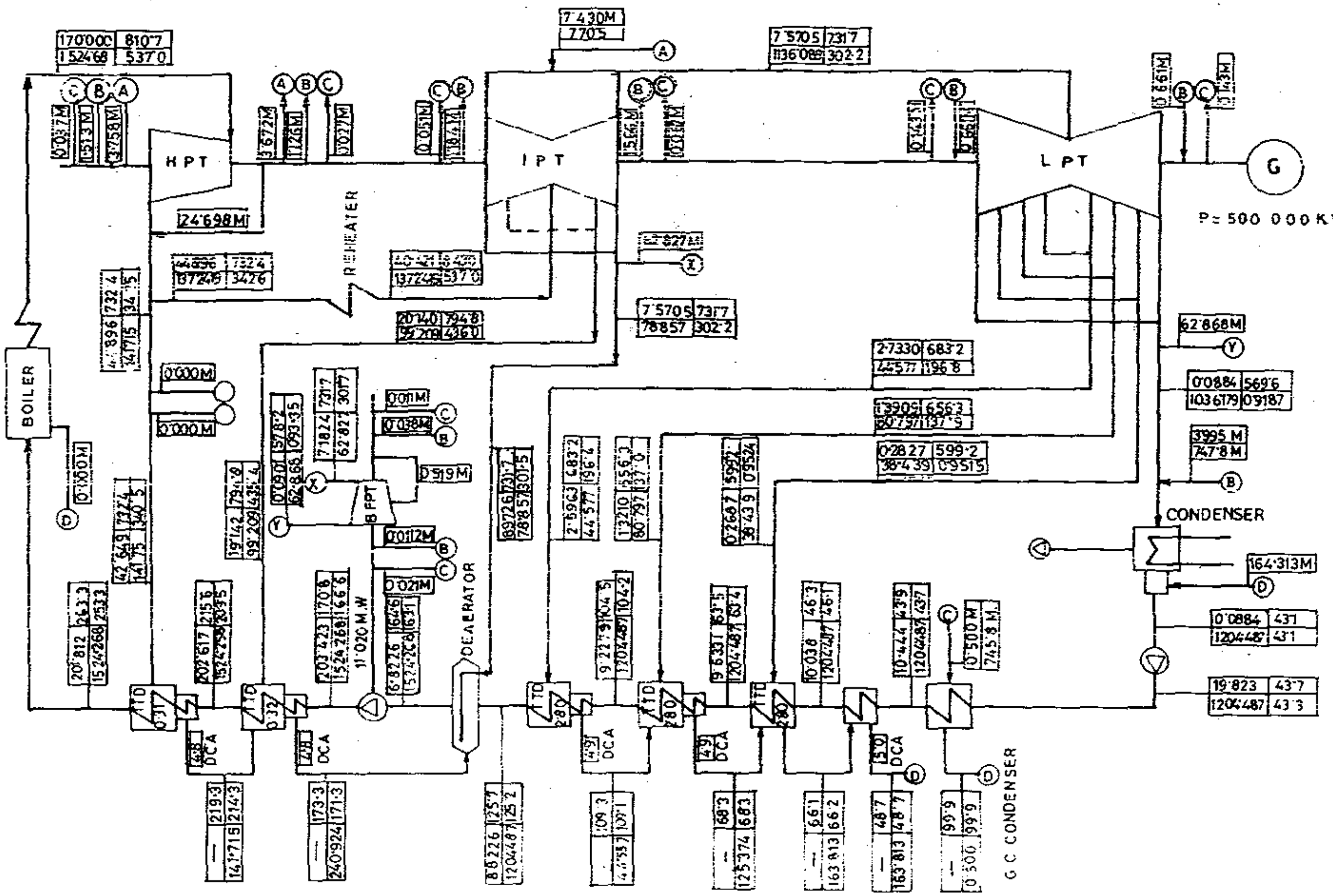
PLATE NO. 5-6



NOTES

1. DATA INDICATED IN THE BLOCK REPRESENT THE FOLLOWING:—

PRESSURE	ENTHALPY
MASS FLOW	TEMP. /DF

2. THE PRESSURE, ENTHALPY, MASS FLOW RATE AND TEMPERATURE AS INDICATED HERE ARE IN ATA, KCALS/KG, TONNES/HR AND °C RESPECTIVELY.

3. THIS DRG. IS A TYPICAL INDICATIVE HEAT BALANCE DIAGRAM REPRODUCED FROM HBD. OF STANDARDS BHEL KWU MAKE 500 MW TURBINE.

HEAT BALANCE DIAGRAM

GUJARAT POWER CORPORATION LIMITED.

2X250MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

DRN. BY	CKD. BY	JOB NO	SCALE	DATE
	T. S.	93005	NTS	16-11-94

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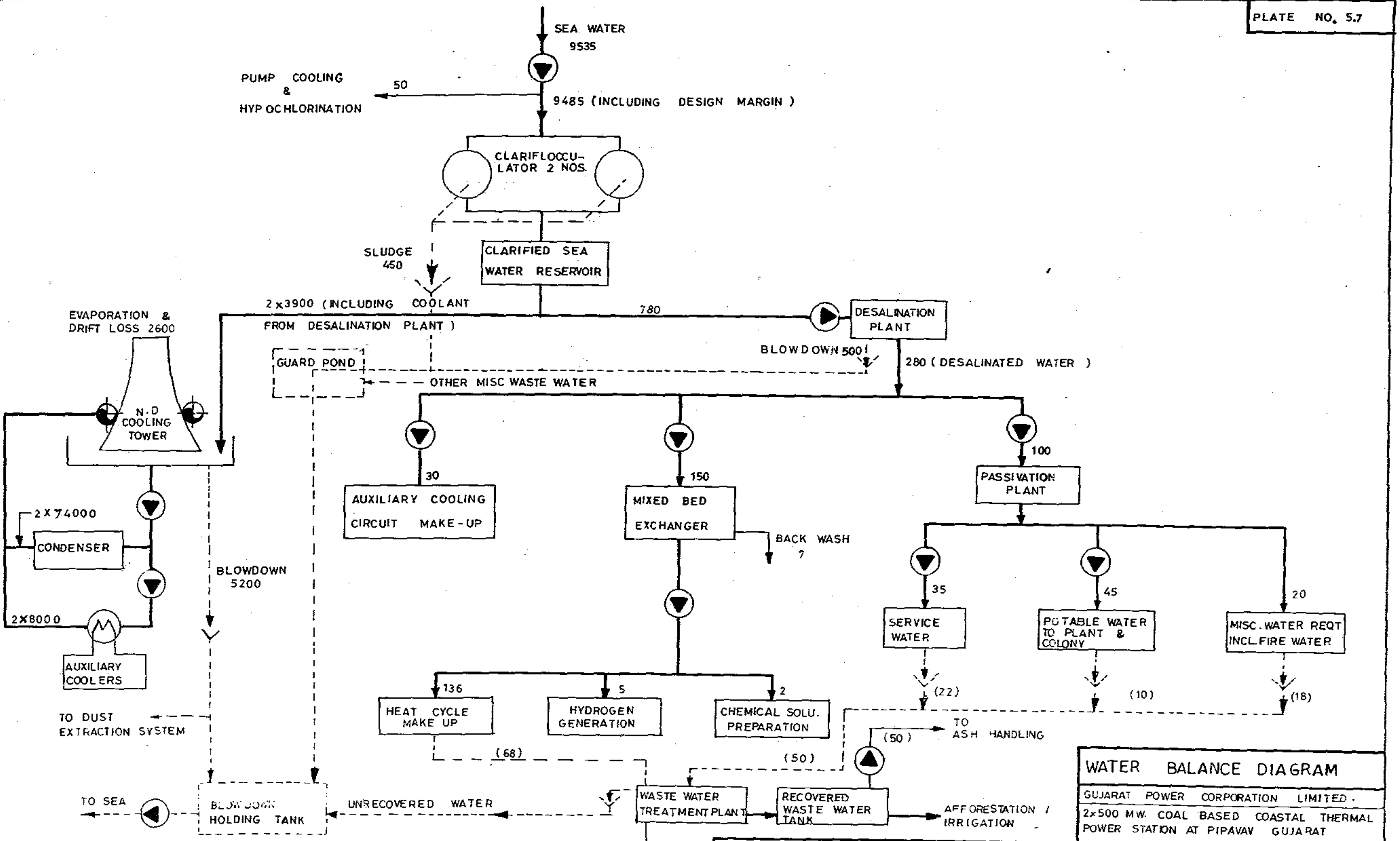
PLATE NO. 5.7



NOTE :– 1. ALL VALUES ARE IN M^3/HR
2. VALUES IN BRACKET ARE TENTATIVE

WATER BALANCE DIAGRAM

GUJARAT POWER CORPORATION LIMITED.
2x500 MW. COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV GUJARAT

DRN. BY	CKD BY	JOB NO	DATE	SCALE
M. SUR.	[signature]	93005	15-11-94	-

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CONSULTING ENGINEERS

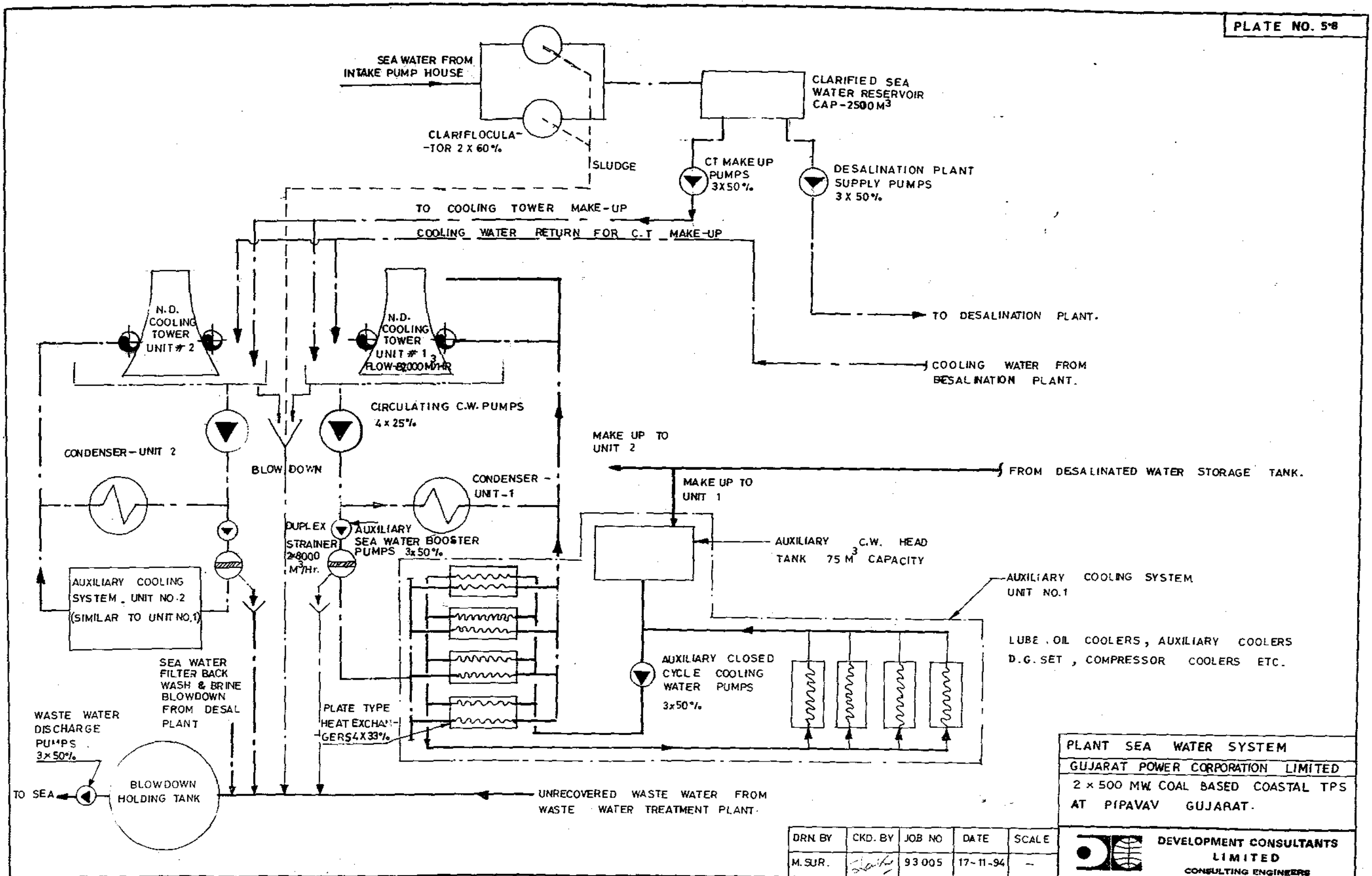


PLATE NO. 5·8
SEA WATER FROM INTAKE PUMP HOUSE
CLARIFIED SEA WATER RESERVOIR CAP-2500 M3
CLARIFLOCULA-TOR 2 X 60%
SLUDGE
CT MAKE UP PUMPS 3X50%
DESALINATION PLANT SUPPLY PUMPS 3 X 50%
TO COOLING TOWER MAKE-UP
COOLING WATER RETURN FOR C.T MAKE-UP
TO DESALINATION PLANT.
COOLING WATER FROM DESALINATION PLANT.
N.D. COOLING TOWER UNIT # 2
N.D. COOLING TOWER UNIT # 1 FLOW-82000 M3/HR
CIRCULATING C.W. PUMPS 4 x 25%
CONDENSER - UNIT 2
BLOW DOWN
CONDENSER - UNIT-1
MAKE UP TO UNIT 2
FROM DESALINATED WATER STORAGE TANK.
MAKE UP TO UNIT 1
DUPLEX STRAINER 2x8000 M3/Hr.
AUXILIARY SEA WATER BOOSTER PUMPS 3x50%
AUXILIARY C.W. HEAD TANK 75 M3 CAPACITY
AUXILIARY COOLING SYSTEM UNIT NO.1
AUXILIARY COOLING SYSTEM UNIT NO.2 (SIMILAR TO UNIT NO.1)
LUBE OIL COOLERS, AUXILIARY COOLERS D.G. SET, COMPRESSOR COOLERS ETC.
AUXILIARY CLOSED CYCLE COOLING WATER PUMPS 3x50%
SEA WATER FILTER BACK WASH & BRINE BLOWDOWN FROM DESAL PLANT
PLATE TYPE HEAT EXCHANGERS 4X33%
WASTE WATER DISCHARGE PUMPS 3x50%
TO SEA
BLOWDOWN HOLDING TANK
UNRECOVERED WASTE WATER FROM WASTE WATER TREATMENT PLANT
PLANT SEA WATER SYSTEM
GUJARAT POWER CORPORATION LIMITED
2 x 500 MW COAL BASED COASTAL TPS AT PIPAVAV GUJARAT.
DRN BY M. SUR.
CKD. BY
JOB NO 93005
DATE 17-11-94
SCALE –
DEVELOPMENT CONSULTANTS LIMITED CONSULTING ENGINEERS

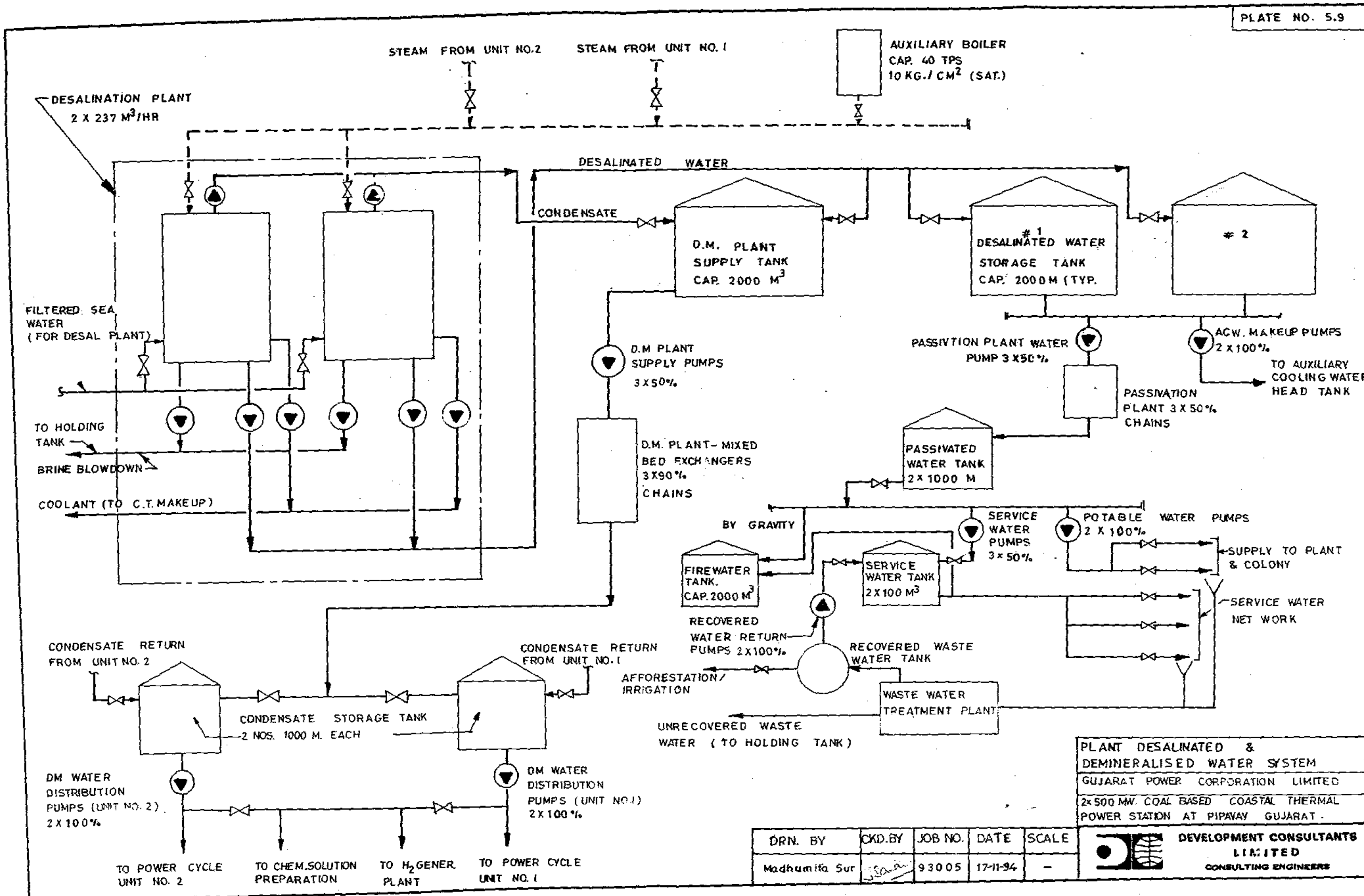
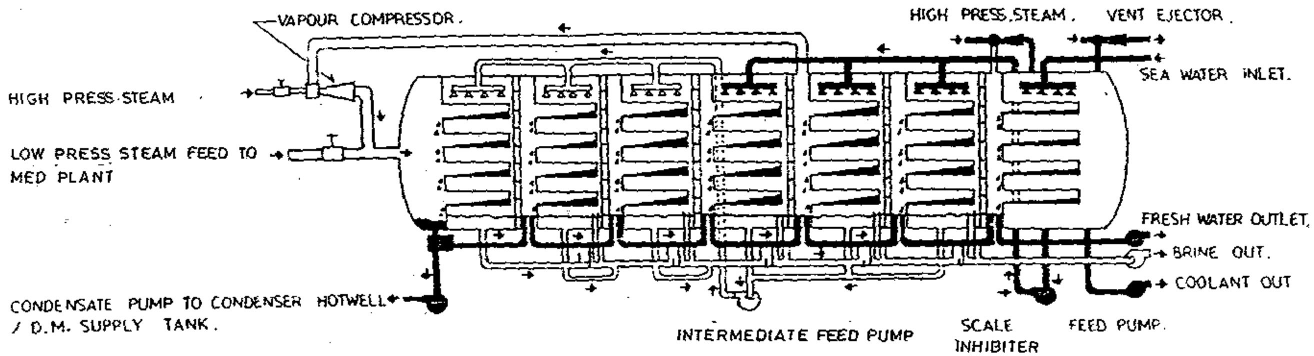
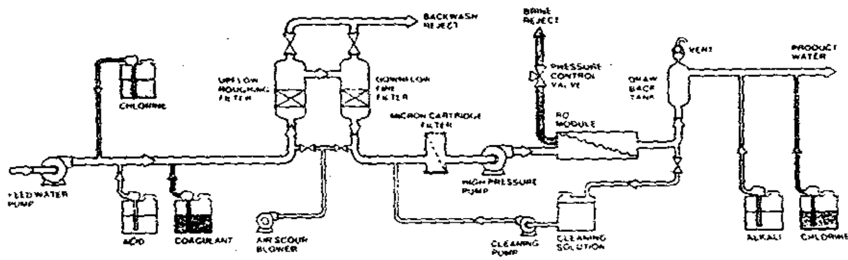


PLATE NO. 5.9
STEAM FROM UNIT NO.2
STEAM FROM UNIT NO.1
AUXILIARY BOILER CAP. 40 TPS 10 KG./CM^2 (SAT.)
DESALINATION PLANT 2 X 237 M^3/HR
DESALINATED WATER
CONDENSATE
D.M. PLANT SUPPLY TANK CAP. 2000 M^3
#1 DESALINATED WATER STORAGE TANK CAP. 2000 M (TYP.
#2
FILTERED SEA WATER (FOR DESAL PLANT)
TO HOLDING TANK
BRINE BLOWDOWN
COOLANT (TO C.T. MAKEUP)
D.M PLANT SUPPLY PUMPS 3 X 50%
D.M. PLANT-MIXED BED EXCHANGERS 3 X 90% CHAINS
PASSIVTION PLANT WATER PUMP 3 X 50%
ACW. MAKEUP PUMPS 2 X 100%
TO AUXILIARY COOLING WATER HEAD TANK
PASSIVATION PLANT 3 X 50% CHAINS
PASSIVATED WATER TANK 2 X 1000 M
BY GRAVITY
SERVICE WATER PUMPS 3 x 50%
POTABLE WATER PUMPS 2 X 100%
SUPPLY TO PLANT & COLONY
FIREWATER TANK. CAP. 2000 M^3
SERVICE WATER TANK 2 X 100 M^3
SERVICE WATER NET WORK
RECOVERED WATER RETURN PUMPS 2 X 100%
RECOVERED WASTE WATER TANK
AFFORESTATION/ IRRIGATION
WASTE WATER TREATMENT PLANT
UNRECOVERED WASTE WATER (TO HOLDING TANK)
CONDENSATE RETURN FROM UNIT NO. 2
CONDENSATE RETURN FROM UNIT NO. 1
CONDENSATE STORAGE TANK 2 NOS. 1000 M. EACH
DM WATER DISTRIBUTION PUMPS (UNIT NO. 2) 2 X 100%
DM WATER DISTRIBUTION PUMPS (UNIT NO.1) 2 X 100%
TO POWER CYCLE UNIT NO. 2
TO CHEM.SOLUTION PREPARATION
TO H_2 GENER PLANT
TO POWER CYCLE UNIT NO. 1
PLANT DESALINATED & DEMINERALISED WATER SYSTEM
GUJARAT POWER CORPORATION LIMITED
2 x 500 MW. COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV GUJARAT.
DRN. BY | CKD.BY | JOB NO. | DATE | SCALE
Madhumita Sur | 93005 | 17-11-94 | -
DEVELOPMENT CONSULTANTS LIMITED CONSULTING ENGINEERS

PLATE. NO. 5-10



TYPICAL MULTI-EFFECT DISTILLATION (MED) FLOW DIAGRAM



TYPICAL PACKAGED SEAWATER RO FLOW DIAGRAM

DESALINATION PROCESS FLOW DIAGRAM
GUJARAT POWER CORPORATION LIMITED
2X500 MW. COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

DRAWN	DATE	CHECK	JOB. NO.	PLT. NO.
Chandra	12.11.94	[illegible]	93005	

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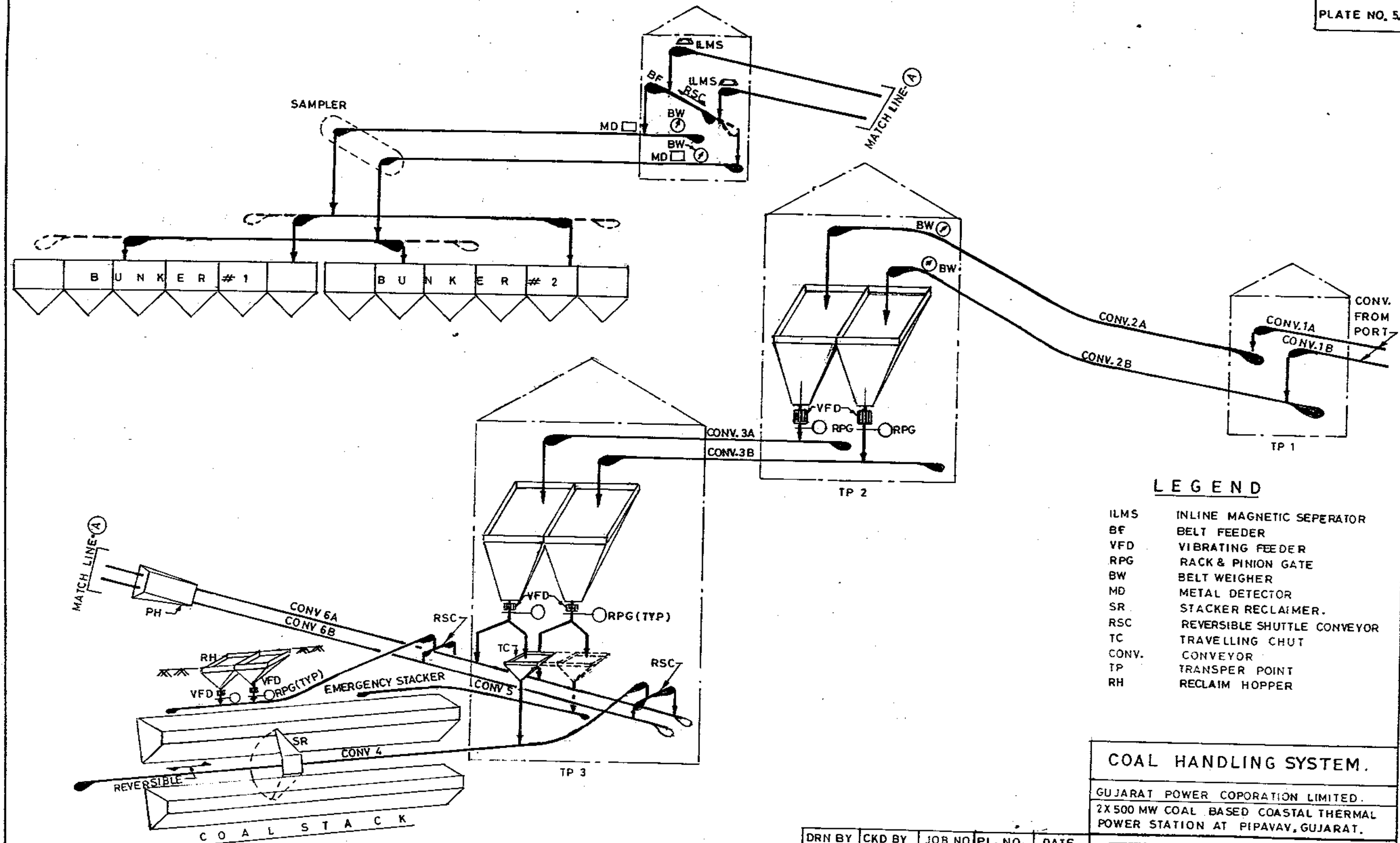
CONSULTING ENGINEERS

PLATE NO. 5.11



LEGEND

ILMS	INLINE MAGNETIC SEPERATOR
BF	BELT FEEDER
VFD	VIBRATING FEEDER
RPG	RACK & PINION GATE
BW	BELT WEIGHER
MD	METAL DETECTOR
SR	STACKER RECLAIMER.
RSC	REVERSIBLE SHUTTLE CONVEYOR
TC	TRAVELLING CHUT
CONV.	CONVEYOR
TP	TRANSPER POINT
RH	RECLAIM HOPPER

COAL HANDLING SYSTEM.

GUJARAT POWER COPORATION LIMITED.

2X500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

DRN BY	CKD BY	JOB NO	PL. NO.	DATE
D.M.		93006	5.11	24-11-94

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

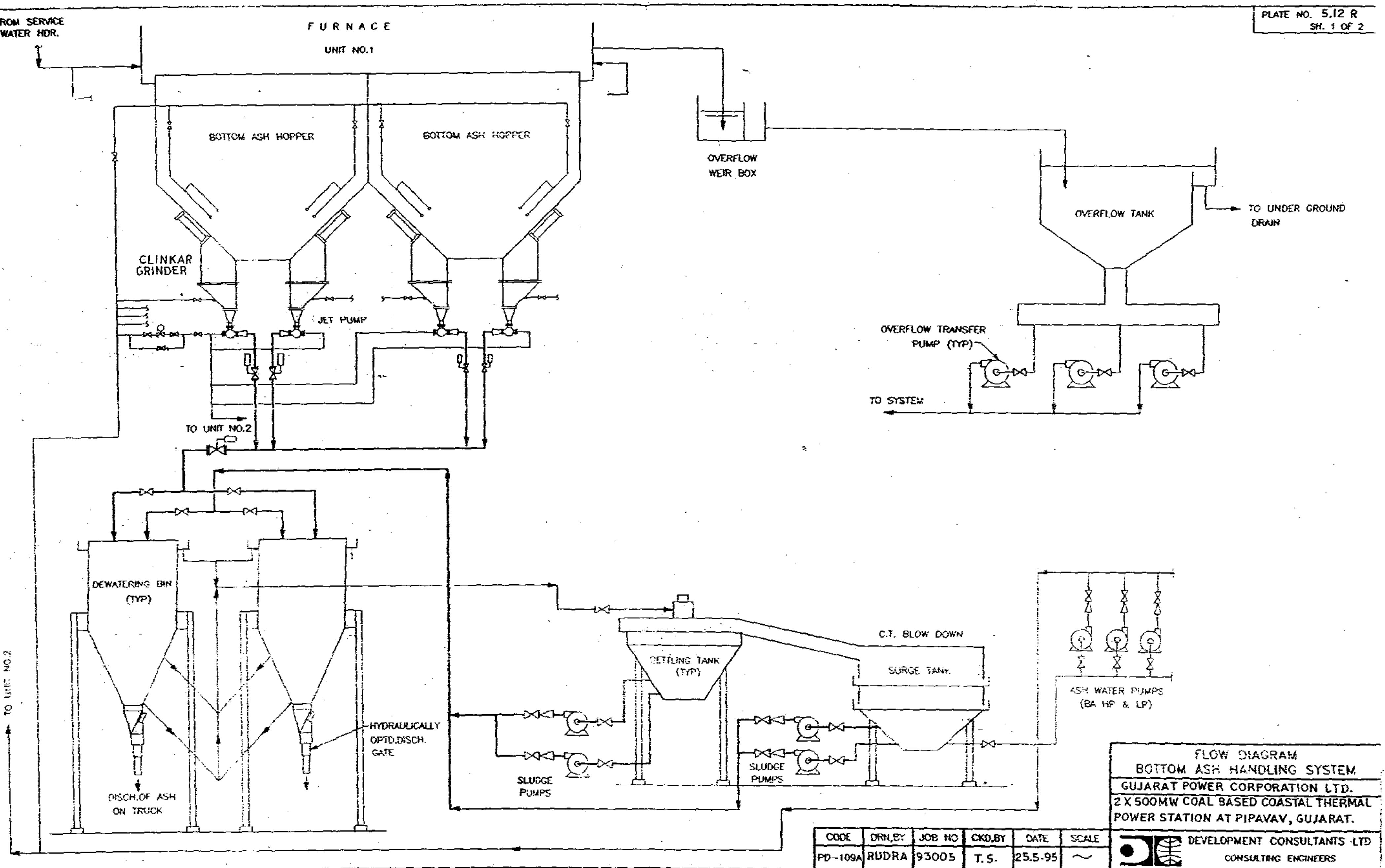


PLATE NO. 5.12 R
SH. 1 OF 2
ROM SERVICE WATER HDR.
FURNACE
UNIT NO.1
BOTTOM ASH HOPPER
BOTTOM ASH HOPPER
OVERFLOW WEIR BOX
OVERFLOW TANK
TO UNDER GROUND DRAIN
CLINKAR GRINDER
JET PUMP
OVERFLOW TRANSFER PUMP (TYP)
TO SYSTEM
TO UNIT NO.2
DEWATERING BIN (TYP)
C.T. BLOW DOWN
SETTLING TANK (TYP)
SURGE TANK
ASH WATER PUMPS (BA HP & LP)
TO UNIT NO.2
HYDRAULICALLY OPTD.DISCH. GATE
SLUDGE PUMPS
SLUDGE PUMPS
DISCH.OF ASH ON TRUCK
FLOW DIAGRAM
BOTTOM ASH HANDLING SYSTEM
GUJARAT POWER CORPORATION LTD.
2 X 500MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.
CODE | DRN.BY | JOB NO | CKD.BY | DATE | SCALE
PD-109A | RUDRA | 93005 | T.S. | 25.5.95 | ~
DEVELOPMENT CONSULTANTS LTD
CONSULTING ENGINEERS

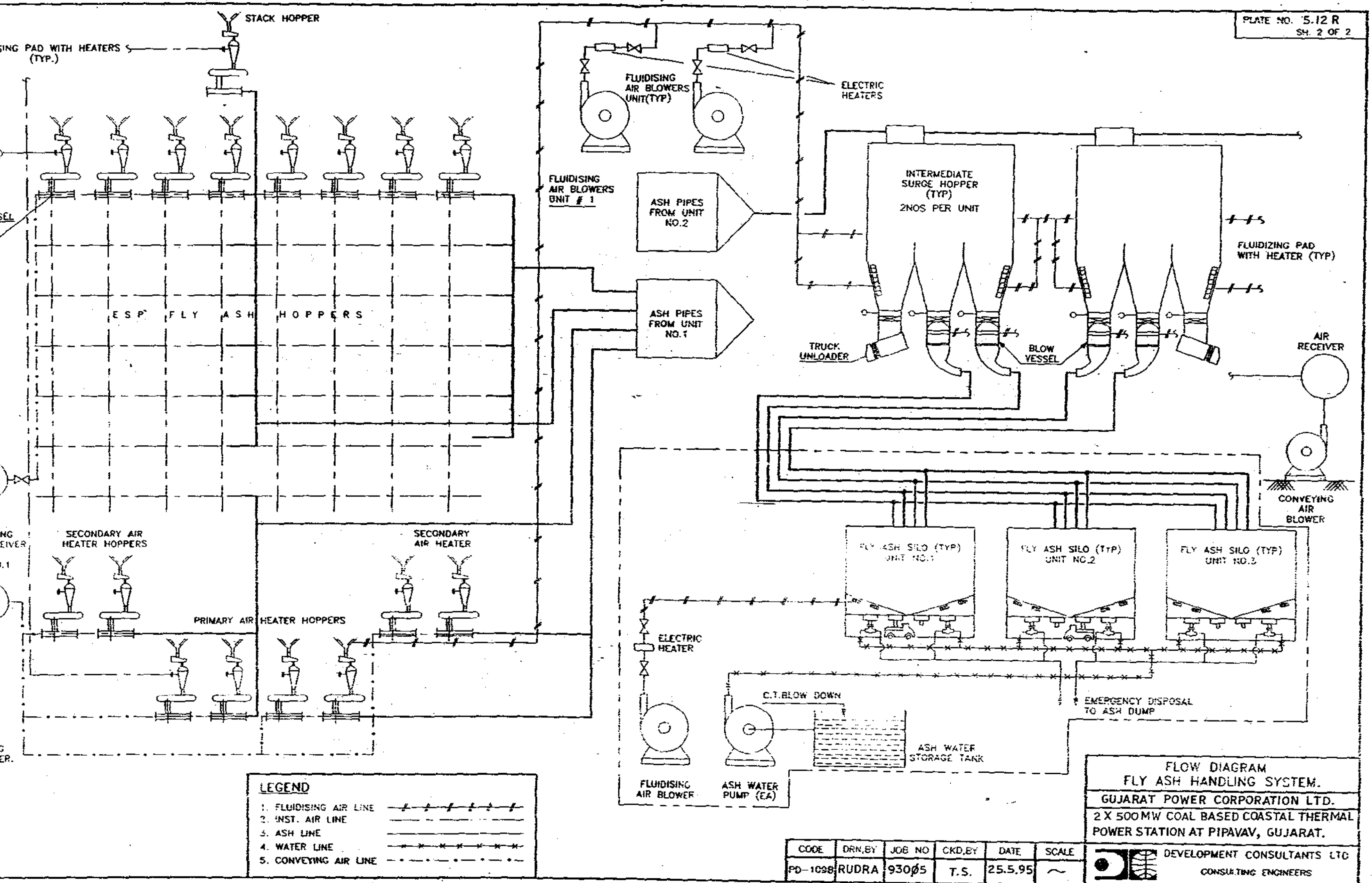


PLATE NO. 5.12 R
SH. 2 OF 2
STACK HOPPER
SING PAD WITH HEATERS (TYP.)
FLUIDISING AIR BLOWERS UNIT(TYP)
ELECTRIC HEATERS
FLUIDISING AIR BLOWERS UNIT # 1
ASH PIPES FROM UNIT NO.2
ASH PIPES FROM UNIT NO.1
INTERMEDIATE SURGE HOPPER (TYP) 2NOS PER UNIT
FLUIDIZING PAD WITH HEATER (TYP)
E S P FLY ASH HOPPERS
TRUCK UNLOADER
BLOW VESSEL
AIR RECEIVER
CONVEYING AIR BLOWER
SECONDARY AIR HEATER HOPPERS
SECONDARY AIR HEATER
PRIMARY AIR HEATER HOPPERS
FLY ASH SILO (TYP) UNIT NO.2
FLY ASH SILO (TYP) UNIT NO.3
ELECTRIC HEATER
C.T.BLOW DOWN
EMERGENCY DISPOSAL TO ASH DUMP
ASH WATER STORAGE TANK
FLUIDISING AIR BLOWER
ASH WATER PUMP (EA)
LEGEND
1. FLUIDISING AIR LINE
2. INST. AIR LINE
3. ASH LINE
4. WATER LINE
5. CONVEYING AIR LINE
FLOW DIAGRAM
FLY ASH HANDLING SYSTEM.
GUJARAT POWER CORPORATION LTD.
2 X 500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.
CODE PD-1098
DRN.BY RUDRA
JOB NO 93005
CKD.BY T.S.
DATE 25.5.95
SCALE ~
DEVELOPMENT CONSULTANTS LTD
CONSULTING ENGINEERS

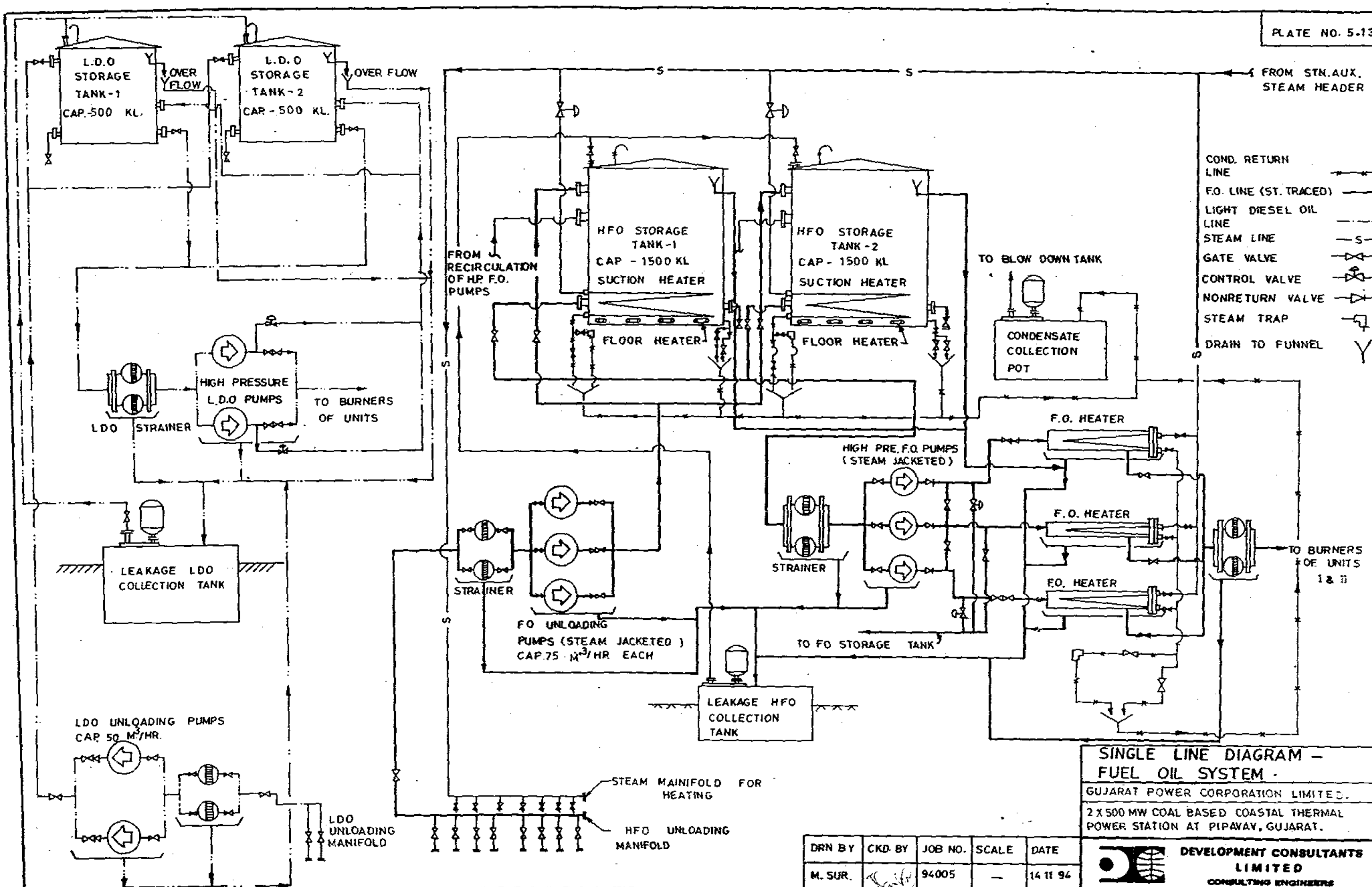


PLATE NO. 5-13
L.D.O STORAGE TANK-1 CAP.500 KL.
L.D.O STORAGE TANK-2 CAP-500 KL.
OVER FLOW
OVER FLOW
FROM STN.AUX. STEAM HEADER
S
HFO STORAGE TANK-1 CAP - 1500 KL SUCTION HEATER
HFO STORAGE TANK-2 CAP - 1500 KL SUCTION HEATER
FLOOR HEATER
FLOOR HEATER
FROM RECIRCULATION OF HP F.O. PUMPS
TO BLOW DOWN TANK
CONDENSATE COLLECTION POT
COND. RETURN LINE
F.O. LINE (ST. TRACED)
LIGHT DIESEL OIL LINE
STEAM LINE
GATE VALVE
CONTROL VALVE
NONRETURN VALVE
STEAM TRAP
DRAIN TO FUNNEL
HIGH PRESSURE L.D.O PUMPS
TO BURNERS OF UNITS
LDO STRAINER
F.O. HEATER
F.O. HEATER
F.O. HEATER
HIGH PRE. F.O. PUMPS (STEAM JACKETED)
STRAINER
TO BURNERS OF UNITS 1 & II
LEAKAGE LDO COLLECTION TANK
STRAINER
FO UNLOADING PUMPS (STEAM JACKETED) CAP.75 M3/HR EACH
TO FO STORAGE TANK
LEAKAGE HFO COLLECTION TANK
LDO UNLOADING PUMPS CAP. 50 M3/HR.
LDO UNLOADING MANIFOLD
STEAM MAINIFOLD FOR HEATING
HFO UNLOADING MANIFOLD
SINGLE LINE DIAGRAM - FUEL OIL SYSTEM -
GUJARAT POWER CORPORATION LIMITED.
2 X 500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.
DRN BY
CKD. BY
JOB NO.
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DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

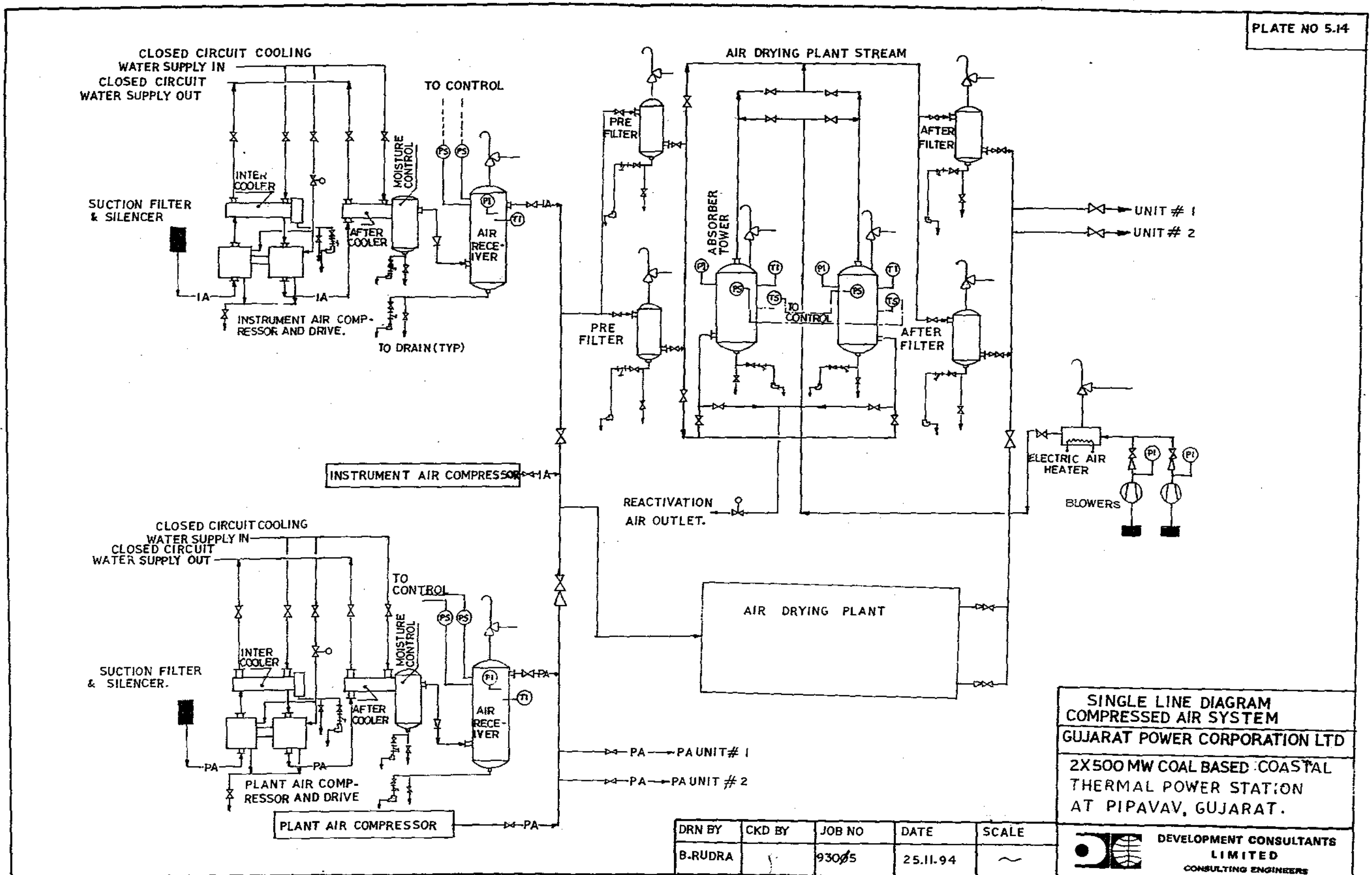
PLATE NO 5.14
CLOSED CIRCUIT COOLING WATER SUPPLY IN
CLOSED CIRCUIT WATER SUPPLY OUT
TO CONTROL
SUCTION FILTER & SILENCER
INTER COOLER
AFTER COOLER
MOISTURE CONTROL
AIR RECEIVER
IA
INSTRUMENT AIR COMPRESSOR AND DRIVE.
TO DRAIN (TYP)
AIR DRYING PLANT STREAM
PRE FILTER
AFTER FILTER
ABSORBER TOWER
TO CONTROL
UNIT # 1
UNIT # 2
ELECTRIC AIR HEATER
BLOWERS
INSTRUMENT AIR COMPRESSOR
REACTIVATION AIR OUTLET.
AIR DRYING PLANT
PLANT AIR COMPRESSOR AND DRIVE
PA
PA UNIT # 1
PA UNIT # 2
PLANT AIR COMPRESSOR
SINGLE LINE DIAGRAM COMPRESSED AIR SYSTEM
GUJARAT POWER CORPORATION LTD
2X500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.
DRN BY
B.RUDRA
CKD BY
JOB NO
93005
DATE
25.11.94
SCALE
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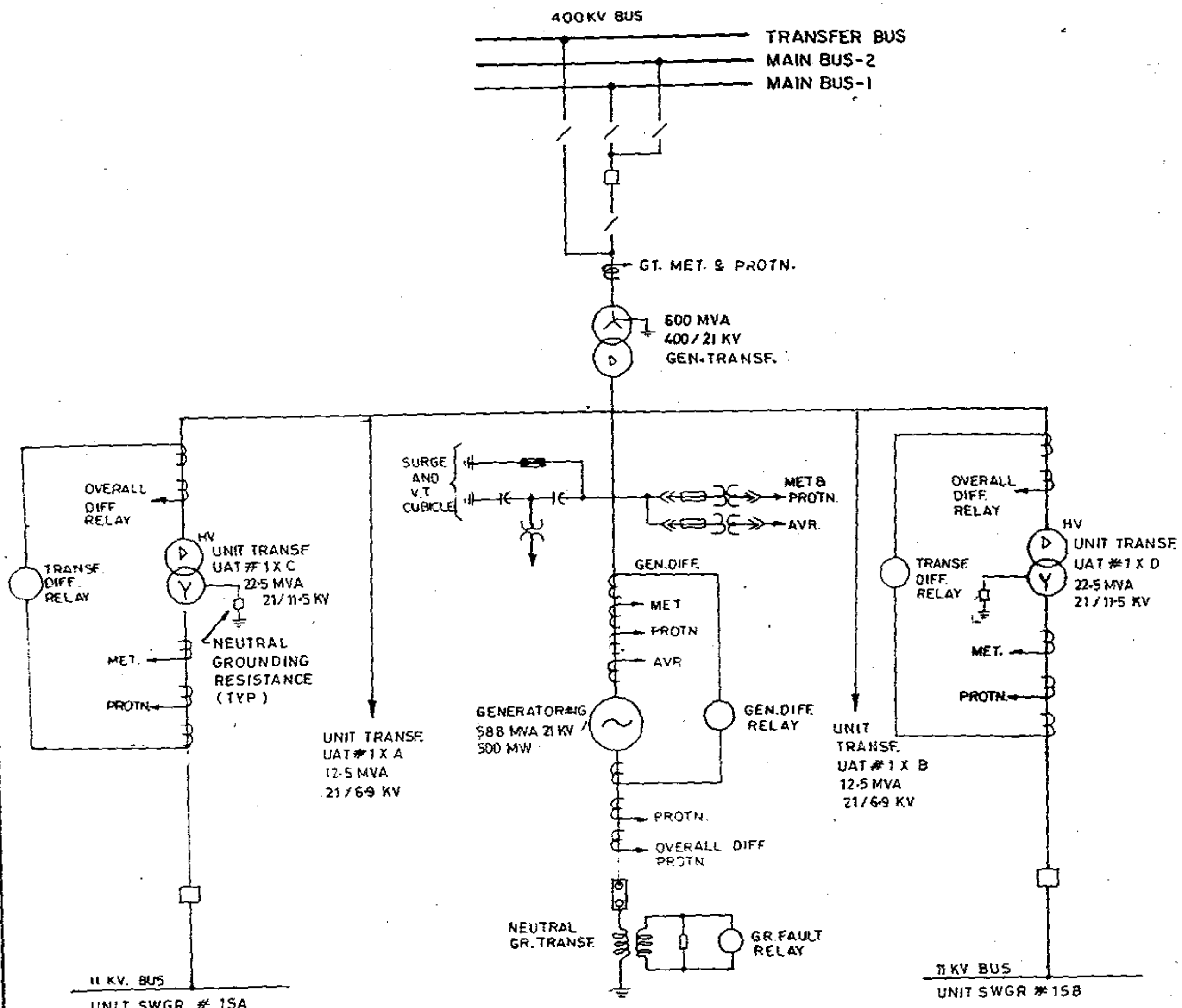
DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

PLATE NO. 5·15



NOTE

ARRANGEMENT FOR UNIT # 2 IS IDENTICAL.

SINGLE LINE DIAGRAM — GENERATOR AND UNIT SYSTEM.

GUJARAT POWER CORPORATION LIMITED.

2 X 500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

DRN.BY	CHK'D.BY	APP'D.BY	DATE	SCALE	JOB NO.	PLATE NO.	REV.
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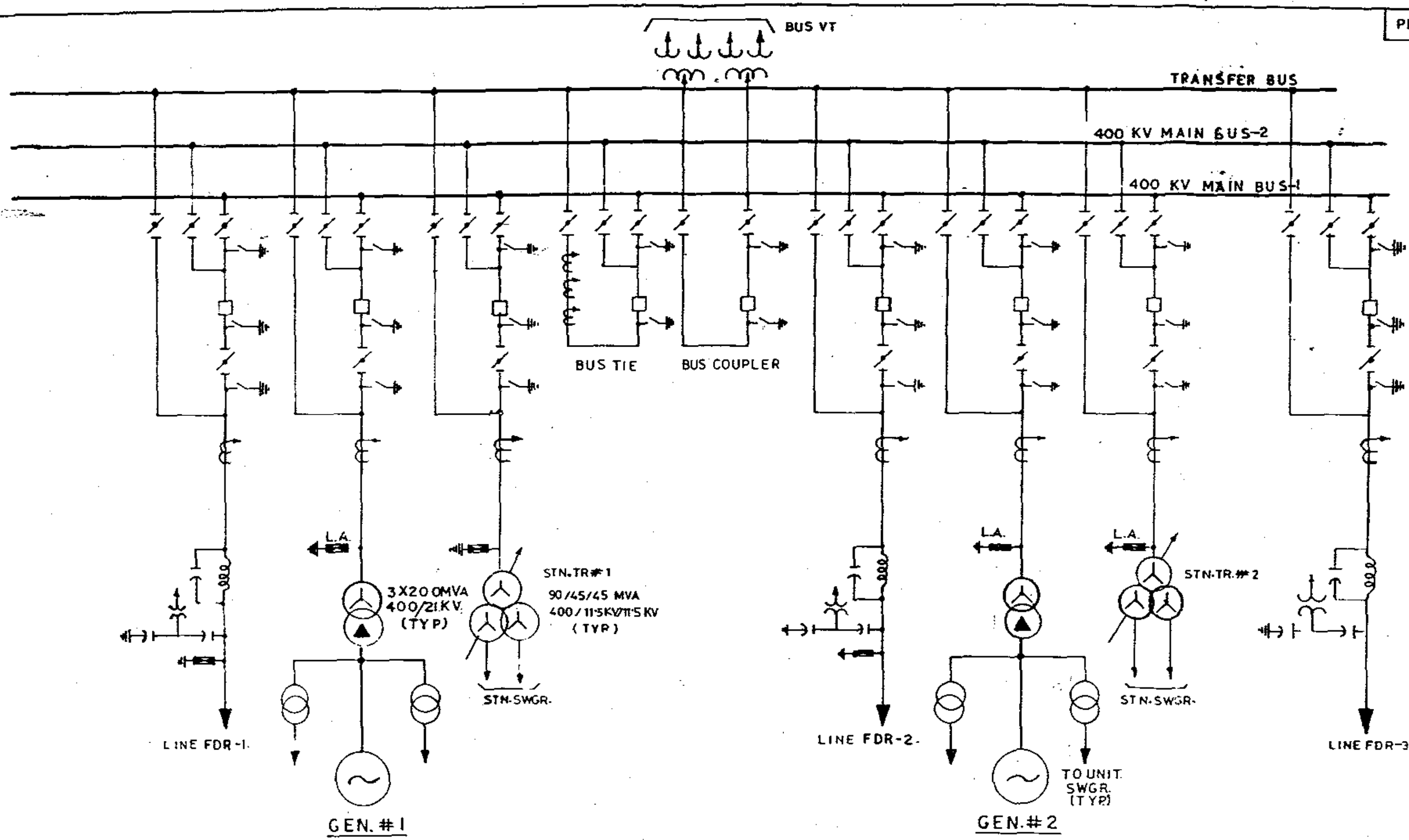
DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

PLATE NO. 5 -16



ELECTRICAL SINGLE LINE DIAGRAM
400 KV SWITCHYARD.

GUJARAT POWER CORPORATION LIMITED.

2 X 500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

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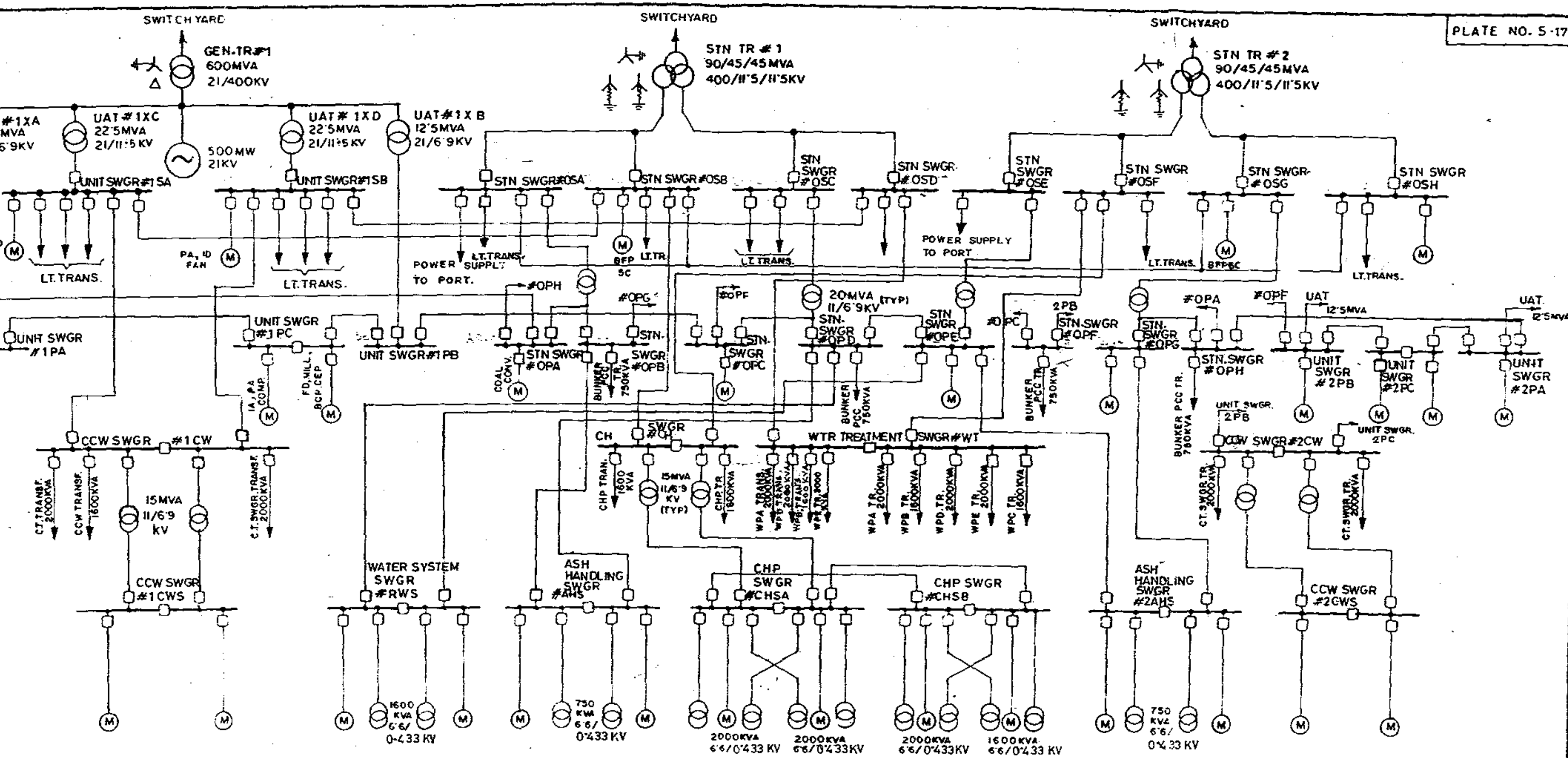
CONSULTING ENGINEERS

PLATE NO. 5-17



NOTE :-

1. UNIT #2 IS NOT SHOWN IN THIS PLATE, IT WILL BE IDENTICAL TO UNIT #1.

STATION CONNECTION DIAGRAM

GUJARAT POWER CORPORATION LIMITED.

2 X 500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.

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S.B. Banerjee.	[signature]		25.11.94	93005	5 - 17	'A'

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 6

ENVIRONMENTAL ASPECTS

SECTION - 6

ENVIRONMENTAL ASPECTS

6.1 Introduction

The proposed 2 x 500 MW coal based thermal power plant of Gujarat Power Corporation Limited will be located with villages Kovaya, Tulsapur, Vand and Charant of Amreli District surrounding the plot. The place is located about 14 Kms south of Rajula town about 8.5 Kms north-east of Jafarabad and 15 Kms west of Pipavav Port. There are some major industries proposed in and around Pipavav Port like - GEB's Gas Based Power Station, ONGC's installation, Larsen & Toubro's White Cement Plant and Narmada Clinker. Besides these, the port facility at Pipavav Port is being augmented to cater these industries. The proposed 2 x 500 MW imported coal based power plant is proposed to be set-up on a plot 7 Kms from the presently proposed Port Complex. It is quite apparent from the above that these basic industries are going to catalyse further industrial growth of the region in near future. It is thus expected that the proposed power project will go a long way in meeting the energy demand of the Gujarat State in general and the Saurashtra region in particular. In addition, the proposed project will generate local employment and promote socially compatible development in the area.

The effect of the project on environment should be seen in broader perspective of overall impact on the adjoining areas. It may be appreciated that the flow of reliable and abundant power from the proposed station would not only encourage growth in the area but may bring about a facelift in industries in the area by switching over to electricity as their source of energy. The proposed new power station would be equipped with modern, sophisticated pollution control devices to bring down the emission of pollutants to a level within acceptable norms of the country.

6.2 Environmental Factors

A thermal power station utilising coal as its prime fuel creates pollution involving the following :-

i) Particulate matters

ii) Toxic gases

iii) Thermal pollution

iv) Chemicals in liquid forms such as acids and alkalies.

The main pollutants from a thermal power plant are discharged through the following sources :

i) Stacks - discharging partiulate matters, toxic gases (e.g. CO, SO_2 & NO_x) and heat

ii) Circulating water blowdown from condenser cooling circuit - discharging heat, water with higher salt concentrations and chemicals added for treatment of (saline) circulating water

iii) Coal Handling Plant - coal dust and particulate matters

iv) Concentrated brine from the desalination plant

v) Effluents from the Mixed bed exchanger of DM Plant - discharging acidic and alkaline liquid through neutralising pit.

6.2.1 Means to Limit Pollution from a Thermal Power Station

In the following paragraphs, the source of pollution and also the methods proposed for limiting the same have been discussed. Some pertinent information on environmental pollution have also been given in **Annexure-6.1**.

i) **Emission from Stack :**

Emissions from stack are particulate matter, toxic gases and heat carried over by flue gases. A suitable height of stack is very important to limit the ground level concentration of pollutants emitted through the stack. A brief discussion on the nature of emission is given below :-

a. Particulate matter

The fuel to be used in this power station is expected to contain a maximum of 14% ash. In the boiler furnace about 20% of ash called Bottom Ash would be retained as Coarse Ash and the balance 80% would be carried along with the flue gas in the form of fine particulate matter as Fine Ash. To limit the concentration of the Fine Ash in the exit flue gas, a dust-trapping arrangement, through electrostatic precipitator (ESP) with a suitably designed stack for proper dispersal, are to be installed.

After separation of most of the Fine Ash in the ESP a negligible amount of Fine Ash remains in the stack emission, since no dust collecion device can be 100% efficient. The dust collection efficiency of electrostatic precipitators, which have been installed in the latest units in the country, ranges from 99.8% to 99.9%. To ensure better environment, seven(7) field ESPs having an efficiency of about 99.9% are envisaged for the proposed 2 x 500 MW unit power plant.

The residual Fine Ash in flue gas, after collection by ESP, is dispersed to the atmosphere through the stacks, height of which is also an important parameter for limiting the ground level concentration of the particulate matter emitted. Selection of ESP with required efficiency together with the dispersion effect of the 275 M height of stack will ensure that the ground level concentration of the particulate matter remains well within the permissible limits.

b. Toxic Gases

The type of fuel proposed to be used in the station may have a maximum sulphur content of 0.6%. The sulphur content is relatively low, on the basis of SO_2 emission per million unit of heat when compared with indigenous coal. Estimated maximum SO_2 emission per stack would be about 2206 Kg/hr and with 275 M high chimney, the ground level concentration is expected to be well within the Department of Environment prescribed values. However, as per present environmental norms, a space provision is kept for installation of a desulphurisation plant in future. Selection of a stack height of 275 M will also ensure the ground level concentration of particulate matter well within the acceptable limits.

Carbon Monoxide as a source of pollution does not exist in the modern power stations as design of combustion control equipment and the furnace eliminate, almost completely, the possibility of incomplete combustion.

Generation of nitrogen compounds (NO_x) in a pulverised fuel boiler may be maintained at a reasonable value by adopting appropriate burner and suitable combustion technology. In this case due to moderate Volatile Matter (VM) content of the main fuel this may be suitably controlled.

It may, therefore, be noted that because of the combustion technology adopted and the chemical composition of the main fuel, emission of toxic gases in unacceptably high amount, can be ruled out.

c. Thermal or Heat Pollution

Heat loss through the stack reprsents only about 6% to 8% of the total heat input to the furnace. The quantum of heat, so lost into the atmosphere, is insignificant considering the capacity of the atmosphere as the ultimate heat sink.

The effect of tall chimney, which takes care of the particulate and noxious gas dispersal, would also indirectly help in minimising the thermal pollution, if any. Due to the high kinetic energy gained by flue gases emanating from the high stack, the effective rise of the plume would ensure discharge of flue-gas at a considerably higher stratum thereby leaving the local environment virtually unaffected.

In view of the above conditions, chances of perceptible environmental pollution, arising from stack emission barely exists.

d. Ground Level Concentration of Pollutants

As stated earlier, the stack height is one of the important parameters affecting the ground level concentration of the particulate matters and toxic gases. The notification on ambient air quality standards issued by the Central Board for Prevention and Control of Water Pollution, Department of Environment, recommends that the Ground Level Concentration (GLC) of the particulate matter and SO_2 shall be limited to 150 and 80 micro grammes per normal cubic metre respectively for residential and mixed use areas. With proper selection of ESP's and with 275 metre high stack, it would be possible to limit the ground level concentration of pollutants with both the units operating at full load, within permissible limits.

ii) Ash/Solid Waste Disposal

Both the Coarse Ash from the furnace bottom and the Fine Ash from the dust collecting hoppers are proposed to be taken to the ash disposal area as per the scheme discussed earlier (Section-5).

Efforts would be made to find gainful use of the solid waste from the boilers in cement plant, building inuustry etc., the possibility of which appears to be bright in view of marketability of the product in nearby areas. However, a land area of about 130 Ha has been earmarked close to the plant boundary for disposal of ash.

iii) Coal Handling Plant :

The coal handling in power plant is a source of particulate pollution under adverse wind-speed condition. In order to limit spreading of dust, water will be sprinkled in the stockyard as and when required. Adequate dust extraction equipment will be installed at specific locations of high dust generation in the system.

iv) Effluent from Water Treatment Plant :

In view of use of desalinated water as input, minimal demineralising is required in this plant. The demineralising process in the DM Plant will generate alternately acidic and alkaline effluent during the regeneration of the two types of ex-changers. It is proposed to install a neutralising basin where proper neutralising arrangement of the effluent will be provided.

The neutral effluent from DM plant will be mixed with other saline effluent discharge of the plant and would be collected in an open reservoir, termed guard pond. The collected water would be treated and monitored for quality where from it would go to CT blowdown tank and disposed by pumping. Non-saline waste water would be separately collected and treated in a treatment plant. The treated water would then be stored in a reservoir and reused in ash handling plant. Excess water would be used for afforestation/horticulture. In **Plate No**.6.1 the scheme for treatment of liquid effluent is shown.

In **Annexure-6.1** and **Annexure-6.2**, enclosed the basic information for environmental clearance in the prescribed format of Department of Environment, Govt. of India and that of Gujarat Pollution Control Board's are furnished.

6.3 Commercial Utilisation of Fly Ash

The ash handling system for the proposed 1000 MW coal based thermal power station comprising two(2) units of 500 MW capacity each at Pipavav would be designed to handle about 52 T/hr of ash generation with worst coal having 14% ash content. The fuel ash after combustion forms fine suspended particles in the boiler furnace and are carried by the hot flue gases on its way to the chimney. The fine particles carried away by flue gases are arrested in the electrostatic precipitators and some comparatively coarser particles in the hoppers of air heaters are known as 'Fly Ash'. About 20% of the fuel ash particles get fused together in furnace and dropped to the bottom of furnace forming coarser material and is known as 'Bottom Ash'.

It is estimated that a maximum of about 247 T of Bottom Ash and 988 T of Fly Ash will be produced daily. Fly Ash will be collected from air heater, chimney and electrostatic precipitator hoppers and will be extracted and conveyed directly to storage silos by pressure conveying system in dry state as generated in the boilers. The Bottom Ash will be transported in slurry form upto dewatering bin with the help of high pressure water supplied by ash water pumps. Two units of 500 MW using imported coal as stated earlier would generate about 0.06 Million Tonnes of coarse ash and 0.25 Million Tonnes of Fly Ash annually.

The concept of ash disposal generally adopted in almost all the thermal power stations upto the recent past was to dispose the mixture of Fly Ash with Bottom Ash in slurry form which is impounded in low lying areas called 'ash pond'. The mixture of Fly Ash and Bottom Ash, due to different physical and chemical properties are found to be ineffective for commercial exploitation. Thus, the disposal of enormous quantity of ash generated regularly from the thermal power stations has become a matter of National concern and attracted attention of the technologists in the country.

With considerable research and development during the past two decades in the developed countries as well as in India, various avenues for commercial utilization of Fly Ash has been established. Fly Ash content being 80% of total ash generated and in view of difference in physical and chemical properties of Bottom Ash and Fly Ash, it is considered appropriate to segregate Fly Ash from Bottom Ash.

The Fly Ash collected in the ash silos are discharged directly for disposal beyond the plant site for commercial exploitation as outlined in the subsequent paragraphs. The Bottom Ash after decantation in the hydrobins will be conveyed in trucks outside the plant site and finds a ready market as a replacement of cinders in land filling etc. The use of Bottom Ash in area filling is found to be satisfactory over years.

Before Fly Ash is recommended for commercial use in any form, it is necessary to study the properties of the same. Fly Ash principally consists of spherical particles of crystalline matter and some unburnt carbon. It varies from light to dark grey in colour. The specific gravity lies between 1.9 and 2.3 and the bulk density of loose dry Fly Ash is around 600 Kg/M^3.

The grading of Fly Ash from precipitator is between medium silt to fine silt. They are basically oxide, silicates or aluminates and thus quite stable compounds. The three pre-dominant elements in Fly Ash are silicon, aluminium and oxygen which together account for 75% to 90% of the material. The coal ash analysis as available from overseas supplier is as follows :-

Ash Analysis :-

a.	Silica (SiO_2)	:	56%
b.	Alumina (Al_2O_3)	:	26%
c.	Iron Oxide (Fe_2O_3)	:	6.5%
d.	Lime (CaO)	:	3.5%
e.	Titania (TiO_2)	:	1.3%
f.	Phospheric Anhydride (P_2O_5)	:	1.0%
g.	Magnesia (MgO)	:	1.3%
h.	Sodium Oxide (NO_2O)	:	0.6%
i.	Potassium Oxide (K_2O)	:	0.8%
j.	Manganate (Mn3O4)	:	0.08%
k.	Sulphate (SO_3)	:	1.6%

A typical particle size distribution through electrostatic precipitator may be as follows :-

Particle Size Range (Micron)	Percentage of Ash collected in ESP fields						
	1	2	3	4	5	6	7
Less than 2	1.07	2.09	3.48	4.69	5.88	1.26	9.09
2 to 5	8.97	14.49	20.72	24.99	29.4	28.95	36.37
5 to 10	17.81	22.38	25.92	27.35	27.94	28.95	27.27
10 to 25	33.96	30.97	26.96	24.22	20.58	21.04	18.19
More than 25	38.20	30.06	22.91	18.75	16.18	15.79	9.00

Fly Ash, being a product of high temperature, has pozzolonic property and forms cementous material when mixed with lime and water.

The above properties of Fly Ash make it suitable for the following commercial uses :-

i. Building blocks

ii. Light weight aggregates

iii. Partial cement replacement

iv. Road sub-base

v. Grouting material

vi. Filler in asphalt mix for roads

vii. Partial replacement of line aggregate in concrete work

viii. Road embankment

ix. Land filling material

x. Recovery of minerals namely Aluminium and Iron

Extensive research work are being conducted to explore all the above referred areas of Fly Ash utilisation. For the subject project four major areas are considered. These areas of utilisation have proven acceptability and the bulk requirement can be met from the Fly Ash generated in the proposed plant.

It may be mentioned here that the project is located in an area with comparatively low population, density. Though land availability for disposal of ash is not a constrain in this area, it is to be endeavoured to dispose ash in an environment friendly manner.

a. **Brick Manufacturing :**

The following two established technologies are in use recently in the country :-

i) <u>Mixed with Clay and Fired as in Ordinary Bricks</u>

Scientists of Central Power Research Institute (CPRI), Bangalore have established that Fly Ash bricks containing 70% Fly Ash and 30% clay have substantially high crushing strength compared to the conventional clay bricks. Moreover, by virtue of Fly Ash being a "fired" material, bricks made out of it require less than 8-hours of firing against minimum 24-hours firing for traditional clay bricks, thereby saving 60% in energy cost. These two salient aspects should attract brick manufacturers for making use of Fly Ash in brick manufacturing. They, however, would require assistance regarding the laboratory facilities as well as technical knowhow of the process.

ii) Stabilized Fly Ash Bricks

Central Building Research Institute (CBRI) have adequately studied the technology and market for implementation of stablized Fly Ash brick plants. Stabilized Fly Ash brick is manufactured by addition of nominal quantity of cement/lime in Fly Ash. These bricks, being much lighter than ordinary clay bricks, impose lesser dead load on the structures and thus results in economy in the building cost. This aspect is expected to increase the use of Fly Ash bricks. Besides the design of brick plant is totally mechanised and ensure proper quality control as well as good finish, which in turn improves architectural appearance of the structure as a whole. It has been observed that such mechanised plant is cost effective when the daily production exceeds around 1 to 1.5 lakh bricks per day, utilising around 400 Tonnes of Fly Ash.

The brick industries presently occupying thousands acres of land render the same unuseful. With the utilisation of Fly Ash such wastage of landmass can be substantially reduced. It may, therefore, be expected that government policies will support these schemes and may render the necessary assistance and incentives so as to encourage utilisation of Fly Ash for manufacture of bricks etc.

The brick plant to be promoted by local entreprenures would receive necessary technical support from the project authorities. The plant cost is mainly to be received as loan from different financial institutions with equity participation from the individual entreprenures.

However, in view of low population density in the area this ancillary unit is likely to have limited local market. However, with the prospect of new industrial units proposed in the region, marketability of bricks may improve.

b. **Cement Replacement :**

With the boom in building and construction industry, the price of cement has increased substantially over past few years. Mixing of Fly Ash reduces lack of hydration by its ability to combine with free lime in cement. Thus for mass concrete work like dams, use of such cement will enable use of normal water in the mix and do away with expensive additives in the concrete work. The reactivity of Fly Ash with lime imparts a high pozzolonic character to cement improving its strength and chemical resistance. Besides rounded particles of Fly Ash improves the workability of concrete and helps in providing denser concrete. The product possesses resistance to corrosion specially sulphates, and is less permeable apart from being durable. Thus Fly Ash can replace cement partially which is permitted as per Indian Standards Institute.

The blending of Fly Ash with cement can be best achieved during its production or mixed in the concrete mixture at the work site. But commercial exploitation can be effective if blended in the cement factory itself and marketed in bagged condition in accordance with the provisions of IS:3812, 1981 for use directly in the building work. However, there is no cement plant in close proximity of the power plant area and thus transportation cost of Fly Ash will be substantial.

But considering the prohibitive cost of cement now-a-days, it may be worthwhile to study this aspect of blending cement. Thus, the extent of utilisation of Fly Ash from this plant in cement plants is not expected to be high mainly due to distant location of the plant from cement plants.

c. **Light Weight Aggregate for Road & Concrete :**

Fly Ash mixed with appropriate amount of cement/lime and water and compacted properly in layers will result in strong hard material. With cement to the tune of 10% and appropriate compaction with optimum moisture, a crushing strength much above 150 Kg/Cm^2 is achievable. Again a suitably designed pelletisation plant may be constructed and the properly graded output can be used extensively for normal building works where grade of concrete of about M-150 is to be adopted. The price of stone aggregate in this region would be moderately high. It is estimated that pelletisation with crushing plant can be set-up at a reasonable cost. Considering the capital cost and running expenditure, the production cost of such aggregate at source is expected to be reasonably low thus enabling marketability as a substitute to stone chips. The other use may be directly in the road works compacted in layer. The local authorities spend a sizable amount regularly on road construction and its maintenance work.

However, the extent of Fly Ash utilisation on this account, if such a plant is set-up would be moderate in view of the location of the plant.

d. **Area Filling :**

The use of Fly Ash as a fill material offers the twin advantage of minimum processing cost and high rate of utilisation. Fly Ash with appropriate moisture content, when properly compacted in layers, forms a suitable load bearing fill. The bulk density being considerably less than the earth fill, fly ash fill exerts less pressure on the ground allowing relatively higher embankment construction on the terrain with poor load bearing ground. Besides, Fly Ash has a self-hardening property and its strength increases with time. Thus because of light weight, stability, low active pressure, negligible settlement and easy handling, Fly Ash is being increasingly used in road works.

There are some limestone mines in the vicinity. Using ash as mine fill in the abandoned mines is a distinct possibility. The overburden after mixing with fly ash from the plant would form a good landfill material. After dumping of ash as minefill if a top soil cover of about 600 mm is provided, this would render the land suitable for cultivation provided water is arranged.

Among the above four alternate methods of utilisation of ash using ash as minefill appears most attractive subject to clearance by mining authorities. However, a plot of 130 Hectares of land is identified to dump ash from the station till the above mode of ash utilisation is adopted and also during any disruption in the normal mode of ash utilisation.

Annexure - 6.1
Sheet 1 of 19

QUESTIONNAIRE

ENVIRONMENTAL APPRAISAL OF THERMAL POWER PROJECTS BASIC INFORMATION ON ENVIRONMENTAL APPRAISAL

1.0 GENERAL INFORMATION ABOUT THE PROJECT

1.1	Name/Title of the Project	:	2 x 500 MW Coal Based Coastal Thermal Power Project
1.2	Name and address of the project	:	GUJARAT POWER CORPORATION LIMITED Panchavati, Ellisbridge Ahmedabad-380006 Gujarat, India.
1.3	Site where proposed plant is to be located (Site Map, Land Layout Plan to include a 25 Kms radius zone around the site, to be enclosed)	:	Site is located near Pipavav in Amreli District, Gujarat Longitude 71° 26'E, Latitude 20° 54'N. The vicinity map and location map are given in Plate No.4.1 and Plate No. 3.1 respectively.
1.4	Capacity of the project under consideration	:	2 x 500 MW.
1.4.1	Whether alternative sites were explored? If so, give following details for each site (Maps to be enclosed)	:	The following alternate locations were studied : namely near Mundra in Kutch District, near Veraval in Junagarh District. The site near Pipavav was selected for techno-economic reasons.
1.4.2	Land use pattern of the land	:	Predominantly fallow and government waste land with marginal cultivation depending on rains.
1.4.3	Cost of land per acre/hectare	:	Rs.2.5 Lakhs per Hectare.
1.4.4	Govt. of India and/privae land/others	:	Mostly private owned and marginally government land.
1.4.5	Topographical feature, demographic profile and physiography	:	Gradually sloping towards the sea.

Annexure - 6.1
Sheet 2 of 19

1.4.6	Nature of soils	:	CLAY LOAM to CLAY indicating moderately fine to fine texture of soil.
1.4.7	Distance from the nearest town/city/monitor human settlements	:	Rajula - 14 Kms. Pipavav Bandar - 15 Kms. Jafarabad - 8.5 Kms.
1.4.8	Population to be displaced	:	Nil
1.4.9	Distance from water source	:	Entire consumptive water would be brought in from the sea. Sea is about 3 to 4 Kms from the site.
1.4.10	Area of forest land, if involved	:	None
1.4.11	Distance of forests from the site	:	Reserve Forest - 8.5 Kms.
1.4.12	Give basis for selection of the final site	:	(Ref. **Plate No.4.1**) 1. Located adjacent to a port under active consideration of government for augmentation to handle 60,000 DWT ships. 2. Near State Highway. 3. Consumptive water located nearby.
1.5	Is this an extension: If, so indicate capacity of the existing plant	:	No
1.6	What is the ultimate capacity envisaged	:	2000 MW Space provision for another 1000 MW considered.
1.7	Name and address of the person, consultant, if any	:	DEVELOPMENT CONSULTANTS LIMITED 24-B, Park Street Calcutta - 700 016

2.0 GENERAL ENVIRONMENTAL INFORMATION

2.1	Details of major industries, thermal power plants, mines, quarries etc. within a radius of 25 Kms of the plant site	:	a. Lime stone quarries. b. Proposed plants of Larsen & Toubro, ONGC and GEB. c. M/s Metdist Limited, U.K. (Copper smelted plant) d. Narmada Clinker e. Pipavav Bandar f. Salt pan
2.2	What is the total human population within a radius of 25 Kms of the plant site indicating the pattern of population dispersal	:	About 150,000 at pesent.
2.3	Give a broad description of the site. Attach maps showing topographical feature	:	Site is 15 Kms West of Pipavav Bandar. See Plate No. 4.1.
2.3.1	Nature of soils	:	Onshore Top soil is sandy upto 0.5 M, coarse in nature. Highly permeable with gradual reduction in value with depth. Soil texture is clayloam to clay. Soil is predominantly saline.
2.3.2	Area of the land proposed to be acquired (attach layout plan)	:	Please refer **Plate No.5.1.**
	i) Area required for plant	:	About 300 Hectares
	ii) Ash disposal	:	135 Hectares. The ash may be reused / sold as landfill and construction material, as much as possible.
	iii) Colony (indicate separately for departmental staff, contractor's staff and others, if any)	:	30 Hectares would be required for the colony.

	iv) Pipe Route	:	4.5 Hectares
	v) Transmission corridors & power evacuation system	:	To be arranged by GEB.
	vi) Approach road, railway bridges etc	:	) 10 Hectares
	vii) Others	:	)
2.3.3	Present use of land - agriculture/ forest/grazing/human settlement/fallow	:	Fallow and Government Waste land.
2.3.4	Area proposed to be built-up or developed	:	300 Hectares.
2.3.5	Specify site characteristics : River basin/estuarine/coastal/others	:	Inland site is about 3 to 4 Kms. from sea.
2.4	Is the site situated in the forest area? Give following details :-	:	No
2.4.1	Area	:	Not applicable.
2.4.2	Type of forests	:	Not applicable.
2.5	Is site situated near to the forests? Give the distance from the site	:	Yes, a reserve forest is 3.5 Kms. from the site.
2.6	Give a description of the flora within 25 Kms. of your plant site under following heads :-	:	
	a. Crops	:	WHEAT, BAJARI, COTTON, JAWAR GROUNDNUT etc.
	b. Forest	:	Forest area mangroves on Sea Coast.
	c. Grass land	:	None
	d. Endangered species	:	None
	e. Other (specify)	:	--

2.6.1	Give a general description of the fauna, especially wild life, endangered species, etc., within a radius of 25 Kms.	:	None worth mentioning within the vicinity.
2.6.2	Give details of the following features, if they exist, within a radius of 25 kms ofthe proposed site:-		
	a. Fisheries	:	Nil
	b. Sanctuarry / natural park / biosphere reserves	:	Nil
	c. Lakes/ponds/reservoir	:	Nil
	d. Stream/river	:	3 Kms from site (Dhatrawardi Nadi).
	e. Estuary/sea	:	About 3-4 Kms from site.
	f. Hills/mountains	:	None.
	g. Historic / cultural / Tourist / archaeological / scenic sites defence installations	:	Airport is about 136 Kms. away at Bhavnagar City.
2.7	**Human Settlement :**		
2.7.1	Total number of persons proposed to be employed :-		
	a. During construction	:	4000 persons.
	b. During operation	:	800 persons.
2.7.2	Do you propose to build a township/housing quarters for your employees/contractor's workers	:	640 residential quarters would be built in the township for the employees.
2.7.3	Area required for above	:	30 Hectares.
2.7.4	Population to be accommodated	:	3200 Persons.

2.7.5	Distance and direction of township from plant site	:	The township planned for the operating staff would be located at a distance of 1 Km. from the site.
2.7.6	Services provided in township :-		
	a. Daily consumption of water	:	1080 M^3/day.
	b. Sewer system	:	) Township would be provided with
	c. Sewage treatment		) septic tank/sewage treatment
			) system, drainage etc.
	d. Drainage	:	
	e. Any other	:	
2.7.7	Number of persons to be displaced along with details of their occupation and incomes	:	None
2.7.8	Number of persons who do not own property but derive their sustenance from the land to be acquired	:	None
2.7.9	Details of rehabilitation plans for oustees	:	Not applicable.
2.7.9.1	Site where they will be resettled	:	Not applicable.
2.7.9.2	Compensation to be paid	:	Not applicable.
2.7.9.3	Authority responsible for their resettlement	:	Not applicable.

3.0 FUEL USE

3.1 Type, quantity and characteristics of fuel use :-

Fuel	Tons per day	% Ash	% Sulphur	Source of supply and its distance from the site
Coal	8823	14%	0.6% (max.)	Overseas sources
(HFO/LDO)	84	1% (max.)	0.2%	Nearby depot

3.2	Has the linkage been established ?	:	Fuel would be sourced from overseas sources.
3.2.1	Name of Mine/Block	:	Not applicable.
3.2.2	Is it a working mine or yet to be opened?	:	Not applicable.
3.2.3	Is the mine situated in the forest area?	:	Not applicable.
3.3	Please furnish a fuel analysis report from a recognised laboratory (Details to include percentage contents of C, H, N, S and Oxygen (if any) and gross calorific value)	:	C : 82% H : 5.4% N : 1.9% S : 0.5% O_2 : 10.2% GCV : 6720 KCal/Kg (Avg.)
3.4	Indicate the type of fuel firing to be adopted	:	Pulverized coal suspended firing.
3.5	Air to fuel ratio to be specified	:	Can be furnished after the supply contract of main equipment is finalised.

4.0 WATER

4.1	Water use and liquid wastes (provide a detailed water balance diagram)	:	Please refer **Plate No.5.6** and **Plate No.5.7.**
4.2	Water is the source of water	:	Sea water for cooling tower. Consumptive sweet water requirement (280 M^3/hr) to be met either from Dhatrawadi/Narmada River, if feasible. Alternatively, desalination of sea water for fresh water applications.
	Will it be adequate for future use?	:	Yes
	Do you propose any measure to augment the water supply and how it will effect the other users?	:	Not applicable.
4.3	Lean season flow	:	Not applicable.
4.4	Give details of the receiving water body	:	Sea water would be pumped from the sea water intake pump house located 4 Kms. away.
4.5	Average daily quantity of water required for :-		
	i) Cooling (make-up)	:	Refer **Annexure-3.1.** (187,200 M^3 sea water)
	ii) Wet Ash Disposal	:	840 M^3 (to use recovered waste water)
	iii) Process	:	5640 M^3 sweet water and 22800 M^3 sea water.
	iv) Others (Potable)	:	1080 M^3.
	v) Total of (i) (iii) & (iv)	:	210,000 M^3 (Sea water rrequirement) & 6720 M^3 of sweet water.

Annexure - 6.1
Sheet 9 of 19

4.6	What type of cooling system is proposed : once-through/closed	:	Semi-open recirculating cooling water system using wet type natural draft cooling towers with sea water as cooling medium.
	i) Give temperature difference between inlet and outlet water	:	Less than 5 °C.
	ii) Annual temperautre profile of the receiving water	:	20 to 32.5 °C.
4.7	Quantity and expected characteristics of the waste water discharged per day from the plant :-		
	i) Cooling	:	124800 M^3 (sea water)
	ii) Ash disposal	:	Nil (Ash disposal system is dry).
	iii) Process	:	168 M^3 (sweet water); 22800 M^3 (sea water).
	iv) Others	:	--
	v) Total of (i) (iii) & (iv)	:	147,600 M^3 (sea water) 168 M^3 (DM water)
4.8	Type of waste water treatment proposed to be adopted for each stream.	:	The effluent from DM Plant would be neutralised in neutralisation pit. Waste water from colony and plant run-offs, floor wash and other effluents etc would be treated for pH, oil and temperature at the Waste Water Treatment Plant. Monitoring of parameters like pH, oil and temperature would be done. The recorded portion of waste sweet water would be reused in Ash Handling Plant. The unrecovered water alongwith sea water wastes would be collected in a holding pond before final discharge into the sea.

4.9	Applicable standards and regulations for the effluents.	:	MINAS - Minimum standards for thermal power station and GPCB standards and MOEF notification dated 19.5.1993 and notification dated 31.12.1993 as applicable.
4.10	Point of final discharge :-		
	Fallow land /agricultural land / sewer / river / lake / bay / estuary / sea	:	Sea.
4.11	Mode of final discharge open channel/ pipeline/covered drains	:	Pipeline.
4.12	If the liquid effluents are finally discharged in river/pond/lake, the impact on the quality of water at the nearest human settlement should be mentioned	:	The effluents including blowdown would be discharged well inside the sea.
4.13	Details of reuse of waste waters, if any	:	The recoverable portion of the non-saline waste water after treatment at the Treatment Plant would be used for Ash Handling, Irrigation / Afforestation etc.

5.0 AIR EMISSIONS

5.1	Please furnish for your location :-		
5.1.1	Wind rose	:	Refer **Annexure-4.1**.
5.1.2	Mean, maximum and minimum temperature for every month of the year	:	Mean - 26.1 °C Maximum - 47.8 °C Minimum - 1.1 °C
5.1.3	Mean wind speed	:	5.9 - 17.6 KMPH
5.1.4	Humidity, rainfall	:	RH - (45 to 77)%; Rainfall - 468 mm and 21.5 rainy days. (Avg.)
5.1.5	Mean cloud cover	:	Refer **Annexure-4.1**.
5.1.6	Percentage (frequency) occurrence of inversions and heights	:	Occurrence only during winter.
5.2	Please specify the following :-		
5.2.1	Number of stacks	:	Two
5.2.2	Number of flues in each stack	:	One per unit
5.2.3	Inter-stack distance	:	About 100 M
5.2.4	Height of each stack	:	275 M
5.2.5	Internal diameter of each stack at the base and top	:	About 23 M at base and 7.5 M at top. Exact value can be furnished after finalisation of supply contract.
5.2.6	Gas velocity	:	25 to 30 m/sec.
5.2.7	Flue gas characteristics :		
	i) Volume ii) Temperature iii) Density iv) Size distribution of particles v) Gas Composition	)	To be furnished later after supply contract is finalised.
5.2.8	Heat emission rate of gases (Kcal/hr) from each stack	)	

5.2.9	Emission rate of SO_2, NO_x and particulates from each stack in kg/hr.	:	Particulate matter - 28.3 Kg/hr. Sulphur Dioxide - 2206 Kg/hr. Oxide of Nitrogen - Less than 400 ppm.
5.2.10	Background pollution levels of SO_2, NO_x and particulates	:	To be furnished after detailed investigation.
5.3	a. What kind of stack emission monitoring is proposed?	:	Continuous monitoring of opacity and SO_2 to check on stack emission. Periodic laboratory analysis of gas.
	b. What equipment is proposed to be acquired or used for this purpose	:	System for monitoring , SO_x, NO_x, CO, Hydrocarbon and electronic smoke density analyser would be provided.
5.4	Give details of the air pollution control equipment proposed to be installed	:	1) High efficiency ESP for flue gas duct separation of about 99.89% 2) 275 M high stack to ensure low GLC.
5.5	Give details of the organisational set-up for maintenance of pollution control equipment and level of expertise and authority of person incharge	:	Separate environment Cell headed by senior environmental manager reporting directly to Chief Executive of the organisation.
5.6	Emission rate of particulates and sulphur dioxide to be released when control equipment is :-		
5.6.1	Functioning normally	:	SO_x - 2206 Kg/hr NO_x - Less than 400 ppm. Particulates - 28.3 Kg/hr.
5.6.2	Not functioning	:	SO_x - 2206 kg/hr. NO_x - 2400 kg/hr/stack. Particulates - 59.12 Kg/hr.
5.7	What special procedure do you propose to lay down for pollution control during periods when emission exceeds prescribed limits for any reason including malfunction of pollution control equipment.	:	It is proposed to have adequate maintenance facilities, spares and trained staff tomaintain the pollution control equipment including the EPS in optimum efficiency. In worst case reduction of generation may be required.

5.8	Other types of pollution	:	None.
5.8.1	Details of measures to control noise	:	Necessary measures will be taken to meet OSHA/EPA other internationally accepted standards and Indian EPa 86 Acts/Rules. Noisy equipment would be suitably enclosed.
5.8.2	Details regarding prevention and control of fire and explosion hazards.	:	All equipment would be designed to relevant codes and statutory regulations. Besides fire figting system to satisfy TAC recommendation. Automatic detection and fire alarm system would cover all major plant and equipment.

6.0 TRANSPORATION OF FUEL

6.1	Proposed mode of transport of coal/oil/gas :-		
6.1.1	By rail/MGR	:	Not applicable.
6.1.2	By sea	:	By 45000/60,000 DWT vessel upto Pipavav Port.
6.1.3	By road	:	Not applicable.
6.1.4	By ropeways	:	Not applicable.
6.1.5	Others	:	Coal by conveyor system from port to site and LDO/LSHS by road from nearby Refinery.

7.0 COAL AND ASH HANDLING

7.1	What procedure will be adopted for coal handling at the plant site	:	Coal will be habdled by blt conveyors, stackers and reclaimers as described in Section-5.
7.2	Give details of dust suppression/ collection equipment for reducing pollution from coal fines and other fugitive emissions from coal handling (wagon tippling, conveyor transfer points, storage, crushing mills, bunker filling etc.)	:	Spraying of water as required.
7.3	How do you propose to prevent/treat the run-off from the coal storage/ handling areas	:	Run-off from coal storage and handling areas will be taken to a plate separator and treated water sent to guard pond.
7.4	What quantity of fly ash and bottom ash will be produced per day?	:	Coarse Ash - 247 Te. Fine Ash - 988 Te.
7.5	Indicate the method of collection, transport and disposal of the ash	:	Collection in bottom hoppers and ESP hoppers. Transportation by mechanical conveyor and truck. A provision of emergency wet ash disposal under exigency condition provided.
7.6	What efforts have been made or you wish to make towards utilisation of ash : Bricks/cement/road construction/ landfil/soil stabilization/other forms of disposal or use.	:	The ash is expected to find an end use as building material. Reuse plan will be worked out in detail engineering stage.
7.7	What precuations are proposed to be taken to prevent pollution of water course and ground water from solid waste disposal, esepcially with regard to coal particles and ash slurry?	:	Not applicable as water will not be used for ash disposal.
7.8	What land area is available for ash disposal? Will it be sufficient for the expected life of the plant (say-30-35 years)?	:	Tentatively 135 Hectares have been earmarked for this. This is expected to be adequate.

8.0 CONSTRUCTION MATERIALS

8.1	Indicate source of supply of stones and location of quarries in the site map with the alignment of the roads to the project site and the distance from the site.	:	From local sources.
8.2	Source of supply of sand and its distance from the site	:	From local sources.
8.3	If new roads are to be built whether there alignment is through agricultural land/forest/grazing land/human settlements/fallow land	:	The proposed site is to be connected to the State Highway No.34. An access road of 3.5 Kms is involved.
8.4	Mode of transportation of heavy equipments, cement and steel i.e. by road or rail or sea	:	By Sea / Road.
8.4.1	Name of the nearest rail head where they will be off loaded and its distance from the site	:	Rajula (14 Kms.) Pipavav Bandar (40 Kms.)
8.4.2	If a new road is to be built from the rail head, the details of land tobe acquired should be given	:	Not applicable.

9.0 OCCUPATIONAL SAFETY AND HEALTH

9.1	Health status of workers especially those engaged in the coal handling, ash collection and ash disposal areas	:	Health monitoring as per statutory requirements will be done.
9.2	Whether any adverse health effect due to noise were observed among the workers engaged in the turbine, compressor room, crushing mills etc.	:	Will be as per the OSHA & EPA - 86 & GPCB rules.
9.3	If the plant is new, precuationary measures proposed to be taken for saety and health protection of workers may be mentioned	:	1. Noise abatement measures and personnel protection equipment to workers. 2. Modern Industrial Medical Centre to be set up. 3. Periodic medical examination.

10.0 ENVIRONMENTAL MANAGEMENT

10.1	Give details of organisational set-up, you propose to have for pollution monitoring and control	:	A separate environment cell headed by senior environmental Manager reporting to the Chief Executive, will be formed.
10.2	What is the level of expertise of the person incharge of pollution control?	:	Senior environmental Manager with adequate experience in pollution control and trained staff to operate pollution monitoring equipment and analyse results.
10.3	Briefly outline the proposed environmental monitoring programme, mention no. of observations addressing to the following parameters :-		
10.3.1	Air	:	) Stack monitoring facilities air monitoring station minimum 3 with one emteorological station. The parameters for monitoring and their frequency will be as per GPCB stipulation and other statutory authorities.
10.3.2	Water	:	)
10.3.3	Ground water	:	)
10.3.4	Stack monitoring	:	)
10.4	Have you been asked by Central/State Pollution Control Boards to take any special environmental control measures and now do you propose to carry out these obligations?	:	Not applicable since this is a new plant.
10.5	Raising of green belt (Area may be indicated in a map)	:	Green belt all along the premises of the complex will be developed. Please refer **Plate No.5.1**.

11.0 DETAILS OF EXISTING UNITS

11.1 If it is an extension, please furnish the following details in respect of the existing units :- : Not applicable since it is new installation.

Sl. No.	Existing Units and their capacity	Efficiency of ESP	Fuel consumption on (coal/oil gas) (Tons/day)	Sulphur content	Stack height	Heat emission rate in Kcal/hr from each stack	Stack emission in kg/hr.		
							SO_2	NO_x	Particulates
					<-----	-------Nil----	----------------------->		

11.2 Have there been public complaints or Questions in the Parliament or State Assembly regarding the environmental problems posed by the existing units. If so, give details : Not applicable.

12.0 Have there been any representations/protests from the public/voluntary organisations against the siting of the new/units/plant at the proposed location? If so, give details. : Not applicable.

13.0 ECONOMICS OF POLLUTION CONTROL

13.1	What is the total project cost ? Capital & Recurring.	:	Rs.3333.28 Crores.	
13.2	Indicate costs of pollution control under the following heads : -	:	Capital	Recurring (Annual)
			(Rs. in Crores)	
13.2.1	Air :-			
	i) ESP	:)	30.00	1.5
	ii) Dust suppression and extraction system for coal handling	:)	2.00	0.05
13.2.1.2	Fly ash control	:)	--	--
13.2.1.3	Sulphur Dioxide control (stack)	:)	29.65	0.5
13.2.1.4	Oxides of Nitrogen control	:)	--	--
13.2.2	Water	:)	5.30	0.3
13.2.3	Solid waste (Ash pond development and ash disposal system)	:)	13.00	1.0
13.2.4	Others (specify) - Sanitary Work	:)	1.5	0.2
	Total	:	81.45	3.55

Name : Mr. R. K. Tripathy , I.A.S.

Designation : Managing Director

Organisation : GUJARAT POWER CORPORATION LIMITYED
Panchavati, Ellisbridge
Ahmedabad-380006
Gujarat, India

GUJARAT POLLUTION CONTROL BOARD

SECTOR 10A, GANDHINAGAR 382 043

Format of Application for obtaining No Objection Certificate of the Board

(To be submitted with all details and plans in Triplicate)

Date :

1. Name of the firm with full Address : GUJARAT POWER CORPORATION LTD.
5TH FLOOR, CENTER POINT,
PANCHVATI, ELLISBRIDGE
AHMEDABAD - 380006

2. Location of the proposed factory (Survey No. of Village or Plot No. of GIDC giving-site plan) : NEAR PIPAVAV IN AMRELI DIST., GUJARAT STATE, LATITUDE 20° 54' N & LONGITUDE 71° 26' E.

3. Correspondence Address : 5th FLOOR, CENTER POINT
PANCHVATI, ELLISBRIDGE,
AHMEDABAD - 380006

4. Purpose for which NOC is required :
   - (a) Plot allotment
   - (b) Financial help
   - (c) Conversion of letter of intent into industrial licence
   - (d) Other : SETTING UP THERMAL POWER PLANT

5. Proposed date of starting production : IN 2000 A.D.

6. List of raw materials with quantity in Metric units (MT/Month) :
   - (i) COAL - 264700 METRIC TONS/MONTH
   - (ii) HFO - 2400 METRIC TONS / MONTH
   - (iii) RAW SEA WATER - 6.3 MILLON Cu. M/MONTH
   - (iv) SWEET WATER - 0.2 MILLION Cu. M/MONTH
   - (v)
   - (vi)
   - (vii) (SWEET WATER WOULD BE PRODUCED BY DESALINATING SEA WATER)
   - (Viii)
   - (ix)
   - (x)

7. List of products with quantity proposed to be produced per month in Metric units (MT/Month)
   - (i) 658.8 MkWh OF ELECTRICAL ENERGY
   - (ii)
   - (iii)
   - (iv)
   - (v)
   - (vi)
   - (vii)
   - (viii)
   - (ix)
   - (x)

8. Description of the manufacturing process with schematic diagram and flow chart :

ELECTRICAL ENERGY TO BE PRODUCED BY BURNING COAL, PLEASE REFER PLATE NO. 5.1

9. Water consumption. (i) Domestic Litre/day
(ii) Industrial

	SWEET	SALINE	
DOMESTIC	~~1.08~~	22.8	M.Litre/Day
PROCESS	5.64	22.8	"
BOILER	3.264	–	"
COOLING	–	187.2	"
WASHING	0.84	–	"
OTHER USES (FIRE WATER ETC.)	0.48	–	"
	11.304	210.0	"

(a)	Processing	Litre/day
(b)	Boiler	Litre/day
(c)	Cooling	Litre/day
(d)	Washing	Litre/day
(e)	Other use	Litre/day
	Total	Litre/day

10. Waste Water (Qnty.)
i) Domestic – (SWEET) 0.24 M.Litre/day

(ii) Industrial –

(a)	Processing (SWEET)	0.168	M Litre/day
(b)	Boiler (SWEET)	1.63	M Litre/day
(c)	Cooling (SALINE)	124.80	M Litre/day
(d)	Washing (SWEET)	0.53	M Litre/day
(e)	Other use (PROCESS (SALINE)	22.8	M Litre/day
	Total	147.6	M Litre/day

(SALINE)
& 2.568 M.Litre /Day (SWEET)

11. Probable quality of wastewater before and after treatment in respect of the following parameters :— (in mg / l except pH and colour)

pH
Colour
Suspended Solids
BOD
COD
Oil & Grease
Cyanides
Heavy Metals
Phenolic-Compounds
Ammonical-Nitrogen
Others

OUTLET WATER TO SATISFY IS2490

12. Final point of disposal of waste water (give name of River, Nala, Pond or S. No. of land alongwith site plan)

SEA.

13. Detailed description of proposed waste water treatment plant with schematic diagram, flowsheet/or detailed engineering drawing as the case may be.

EFFUENT FROM THE DM PLANT WOULD BE NEUTRALISED IN A NEUTRALISATION PIT. OTHER WASTE WATER WOULD BE TREATED FOR PH, OIL AND TEMPERATURE AT THE TREATMENT PLANT.

14. Details of fuel Consumption

Coal	8823	MT/day
Oil		Kl/day
Diesel		Kl/day
Gas		M^3/day
Other		

	From stack attached to boiler (in ppm or mg/Nm³)	From stack attached to process vent (in ppm or mg/Nm³)
15. Details of pollutants in gaseous emissions in respect of the following :		
Particulate matter	12.8 mg/Nm3	
SOx	1041 mg/Nm3	
NOx	LESS THAN 400 P.P.M.	
Ammonia	N.A.	
Chlorine	N.A.	
HCl	N.A.	
HF	N.A.	
Hydrocarbons		
Others		

16. Details of of pollution control measures with schematic diagram flow sheet / detailed engineering drawings, as the case may be (with stack / chimney specifications, scrubber, ESP, bag filters etc.)

AS PER THE PLANT WATER SCHEME A HOLDING POND FOR WASTE WATER IS CONSIDERED BEFORE DISPOSAL, AFTER NECESSARY MONITORING. HIGH EFFICIENCY E.S.P. HAS BEEN CONSIDERED FOR CONTAINING ASH DISPERSAL AT STACK OUTLET. TO KEEP GROUND LEVEL CONCENTRATIONS OF POLLUTANTS WITHIN SPECIFIED LIMITS, THE STACKS HAS BEEN TAKEN CONFORMING TO DOE NORMS.

17. Details of the Hazardous wastes :-

(i) Type of wastes :-

(a) Containing heavy metals
(b) Containing cyanide, Phenolic compounds pesticides.
(c) Oily wastes
(d) Organic matters
(e) Containing acid/alkali
(f) Other solid waste ASH

(ii) Quantity of wastes in kg/day.

1235 MT OF ASH WOULD BE GENERATED PER DAY

(iii) Composition of waste

(TENTATIVE) SiO_2 56% Al_2O_3 26% Fe_2O_3 6.5% OTHERS IN TRACES

(iv) Details of treatment of the waste

NOT APPLICABLE

(v) Details of waste disposal arrangement (give survey No. of land, name of village and site plan with capacity of the site)

ASH WOULD BE COLLECTED IN BOTTOM HOPPERS AND ESP HOPPERS. THIS ASH WOULD BE TRANSPORTED TO DISPOSAL SITE.

(vi) Precautionary measurers proposed to be taken in handling, transportation and disposal of waste.

DRY EXTRACTION AND DISPOSAL OF ASH WOULD BE DONE

(vii) Other safety measures :

18. Details of hazardous/toxic chemicals :

NOT APPLICABLE

(i) Name and quantity in MT/day of hazardous/toxic chemicals to be handled.

(ii) Characteristics of toxic chemicals (Physico-chemical as well as toxicity properties) N.A.

(iii) Precautionary measures proposed to be taken for handling, storage & processing of these chemicals. N.A.

(iv) Disaster Control Plan (For Large Scale units only) N.A.

(v) Other Safety measures : N.A.

19. List of directors/Partners/Owners with complete address

(1)

(2)

(3)

(4)

20. Following documents should invariably be attached with this form

(i) Copy of SSI/DGTD letter GPCL to furnish

(ii) Copy of NA permission and details about residential area, industrial area, public places, water stream etc. surrounding the proposed industrial plant site within a radius of 5 Kms with waste water treatment and disposal systems clearly indicating waste water disposal site. -do-

(iv) Land possession / acquisition certificates. -do-

(v) For larga scale units Environmental Impact Assessment and Oceanographic or other survey if required will have to be furnished in the prescribed time limit -do-

(vi) Cost of project.

(vii) Cost of proposed pollution control measures. (water, air and hazardous westes)

21 (1) I hereby give an undertaking that the above information is correct.

(2) I undertake that I/my company will abide by the provisions as well as rules and regulations made under the Water (Prevention and Control of Pollution) Act, 1974; the Air (Prevention and Control of Pollution) Act, 1981; the Environmental (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Cess Act 1977.

(3) I undertake that I/my company will obtain the consent of the Board under Water, Air and Environmental (Protection) Acts before commencing the production.

(4) I understand that any condition imposed by the Board while granting NOC will be binding to me/my company.

22 I/We enclose herewith the Bank Draft No. dated for

Rs. drawn in favour of GPCB, Gandhinagar as NOC fees

Signature

Date : Name Mr. R. K. Tripathy, I.A.S.

Designation MANAGING DIRECTOR, GPCL

N.B. : (1) All correspondence with this Board shoud be addressed to the Member Secretary of the Board.

(2) If the application is not complete in all respects it is liable to be rejected straightway.

(3) The applicant shall pay NOC fees by Demand Draft drawn in favour of Gujarat Pollution Control Board, Gandhinagar in accordance with the following rate schedule.

RATES OF THE NOC FEES

Investment (Rs. in Crores)				Rates of NOC Fees	
Upto	0.25			Rs.	1,000/-
Above	0.25	to	0.50	Rs.	1,250/-
Above	0.50	to	1.00	Rs.	2,500/-
Above	1.00	to	5.00	Rs.	12,500/-
Above	5.00	to	10.00	Rs.	25,000/-
Above	10.00	to	25.00	Rs.	37,500/-
Above	25.00	to	50.00	Rs.	50,000/-
Above	50.00	to	100.00	Rs.	75,000/-
Above	100.00	to	500.00	Rs.	1,50,000/-
Above	500.00	to	1000.00	Rs.	2,50,000/-
Above	1000.00	to	5000.00	Rs.	3,50,000/-
Above	5000.00			Rs.	5,00,000/-

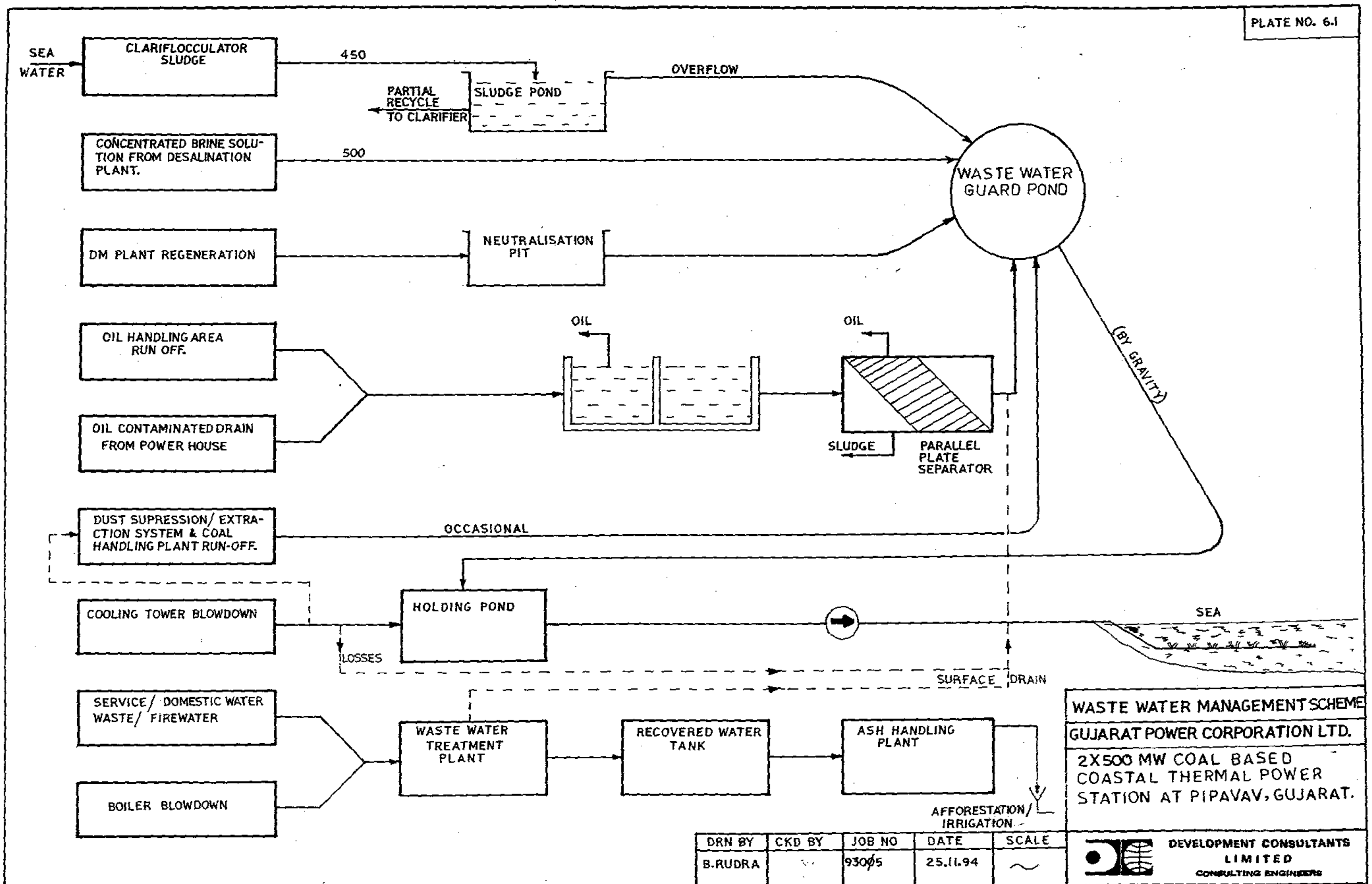


PLATE NO. 6.1
SEA WATER
CLARIFLOCCULATOR SLUDGE
450
SLUDGE POND
PARTIAL RECYCLE TO CLARIFIER
OVERFLOW
CONCENTRATED BRINE SOLUTION FROM DESALINATION PLANT.
500
WASTE WATER GUARD POND
DM PLANT REGENERATION
NEUTRALISATION PIT
OIL HANDLING AREA RUN OFF.
OIL CONTAMINATED DRAIN FROM POWER HOUSE
OIL
OIL
SLUDGE
PARALLEL PLATE SEPARATOR
(BY GRAVITY)
DUST SUPRESSION/ EXTRACTION SYSTEM & COAL HANDLING PLANT RUN-OFF.
OCCASIONAL
COOLING TOWER BLOWDOWN
HOLDING POND
LOSSES
SEA
SURFACE DRAIN
SERVICE/ DOMESTIC WATER WASTE/ FIREWATER
BOILER BLOWDOWN
WASTE WATER TREATMENT PLANT
RECOVERED WATER TANK
ASH HANDLING PLANT
AFFORESTATION/ IRRIGATION
WASTE WATER MANAGEMENT SCHEME
GUJARAT POWER CORPORATION LTD.
2X500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.
DRN BY B.RUDRA
CKD BY
JOB NO 93005
DATE 25.11.94
SCALE ~
DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 7

CONSTRUCTION FACILITIES
AND
GENERATING PLANT OPERATION

SECTION - 7

CONSTRUCTION FACILITIES
AND
GENERATING PLANT OPERATION

7.1 Construction Aspects

7.1.1 General

The proposed project being a grass roots station, adequate construction facilities will have to be created in view of its location and the basic requirements. The plant layout has been made in such a manner that adequate space is available for offices, covered and uncovered storages for the project authority, Contractors' offices and stores etc. keeping in view the area required for permanent facilities.

7.1.2 Construction of Road

The proposed plant site is located near the State Highway (SH-34). However, presently there is no access road to the site. A road is proposed to be built connecting this highway to the plant site. This road access to the plot as shown in **Plate No.4.2** would form priority for taking up the project work. The nearest rail heads namely at Rajula R.S. (14 Kms) and Pipavav Port (40 Kms) are connected by metregauge railway line of the Western Railways. No provision has been kept for use of the railway system in the present project. Plant machineries and equipment would be transported by sea and road.

7.1.3 Construction Building

About 2000 Sq.M of construction office space and 4000 Sq.M of covered storage is proposed to be provided. In addition to these open storage space, a small garage, yard toilets etc. are also proposed to be built. It is also proposed to construct an erectors' hostel to accommodate some staff during construction stage and this building may be converted to a bachelors' hostel during operation.

7.1.4 Construction Water

The maximum requirement of construction water is estimated at 80 M^3/hr for potable and service purposes. This may be catered to by digging tubewells and having an overhead steel tank during construction period.

7.1.5 Construction Power

A GEB distribution substation is expected to be in operation at Pipavav before the beginning of the site activities. However, the nearby 400 kV substations are at Amreli and Jetpur. Till the powerline to the plant site from the Jetpur/Amreli substation is ready, construction power would be drawn from the Pipavav substation. After completion of the 400 kV transmission line construction power may be drawn from Jetpur/Amreli. Later this line would be used for power evacuation. The high voltage supply will be stepped down to 415 V, 3 phase, 4 wire supply system by suitable transformer and a ring main grid will be provided. The peak demand for construction power is estimated at 4000 kVA, assuming some quantity of site fabrication of steel. In case of delay in obtaining supply from GEB for construction power, arrangements for providing diesel generating sets of adequate size will be made.

7.1.6 Construction Equipment

A small number of construction equipment, namely Bulldozer, Road-Roller, Crawler and Tyre-mounted Cranes, Tractor-Trailors, Winches, Lifting-tackles etc. are proposed to be arranged by the project authorities. Further, sump pumps, welding sets, air-compressors would also be provided. Miscellaneous tools, survey instruments etc. would also be required. Though the major construction equipment would have to be brought by the Contractors, the above essential equipment are proposed to be arranged in the interest of the project and they may be rented to the Contractors as found necessary.

A few transport vehicles like Cars, Jeeps, Trucks, Ambulance Van, Cash Van etc. are also proposed to be procured by the project authorities.

7.1.7 Construction Materials

a. **Stone Aggregate :**

Quarries for stone aggregate are available in adjacent areas not far from the power station site and the aggregate can be transported by road.

b. **Sand :**

Coarse to medium sand is available from the river bed within a radius of 15 Kms from the site and may be transported by road.

c. **Bricks :**

There are a number of brick manufacturing agencies in the nearby areas and hence there should not be any difficulty in getting sufficient quantity of bricks.

7.2 Philosophy of Plant Design & Operation

With the installation of larger units, management of high energy system without human error has become the main objective not only to sustain high reliability but also to avert costly damages during operation.

Various safety supervisory systems like Burner Management System (BMS/FSSS) or Automatic Turbine Run-up System (ATRS) have become integral part of modern power station design with microprocessor based control and Data Acquisition System (DAS). These facilities will be provided in the proposed station as part of the boiler, turbine and control system.

Sequential steps will be provided to assure safe start-up with minimum operating intervention. Highest availability with optimum manpower requirement has been the guiding philosophy of plant design and operation.

7.3 Organisational Set-up

The station will be headed by a Senior Executive in the rank of General Manager and day to day work of the station will be looked after by him. He will be assisted by senior executives under him who will hold independent charge of their departments and their functions.

The operation of the station would be the overall responsibility of the Deputy General Manager (Operation) and would directly report to the General Manager. The proposed organisational set-up for the operation of the plant is given in **Plate No.7.1**. The total manpower employed is estimated at 800 of which nearly 400 will be deployed for plant operation in keeping with the design and operating philosophy.

The maintenance wing will be headed by Deputy General Manager (Maintenance) and would be assisted by Manager/Superintending Engineer. The Managers of different disciplines would have adequate staff under them to look after the work under respective disciplines. Approximately 360 persons would be deployed in maintenance of the plant and machineries. The assessment of administrative, general services and miscellaneous maintenance staff requirements under the Deputy General Manager (Administration) involving about 80 personnel is also given in **Plate No.7.1**.

The above staffing is based on the philosophy of minimizing the manpower requirement during evening and night shifts and concentrating on maintenance efforts during the day shifts when the Deputy General Manager (Maintenance) is available at the plant, actively engaged in supervision. A minimum number of people, therefore, will be in attendance during the evening and night shifts, on the assumption, that only the routine and minor repairs would be attended to during these hours. Should major repairs be necessary during these hours, the shift charge engineers would deploy the appropriate maintenance personnel for the work. With this method of operation a large maintenance staff could be avoided.

7.4 Training of Personnel

It is envisaged to have a training programme to be looked after by Manager (Planning), who would look after the training of Technical and Management Trainees, Supervisor Trainees, Trade Apprentices etc. to replenish the requirements of trained personnel for the generating company.

Depending upon the background of the organisation entrusted to implement the project, the personnel for operation and maintenance of the new units may be of the following categories :

i) New recruits without appreciable experience

ii) Personnel obtained from in-house cadres of the project implementation authority, if any

iii) Personnel directly recruited for the station having experience in power plant practices.

In case of new recruits who do not have appreciable exposure to power station practices, the training programme will include :

a. General theoretical training in power station operation and maintenance.

b. Actual in-plant training in the operating stations of other power generating companies viz. GEB, NTPC etc.

In case of the personnel, who will be deputed from the existing cadre of the project authorities and direct recruits with previous power station experience, part of the above mentioned training will be eliminated.

If required, the personnel will be sent for training in Power Training Institutions at Neyveli, Durgapur, Nagpur and Delhi run by the Central Electricity Authority and the training institution of Tata Electric Co. at Trombay for training of thermal power station personnel of the supervisory and operative cadre.

The training programme for familiarisation with the new station will vary with the nature of duties as explained below :

i) Maintenance Personnel :

A number of personnel experienced in the maintenance of mechanicals, electricals and control & instrumentation would be employed and posted at the construction site, immediately after the major civil work is over so that they may be closely associated with the construction of all plant and equipment and thereby familiarise themselves with the components and methods of assembly.

ii) <u>Operating Personnel</u> :

The key operating personnel would first go through the course at a thermal power plant training institute, if necessary, as mentioned above. Lectures by suppliers' engineers and drills for various operations would be organised during this period. All operating personnel would be actively associated with all phases of the commissioning of the plant.

iii) <u>Supervisory Staff & Senior Officers</u> :

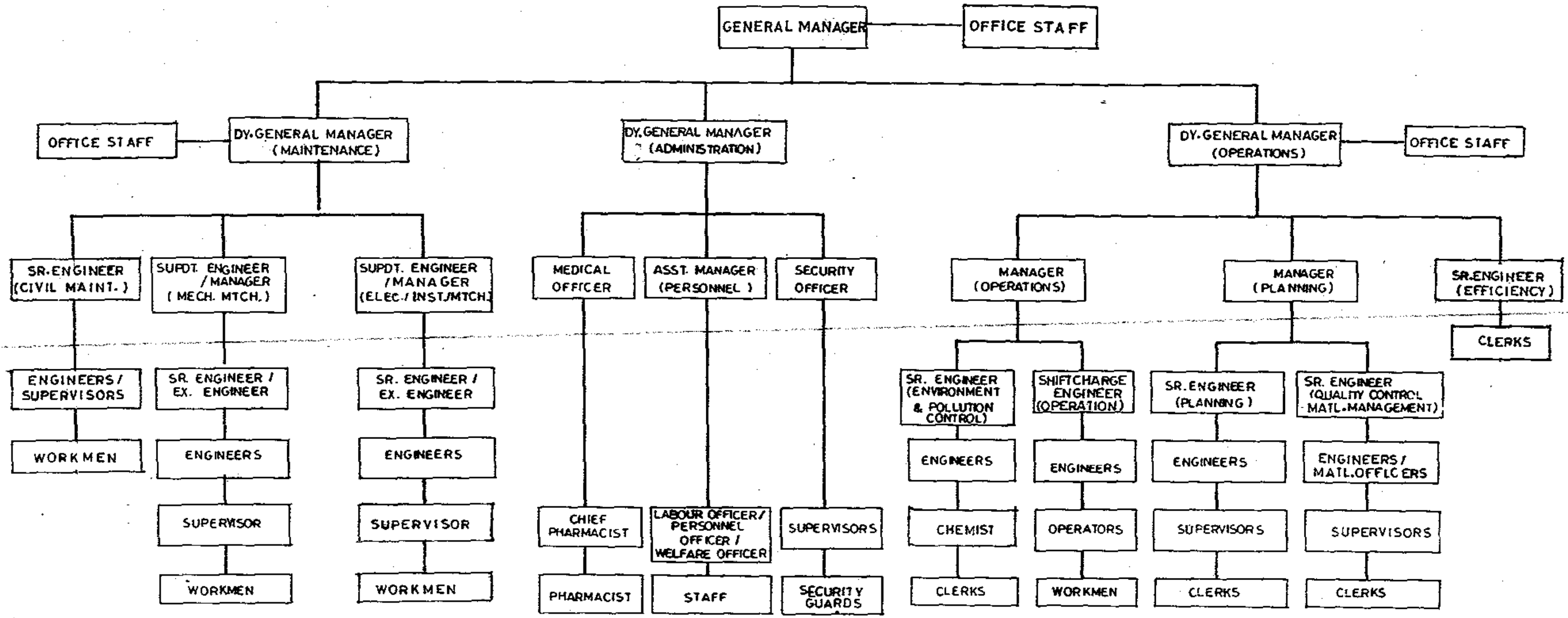
They will be employed and posted at the construction site about six(6) months before the commissioning of the unit for familiarising themselves with the same. During the period, they will be given a short orientation training on the operation of pulverised fuel-fired reheat power stations by visiting experts from the principal suppliers.

iv) <u>Chemists</u> :

Qualified chemists, adequately experienced in power plant operation would be employed and placed at the work site at least two months before the initial run, so that they could set-up a laboratory for water and other testings.

The training schemes mentioned above indicate the type and method of training, but the recruitment and general procedure of training would be in conformity with the existing training scheme of the project implementation authority.

PLATE NO. 7.1



ORGANISATION CHART FOR PLANT OPERATION			
GUJARAT POWER CORPORATION LIMITED.			
2 X 500 MW COAL BASED COASTAL THERMAL POWER STATION AT PIPAVAV, GUJARAT.			
DRN. BY	CKD. BY	DATE	JOB NO.
M.G.	[signature]	19.2.94	93095

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 8

EMPLOYEE FACILITIES
AND
RESIDENTIAL TOWNSHIP

SECTION - 8

EMPLOYEE FACILITIES
AND
RESIDENTIAL TOWNSHIP

8.1 In-Plant Facilities

Apart from the main power house building housing the power generating equipment and other buildings required for running and maintaining the power plant the following facilities are required to be provided inside the power station premises for the operation, maintenance and administration employees :-

i) Administrative Building

ii) Technical Office

iii) Canteen

iv) First-Aid Centre

v) Car Parks and Cycle Sheds

vi) Gate House Complex

vii) Toilets, wash-rooms, change-rooms, drinking water etc. provided in main buildings and yard to meet requirements of the Factories Act.

viii) Training Institute

Of the above facilities, some of the buildings will be required in construction phase while the others will be required during operation of the plant. A well through-out investment under these heads will expedite construction and provide permanent facilities at a later date. Administrative building for about 140 persons will be located adjacent to the plant entry gate, but outside the security boundary. The plant entry gate will be flanked by security office on one side and time office on the other. Time keeping will be done by means of punch clock operation or electronic register. A service building located adjacent to the main power house building will serve as technical office and first-aid centre for the proposed station. A canteen has been located in suitable area. Car parks, cycle sheds have been considered adjacent to the main plant. Toilet, wash room, change room, etc. will be provided as required.

8.2 Residential Towhship

b. Residential Quarters :

It is estimated that a total of about 800 employees would be working for operation, maintenance and administration of the proposed plant of 1000 MW installed capacity. Being close to Rajula, Jafarabad and Pipavav towns it is envisaged that about 80% of the total employees would have to be provided with residential accommodation in the colony of the station. The rest of the employees are expected to come from the neighbouring towns. Some employees are also expected to come from the adjoining villages. The residential requirements are proposed on the basis of the norms set by the Bureau of Public Enterprises (BPE) which may however, be revised as per the norms of the project authorities during execution stage. It is, therefore, proposed to build residential quarters for a total of 640 employees.

The estimated number of quarters proposed to be built are given below :-

Type	Plinth Area	Total No. of Personnel	Housing provided in the Project Cost
A	@ 159 M^2	5 Nos.	5 Nos.
B	@ 139 M^2	20 Nos.	20 Nos.
C	@ 84 M^2	130 Nos.	100 Nos.
D	@ 56 M^2	300 Nos.	255 Nos.
E	@ 35 M^2	345 Nos.	260 Nos.
Total :		**800 Nos.**	**640 Nos.**

In addition to the above one Erectors' Hostel and a Guest House would be built. These buildings will have to be suitably located. Besides, security barrack would be built for the watch and ward staff. In view of the windrose pattern of the area, it is proposed to locate the township on the western side of the plant across the proposed access road originating from State Highway (SH-34) as shown in Plate No.4.2.

b. Community Facilities :

In order to attract and retain a competent work staff, the township should be developed with an aim to satisfy the diversified needs of the employees and their families. One way to attain this is to provide adequate and different types of community facilities.

The neighbouring towns at Pipavav, Rajula and Jafarabad towns have only limited community facilities; whatever it has, is not adequate for sharing with the population of the proposed township. Thus, the new township must accommodate different facilities for children, facilities of daily use, some recreational facilities, and certain essential facilities to satisfy the day to day needs of the residents. These should include children's play areas and play field, primary-cum-nursery schools, a high school under the State Education Board, health centre and hospital, shopping facilities, community centre, club house, open air theatre, bank, post office, and the like.

The list of facilities proposed for the township for the station are as follows :-

• Tot lot	-	Two(2) Nos.
• Play ground	-	One(1) No.
• Primary-cum-nursery school	-	One(1) No.
• High school	-	One(1) No.
• Community centre with open air theatre	-	One(1) No.
• Shopping centre	-	Two(2) Nos.
• Health Centre & Hospital	-	One(1) No.
• Bank	-	One(1) No.
• Guest House	-	One(1) No.

SECTION – 9

PROJECT IMPLEMENTATION
AND
MONITORING

SECTION - 9

PROJECT IMPLEMENTATION
AND
MONITORING

9.1 Introduction

Successful implementation of any project requires the joint participation of the Owner, the Consultant, the Vendors and the Contractors. The Owner plays the most important role in spelling out the objectives, setting out the time schedules and ensuring the flow of funds. Depending on the in-house capability, the Owner may also undertake other responsibilities like monitoring and expediting the project. In other areas, the Owner engages the services of competent Consultants to advise and assist in the design, engineering and procurement of equipment and services required for the project. The Vendors and Contractors in turn, render the services required of them in the spirit of the specifications prepared by the Consultants.

9.2 Project Organisation of the Owner

The project would be implemented under the overall direction of the Chief Engineer and in this assignment he will be assisted by the senior executives of different disciplines and the Planning and Projects Department. The Planning and Projects Department assisted by other concerned departments and supported by the Consultants would be responsible for the project from its inception till all relevant clearances are obtained, financial packages are tied up and other preliminary work are completed. The Planning and Projects Department assisted by the Consultants will, thereafter, take-up the implementation of the project.

They will be involved in various activities of the preliminary stage so that the changeover from the preliminary to the implementation stage becomes smooth. This department will be assisted by a senior executive who would be assisted by a team of experienced engineers from various disciplines, such as, Civil, Mechanical, Electrical and Instrumentation.

In specialised areas the Planning and Projects Department would also be assisted by the Estate, Legal, Industrial Relations, Security, Purchase & Finance Departments of the company in the process of execution of the project. Their roles would be briefly as follows.

The Estate Department would take-up the work of acquisition of land and rehabilitation of affected population, if any, in close coordination with the local bodies and Government Departments. All legal matters arising out of land disputes, etc. would be tackled by the Legal Department. Industrial Relations Department would assist in achieving good public relation and peaceful labour situation, which, in turn, will facilitate speedy implementation of the project. A senior official of the Purchase Department would be specially deputed for procurement of cement, steel, cables and miscellaneous standard items required for the project. Security Department's personnel would be deployed from the time the building materials would start arriving at site.

Besides, engineers in Testing and Operation & Maintenance Departments would be recruited at the appropriate time during construction and precommissioning stages of various plant and equipment.

9.3 Project Execution

The principal objective of the project execution team are to design, procure, construct and commission the power station within the scheduled time and cost, ensuring high availability of the generation equipment. These are broadly classified as under.

9.3.1 Basic Design & Planning

The basic design parameters firmed up in the project report stage alongwith their implications on the cost of the project and the implementation schedule would form the basic guideline. The component systems and sub-systems of the power plant would be reviewed for compatibility with one another and conformity with environmental regulations, so as to arrive at an optimised design for the plant as a whole. Cost estimates would be reviewed for comprehensiveness and checked against budgetary quotations and/or engineered costs of other projects.

9.3.2 Engineering & Procurement

The project implementation may be done by awarding total turnkey contract to a reputed and capable party/contractor including design engineering, construction, civil, mechanical electrical, instrumentation and control systems/works for various functional areas like main plant and equipment, BOP and offsites. Alternatively the total project work would be grouped into various system-based work packages. The grouping would be done in a manner so that the interfaces and terminal points are clearly and conveniently defined, to minimise interlinking/interconnecting problems. This would be helpful for the speedy implementation of the project.

Design basis reports followed by specifications for each package or item would be prepared by the Consultant and these would be finalised after review by the Projects Department.

Pre-award Contract Management :

The specifications would be prepared indicating broad parameters and basic technical requirements, alongwith necessary commercial and contractual sections. Tenders would be invited for each package or item from selected technically competent, reliable and financially sound manufacturers/suppliers. The system of tendering, grouping of equipment, procedure for award of contract would be carefully formulated with the basic objective of obtaining the best, reliable and proven equipment to meet the technical requirement and parameters and to operate at the required level of technical efficiency.

Tender offers will be jointly evaluated by the Projects Department and the Consultants for both technical and commercial aspects before awarding the contracts.

Post-award Contract Management :

This function involves expediting and coordination of work through a constant follow-up with the Contractors in order to ensure timely deliveries of equipment as per the requirements of the project site.

Manufacturers' Level-1 network for delivery schedule for each contract will be prepared in relation to the target schedule and associated activities. Manufacturers' drawings will then be approved by the Planning and Projects Department and the Consultants after necessary scrutiny. Revisions, if required, will be incorporated promptly and status report prepared at the end of each month. Quality assurance and physical progress at manufacturers' works would be regularly monitored.

Project engineers would be sent to manufacturers' works during various stages of progress, such as, assembly, testing or trial operation of plant and equipment, whenever necessary, before giving clearance for despatch.

Arrangements would also be made for witnessing the factory tests of major equipment by the Consultants and the Projects Department representatives.

Materials Management :

A team of project personnel at site would be entrusted with the responsibility of receiving, handling and safe storing of the materials under the supervision of Project Engineers of the respective sections. Sequential storing according to erection schedule would be carried out and all records would be maintained. Cranes, trailers, jigs and tools would be procured for handling of equipment.

9.3.3 Construction & Erection

Some of the major packages, such as, Coal Handling, Ash Handling, Fuel Oil Handling Systems, Cooling Towers, etc. would be undertaken on a turnkey basis. The Contractors would be entrusted with the design, engineering, manufacture, supply, erection, testing and commissioning for these packages.

Other packages or items would be executed on supply basis and separate orders for erection and/or supervision of erection and commissioning would be issued.

Under the contract agreement, the Contractors would be bound to complete delivery and/or erection within the schedule. All measures would be taken to keep the target as scheduled. Progress of activities by the Contractors, their resources and ability to adhere to the quality control would be supervised continuously. Arrangements would also be made for timely delivery of site drawings and working manuals from the Contractors.

Necessary help and service would be rendered to each contractor for mobilization before commencing erection/construction.

Experienced engineers will be deputed to supervise civil construction at every stage of progress right from excavation work to concreting or finishing to ensure quality and accuracy of work.

Necessary wired and wireless communication systems would be provided at site for internal and external use. The facilities would be extended to major Contractors at their site offices also.

9.3.4 Testing & Commissioning

A Testing & Commissioning Group including Operation and Maintenance personnel would be deputed for precommissioning checks and final commissioning of various plant and equipment. A commissioning network and procedure would be prepared jointly with all concerned which would guide the team for execution of commissioning activities. Proper documentation of the commissioning activities would be made for safety and orderly commissioning of the plant.

9.4 Project Monitoring, Coordination & Control

9.4.1 Project Monitoring Information System

Progress of each activity at every stage would be physically monitored by respective supervising engineers. All detailed information would be passed on to the Central Monitoring Cell to keep track of the work progress. Similarly, costing of individual items would be monitored and recorded preferably with the help of a software.

Central Monitoring Cell would monitor the progress and report to the senior executives for information and necessary action.

9.4.2 Coordination

Regular meetings would be held at site among the representatives of the Contractors engaged at work site, the Consultants and the Engineers of Projects Department to review the progress of each activity. At these meetings, slippages in progress if any, would be identified and corrective measures taken. The problems arising out of site and material constraints would be promptly sorted out. The meetings would also be attended to by one of the senior executives of the company to facilitate on-the-spot decisions. Minutes of meetings would be circulated among all concerned for necessary follow up action.

Coordination meetings between the Consultants and the senior executives of the Owner would be held regularly for major decisions in regard to planning, designing of various plant and equipment, execution procedures, manpower deputations, industrial relations, security, etc. Steps would be taken to ensure regular interactions between the Vendors, the Consultants and Projects Department to finalise interface engineering.

9.4.3 Reporting

Various reports would be generated in regard to the physical and financial progress of the project on monthly, quarterly and yearly basis for forwarding to the various Government Departments, Financial Institutions as well as for internal use. Daily progress of the major items of work, alongwith their monthly targets, would be reported to the project head.

9.4.4 Financial Control

Actual cost records would be regularly monitored against forecasts which would be forwarded to Finance Department by the Projects Department on monthly, half-yearly and yearly basis, depending on the actual progress of delivery and erection/construction. Fund requirements would be assessed and arranged accordingly.

9.5 Project Implementation Schedule

The project schedule given in **Plate No**.**9.1** has been developed with the following assumptions :-

a) Zero date has been taken as the day of ordering of main equipment packages (e.g. steam generator, TG and auxiliaries).

b) Appointment of the Consultant will be 9 months prior to the 'zero date'.

c) Land acquisition would be done 10 months prior to zero date. Concurrently, a site office is to be opened to commence initial work viz. topographic survey, soil testing etc.

d) The first activity to be started at site is the land development work, i.e. earth cutting and filling, compacting, levelling and grading. This activity will start 9 months before 'zero date'.

e) Providing the required construction facilities will be the next major activity requiring earnest attention for smooth execution of the project. The work for the construction facilities like supply of water and power, construction of approach road, stores, office, etc. is scheduled to start from (-)6th month and completed by the (+)4th month (i.e. total 10 months).

f) For major packages, the time period between issue of tender notice and issue of purchase order has generally been taken as nine(9) months giving a period of three(3) months for each of the following activities :-

   i) Tendering time
   ii) Evaluation of bids including obtaining clarifications from Tenderers
   iii) Negotiations with Tenderers and placement of orders

g) The date for placement of orders for boiler and turbo-generator has been assumed to be six(6) months from the date of according financial approval for the project and allocation of fund.

h) Foundation load data for boiler and turbine would be available within two(2) months of placement of orders.

i) All technical particulars necessary for design of miscellaneous equipment and piping would be available six(6) months after issue of purchase order.

j) The erection of boiler can start by (+)10th month after placement of order and the erection can be completed by (+)39th month.

k) The erection of turbo-generator can start (+)30th month after placement of order and that erection can be completed by (+)44th month.

l) Time envisaged between boiler light-up and turbine synchronisation is four(4) months. Further two(2)/three(3) months period has been kept between synchronisation and commercial operation.

m) It has also been assumed that the manufacture and delivery schedule of all other systems can be made to suit the erection and commissioning time for the turbine.

o) The foundation-work for the power station building is scheduled to start six(6) months after the project 'zero date' and would be completed in time to suit the erection schedule.

m) The foundation work for the power station building is scheduled to start four(4) months after the project 'zero date' and would be comleted in time to suit the erection schedule.

n) The commissioning of the first unit of 500 MW will be done on 48th month. The acitivities for the second unit will continue with a time gap of six(6) months.

The milestone events are placement of order for the Boiler and Turbo-generator, placement of order for structural steel, date of boiler light up and the date of commissioning of the unit.

DEVELOPMENT CONSULTANTS LTD.

CONSULTING ENGINEERS

24B, PARK STREET, CALCUTTA-16

(INDIA)

SP - SPECIFICATION
TE - TENDERING EVALUTION
CON - CONSTUCTION
ER - ERECTION
MD - MANUFACTURE & DELIVERY
COM - COMMISSIONING
FAB - FABRICATION

PROJECT SCHEDULE

PROJECT 2X500MW COAL BASED THERMAL POWER STN.

OWNER GUJARAT POWER CORPN. LTD.

LOCATION PIPAVAV, DT. AMRELI, GUJARAT

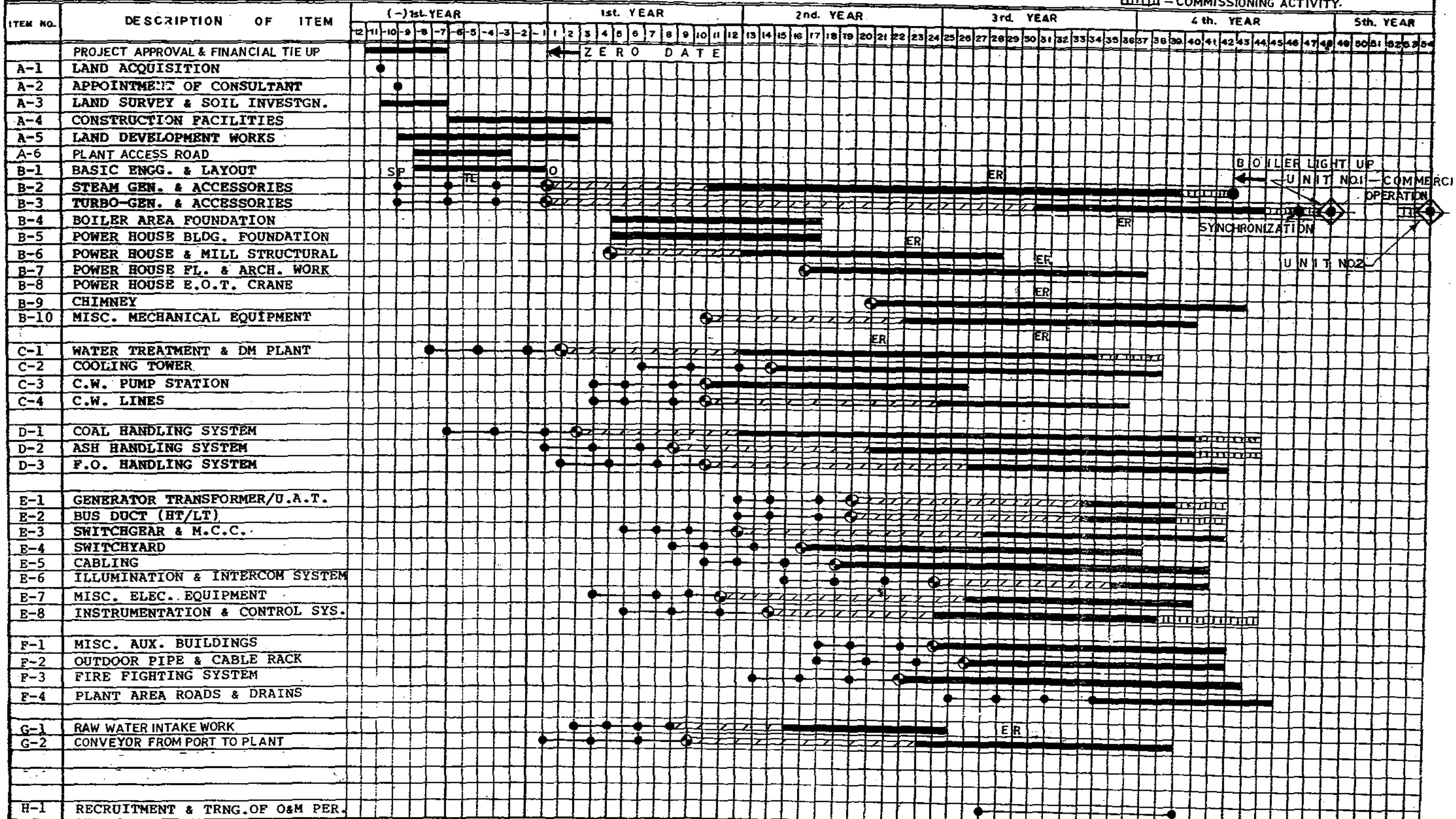
- MILE STONE EVENTS
- DATE OF ORDER
- UNIT COMMISSIONING
- COMMISSIONING ACTIVITY.

PLATE NO. 9.1

SHEET 1 OF 1

DATE 24.11.94

JOB NO. 93005



SECTION – 10

PROJECT COST ESTIMATE
AND
FINANCIAL ASPECTS

SECTION-10

PROJECT COST ESTIMATE
AND
FINANCIAL ASPECTS

10.1 Basis of Estimates

The estimated project cost have been worked out on the following basis and assumptions :

a. Main Equipment :

- The cost of steam generator burning coal of composition mentioned earlier as main fuel, in a pulverized fuel furnace, its auxiliaries and critical high pressure piping have been considered on the basis of budgetary price indications from an indigenous vendor.

- The cost of turbine generator including its auxiliaries and associated equipment and piping have been taken from the price of an indigenous vendor for a plant of similar capacity with necessary adjustment required for the system proposed.

b. Auxiliary Plants and Equipment :

All auxiliary plants and equipment other than desalination plant have been considered to be of indigenous supply from reputed vendors. However, some component may be imported as necessary by the vendor for individual package.

c. **C.W. System :**

- For conveyance of consumptive sea water underground steel gunited pipe have been considered from the intake pump house to plant and discharge line from the plant to sea in R.C.C./hume pipe.

- Power supply to the intake pump house shall be made available by a double circuit 33 kV line from the power plant. The supply lines will be partly overhead and partly cable.

- Buried prestressed concrete ducts have been considered for circulating cooling water system with natural draft wet cooling towers using sea water.

d. **Fuel :**

- Coal is considered to be available from overseas sources. In the present study coal from South African sources has been considered. The delivered cost of coal at site been calculated on the basis of the following assumptions :

- Based on the quotations received from the overseas vendors :-
  - Price of coal (FOB) : US $ 34/Ton
  - Cost of transportation : US $ 12/Ton

The cost of coal including freight and marine insurance, adds to US $ 46/Ton.

- A concessional customs duty @ 15% on CIF value.
- Port handling charge @ 1% on the above cost.
- For the port facilities a sum of Rs.146.32 would be involved which would be added to the project cost.
- Exchange rate of Rs.31.50 per US Dollar.

On the basis of the above the fuel cost works out to be Rs.1683.03 per ton.

Coal from the port would be conveyed to the power plant by a set of twin stream conveyor system. The length of conveyor from the port battery limit (TP-1) to the plant is about 2.2 Kms.

- A stockpile of coal for 21-days capacity has been provided with reversible stacker-cum-reclaimer facility.
- The design gross calorific value of coal has been taken as 6720 KCal/Kg.
- Heavy fuel oil and light diesel oil to be used as start-up and/or stabilization fuel and would be received from nearby depot by road. A storage of 60 days' inside the plant is considered.

e. Land :

- The area designated for power plant is assumed to be fairly levelled with 0.5 M average depth of cutting since detail survey data is not yet available.

- Cost of land @ Rs.2.5 Lakhs/hectare is considered for estimation.

f. Ash Disposal :

Dry ash from the silos is considered to be disposed to a plot of land located within 1 Km from the TPS. Due to high pozzolonic property, it is expected to find a good market. Revenue from sale has not been considered.

g. Electrical System :

400 kV step-up substation switchyard with 9 Nos. of bays including three(3) feeder bays have been considered for evacuation of power in the present cost estimate. GEB would evacuate the power from station switchyard. Final evacuation scheme is to be decided by GEB.

h. Environmental :

- Stack emission	:	Two-single flue chimney of 275 M height with on-line gas monitoring system has been considered.
- Desulphurisation	:	With the sulphur content in coal, no desulphrisation of the gas is envisaged. However, a space for putting up desulphurisation has been provided the layout.

- Effluent	:	The main effluent from the station would be cooling tower blowdown and concentrated brine from desalination plant. The effluent after necessary treatment would be conveyed through R.C.C. pipe to the sea. Waste sweet water would however be reused as far as practicable.

i. Time Schedule :

- Commissioning of

1st Unit	:	46 months (from zero date)
2nd Unit	:	52 months

- Commercial operation of

1st Unit	:	48 months
2nd Unit	:	54 months

j. Manpower :

Total manpower of 800 personnel for O&M, administration and finance.

k. Taxes, Duties, Insurance etc. :

For plant and equipment taxes, duties, insurance etc. are considered at following rates :-

i) Ocean freight and marine insurance has been considered @ 6.5% on F.O.B. price.

ii) Customs duty @ 20% for project import, port handling charge @ 1% and inland transportation & insurance @ 2.5%.

iii) Freight, insurance and octroi for indigenous items @ 4% on F.O.R. cost.

iv) For mechanical equipment weighted average exice duty for indigenous mechanical items has been taken as 10% on ex-works cost and another 4% towards sales tax. No octroi has been considered. For electrical and instrument items above duties and taxes would be @ 23.42% (weighted average).

v) Erection and commissioning insurance for plant and equipment @ 0.75% on erected cost has been considered.

vi) The estimates have been prepared and presented in line with CEA format.

10.2 Project Cost Estimate

The estimated capital expenses for the proposed 2 x 500 MW units on the above basis comes to Rs.3333.28 Crores without considering interest during construction. This amounts to Rs.33332.80 per installed KW (without IDC). The overall project cost including the capital expenses on account of port facilities works out to be Rs.3479.60 Crores. An abstract of the cost estimate is given below. Detailed Cost Estimates for power plant have been included in **Annexure-10.1** at the end of this section.

Abstract of Cost Estimate for 2 x 500 MW Power Project in Gujarat

Item	Description	Estimated Cost (Rs. in Crore)	Percentage of Works Cost	Percentage of Project Cost (Without IDC)
1.	Preliminary Investigation & Land	13.49	0.46	0.40
2.	Civil work	301.89	10.29	9.06
3.	Mechanical work	2367.50	80.72	71.03
4.	Electrical work	191.55	6.53	5.75
5.	Instrumentation and control	58.56	2.00	1.75
6.	**Total Works Cost**	**2932.99**	**100.00**	**87.99**
7.	Overhead construction cost	190.65	-	5.72
8.	Training of O&M staff	1.00	-	0.03
9.	Contingency @ 5%	146.64	-	4.40
10.	Preliminary & capital issue expenses	62.00	-	1.86
11.	**Capital Expenses (Power Plant)**	3333.28		100.00
12.	Capital Expenses for Port Facilities	146.32		
13.	**Overall Project Cost**	3479.60		

10.3 Financial Aspects

The main objective of this sub-section would be to estimate and analyse the capital as well as generating cost of the proposed project so as to be in a position to estimate tariffs applicable for the project and assess its financial viability.

The major assumptions are as follows :-

- The debt Equity Ratio to be 70 : 30.
- The unit one would start commercial operation from the 48th month. The unit two would be on stream on 54th month.
- Foreign loans of the order of 50% of the loan amount of the project cost attract an overall interest rate of 12.6% per annum and Indian currency loan of equivalent amount will attract interest @ 18.5%.
- Interest during construction to be capitalised.
- Equity to be raised through promoters, contribution/Public Issue/Right Issues etc.
- Debt to be sourced from All India Financial Institutions and overseas sources. Total borrowinng from the All India Financial Institutions not to exceed 40% of the Project Cost.
- The rate of interest on working capital loan would be 18.5% p.a.
- Terms of Repayment of Loan within 10th operating years with no moratorium.
- Price of Coal would be Rs.1683.03 per MT. Cost of fuel has been estimated by considering a Station Heat Rate of 2500 KCal/kWh and designed GCV of fuel as 6720 Kcal/Kg.
- The delivered cost of Fuel Oil would be Rs.7000/- per KL.
- Working Capital to be estimated as per guidelines of CEA.
- The Plant Load Factor to be 68.49%. The annual working hours to be 6000 hours.
- The auxiliary consumption to be @ 8%.

- O & M expenses to be @ 2.5%.
- Depreciation to be provided @ 7.84% as per guidelines of CEA for estimation of book profit and as per WDV method for calculating tax liability. Assets has been regrouped for the purpose of depreciation under WDV Method.
- Tax liability to be calculated after considering deductions u/s 32, & 80-IA of the Income Tax Act.
- Two-part tariff has been calculated as per the norms of CEA.

On the basis of above, the estimated two-part tariff works out to be Rs.2.76 per kWh in 1st year of operation. The detail computation of financial aspects is furnished in **Annexure-10.2.**

Annexure-10.1

PROJECT COST ESTIMATE
FOR
POWER PLANT COMPLEX
FOR 2 X 500 MW COAST BASED THERMAL POWER STATION
IN GUJARAT

Base Date : August-1995

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
100	**PRELIMINARY INVESTIGATION** (Topographic Survey, Soil Investigation, Studies etc.)			LS	150.00
200	**LAND**			LS	1198.75
201	Plant Area	300	Hect.	2.5 Lakhs	750.00
202	Housing Area	30	Hect.	2.5 Lakhs	75.00
203	Intake Pipe Route	4.5	Hect.	2.5 Lakhs	11.25
204	Ash Pond Area	135	Hect.	2.5 Lakhs	337.50
205	Access road and other miscellaneous requirement	10	Hect.	2.5 Lakhs	25.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
300	**CIVIL WORKS**				30187.87
301	**Site Levelling, Grading & Fencing**				2664.00
301.1	Earthwork in excavation & filling of plant area	2.20	Mln. CuM	100	2200.00
301.2	Earthwork in finished grading in plant area	0.20	Mln. CuM	150	300.00
301.3	Landscaping & Horticulture			LS	20.00
301.4	Plant area drainage			LS	30.00
301.5	Plant boundary wall	5000	M	1800	90.00
301.6	Fencing & gates	1000	M	900	9.00
301.7	Sanitary & sewage			LS	15.00
302	**Roads, Bridges, Railway Siding**				404.00
302.1	Roads :				384.00
	a. In-plant :-				64.00
	Double Lane	2.0	Km	20 Lakh	40.00
	Single Lane	2.0	Km	12 Lakh	24.00
	b. Plant access road :-				
	Double Lane	4.0	Km	20 Lakh	80.00
	c. Access road to berth	5.0	Km	20 Lakh	100.00
	d. Modification of existing road for plant approach	14.0	Km	10 Lakh	140.00
302.2	Transformer Track	0.2	Km	100 Lakh	20.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
303	**Foundation for Power House Building, Boiler Area Transformer Yard etc.**				**2643.76**
303.1	Excavation including backfilling	75000	CuM	120	90.00
303.2	P.C.C. (M-10)	4000	CuM	2000	80.00
303.3	R.C.C. (M-15, M-20 & M-25)	48500	CuM	2600	1261.00
303.4	Formwork	87300	SqM	120	104.76
303.5	Reinforcement	5350	MT	18000	963.00
303.6	Grounding System	100	MT	20000	20.00
303.7	Other (Water-proofing, under piping, embedments, vibrating damping pad etc.)			LS	125.00
304	**Structural Steel Works**				**5500.00**
304.1	Structural Steel (supply, fabrication and erection)	20000	MT	23000	4600.00
304.2	Stainless Steel Lining in Hopper	6000	SqM	15000	900.00
305	**Main Plant General Civil Works**				**2471.00**
305.1	R.C.C. (M-15, M-20 & M-25)	10200	CuM	2600	265.20
305.2	Pre-cast concrete (M-20 & M-25)	1350	CuM	6000	81.00
305.3	Formwork	45000	SqM	120	54.00
305.4	Reinforcement	1200	MT	18000	216.00
305.5	Steel Embedments including Anchor Bolts	150	MT	25000	37.50
305.6	Miscellaneous Steelwork	600	MT	23000	138.00
305.7	230 mm Brickwork	12000	CuM	1500	180.00
305.8	Others (Brickwork, flooring, plastering, painting, roof treatment, doors, windows, false ceiling, sanitary, PVC water stop, vibration damping pad etc.)	50000	SqM	3000	1500.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
306	Ash Handling System				956.78
306.1	Foundation for Bottom Ash Hopper				19.14
306.1.1	Excavation including backfilling	1750	CuM	120	2.10
306.1.2	P.C.C. (M-10)	50	CuM	2000	1.00
306.1.3	R.C.C. (M-20)	300	CuM	2600	7.80
306.1.4	Reinforcement	35	MT	18000	6.30
306.1.5	Formwork	1200	SqM	120	1.44
306.1.6	Inserts	2	MT	25000	0.50
306.2	Fly Ash Storage Silos and Hydrobins				139.48
306.2.1	Excavation including backfilling	3000	CuM	120	3.60
306.2.2	P.C.C. (M-10)	150	CuM	2000	3.00
306.2.3	R.C.C. (M-20)	2500	CuM	2600	65.00
306.2.4	Reinforcement	300	MT	18000	54.00
306.2.5	Formwork	1000	SqM	120	1.20
306.2.6	Misc. Items @ 10% of above				12.68
306.3	Ash Water Pump House and MCC Room 25 M x 12 M x 6 M (D)	300	SqM	8000	24.00
306.4	Compressor House and MCC Room 35 M x 20 M x 6 M (H)	700	SqM	8000	56.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
306.5	Ash Pipe Trench and fire Bridge				191.66
306.5.1	Excavation including backfilling	10800	CuM	120	12.96
306.5.2	P.C.C. (M-10)	180	CuM	2000	3.60
306.5.3	R.C.C. (M-20)	1800	CuM	2600	46.80
306.5.4	Reinforcement	180	MT	18000	32.40
306.5.5	Formwork	5400	SqM	120	6.48
306.5.6	Structural Steelwork	225	MT	30000	67.50
306.5.7	P.C.C. (M-20)	75	CuM	6000	4.50
306.5.8	Misc. Items @ 10% of above				17.42
306.6	Ash Pond Development				426.50
306.6.1	Excavation and embankment preparation	0.675	Million CuM	60	405.00
306.6.2	Associated miscellaneous items @ 30%				121.50
307	**Sea Water Intake**				3388.80
307.1	Offshore Intake Structure			LS	1200.00
307.2	Offshore Ducts (3 Nos. 1500 Q 3 Km long)			LS	2000.00
307.3	Intake Pump House incl. electrical room				188.80
307.3.1	P.C.C. (M-15)	100	CuM	4000	4.00
307.3.2	R.C.C. (M-20 & M-25)	1500	CuM	6000	90.00
307.3.3	Reinforcement	180	MT	21000	37.80
307.3.4	Misc. Structural Steel	30	MT	30000	9.00
307.3.5	Formwork	4000	SqM	400	16.00
307.3.6	Stainless Steel Fixtures	2	MT	2 Lakh	4.00
307.3.7	Sluice Gates	2	Nos.	4 Lakh	8.00
307.3.8	Architectural and other misc. items			LS	20.00

Annexure-10.1
Sheet 6 of 32

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
307.4	Intake Sea Water Pipeline to Plant	(Included in Mechanical works)			0.00
308	**Plant Water System**				515.35
308.1	Concrete Channel (Cooling tower to CW pump house)				111.86
308.1.1	Excavation including backfilling	20200	CuM	120	24.24
308.1.2	P.C.C. (M-10)	125	CuM	2000	2.50
308.1.3	R.C.C. (M-20)	1700	CuM	2600	44.20
308.1.4	Reinforcement	190	MT	18000	34.20
308.1.5	Formwork	5600	SqM	120	6.72
308.2	C.W. Pump House (Sea Water)				206.44
308.2.1	Excavation including backfilling	15000	CuM	120	18.00
308.2.2	P.C.C. (M-10)	185	CuM	2000	3.70
308.2.3	R.C.C. (M-20)	2100	CuM	2600	54.60
308.2.4	Reinforcement	250	MT	18000	45.00
308.2.5	Formwork	4500	SqM	120	5.40
308.2.6	Embedded Steel	25	MT	25000	6.25
308.2.7	Structural Steelwork	140	MT	23000	32.20
308.2.8	Architectural items @ 25%				41.29
308.3	Clariflocculator	(Included in Mechanical works)			0.00
308.4	Chemical House	-do-			0.00
308.5	Classified Sea Water Storage Sump & Pump House				47.32
308.5.1	Pump House 13 M x 28 M x 8 M Ht.	364	SqM	8000	29.12
308.5.2	Pump House 13 M x 28 M x 8 M Ht.	260	SqM	7000	18.20

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
308.6	Fire Water Pump House including Tank Foundation				18.39
308.6.1	Excavation including backfilling	600	CuM	120	0.72
308.6.2	P.C.C. (M-10)	50	CuM	2000	1.00
308.6.3	R.C.C. (M-20)	300	CuM	2600	7.80
308.6.4	Reinforcement	30	MT	18000	5.40
308.6.5	Formwork	1500	SqM	120	1.80
308.6.6	Misc. Civil works @ 10%				1.67
308.7	Desalinated Water Storage Tanks and Pump House				62.30
308.7.1	Excavation including backfilling	5400	CuM	120	6.48
308.7.2	P.C.C. (M-10)	150	CuM	2000	3.00
308.7.3	R.C.C. (M-20)	900	CuM	2600	23.40
308.7.4	Reinforcement	108	MT	18000	19.44
308.7.5	Formwork	3600	SqM	120	4.32
308.7.6	Misc. Civil works @ 10%				5.66
308.8	Blowdown Holding Tank (Capacity 8000 CuM)				69.04
308.8.1	Excavation including backfilling	10500	CuM	120	12.60
308.8.2	P.C.C. (M-10)	200	CuM	2000	4.00
308.8.3	R.C.C. (M-20)	1050	CuM	2600	27.30
308.8.4	Reinforcement	125	MT	18000	22.50
308.8.5	Formwork	2200	SqM	120	2.64

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
309	**Coal Handling System**				1215.92
309.1	Reclaim Hoppers, Conveyor Tunnel, Pent House & Transfer Points				736.28
309.1.1	Excavation including backfilling	124600	CuM	120	149.52
309.1.2	P.C.C. (M-10)	650	CuM	2000	13.00
309.1.3	R.C.C. (M-20)	11600	CuM	2600	301.60
309.1.4	Formwork	25800	SqM	120	30.96
309.1.5	Reinforcement	1250	MT	18000	225.00
309.1.6	Structural Steel (by vendor)	-		-	0.00
309.1.7	Others (Water-proofing)	5400	SqM	300	16.20
309.2	Trestle & Ground Conveyor Foundations (including corss country conveyor)				272.10
309.2.1	Excavation including backfilling	19500	CuM	120	23.40
309.2.2	P.C.C. (M-10)	2100	CuM	2000	42.00
309.2.3	R.C.C. (M-20)	4500	CuM	2600	117.00
309.2.4	Formwork	13500	SqM	120	16.20
309.2.5	Reinforcement	375	MT	18000	67.50
309.2.6	Structural Steel (by vendor)	-		-	0.00
309.2.7	Anchor Bolts etc.	24	MT	25000	6.00
309.3	Conveyor Gallery (including cross country conveyor)				69.39
309.3.1	Structural Steel including AC sheeting (by vendor)	-		-	0.00
309.3.2	Pre-cast Concrete Walkway (M-20)	450	CuM	3500	15.75
309.3.3	Reinforcement	48	MT	18000	8.64
309.3.4	Miscellaneous works			LS	45.00

Annexure-10.1
Sheet 9 of 32

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
309.4	Stacker-Reclaimer Foundation				138.15
309.4.1	Excavation including backfilling	10500	CuM	120	12.60
309.4.2	R.C.C. (M-20)	2400	CuM	2600	62.40
309.4.3	Formwork	14500	SqM	120	17.40
309.4.4	Reinforcement	250	MT	18000	45.00
309.4.5	Anchor Bolts etc.	3	MT	25000	0.75
310	**Desalination Plant**	2000	SqM	7000	**140.00**
311	**DM Plant & DM Tank Foundation**				**93.44**
311.1	Excavation including backfilling	2000	CuM	120	2.40
311.2	P.C.C. (M-10)	150	CuM	2000	3.00
311.3	R.C.C. (M-20)	1200	CuM	2600	31.20
311.4	Formwork	3000	SqM	120	3.60
311.5	Reinforcement	120	MT	18000	21.60
311.6	Structural Steel	15	MT	23000	3.45
311.7	Inserts	2	MT	25000	0.50
311.8	Special Chemical Treatment	500	SqM	1800	9.00
311.9	Architectural @ 25%	-	-	-	18.69

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
312	<u>Single flue Stack (2 Nos. - 275 M High)</u>				<u>2965.10</u>
312.1	Excavation including backfilling with ordinary soil	30000	CuM	120	36.00
312.2	Backfilling (Sand)	13680	CuM	150	20.52
312.3	P.C.C. (M-10)	300	CuM	2000	6.00
312.4	R.C.C. (M-15 & M-20)	4645	CuM	2600	120.77
312.5	R.C.C. in chimney shell (M-25)	23500	CuM	3200	752.00
312.6	Reinforcement	2820	MT	20000	564.00
312.7	Structural Steel	360	MT	30000	108.00
312.8	Brickwork (Fire-proof)	3000	SqM	6500	195.00
312.9	Acid-proof brick lining	300	CuM	15000	45.00
312.10	Formwork (Steel)	74000	SqM	200	148.00
312.11	Formwork (Ordinary)	660	SqM	120	0.79
312.12	100 Te Piles	900	Nos.	30000	270.00
312.13	Service Lift	2	Nos.	50 Lakh	100.00
312.14	Embedment Steel	12	MT	30000	3.60
312.15	Anchor Bolts	8	MT	30000	2.40
312.16	Other (Lighting arragement, lightning arrestors, painting and other misc. items etc. @ 25%)				593.02
313	<u>Switchyard (400 kV)</u>	(Included in Electrical Cost)			

Annexure-10.1
Sheet 11 of 32

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
314	<u>**F.O. Pump House, Storage Tank Foundations & Dykes**</u>				<u>87.89</u>
314.1	Excavation including backfilling with ordinary soil	10000	CuM	120	12.00
314.2	Sand Filling	4000	CuM	150	6.00
314.3	P.C.C. (M-10)	180	CuM	2000	3.60
314.4	R.C.C. (M-20)	1100	CuM	2600	28.60
314.5	Reinforcement	110	MT	18000	19.80
314.6	Formwork	7000	SqM	120	8.40
314.7	Others (Anchor Bolts etc.)	6	MT	25000	1.50
314.8	Architectural items @ 10%				7.99
315	<u>**Low Pressure Pipe Supports, Cables & Pipe Racks and Treches**</u>				<u>323.40</u>
315.1	Excavation including backfilling	18000	CuM	120	21.60
315.2	P.C.C. (M-10)	500	CuM	2000	10.00
315.3	R.C.C. (M-20)	5100	CuM	2600	132.60
315.4	Reinforcement	550	MT	18000	99.00
315.5	Formwork	24000	SqM	120	28.80
315.6	Pre-cast Concrete	300	CuM	3500	10.50
315.7	Steel Embedments	10	MT	25000	2.50
315.8	Structural Steel	80	MT	23000	18.40

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
316	**Miscellaneous Plant Buildings**				**506.00**
316.1	Coal Handling Plant Control Station	500	SqM	7000	35.00
316.2	Ash Handling Control Station	300	SqM	7000	21.00
316.3	ESP Control Stations (2 Nos.)	1040	SqM	7000	72.80
316.4	Switchyard Control Room	360	SqM	7000	25.20
316.5	Start-up Boiler House	150	SqM	6000	9.00
316.6	Compressor House and Diesel Generator Complex	1500	SqM	7000	105.00
316.7	Permanent Workshop	900	SqM	7000	63.00
316.8	Permanent Stores	2500	SqM	7000	175.00
317	**Miscellaneous Non-Plant Buildings**				**363.50**
317.1	Administrative Building	1500	SqM	6500	97.50
317.2	Technical Office	1200	SqM	6500	78.00
317.3	Gate House Complex including First-Aid and Safety Office	600	SqM	6500	39.00
317.4	Canteen	750	SqM	8000	60.00
317.5	Toilet, Change Room and Rest Rooms	540	SqM	5000	27.00
317.6	Car Park and Cycle Sheds	1200	SqM	3000	36.00
317.7	Training Institute	400	SqM	6500	26.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
318	Township				2473.87
	Type of Buildings	Nos.	Permissible Plinth Area (Sq.M)	Plinth Area Rate (Rs.)	Total Cost (Rs. Lakhs)
318.1	Residential Buildings				1656.98
318.1.1	A	5	159	5500	43.73
318.1.2	B	20	139	5500	152.90
318.1.3	C	100	84	4500	378.00
318.1.4	D	255	56	4500	642.60
318.1.5	E	260	35	4500	409.50
318.1.6	Erector's Hostel	1	550	5500	30.25
318.2	Non-Residential Buildings				246.00
318.2.1	Primary-cum-Nursery School	1	400	5500	22.00
318.2.2	High School	1	600	5500	33.00
318.2.3	Shopping Centre	2	400	5500	44.00
318.2.4	Community Centre with Open Air Theatre	1	900	5500	49.50
318.2.5	Health Centre & Hospital	1	500	5500	27.50
318.2.6	Bank	1	400	5500	22.00
318.2.7	Guest House	1	400	7000	28.00
318.2.8	Tot Lot	2	500	1000	10.00
318.2.9	Playground	1	1000	1000	10.00
318.3	Land development, playground, road, drainage, water supply, sanitary, electric supply and distribution, street lighting and sewerage etc. @ 30% on items 318.1 and 318.2 above				570.89

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
319	**Temporary Construction and enabling works**				**630.00**
319.1	Offices and Stores, Workshop, Canteen, Security Sheds and Yard Toilets	10000	SqM	4000	400.00
319.2	Construction Water Supply			LS	60.00
319.3	Construction Power Supply etc.			LS	50.00
319.4	Service Road and Drainage			LS	60.00
319.5	Temporary Fire Fighting			LS	30.00
319.6	Miscellaneous facilities			LS	30.00
320	**Environmental Protection**				**100.00**
320.1	Waste water treatment plant including recovered waste water pond (Guard Pond)			LS	25.00
320.2	• Oil water separator	25	SqM	4000	1.00
	• Coal water separator	100	SqM	4000	4.00
320.3	Sludge Pond	3000	SqM	1000	30.00
320.4	Coal Dust & Oil Water Collection Sump	2000	SqM	2000	40.00
321	**Sub-Total** (Items 301 thru' 320)				**27443.52**
322	Other miscellaneous unforeseen items @ 10% of item 321				**2744.35**
323	**Total of Civil Works**				**30187.87**

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
400	**MECHANICAL WORKS**				**236750.52**
401	**Main Plant**				**136000.00**
401.1	1700 TPH coal fired pulverized fuel steam generator with single reheat and associated auxiliaries viz. mills, burner system, DIPC, draft system, ESP, high pressure piping, microprocessor based controls etc.				
401.2	500 MW Turbo-generator set with all auxiliaries and accessories like regenerative HP/LP heaters, boiler feed pumps, interconnected piping, sea water cooled condenser and HP/LP bypass system, microprocessor based control etc.	2	Nos.	68000 Lakh	136000.00
402	**Coal Handling Plant (1600/800 TPH)**				**14222.56**
402.1	Belt Conveyors				
	a. From port to TPS 1600 mm wide 20° troughing angle, 1600 TPH capacity	8000	M	42000	3360.00
	b. Within the TPS 1200 mm wide 20° troughing angle, 800 TPH capacity	1600	M	32000	512.00
402.2	Bunker sealing belt with tensioning device	450	M	3000	13.50
402.3	In-line Magnetic Separator	2	Nos.	13	26.00
402.4	Belt Feeders	3	Nos.	18 Lakh	54.00
402.5	Belt Weighers	4	Nos.	5 Lakh	20.00
402.6	Coal Sampling Unit	1	No.	30 Lakh	30.00
402.7	Travelling Chutes	1	No.	35 Lakh	35.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
402.8	a. 800 TPH vibrating feeder	4	Nos.	3.2 Lakh	12.80
	b. 400 TPH vibrating feeder	2	Nos.	1.8 Lakh	3.60
402.9	1600 TPH/800 TPH self-propelled reversible stacker-cum-reclaimer	1	No.	1100 Lakh	1100.00
402.10	Electro-mechanical type and capacitance type level indicators	48	Nos.	2 Lakh	96.00
402.11	Manual Hoist	10	Nos.	0.30 Lakh	3.00
402.12	Electric Hoist	4	Nos.	1.8 Lakh	7.20
420.13	Sump Pump	6	Nos.	1 Lakh	6.00
402.14	Flap Gate	2	Nos.	0.75 Lakh	1.50
402.15	Metal Detector	2	Nos.	5 Lakh	10.00
402.16	Belt Vulcaniser	2	Nos.	2 Lakh	4.00
402.17	Water Supply System			LS	80.00
402.18	Rack Pinion Gate	4	Nos.	3 Lakh	12.00
402.19	Fixed Stacker with telescopic chute 1600 TPH capacity	1	Set	100 Lakh	100.00
402.20	Structural steelwork including chutes	18400	MT	35000	6440.00
402.21	Liners for chutes	30	MT	2 Lakh	60.00
402.22	Mimic & Control Panel			LS	90.00
402.23	Platforms, Inserts etc.	2500	MT	35000	875.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
402.24	Dust extraction/dust suppression/ ventilation systems and air conditioning			LS	150.00
402.25	Bulldozers	2	Nos.	75 Lakh	150.00
402.26	Payloaders	2	Nos.	15 Lakh	30.00
402.27	Misc. items at 10% on items 402.1 thru' 402.26				940.96
403	**Mill Reject System**	(Not Reqd.)			0.00
404	**Ash Handling Plant**				**5700.00**
404.1	Bottom Ash System :			LS	1500.00
	Hopper with clinker grinder, ejectors and associated ash slurry piping upto hydrobins, settling tanks, surge tanks, pumps, piping etc.				
404.2	Fly Ash System :			LS	3200.00
	Pressure conveying system including nuovo feeder, unloading valves, compressed air system upto intermediate surge hopper and upto fly ash bins				
404.3	Fludising blower with piping and control air piping				
404.4	Equipment for ash management in ash pond			LS	800.00
404.5	Design engineering charges			LS	200.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
405	<u>Plant Water System</u> (Excluding piping, valves and fittings)				<u>12536.60</u>
405.1	<u>Circulating Cooling Water Circuit</u>				<u>1370.00</u>
405.1.1	Circulating Cooling Water Pumps 21000 CuM/hr, 26 MWC, 6.6 kV drive motor	8	Nos.	145 Lakhs	1160.00
405.1.2	Auxiliary Sea Water Booster Pumps 4000 CuM/hr, 40 MWC, 6.6 kV drive motor	6	Nos.	35 Lakhs	210.00
405.2	<u>Sea Water System</u>				<u>525.00</u>
405.2.1	Sea Water Intake Pump 5500 CuM/hr, 35 MWC, 6.6 kV drive motor	3	Nos.	45 Lakh	135.00
405.2.2	Sea Water Clariflocculators 5800 CuM/hr capacity	2	Nos.	150 Lakh	300.00
405.2.3	Cooling Tower Make-up Pumps (sea water) 55800 CuM/hr, 15 MWC	3	Nos.	30 Lakh	90.00
405.3	<u>Desalination Plant</u> * 5688 CuM/day MED plant including pre-filter Note : * Imported	2	Chains	1620 Lakh	<u>3240.00</u>
405.4	<u>Desalinated Water System</u>				<u>45.60</u>
405.4.1	Auxiliary Cooling Water Make-up Pumps 70 CuM/hr, 40 MWC, 415 V drive motor, vertical	2	Nos.	3 Lakh	6.00
405.4.2	Desalinated Plant Supply Pumps 900 CuM/hr, 25 MWC, 415 V drive motor	3	Nos.	7 Lakh	21.00
405.4.3	Passivation Plant Supply Pumps 60 CuM/hr, 20 M head, 415 V drive motor, vertical	3	Nos.	3 Lakh	9.00
405.4.4	DM Plant Supply Pump 80 CuM/hr, 25 MWC	3	Nos.	3.2 Lakh	9.60

Annexure-10.1
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Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
405.5	Passivated Water System				170.00
405.5.1	Passivated Water Plant - 3 chains of 60 CuM/hr with all accessories and auxiliary equipment	3	Nos.	LS	120.00
405.5.2	Chemical house equipment and dozing system	(Incl. in item 405.5.1 above)			
405.5.3	Chlorine dozing equipment for potable water, shot chlorination for CCW circuit and sea water conveying piping			LS	50.00
405.6	Passivated Water Pumps				12.00
405.6.1	Potable Water Pump - 90 CuM/hr, 35 MWC, 415 V drive motor	2	Nos.	3 Lakh	6.00
405.6.2	Service Water Pump - 25 CuM/hr, 60 MWC, 415 V drive motor	3	Nos.	2 Lakh	6.00
405.7	DM Water System				163.50
405.7.1	DM Plant having mixed bed exchanger and associated equipment (3 streams of 90 CuM/hr each)			LS	150.00
405.7.2	DM Water Distribution Pump 80 CuM/hr, 20 MWC	3	Nos.	4.5 Lakh	13.50
405.8	Miscellaneous Pumps				119.50
405.8.1	Recovered Water Return Pump 50 CuM/hr, 50 MWC	2	Nos.	2.25 Lakh	4.50
405.8.2	Emergency Make-up Pump - 300 CuM/hr, 40 MWC, 415 V drive motor	4	Nos.	7.5 Lakh	30.00
405.8.3	Boiler Fill-up pump - 200 CuM/hr, 200 MWC, 415 V drive motor	2	Nos.	8 Lakh	16.00
405.8.4	Waste Water Discharge Pumps 3200 CuM/hr, 50 MWC, vertical	3	Nos.	23 Lakh	69.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
405.9	Cooling Circuit Equipment				6244.00
405.9.1	Plate Type Heat Exchangers 1750 CuM/hr desal water flow and 2600 CuM/hr CW flow with duplex strainers	8	Nos.	LS	800.00
405.9.2	Natural Draft Cooling Tower - Capacity : 82000 CuM/hr Cooling Range : 8 °C	2	Nos.	2680 Lakh	5360.00
405.9.3	Auxiliary Closed Cycle Cooling Water (DM) Pump, 3000 CuM/hr, 50 MWC, 6.6 kV drive motor	6	Nos.	14 Lakh	84.00
405.10	Miscellaneous Storage Tanks				497.00
405.10.1	Desalinated Water Storage Tank 2000 CuM capacity with rubber lining	2	Nos.	75 Lakh	150.00
405.10.2	DM Water Supply Tank - 2000 CuM capacity with inside rubber lining	1	No.	75 Lakh	75.00
405.10.3	Condensate Storage Tank - 1000 CuM capacity with inside rubber lining	2	Nos.	54 Lakh	108.00
405.10.4	Passivated Water Tank - 1500 CuM	2	Nos.	42 Lakh	84.00
405.10.5	Auxiliary Cooling Water Head Tank 100 CuM capacity	2	Nos.	12 Lakh	24.00
405.10.6	Service Water Head Tank 100 CuM capacity	2	Nos.	8 Lakh	16.00
405.10.7	Fire Water Tank 2000 CuM capacity	1	No.	40 Lakh	40.00
405.11	Travelling Water Screen and Trash Rack in sea water intake pump house	3	Nos.	50 Lakh	150.00

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
406	LP Piping System				3185.00
406.1	Miscellaneous piping, valves and specialties for all raw water, (MS with gunniting and MRSL) clarified water, desalinated and DM water, instrument and plant air, and auxiliary steam system	4200	Te	LS	2520.00
406.2	Large diameter fabricated circulating cooling water pipelines end pieces of carbon steel with inside and outside gunniting	500	MT	45000	225.00
406.3	Expansion joints, butterfly valves, vent valves etc.	Lot		LS	440.00
407	Fuel Oil Unloading and Transfer System				208.50
407.1	LDO Storage Tank 500 KL capacity	2	Nos.	12 Lakh	24.00
407.2	LDO Unloading Pumps (50 CuM/hr, 35 MLC)	2	Nos.	2.75 Lakh	5.50
407.3	LDO Transfer Pumps (100 CuM/hr, 35 MLC)	2	Nos.	4 Lakh	8.00
407.4	HFO Storage Tanks - 1500 KL capacity with suction heaters bed coil etc.	2	Nos.	27 Lakh	54.00
407.5	HFO Unloading Pumps (75 CuM/hr, 35 MLC)	3	Nos.	4 Lakh	12.00
407.6	HFO Transfer Pumps (150 CuM/hr, 50 MLC)	3	Nos.	5 Lakh	15.00
407.7	Petrol & Diesel Filling Station			LS	15.00
407.7.1	Petrol Filling Station	1	No.		
407.7.2	Diesel Filling Station	1	No.		
407.8	Strainers and Accessories	Lot		LS	15.00
407.9	Pipelines for oil, steam and condensate including valves, traps, flexible hoses, pipe trestles, heater sets etc. including insulation			LS	60.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
408	Air Conditioning System				305.00
408.1	Central Chilled Water Plant with all high side and low side equipment, accessories, ducting, piping, grilles etc. (3 x 150 TR plant (2R + 1 S) per unit)			LS	120.00
408.2	D-X Plant for ESP Control Room (4 x 40 TR Plant)			LS	60.00
408.3	D-X Plant for Desal Plant Control Room & DM Plant Control Rooms (2x40 TR Plant + 2x40 TR Plant)			LS	60.00
408.4	D-X Plant for Switchyard Control Room (3 x 50 TR - 2R + 1S)			LS	40.00
408.5	Packaged Airconditioners with ducting, grilles, diffusers, piping etc. for six(6) nos. of local control rooms (2 x7.5 TR for each control room)			LS	25.00
408.6	D-X Plant for Coal Handling Plant Control Room	(Incl. in item 402.25)			
409	Ventilation System				316.00
409.1	Air Washer Unit with centrifugal fan, auto-viscous filters, ducting, grilles etc. (6 units of 1,30,000 Cum/hr)			LS	180.00
409.2	Roof Extractors for TG Building and Coal Conveyor Bay (2 x 60,000 CuM/hr)			LS	33.00
409.3	Supply/Exhaust Fans for miscellaneous rooms in power house like cable spreaders rooms, toilet and elevator M/C room etc. (8,00,000 CuM/hr)			LS	28.00
409.4	Unitary Air Filtration Plant with centrifugal fan, ducting grilles etc. for ESP switchgear and MCC room (1,20,000 CuM/hr)			LS	35.00
409.5	Supply/Exhaust Fans for various auxiliary buildings like ash compressor house & MCC DG set room and air compressor room, A/C Plant room, DM Plant Building (2,60,000 CuM/hr)			LS	40.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
410	<u>Fire Fighting System</u>			LS	<u>2000.00</u>
410.1	Automatic Sprinkler System Emulsifier System, Hydrant System, Portable Fire Extinguishers	(As required)			
410.2	Electric friven fire water pump	3	Nos.		
410.3	Diesel engine driven fire water pump	2	Nos.		
410.4	Jockey pump set, sump pumps miscellaneous tanks, compressors, pipes and fittings etc. complete	(As required)			
410.5	Fixed Foam System for fuel oil handling area				
410.6	Fire Tender, Fire Jeep, portable Pumps and associated facilities				
410.7	Automatic Fire Detection & Alarm System				
411	<u>Cranes/Hoisting Equipment</u>				<u>465.00</u>
411.1	Power House EOT (115/25 Te each)	1	No.	225 Lakh	225.00
411.2	20 Te EOT Crane for CWPH	1	No.	45 Lakh	45.00
411.3	Intake Pump House Crane pendant operated 10 Te capacity	1	No.	30 Lakh	30.00
411.4	7.5 T pendant operated cranes for filter water pump house, clarified water pump house, ash slurry pump house, ash water pump house, workshop, stores etc.	9	Nos.	15 Lakh	135.00
411.5	Misc. hoists and lifting tackle and transfer trolley etc.			. LS	30.00

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Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
412	Compressed Air System				400.00
412.1	Plant Air Compressor 55 N CuM/min., 8 Kg/Sq.Cm(g)	4	Nos.	40 Lakh	160.00
412.2	Instrument Air Compressors 55 N CuM/min., 8 Kg/Sq.Cm(g)	4	Nos.	40 Lakh	160.00
412.3	Air Drying Units including air receivers, piping, fittings and other equipment	(As Required)		LS	80.00
413	Other Equipment				1713.00
413.1	Central Turbine Oil Storage and Purification Units			LS	80.00
413.2	Hydrogen Generation Plant	(Not Reqd.)			
413.3	HP and LP Dozing System			LS	90.00
413.4	Elevators			LS	168.00
413.4.1	Passenger-cum-Goods Elevator for Boiler (2000 Kg capacity)	2	Nos.		
413.4.2	Passenger Elevator for Power House (1088 Kg capacity)	2	Nos.		
413.4.3	Passenger-cum-Goods Elevator in Mill area	2	Nos.		
413.5	Condenser Tube Cleaning System with accessories	2	Sets	LS	500.00
413.6	Emergency Diesel Generator Set	(Incl. in Elec. Cost)			
413.7	Workshop and Maintenance Equipment			LS	100.00
413.8	Laboratory Equipment			LS	75.00
413.9	CO_2, H_2 & N_2 Gas Cylinders			LS	60.00
413.10	Road Weigh Bridge 30 Te capacity	2	Nos.	LS	60.00
413.11	Oil Fired Start-up Boiler	1	No.	LS	80.00
413.12	Condensate Polishing Unit	2	Nos.	LS	300.00
413.13	Miscellaneous unaccounted items			LS	200.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
414	Thermal Insulation			LS	270.00
415	Painting			LS	150.00
416	Pollution Control & Monitoring Equipment with relevant civil works				270.00
416.1	Plate Separator for Coke & Limestone Handling Plant's dust extraction and dust suppression system			LS	80.00
416.2	Sludge drying bed for above			LS	30.00
416.3	Oil water separator with oil recovery pumps and accessories			LS	40.00
416.4	Plate settlers for service water waste/BBD etc.			LS	20.00
416.5	Monitoring instrument for liquid and gaseous effluent from the plant			LS	100.00
417	Construction Water Supply and Distribution System			LS	200.00
418	Sub-Total (Item Nos.401 to 417)				177941.66
419	Spares @ 3% of Item No.418				5338.25
420	Sub-Total				183279.91
421	Ocean Freight, Marine Insurance, Customs Duty, Port Handling Charges for Item No.405.3 @ 29.72%				991.82
422	Excise Duty, Sales Tax etc. @ 14.4% on item 420 less item no.405.3				25911.75
423	Freight & Insurance, Octroi @ 4% on item 420 less 50% of item 405.9.2				7220.78
424	Erection, Testing & Commissioning @ 10% of item 418 less item nos. 410 & 416.5				17584.16
425	Erection and commissioning insurance @ 0.75% of erected cost of plant and equipment				1762.10
426	Total of Mechanical Works				236750.52

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Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
500	**ELECTRICAL WORK**				19155.26
501	**Power Transformer**				3455.00
501.1	Generator Transformer 21 kV/400 kV, 200 MVA	7	Nos.	300 Lakh	2100.00
501.2	Unit Auxiliary Transformer 21/11.5 kV - 22.5 MVA	4	Nos.	60 Lakh	240.00
501.3	Unit Auxiliary Transformer 21/6.9 kV - 22.5 MVA	4	Nos.	60 Lakh	240.00
501.4	Station Auxiliary Transformer 400/11.5/11.5 kV - 90/45/45 MVA	2	Nos.	225 Lakh	450.00
501.5	Station Auxiliary Transformer 11/6.9 kV - 20 MVA	4	Nos.	50 Lakh	200.00
501.6	Station Auxiliary Transformer 11/6.9 kV - 15 MVA	6	Nos.	37.5 Lakh	225.00
502	**Bus Duct**				1110.00
502.1	Generator Bus Ducts - 24 kV, 20 kA main bus duct with generator neutral bus-duct, neutral grounding cubicles, CT's, SP PT cubicle and associated equipment including tap-off connection	2 x 175	M	LS	600.00
502.2	HT Bus Ducts				510.00
502.2.1	Segregated phase bus duct, 12 kV, 2 kA phase segregated bus ducts with bends, seal off bushings etc.	750	M	LS	210.00
502.2.2	Segregated phase bus duct, 7.2 kV, 3.0 kA phase segregated bus duct with bends, seal off bushings	750	M	LS	300.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
503	**11 kV/6.6 kV Switchgear** (Incorporating SF-6 circuit breakers)				1000.00
503.1	Unit Switchgear 11 kV, 40 KA, 50 Hz, Indoor (4x9 Nos.)			LS	400.00
503.2	Station Switchgear 11 kV, 40 KA, 50 Hz (32 Nos.)				
503.3	6.6 kV Switchgears (Incorporating SF-6 circuit breakers)			LS	600.00
	• Unit Switchgear 6.6 kV, 40 KA (12x2 Nos.)				
	• Station Switchgear 6.6 kV, 40 KA (28 Nos.)				
	• Coal Handling plant Switchgear 6.6 kV, 40 KA (15 Nos.)				
	• Ash Handling Plant Switchgear 6.6 kV, 40 KA (15 Nos.)				
	• Water Supply System Switch-gear - 6.6 kV, 40 KA (12 Nos.)				
504	**415 V System**				1760.00
504.1	L.T. Transformers				600.00
504.1.1	2000 kVA 6.6 kV/433 V (8 Nos. dry & 10 Nos. oil-filled)			LS	600.00
504.1.2	1600 kVA 11 kV/433 V (18 Nos. dry oil filled)				
504.1.3	1000 kVA, 11 kV/433 V (4 Nos. dry & 2 Nos. oil filled)				
504.1.4	2000 kVA, 6.6 kV/433 V (4 Nos. dry & 2 Nos. oil filled)				
504.1.5	1600 kVA, 6.6 kV/433 V (4 Nos. dry & 4 Nos. oil filled)				

Annexure-10.1
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Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
504.1.6	1000 kVA, 6.6 kV/433 V (4 Nos. dry & 4 Nos. oil filled)				
504.1.7	750 kVA, 6.6 kV/433 V (4 Nos. dry & 4 Nos. oil filled)				
504.1.8	500 kVA 433 V/415 V (4 Nos. dry)				
504.2	415 V Switchgear			LS	160.00
504.3	415 V Motor and Power Control Centre				
504.4	415 V Distribution Board			LS	1000.00
504.5	Local Distribution Board				
504.6	Push Button Station				
505	**DC Power Supply System Battery** : Station Battery, Battery Charger, Board etc. (220 V, 1500 AH)	6	Sets	50 Lakh	300.00
506	**Power & Control Cables**				**2250.00**
506.1	Power Cables				2000.00
506.1.1	6.6 kV Cables (Size: 185-630 Sq.mm)	100	Kms		
506.1.2	1.1 kV Single Cortre Cables (Size : 630 Sq.mm)	80	Kms		
506.1.3	1.1 kV Multicore Cables (16-400 Sq.mm)	300	Kms	LS	2000.00
506.2	Control Cables : Multicore cables 650 V/1100 V Grade (1.5/2.5 Sq.mm 2-20 Core) Fire Survival Cable	700	Kms		
506.3	1.1 kV Twisted pair screened cables	50	Kms		
506.4	Cable Trays and other accessories			LS	250.00

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
507	**Control & Relay Panels**				**300.00**
507.1	Unit Control Board				
507.2	Station Control Board with Synchronising Bracket				
507.3	Marshalling Kiosks, Relay Panel for 400 kV bus bar, feeders, protection synchronising trolley test kit for switchyard control board			LS	300.00
507.4	Generator, Station Transformer, Interbus Transformer Relay Panels				
507.5	400 kV Relay and Control Panels				
508	**400 kV Switchyard (including civil/ structural cost & fire fighting equipment)**				**1296.00**
508.1	Outgoing Line Bay	3	Nos.		
508.2	Generator Transformer Bay	2	Nos.	LS	1296.00
508.3	Station Transformer Bay	2	Nos.		
508.4	Bus Tie/Bus Coupler	2	Nos.		
509	**Station Lighting System**			LS	**800.00**
509.1	Lighting Branch Boards				
509.2	Lighting Distribution Board				
509.3	Four-way Welding Branch Board				
509.4	AC Emergency Lighting Board				
509.5	AC/DC Emergency Lighting Board	Lot			
509.6	Lighting Fixtures				
509.7	Cable (Multicore, 11 kV) Size : 16-240 Sq.mm				
509.8	Receptacles, Inspection, Lighting, Transformers, Towers, Poles etc.				

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
510	**Intercommunication System (Telephone & Paging)**			LS	200.00
511	**Electrical Equipment of Auxiliary System**				300.00
511.1	Coal Handling Plant	Lot (Incl. in items 503.3 & 504.4 above)			
511.2	Ash Handling System				
511.3	F.O. Facilities				
511.4	Water Treatment Plant				
511.5	Conveyor From Port to Plant			LS	150.00
511.6	Auxiliary Cooling System (Bearing Cooling etc.)	(Included under Mech. works)			
511.7	Fire Fighting				
511.8	Intake Pump House			LS	150.00
512	**Grounding & Lightning Protection System including neutral grounding resistors**			LS	200.00
513	**Electrical Workshop & Lab Equipment**			LS	100.00
514	**DG Set with AMF Panel** (433 V, 50 Hz)	3x1000	kVA	130 Lakh	390.00
515	**Sub-Total**				13461.00
516	Spares @ 3% on item 515				403.83
517	**Sub-Total** (Item 515 + 516)				13864.83
518	Excise Duty, Sales Tax etc. @ 23.42% on item no.517				3247.14
519	Freight & Insurance @ 4% on item 517				554.59
520	Erection, Testing & Commissioning @ 10% on item 515				1346.10
521	Erection and Commissioning Insurance @ 0.75% of erected cost of plant and equipment				142.59
522	**Total of Electrical Works**				19155.26

Annexure-10.1
Sheet 31 of 32

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
600	**INSTRUMENTATION AND CONTROLS**				5856.56
601	Transmitters				350.00
602	Panel/Desk/Cabinets/Local Panel				150.00
603	Integrated DAS, DDC & PLC with accessories				2500.00
604	Control Valves				150.00
605	Analyzer & SWAS				240.00
606	UPS				200.00
607	Annunciation System				20.00
608	Actuators				300.00
609	Instruments Cables & Compensating Cable				250.00
610	Lab Instrument				50.00
611	Erection Material				100.00
612	**Sub-Total** (Supply Price)				4310.00
613	Spares @ 3% of item 612				129.00
614	**Sub-Total**				4439.30
615	Excise Duty, Sales Tax, Octroi etc. @ 23.42% on item no.614				1039.68
616	Freight & Insurance @ 4% of item no.614				177.57
617	Erection, Testing & Commissioning			LS	200.00
618	Erection and Commissioning Insurance @ 0.75% of erected cost of plant and equipment				43.92
619	**Total Cost of Instrumentation & Control**				5856.56
620	**Total Works Cost** (Sum of items 100 to 600)				293298.95

Annexure-10.1
Sheet 32 of 32

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
700	**OVERHEAD CONSTRUCTION COST**				19064.43
701	Tools & Plants @ 1%				2932.99
702	Establishment, Consultancy, Pre-operative Expenses and Audit & Accounts @ 5%				14664.95
703	Special Tools & Plant @ 1%				2932.99
704	Less Receipt and Recoveries @ 50% of item 703				1466.49
800	**TRAINING OF O&M STAFF**				100.00
900	**CONTINGENCY @ 5%**				14664.95
1000	**PRELIMINARY & CAPITAL ISSUE** EXPENSES				6200.00
1100	**TOTAL CAPITAL EXPENSES** (Sum of items 100 thru' 1000)				333328.33
1200	**CAPITAL EXPENSES FOR PORT FACILITIES** (Refer Vol.I of the report)				14632.00
1300	**OVERALL PROJECT COST**				347960.33

Annexure - 10.2

Tables for Estimation of Cost of Generation

Table-1 (Sheet 1 and 2)	•	Estimation of Project Cost & Interest During Construction
Table-2	•	Means of Financing
Table-3	•	Margin Money for Working Capital
Table-4	•	Estimation of Two-Part Tariff

Annexure - 10.2
Sheet 1 of 5

ESTIMATION OF COST OF GENERATION

TABLE NO. 1

Estimation of Project Cost And Interest During Construction Period

(Figures in Rs. Million)

PROJECT COST	AMOUNT
Preliminary Investigation	15.00
Land	119.90
Civil Works	3018.80
Mechanical Works	23675.05
Electrical Works	1915.50
Instrumentation	585.60
Preliminary and Capital Issue Expenses	620.00
Other Works Cost, Construction Management etc.	1916.50
Contingencies	1466.40
Capital Expenses (Power Plant) :	**33332.80**
Capital Expenses (Port Facilities) :	1463.20
Overall Project Cost :	**34796.00**

Annexure - 10.2
Sheet 2 of 5

(Figures in Rs. Million)

PARTICULARS	CONSTRUCTION MONTHS/CONSTRUCTION YEAR						TOTAL
	YR-0	1-12 YR-1	13-24 YR-2	25-36 YR-3	37-48 YR-4	49-60 YR-5 (Opt. Yr.-1)	
Foreign Loan Interest 12.6%	0.00	1500.00 94.50 0.00 0.00	2600.00 163.80 200.91 0.00	3300.00 207.90 226.22 348.24 0.00	3211.60 202.33 254.73 392.12 442.00	1200.00 18.90 71.71 110.38 124.42 107.54	11811.60
Annual Interest		94.50	364.71	782.36	1291.17	432.95	2965.68
Rupee Loan Interest 18.5%	0.00	1400.00 129.50 0.00	2600.00 240.50 282.96 0.00	3250.00 300.63 335.30 525.49 0.00	3161.60 292.45 397.34 622.71 656.87	333.00 7.7 117.71 184.48 193.02 159.75	10744.00
Annual Interest		129.50	523.46	1161.42	1969.36	662.66	4446.39
Total Interest		224.00	888.16	1943.78	3260.53	1095.60	7412.08
Total Cash Out : Equity Forex Loan Rupee Loan Int. on FC Loan Int. on LC Loan	 0.00	 2100.00 1500.00 1400.00 94.50 129.50	 3340.00 2600.00 2600.00 364.71 523.46	 2280.00 3300.00 3250.00 782.36 1161.42	 3520.00 3211.60 3161.60 1291.17 1969.36	 1000.00 1200.00 333.00 432.95 662.66	 12240.00 11811.60 10744.60 2965.68 4446.39
Total :	0.00	5224.00	9428.16	10773.78	13153.73	3628.60	42208.28

Project Cost :-			
Capital Cost			34796.20
Interest During Construction Period	:		7412.08
Capitalised Project Cost	:		42208.28
Margin Money for Working Capital	:		579.00
Total Project Cost	:		42787.28
Represented by :-			
Equity	:		12819.00
Loan (including interest)	:	Forex	14777.28
		Rupee	15190.99
TOTAL	:		42787.28

Annexure - 10.2
Sheet 3 of 5

TABLE NO. 2

Means of Financing

(Figures in Rs. Million)

SOURCE	AMOUNT	SHARE OF PROJECT COST
Equity	12240.00	29%
Forex Loan	14777.28	35%
Rupee Loan	15190.99	36%
Project Cost	42208.28	100%
Total Equity	12240.00	29%
Total Debt	29968.28	71%
Debt Equity Ratio	2.33 : 1	

Annexure - 10.2
Sheet 4 of 5

TABLE NO. 3

Margin Money For Working Capital

(Figures in Rs. Million)

PARTICULARS	INVENTORY (Days)	YR-1	YR-2	YR-3	YR-4	YR-5	YR-6	YR-7	YR-8	YR-9	YR-10
Coal	21	160.05	213.40	213.40	213.40	213.40	213.40	213.40	213.40	213.40	213.40
Fuel Oil	60	18.12	24.16	24.16	24.16	24.16	24.16	24.16	24.16	24.16	24.16
O&M Expenses	30	65.10	86.80	95.48	105.03	115.53	127.09	139.79	153.77	169.15	186.07
Debtors	60	1879.21	2505.62	2505.62	2505.62	2505.62	2505.62	2815.96	2985.86	3036.92	3081.78
Total		2122.43	2829.91	2038.58	2848.12	2858.62	2870.16	3193.20	3377.07	3443.49	3505.25
Bank Credit		1543.04	2057.38	2057.38	2057.38	2057.38	2057.38	2290.14	2417.57	2455.86	2489.51
Margin Money		579.00	773.00	781.00	791.00	801.00	813.00	903.00	960.00	988.00	1016.00
Working Capital		2057.38	2743.18	2743.18	2743.18	2743.18	2743.18	3053.52	3223.42	3274.48	3319.34
Increase in Working Capital		2057.38	685.79	0.00	0.00	0.00	0.00	310.34	169.91	51.05	44.87

Annexure - 10.2

TABLE NO. 4

Estimation Of Two-Part Tariff

(Figures in Rs. Million)

PARTICULARS	YR-1	YR-2	YR-3	YR-4	YR-5	YR-6	YR-7	YR-8	YR-9	YR-10
Fixed Charges :-										
Interest on Term Loan	3504.20	4672.27	4672.27	4088.24	3504.20	2920.17	2336.14	1752.10	1168.07	584.03
Depreciation	2491.89	3322.52	3322.52	3322.52	3322.52	3322.52	3322.52	3322.52	3322.52	3322.52
O & M Expenses	791.41	1055.21	1160.73	1276.80	1404.48	1544.93	1699.42	1869.36	2056.30	2261.93
Income Tax Payable	0.00	0.00	0.00	0.00	0.00	0.00	1887.90	2921.48	3232.06	3504.99
Return on Equity	1538.28	2051.04	2051.04	2051.04	2051.04	2051.04	2051.04	2051.04	2051.04	2051.04
Interest on Working Capital	214.10	285.46	285.46	285.04	285.46	285.46	285.46	285.46	285.46	285.46
Total Fixed Charges	8539.88	11386.50	11492.02	11024.06	10567.71	10124.12	11582.48	12201.97	12115.45	12009.97
Saleable Generation	4140	5520	5520	5520	5520	5520	5520	5520	5520	5520
Fixed Charges (Rs./unit)	2.06	2.06	2.08	2.00	1.91	1.83	2.10	2.21	2.19	2.18
Energy Charges :-										
Coal	2781.76	3709.02	3709.02	3709.02	3709.02	3709.02	3709.02	3709.02	3709.02	3709.02
Fuel Oil	110.25	147.00	147.00	147.00	147.00	147.00	147.00	147.00	147.00	147.00
Energy Cost	2892.01	3856.02	3856.02	3856.02	3856.02	3856.02	3856.02	3856.02	3856.02	3856.02
Total Saleable Generation (MkWh)	4140	5520	5520	5520	5520	5520	5520	5520	5520	5520
Energy Charge/unit (Rs.)	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Two-Part Tariff (Rs./unit)	2.76	2.76	2.78	2.70	2.61	2.53	2.80	2.91	2.89	2.87
Revenue	11431.89	15242.52	15242.52	15242.52	15242.52	15242.52	17130.41	18164.00	18474.58	18747.51