GUJARAT POWER CORPORATION LTD.

TECHNO-ECONOMIC FEASIBILITY REPORT

FOR 2 X 500 MW

COAST BASED THERMAL POWER STATION

IN GUJARAT

VOLUME - I

PORT FACILITIES

AUGUST - 1995

DEVELOPMENT CONSULTANTS LIMITED

CONSULTING ENGINEERS

24-B PARK STREET • CALCUTTA-700016

Annexure - 10.2

EFFECT OF BERTH INSTALLATION ON COST OF COAL

Estimation of Project Cost and Interest During Construction Period

(Figures in Rs. Crores)

PROJECT COST	AMOUNT
Preliminary Investigation	0.20
Land	0.20
Civil Works	52.71
Mechanical Works	73.70
Electrical Works	4.20
Instrumentation (included above)	
Preliminary Capital Issue Expenses	2.60
Overhead Works Construction Cost	8.77
Contingencies	3.93
T O T A L :	**146.31**

Annexure - 10.2
Sheet 2 of 3

Construction Months Construction Year	1-12 YR-1	13-24 YR-2	25-36 YR-3	Total
Foreign Loan	3.00	23.20	3.00	29.20
Interest	0.12 0.00 0.00	0.93 0.25 0.00	0.12 0.27 1.93	
Annual Interest	0.12	1.18	2.32	3.62
Rupee Loan	12.89	24.14	37.08	74.11
Interest	1.03 0.00	1.93 2.23 0.00	2.97 2.58 4.17	
Annual Interest	1.03	4.16	9.72	15.26
Total Interest	1.15	5.34	12.04	18.88
Equity	12.00	18.00	13.00	43.00
Forex Loan	3.00	23.20	3.00	29.20
Rupee Loan	12.89	24.14	37.08	74.11
Interest on FC Loan	0.12	1.18	2.32	3.62
Interest on LC Loan	1.03	4.16	9.72	15.26
T O T A L :	**29.04**	**70.68**	**65.02**	**165.19**

INTEREST DURING CONSTRUCTION PERIOD	:	18.88
CAPITALISED PROJECT COST	:	165.19
WORKING CAPITAL	:	0.50
TOTAL PROJECT COST	:	**165.69**

Annexure - 10.2
Sheet 3 of 3

(Values in Rs. Crores unless mentioned otherwise)

TOTAL PROJECT COST	:	165.69
ANNUAL FIXED EXPENSES :-		
• Interest on term loan (Average basis)		
- FC	:	1.31
- LC	:	7.15
• O&M Expenses @ 1%	:	1.66
• Depreciation @ 7.84%	:	12.99
• Return on Equity @ 16%	:	6.88
• Total of Fixed Cost	:	28.33
ANNUAL VARIABLE EXPENSES :-		
• Annual Maintenance (to GPPL)	:	0.9
• Service Charges	:	13.50
• Total Variable Expenses	:	14.40
TOTAL ANNUAL EXPENSES	:	42.73
ANNUAL COAL TRANSPORTATION	:	2.26 Million Te
SPECIFIC EXPENSES ON A/C OF BERTH FACILITY	:	Rs.189.07 per Te

ii) Customs duty @ 20% for project import, port handling charges @ 1.5% and inland transportation and insurance @ 2.25%.

iii) Erection and commissioning of equipment is taken as 10%.

iv) The estimates have been prepared and presented in line with Central Electricity Authority (CEA) format.

10.2 Project Cost Estimate

The estimated capital expenses for the proposed coal unloading berth on the above basis comes to Rs.143.72 Crores. An abstract of the cost estimate is given below. Detailed Project Cost Estimates have been included in **Annexure-10.1** at the end of this section.

Abstract of Cost Estimate
for the Coal Unloading Jetty
for 1000 MW Power Project in Gujarat

Item	Description		Estimated Cost (Rs. in Cores)
1.	Preliminary Investigation & Land	-	0.40
2.	Civil works	-	52.71
3.	Mechanical work	-	73.70
4.	Electrical work	-	4.20
5.	Total Works Cost	-	131.02
6.	Overhead Construction Cost	-	8.77
7.	Contingency @ 3%	-	3.93
8.	**Capital Expenses**	-	143.72

10.3 Financial Aspects

Following annual charges are payable over and above capital expenses for dredging and other maintenance of harbour and approach channel, pilotage charges during entry and exit of the ship from the harbour, berthing charges, charges for supplying drinking and service water for operation and ballasting of ship, charges for using refueling facility. These charges will be levied by Gujarat Pipavav Port (GPPL) Authority. In addition, provision for annual maintenance of jetty structure and equipment, operation and maintenance staff has to be provided for by GPCL.

Port Charges :-

a. Annual maintenance cost = Rs. 90 Lakhs

b. Service charges including pilotage, berthing, water electricity, refueling facility etc. @ Rs.50 per DWT = Rs.1350 Lakhs per year

c. Maintenance of jetty and equipment @ 1% of Capital Expenses.

d. Staff :

23 during construction phase
30 during subsequent operation and maintenance

In **Annexure-10.2** the effect of berth installation on cost of coal is shown.

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8.	**Capital Expenses**	-	**143.72**

Table - 4.2B

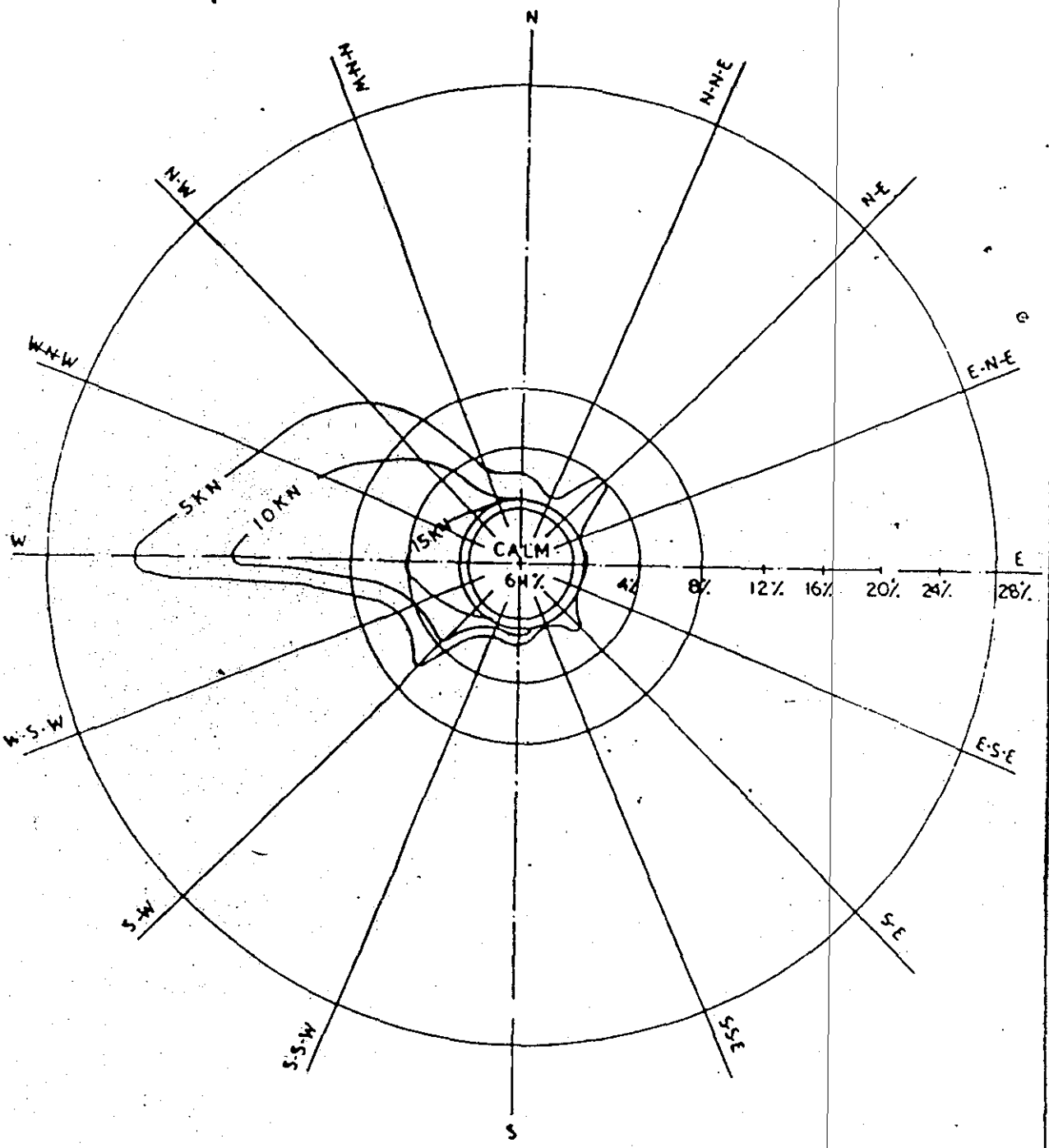
EXPECTED WAVE HEIGHT AT PROPOSED BERTH LOCATION

Wave Height at Near Shore (M)	Expected Number of Days of Occurrence (Days)	Diffracted Wave Height at Berth (M)	Remarks
≤ 2 M	329	≤ 0.5 M	Ship berthing possible
> 2 M ≤ 3 M	19	> 0.5 ≤ 0.9 M	Berthing not advisable
> 3 M	17	> 0.9 M	Berthing not advisable

Note : About 329 days in a year berth will be available for coal unloading.

PLATE. NO. 4.1

WIND ROSE DIAGRAM (PIPAVAV)

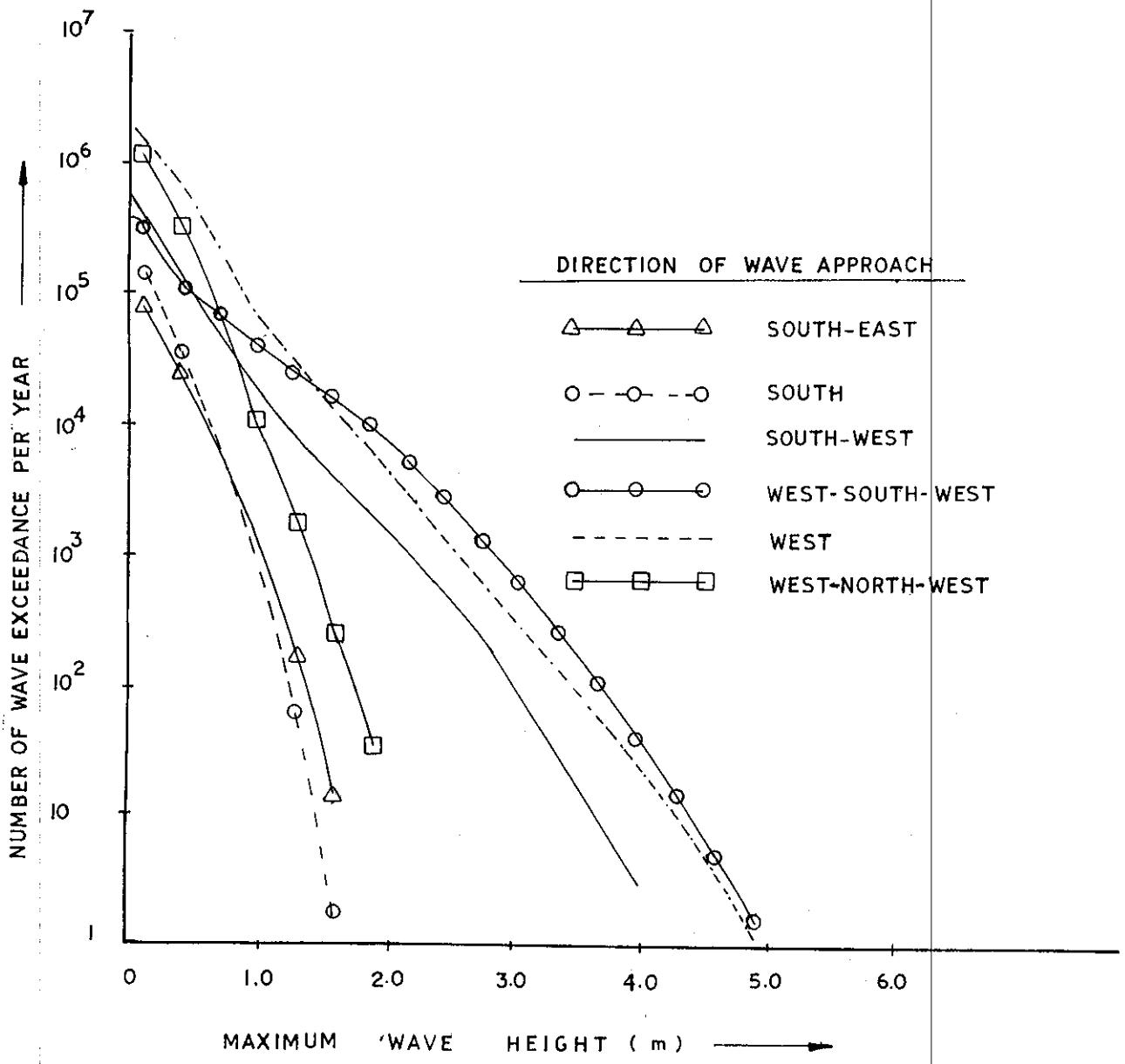


WIND ROSE DIAGRAM AT PIPAVAV.
GUJARAT POWER CORPORATION LIMITED
2 X 500 MW COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL.

DRN. BY	CKD. BY	JOB NO	DATE
D.M.	T.S.	93005	17.12.94

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

PLATE NO 4.2



WAVE EXCEEDENCE FROM CRITICAL DIRECTIONS AT PIPAVAV

GUJARAT POWER CORPORATION LIMITED

2X500MW COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL

DRN	CKD	JOB NO	DATE	SCALE
B.S.R	T.S.	93005	15.12.94	~

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 5

TECHNICAL FEATURES

SECTION - 5

TECHNICAL FEATURES

5.1 General

The basic tenet governing the planning and construction of harbour is to provide a water area well protected from storms and other natural forces where suitable marine terminal facilities can be provided for safe berthing of ships and efficient cargo handling. The type of docking structure and terminal facilities required would depend on the geographical feature at site, soil condition, and the environmental, berthing and other operational loads likely to be encountered by the structure.

The marine terminal to be constructed for the proposed power plant should be properly planned, designed, and adequately equipped to receive large coal carriers, unload the bulk cargo and convey the same efficiently to the power plant. The continuous supply of large volume of coal for smooth operation of power plant can best be achieved by providing a dedicated unloading facility for the power plant. However, the large expenses of creating a port facility with the lone purpose of transporting coal for the power plant would be prohibitive. Accordingly, alternate strategies which would fulfil the desired objective more economically without jeopardizing the operational efficiency and navigational safety needs careful evaluation.

The Report On Site Selections For Coal Unloading Jetty submitted earlier dealt in depth the above aspects and the dedicated berthing facility offered by Gujarat Pipavav Port Limited was recommended for housing the coal unloading jetty for the power plant.

5.2 Harbour Planning and Layout

The typical site features around the envisaged Pipavav Port location is shown in **Plate 5.1**. The harbour is proposed to be constructed along a bay/waterway spanning along north-east directions. The waterway is flanked by a natural island, the Shyal Bet, along its south-east side and by marshy land approaching the shore along its north-west side. The available water depth is of the order of 10 M. The average width of the channel bounded by the 10 M contour line is of the order of 400 M.

The mouth of the channel at entry is sufficiently wide to permit the entry of large vessels. At the same time it is not as broad as to allow unacceptable wave penetration inside the harbour zone. A turning circle is proposed to be constructed at the end of the channel where sufficient manoeuvring space is available to ensure safe turning of ships likely to call on the port. The length of the channel from the entry point upto the turning circle is of the order of 2000 M.

As has been shown in the Site Selection Report the general climatic condition in this region is likely to be moderate. Analysis of wind record presented in the form of windrose diagram in **Plate No.4.1**, reproduced from the Site Selection Report, indicates very moderate wind condition at site. The wind direction is predominantly westerly and most of the wind energy is concentrated within the band of 45 degree between west and north-west. About 6% time in the year calm wind having speed less than 1 knot is expected in the region. Exceedance of wind speed beyond 20 knot would be very rare.

The tidal cycle at site would be semi-diurnal in nature. The mean higher tidal range (spring) is expected to be 2.7 M and the mean lower (neap) tidal range is expected to be 1.2 M.

Average current at site will be of the order of 1.1 knots to 1.3 knots which at high spring might attain a speed of 3 knots.

As has been identified in the Site Selection Report, wave climate along the near shore region of Pipavav is moderate. Occurrence of wave around 1 M in height would be frequent but occurrence of waves exceeding 4 M in height would be rare. South-West monsoon (June to September) and hot season (April-May) would experience most critical wave actions. The proposed location of Pipavav Port is exposed to wave actions from the section bordering south-east to south-west. This band happens to be the most vulnerable sector through which frequent wave actions are expected.

Although in near shore region of Pipavav, the occurrence of waves exceeding 1 M in height, which do not permit safe ship berthing is very frequent, the typical geographical feature at site, particularly the presence at Shyal Bet, accord favourable natural protection to ensure that the waves penetrating inside the proposed harbour zone will be significantly attenuated. The result of physical model test and numerical simulation studies indicated that a 2 M external wave will attenuate to a height ranging between 0.5 M to 0.6 M on reaching the proposed harbour location (vide Site Selection Report) which may be considered as tranquility limit for efficient berthing and operation of the design bulk carrier. Wave climate analysis presented in the Site Selection Report indicates that waves are not likely to exceed 2 M in height for more than 36 days a year in the near shore region. As such the possible down time of operation would be of the order of 36 days in a year. Keeping a margin of safety, it may be presumed that ship operation in the harbour would be possible for about 300 days in a year without any artificial protective barrier.

Soil test data based on boring made in June 1991 in the nearby area indicated Soil Stratification as follows :

- From sea bottom at CD-9 M upto a depth of about CD-19/20 M : Firm to very firm clay underlaying a layer of soft mud of about 1 M.
- Below CD-20 M : Highly weathered rock with SPT values of more than 100.

For assessment of jetty foundation similar soil stratification may be presumed in this report.

The above basic information on geographical features, operating climate and soil data have been used for arriving at the proposed harbour layout and design. However, for final design the site investigations would be required to verify and establish such data

5.2.1 Size and Shape of Harbour & Turning Basin

The harbour layout would be such as to ensure safe approach to harbour, efficient docking, smooth cargo handling and finally safe exit of the ships from the harbour. Accordingly, the planning and layout of the harbour must take into consideration the water area necessary for an approach/departure channel, turning basin, anchorage or berth in addition to the shore area needed for cargo handling and other port related facilities.

For natural harbours, however, as in the present case, best effort has to be made for optimum utilisations of natural features and protections in arriving at an appropriate harbour layout.

As can be seen in **Plate No.**5.1, most part of the sheltered zone is comparatively narrow and would not permit turning of the design ship. As such, it is proposed to locate the berths along the length of the waterway on the side opposite the Shyal Bet with the

turning basin at the end of the channel. Thus, the channel has to be sufficiently wide to ensure safe passage of incoming and and outgoing ships side by side i.e. a two-way traffic is envisaged.

The size of the design ship will govern the dimensions of the harbour. The design ship recommended for coal transportation is 60000 DWT ore carrier with expected length, breadth and draft as 239 M, 32.9 M and 12.7 M respectively. This will require a harbour basin of 133 M wide for two-way traffic with water depth of 15.2 M at the basin. However, the natural water depth inside the bay is not sufficient to cater the need of the design vessel. Accordingly, the harbour basin has to be dredged to suitable depth. The required depth should be 15 M from the mean sea level i.e. around 13.2 M below the chart datum. The berth is to be constructed along the length of the channel adjacent to the proposed L&T Jetty. A turning circle with diameter of the order of 500 M is proposed to be developed at the end of the channel for turning of the design vessel with the assistance of tugs.

The position of the dredged channel and the turning basin is shown by hidden line in **Plate No.5.1.**

5.2.2 Location and Width of Entrance to Harbour

In order to reduce the wave height within the harbour, the entrance should be no wider than necessary to provide safe navigation and to prevent dangerous currents when the tide is coming in and going out. The natural features at site provides an entrance width of the order of 750 M which reduces conically as the proposed berth is approached. This width is sufficient to ensure safe entry of the design vessel to the harbour. The entrance is exposed along the sector bordering south-east and south-west directions, which happens

to be the most critical direction for wave action. However, the harbour being open at the other end, the storm waves during their passage through the approach channel will gradually attenuate and would pass through the opposite end without any possibility of generating unacceptable reflected wave climate inside the harbour region. Experimental investigations and numerical model studies as have been reported in the Site Selection Report indicate that during most part of the year the wave climate inside the proposed berth location would be within the tranquility limit and occurrence of waves exceeding the limiting height of 0.6 M is not expected for more than 36 days in a year.

As such, the entrance does not require any artificial protection to ensure safe monoeuvring, berthing and cargo handling of the design ship.

5.2.3 Number, Location and Orientation of Docks

The number of berths will depend on the nature of cargo, cargo throughput, efficiency and speed of handling equipment, traffic intensity at the port and finally on the status of the docking facility i.e. whether the dock is dedicated to a particular user or has to be shared with other users. All these aspects have been considered in depth in the Site Selection Report and it has been established that a dedicated single berth capable of receiving coal carriers of 60,000 DWT class would be sufficient to meet the annual requirement of 2.5 Million Tonnes of coal for the first phase operation of the power plant when 1000 MW power generation is envisaged. For the second phase of development however, when power generation is planned to be augmented to 2000 MW level needing 5 Million Tonnes of coal per year an additional berthing facility having identical capacity would be necessary.

For the selection of appropriate location of the berth, the fundamental consideration would be smooth transportation of coal from the unloading jetty to the power plant with minimum travel distance. The location of the berth would be such as to ensure easy berthing and cargo handling and to provide adequate safety of ships and berthing structures from the environmental forces. Moreover, the site features would not create any avoidable difficulties and hindrance in the construction and subsequent maintenance of the harbour and berthing structure. In addition, the proposed location must allow for any future expansion of the docking facility.

The berthing site offered by Gujarat Pipavav Port Limited inside the sheltered bay adjacent to the proposed L&T Jetty (vide **Plate No.5.1**) promises adequate protection from the actions of wind, waves and current. No serious difficulty in construction of the berthing structure is anticipated and the presence of the structure is not expected to create any obstruction or morphological changes so as to render the maintenance of the harbour difficult and expensive. Moreover, adequate space has been kept for the future expansion of the jetty. Accordingly, the space offered by the GPPL has been considered suitable for the location of the cargo unloading jetty.

The expected behaviour of ships moored inside the harbour needs careful consideration in the preliminary design stage. Serious motions of moored ship not only make cargo handling operation difficult but also in extreme cases might cause snapping of the mooring ropes. Such ship motion problems can greatly be relieved by proper alignment of moored ship with respect to the prevailing wave and current directions. The ship aligned along the direction of wave propagation and current flow would reduce the moored ship motions to a significant extent. Moreover, drift force acting on the ship under such condition being comparatively small, berthing and deberthing operation would be relatively easy. These

factors will be of prime importance when arriving at an appropriate location and alignment of the berth. Other factor, which needs consideration is the direction of the prevailing wind. The wind force, particularly on the light ship would be of appreciable magnitude. As such, ship at berth should be so oriented that its longitudinal face having much higher windage area is not exposed to severe wind action. If that is not achievable, orientation should be such that wind action would push the ship away from the berth. Considering all the above aspects, it is recommended that the berth be oriented along N-N-E direction at a bearing of 25 degree with respect to north. This will ensure that the ship berthed alongside the jetty will be oriented or nearly oriented along the prevailing wave and current directions. Further, wind from N-N-E direction is expected to be very mild as indicated from wind data analysis (vide **Table-4.1** and **Plate No.4.1**). As such, the proposed berth orientation would ensure that the wind induced push of the light ship on the jetty would be nominal.

5.2.4 Shore Connectivity for Marine Terminal

The final attribute of marine terminal layout is its connection to the shore. Unlike general purpose cargo berths, which necessitate direct road/railway link for transportation of cargo, the present scope is limited to direct transportation of coal from the ship unloader to the power plant through conveyor belt system. As such, full length linkage of the marine terminal to the shore is not called for and a relatively cheaper option would be acceptable in the present case. Considering the typical site features, an L-Shaped pier with its major arm constituing the dock and connected to the shore by a trestle bridge carrying the conveyor belts with necessary transfer points(TP$_s$) as shown in **Plate No.5.2** and approach road to the dock and other essential supply lines (e.g. power, water etc.) would be adequate.

The layout plan of the harbour will thus constitute a pier aligned at an angle of 25 degree with N-S direction and connected to the shore by a trestle bridge at the end of the pier giving a typical L-shaped appearance in the plan view. Typical plans, elevation and side view of the pier and trestle bridge are given in **Plate No.5.2.**

5.3 Selection of Dock Type

The function which a dock is expected to serve will be of paramount importance in selecting the type of dock to be used. However, there are other factors which will enter into the determination of the type of dock to be constructed. These include typical geographical feature at site, type and size of ships to use the dock, the direction of waves and wind, soil condition and last but of considerable importance the economy in construction.

In the present case, the envisaged function of the berth is to receive the coal carrier of maximum size of the order of 60000 DWT, unload the cargo and transport the same directly to the power plant through belt conveyor system. As such, no arrangement would be necessary for temporary intermediate storage of the cargo. Accordingly, the width of the dock may be restricted to accommodate mainly the cargo handling equipment. Geographical features at site indicate presence of wide shallow water zone bordering the approach channel and the shore. Prevailing wave and wind directions dictate that the berth should be oriented longitudinally almost along N-N-E direction. As such, the construction of finger type pier projecting out from the shore towards deep water zone is ruled out. In such situation it would be convenient and cheaper to place the dock in the deep water region aligning in the direction of prevailing waves. Accordingly an L-shaped pier with approach trestle from the shore is proposed. As the trestle has to support

relatively light load, (viz. the load from the conveyor system and access road), it will be comparatively of cheaper type of construction. The soil condition at site is favourable for pile foundation. Accordingly dock of open construction with the decks constructed with poured-in-place concrete and supported by rows of reinforced concrete piles driven upto the rock level is proposed. The piles would be capped by concrete girders which distribute the load to the piles from the deck framing. In addition to transverse pile cap girders, longitudinal beams, particularly at the points of concentrated loads such as along the rails for the cargo unloader, are to be placed beneath the deck slab.

In order to obtain principal dimension of berthing and conveyance structure preliminary design analysis has been carried out. Design base report for the jetty and the trestle bridge is given in **Annexure-5.1**.

Plate No.5.2 shows the open dock facility proposed for receiving the design coal carriers.

5.4 Berthing of Ship

When an approaching vessel strikes a berth a horizontal force acts on the berth. The magnitude of this force depends on the kinetic energy of the moving vessel and is a function of the virtual mass of the ship, its velocity normal to the berth and angle of approach with respect to the berth. In order to protect the dock as well as the ship's hull from the damaging effect of berthing impacts, it is necessary to provide series of fenders to absorb the berthing energy of the incoming ship. Even under ideal conditions and under perfect control when a ship might approach a dock without striking a severe blow, fendering strip would be necessary to separate the hull from the dock and to act as rubbing strip to prevent the paint from being damaged on account of relative motion between the dock and the ship, caused by the wind and waves. Moreover a well designed fendering

system greatly helps to reduce oscillatory motions of a moored ship thereby reducing the possibility of mooring failure and improving the efficiency of cargo handling.

Importance of proper fendering arrangement has been recognised since early days of shipping and over the years various designs have been introduced to suit different requirements. In designing the fender system for the coal unloading jetty, capabilities of various commercially available fender types have been ascertained and an appropriate arrangement which satisfies the special requirements of large coal carriers has been suggested.

Berthing analysis of 60,000 DWT coal carriers indicates that the fender should be capable of absorbing berthing energy of the order of 77 Tonne Metre. In addition, the fenders should cater for the special requirements of the design ship.

As is well-known, the hulls of large bulk cargo vessels of late are generally constructed by relatively thin steel plate/frame for their sizes. As such, they are vulnerable to damage from the berthing impact and need adequate protection against possible deformation and damage.

On the other hand, the flexibility of operation in coal loading/unloading facilities is much more restricted than that at an oil handling berth. Owing to this limitation, movements of large coal carriers at berth are required to minimize. Permissible movements of various types of ships at berth as is reproduced below from the magazine "The Dock & Harbour Authority, September, 1981, clearly brings out the desirability of restricting the movements of general cargo/ore carriers which include coal carriers as well particularly in Sway and Yaw mode of motion.

MOVEMENT ALLOWANCE OF SHIP AT BERTH

Ship Type	Surging (M)	Swaying (M)	Heaving (M)	Rolling (Deg)	Yawing (Deg)
Tanker	± 2.3	± 1 (Away from berth)	± 0.5	± 4	± 3
Ore Carrier	± 1.5	± 0.5	± 0.5	± 4	± 2
General Cargo	± 1	± 0.5	± 0.5	± 3	± 2

Thus the fender system required to be provided for the proposed coal unloading berth should

- be capable of absorbing the berthing energy of the order 77 Tonne Metre
- have sufficient contact area with ship hull so as to reduce the pressure on hull within acceptable limit
- have inherent capability of reducing the movements of moored ship particularly in Sway and Yaw mode.

The survey of technical literatures on commercially available fenders indicate that Pi-type fenders with rubbing board (front panel) would be suitable for the proposed coal berth operation. The large frontal board fitted in front of the rubber blocks would act as an interface between the ship and the berth and would distribute the fender reaction force over a large area of the hull surface thereby reducing the face pressure. Further, these fenders being of buckling type offers significant resistance against swaying and yawing of ship at berth. Among available Pi-type fenders, the fender with height 1.4 M and length 1.5 M having brand name HPi - 1400 H x 1500 L (CPO) having energy absorption capacity

of 93.8 TM at 0° angle and 80 TM at 10° angle (more than desired value 77 TM) at 52.5% fender deflection with reaction load of 161.7 T and 159.5 T at 0° and 10° angles respectively appears to fulfil the present requirement and hence recommended for adoption. Installation pitch for the fenders has been calculated as 33 M. Accordingly 10 sets of fenders at an installation pitch of 33 M to cover the entire jetty length of 300 M is proposed to be adopted.

The salient features for fender details alongwith typical fender drawing are in **Table-5.1** and **Plate No.5.3** respectively.

5.5 Mooring of Ship

The ship after safe berthing has to be tied to the dock to restrict her movements within acceptable limits so as to ensure efficient cargo handling. Conventional mooring arrangement where ship will tie up to the dock with bow and stern lines, spring and breast lines is proposed to be adopted. These howsers will be fastened to mooring bollards located along the deck longitudinally at a spacing of about 15 M by galvanised bolts passing through pipe sleeves set in concrete, which enables the bolts to be removed at a later date, if damaged. The mooring ropes exert considerable amount of pull on the bollards. Accordingly bollards are usually designed to take line pulls of the order of 35 Tonne. Bollards at the corners of the deck known as corner mooring posts receiving the bow and stern howsers are expected to experience comparatively more pull. Accordingly heavier corner posts capable of withstanding 50 Tonnes tension are proposed.

The base of the bollard should be grouted in a recess formed in the deck which will permit the shear from the line pull to be transmitted directly to the concrete deck.

5.6 Coal Unloading and Conveyance

Coal unloading and subsequent transportation to the power plant may be considered as an integrated operation which will complement each other to maintain essential flow of coal to the power plant. As has been shown in the Site Selection Report the desired average unloading rate is of the order of 1500 T/hour. The most popular piece of equipment for high speed unloading of bulk cargo is the clamshell bucket which grab bulk cargo from the cargo hatch and discharge the same to a specially designed built-in hopper in the unloader. Although many commercial designs of grab bucket unloader are available, large unloading capacity can be attained by a bucket working from a travelling trolley on the boom of an unloading tower on the dock. The tower may be stationary or travelling type. However, higher unloading rate can be attained by the travelling type because the tower can be moved from hatch to hatch much faster than the ship can be moved to a new position in front of a fixed tower. As such travelling tower moving on rails laid longitudinally along the length of the dock would be desirable. This tower will have suitable locking arrangements on rails. Further, two unloaders with average unloading capacity 750 T/hour each would be more flexible than single unloader with 1500 T/hour capacity. This would maintain some degree of unloading operation in case one unloader becomes inoperative and is under emergency maintenance.

The basic Technical Specifications and typical features of a grab bucket type unloader of average unloading capacity are given in **Table-5.2** and **Plate No.5.4.**

Coal unloaded from the ship by the grab buckets will be discharged into the hoppers of the unloaders. These hoppers will feed the conveyor belts which will transport coal to the power plant. The transportation of coal upto shore at a distance of about 2.5 Kms from

the unloading berth (vide **Plate No.5.1**) has been covered in this report. Erection and maintenance of conveyor belt upto this point will be the responsibility of a specially constituted port group by GPCL. Thereafter control will be transferred to the power plant group. Basic design and selection of type and size of conveyor belt are covered in the Report on Power Plant and similar features have been adopted in this report. Accordingly two conveyor lines with 1600 mm wide belt, 20 degree troughing angle and 1600 TPH capacity each, has to be installed.

5.7 Utilities and Services

The berth envisaged for docking and unloading coal for onward transmission to the power plant will be a part of a large port facility proposed to be developed by the GPPL. Accordingly, the basic services like pilotage, berthing of ship, drinking and service water, refueling facility of ships have to be drawn from the infrastructural facilities of the port.

For smooth and efficient function, shipping terminals will be equipped with standard utilities such as lighting for night operation, electric power for mechanical equipment used in unloading of vessels, appropriate communication system for exchange of information between the ship's Captain on-board and material handling equipment Operator on the berth, power supply feeder, substation and distribution system, potable and service water supply, fire protection system and other miscellaneous items.

While supply of drinking and service water has to be drawn from port infrastructural facilities, installation of various supply lines have been covered in this project. All electric power for the system will be supplied from the Power Plant.

5.8 Maintenance of Berthing Dock & Harbour Zone

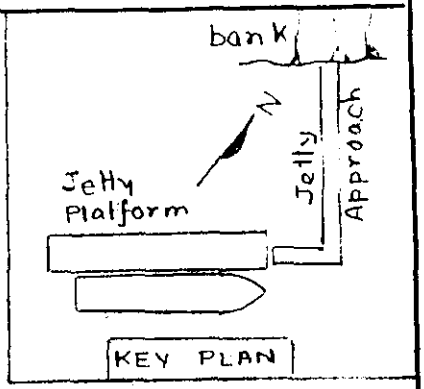
Maintenance of berthing structure, various dock equipment and machineries to ensure smooth supply of coal to the power plant will be the responsibility of GPCL. A separate group looking after the operation and maintenance of berthing structure will be constituted for the same.

Dredging and other maintenance of approach channel and harbour zone, navigational aids will be taken care of by GPPL.

DESIGN BASE REPORT
FOR COAL UNLOADING JETTY
OF 2 X 500 MW COASTAL POWER PLANT
AT PIPAVAV (GUJARAT)
FOR G.P.C.L.

CALCULATION DOCUMENT SHEET 2 OF 4

JOB NO. 93005 DOCUMENT NO.



A. Jetty Platform

Loadings: The following basic load cases are considered in the design :-

i) Dead Load of the structure
ii) Live load on the platform
iii) Weight of unloader
iv) Berthing impact of ship.
v) Seismic Load (By seismic co-efficient method as per IS:1893-'84)

Forces from waves and wind are negligible as compared to the forces already mentioned

Combinations done are,

a) i)
b) i) + iii)
c) i) + ii) iii)
d) i) + ii) + iii) + iv)
e) i) + iii) + iv)
f) i) + iii) + v)
g) i) + ii) + iii) + v)

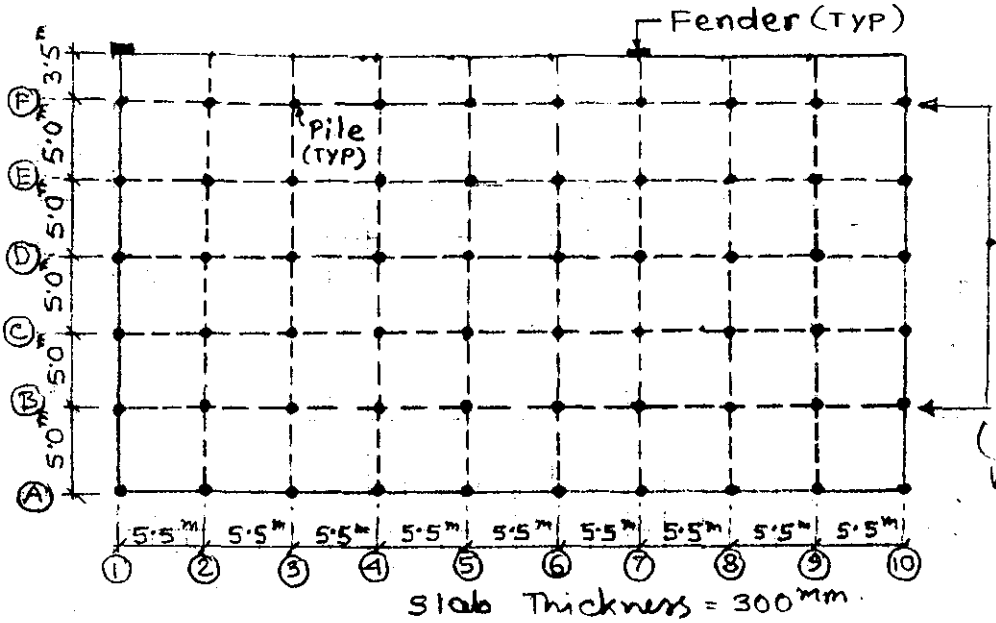
For calculation of Seismic Load 50% of Live load is considered and masses are lumped on peripheral nodes only.

Analysis: A three dimensional analysis is done using SAP-IV considering columns and beams as beam-elements and slabs as plane stress elements. To obtain the worst effect analysis is carried only on the smallest-devided part (by expansion joints, adopted as shown in sketches) of 49.5 m of the structure is taken under consideration

CALCULATION DOCUMENT

JOB NO. 93005 DOCUMENT NO.

The member sizes of the str. is shown below:-

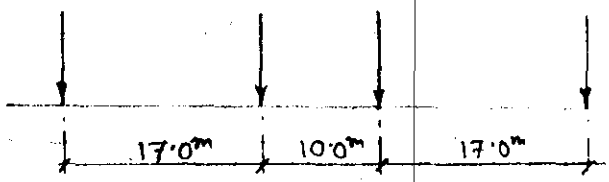


Slab Thickness = 300mm.

Beam sizes along grid (B) & (E) are 800mm x 1250 mm and all other beam sizes are 450 mm x 1000 mm.

All piles are taken as 1000 mm diameter and fixity is assumed at a level of 25.0m from top of deck slab.

The moving load from unloader along grid (B) & (F) are taken as shown in figure.



(Here loads are taken as purely concentrated and hence impact factor is taken as 1.0)

Design: Design is carried according to IS:456-'78 and partial safety factors for comb. a) to f) are taken as 1.5 and for comb. g) as 1.2.

Grade of Conc. used for deck slab and beam is M25 and that for piles is M20. Grade of reinf. used is Fe415 everywhere.

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CALCULATION DOCUMENT SHEET 4 OF 4

JOB NO. 93005 DOCUMENT NO.

B. Jetty approach:

Loading: The basic load cases and combinations are taken as below:-

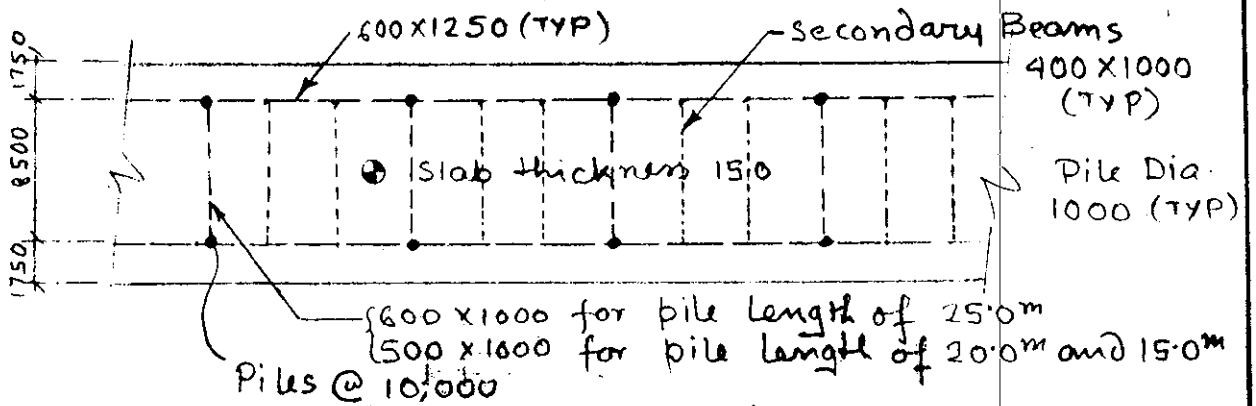
i) Dead load of the structure
ii) Live load
iii) Seismic load (By seismic co-efficient method as per IS:1893-'84)

Combinations:-

a) i), b) i) + ii), c) i) + iii), d) i) + ii) + iii)

[As Jetty platform, here the 50% of Live load is considered for seismic load calculations]

Analysis: A plane frame analysis is done along the direction perpendicular to the bridge alignment for different depth of sea-bed. The general arrangement for typical bay is shown below with the member sizes thereon.



(Dimensions are in mm)

Note:- For expansion joints see detail sketches and pile fixity is taken as 25.0m, 20.0m and 15.0m below the deck Level depending on the sea bed profile.

Design: Design is carried according to the same specifications applied for Jetty Platform

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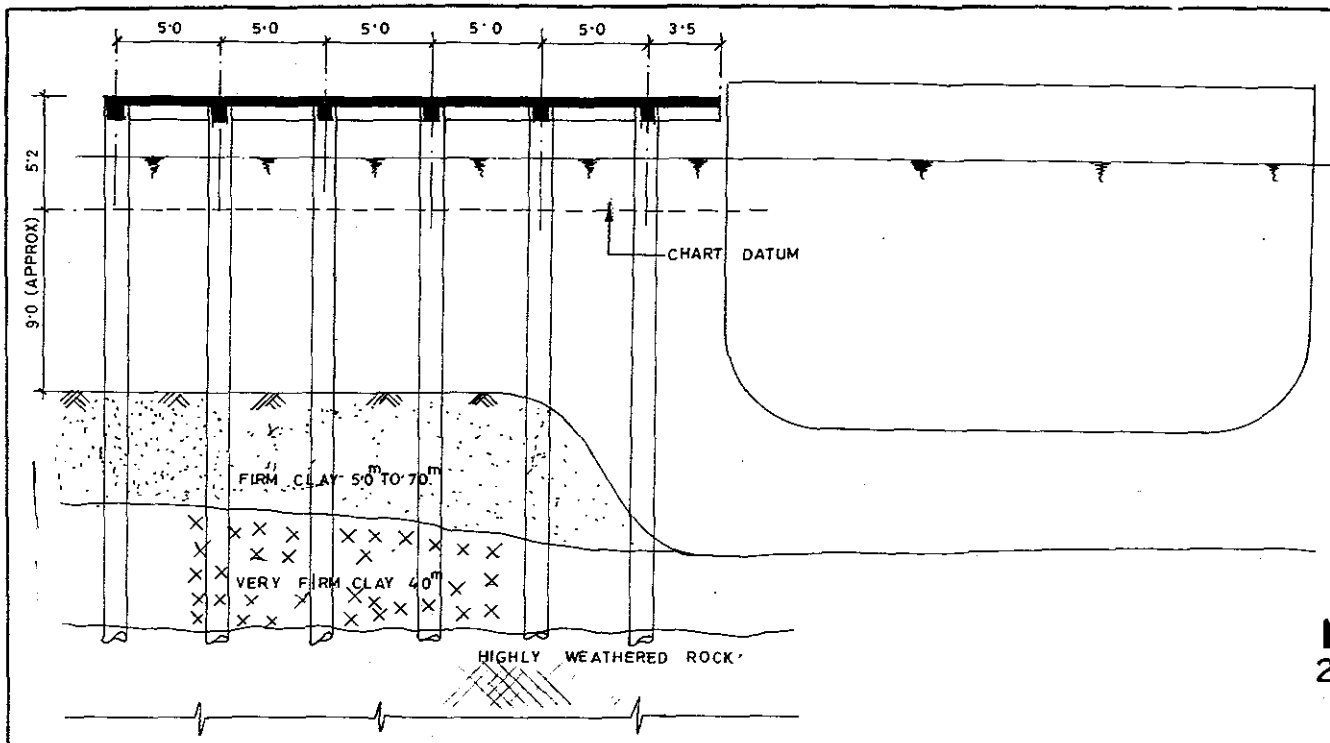
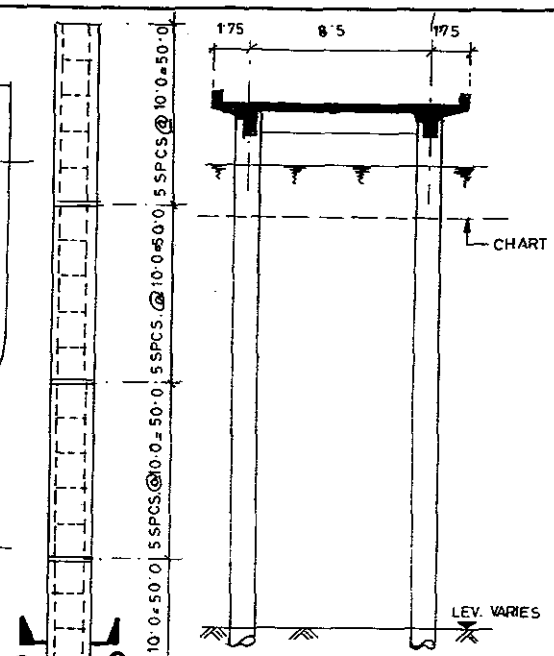
PLATE NO. 5.2



SECTION 1-1



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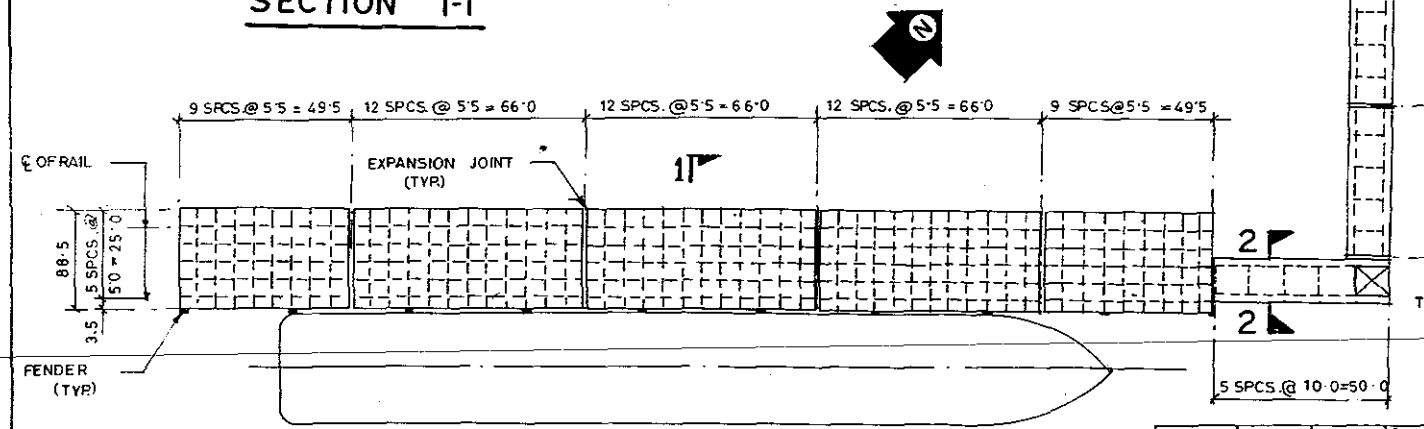

GUJARAT POWER CORPORATION LIMITED

2X500 MW. COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL.

DRN. BY	CKD. BY	JOB NO.	SCALE	DATE
M S	TS	9305		15.12.94

DEVELOPMENT CONSULTANTS LIMITED
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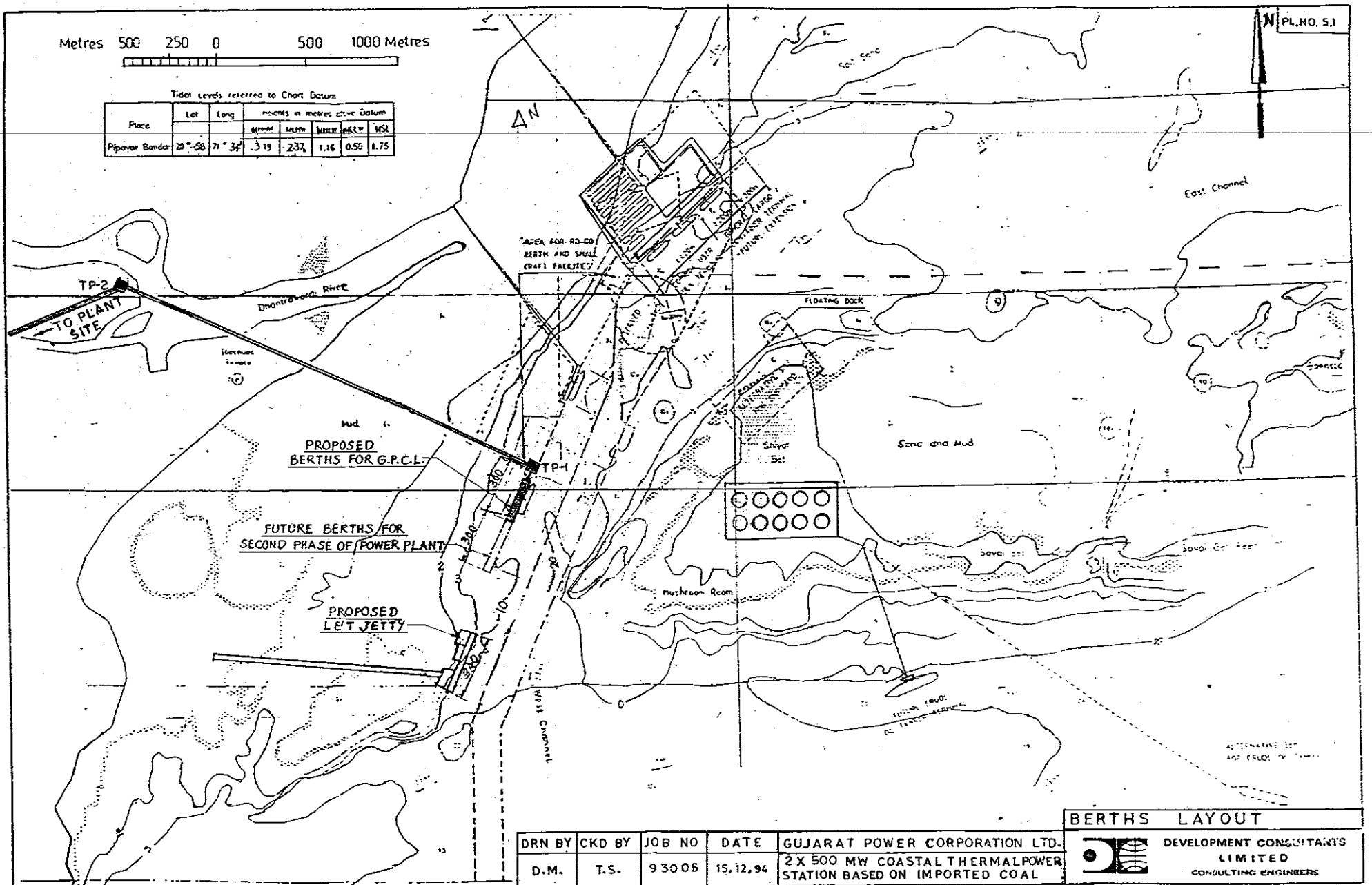

DRN BY	CKD BY	JOB NO	DATE	GUJARAT POWER CORPORATION LTD.
D.M.	T.S.	93005	15.12.94	2 X 500 MW COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL

BERTHS LAYOUT

DEVELOPMENT CONSULTANTS LIMITED
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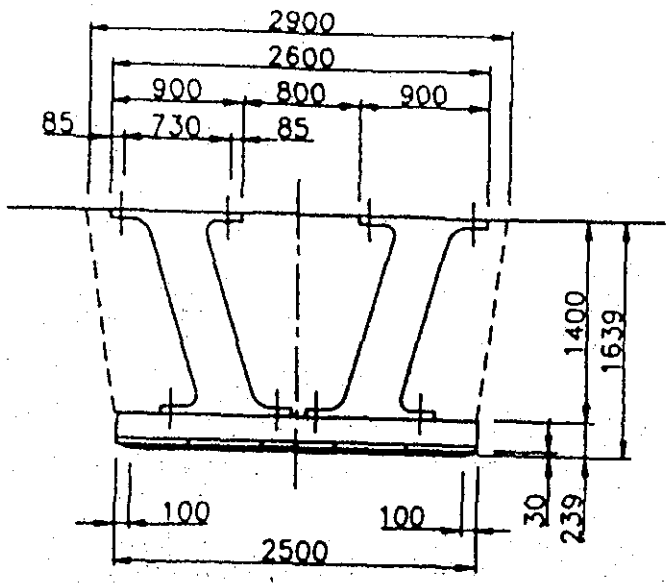
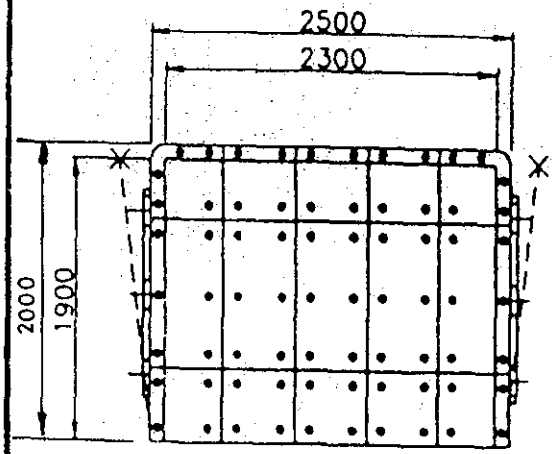
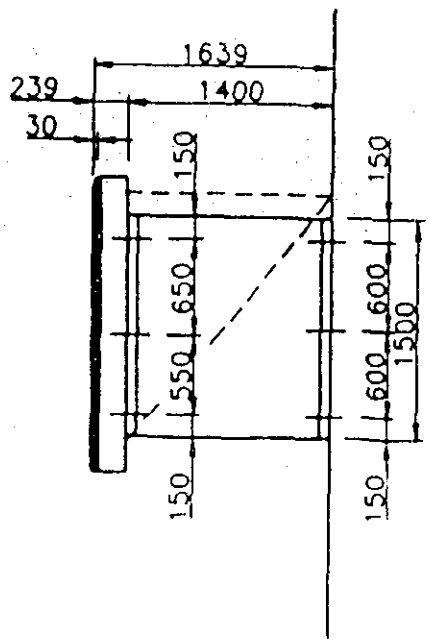
PLATE NO. S.3







DETAILS OF PI-FENDER WITH RUBING BOARD.

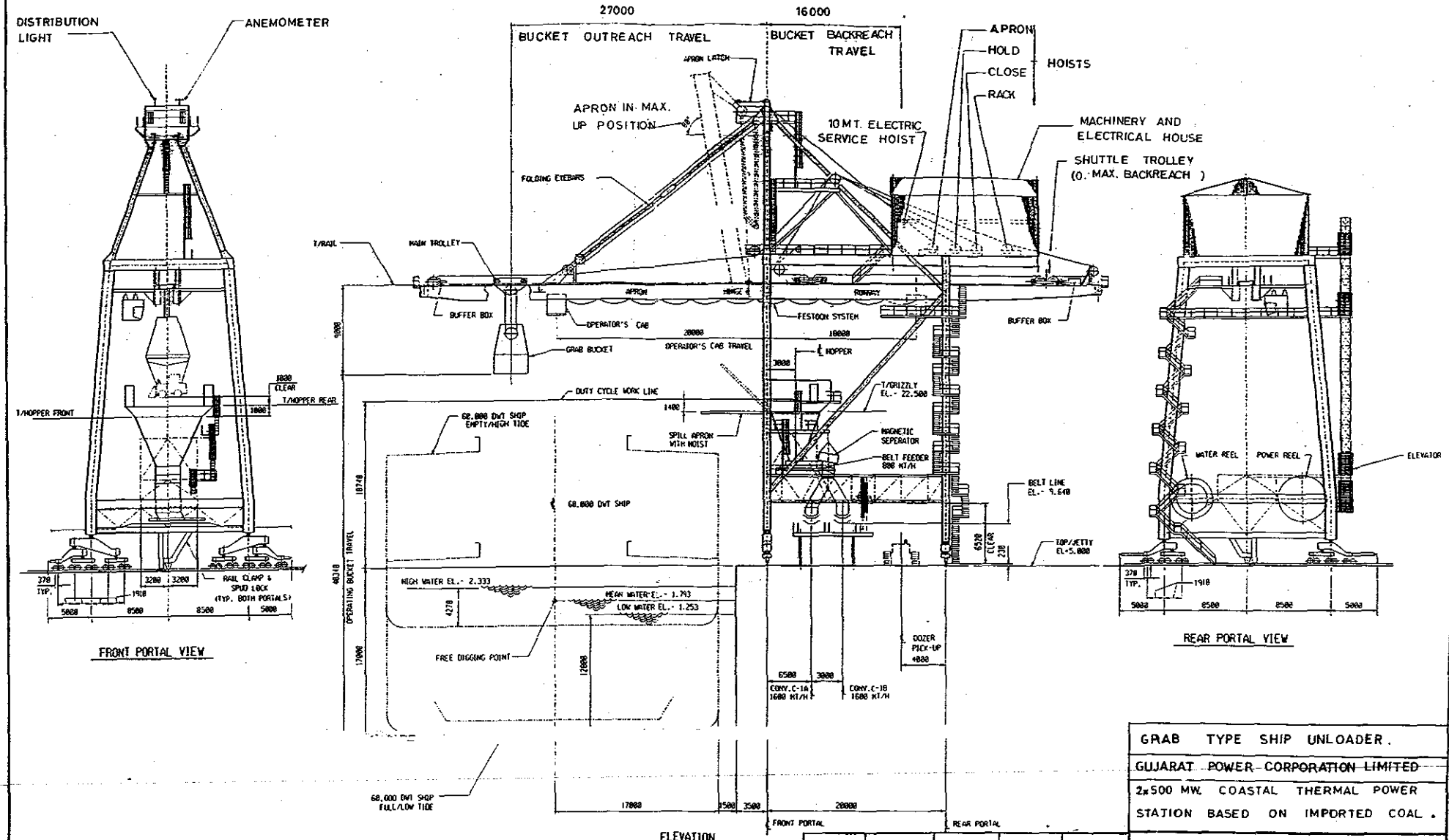
GUJARAT POWER CORPORATION LIMITED.

2 X 500 MW COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL.

	DRN BY	CKD BY	JOB NO	DATE
	D.M.	T.S.	93005	12.12.94

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

PLATE NO. 5·4



GRAB TYPE SHIP UNLOADER.

GUJARAT POWER CORPORATION LIMITED

2x500 MW. COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL.

DRN.BY	CKD.BY	JOB NO.	DATE	SCALE
D.M.	S.B.	93005	9.8.95	

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 6

ENVIRONMENTAL
AND
SOCIAL ASPECTS

SECTION - 6

ENVIRONMENTAL AND SOCIAL ASPECTS

6.1 Introduction

The main objective of the project is to ensure steady, uninterrupted and economic flow of coal to the power plant so that the planned generation can be maintained with minimum cost of production of electricity. Generation and supply of electricity at a reasonable tariff is a social responsibility as electricity constitute the basic fibre for a modern life style and various economic activities like industry, commerce and agriculture. Associated with this responsibility, there is also a very vital social obligation - the obligation of maintaining clean environment. As such, not only the environmental impact of power plant operation will be considered in depth, but also the effects of all associated activities, including the construction and operation of coal unloading berth, on the surrounding environment should be assessed carefully so that appropriate corrective and control measures can be suggested to mitigate the pollution potential of various activities to the barest minimum.

The environmental aspects of power plant construction and operation have been covered in a separate report on power plant. This report deals with the possible impact of jetty construction, operation and maintenance on the surrounding environment.

6.2 Social And Environmental Aspects

The impact of power plant on the socio-economic fabric of modern civilization is tremendous. A power plant stirs allround development in industrial and agricultural activities. The large scale employment thus generated is bound to activate social and

economic upliftment of inhabitants around the plant. Although a power plant has its own environmental pollution potential, it can mitigate atmospheric contamination level to some extent by eliminating oil lamps, inefficient agricultural machineries run by crude oil, local generating set, hazardous cooking medium, to mention a few.

It is in this context, the importance of this study on cargo unloading facility has to be judged. It is a part of a total project e.g. power plant and port facility together and its successful implementation and efficient operation would have a distinct impact on the operation efficiency of the power plant which in turn will influence the social and environmental aspects. However, the direct influences of the jetty construction and operation on social fabric and surrounding environment are limited. Nevertheless, these limited options have to be identified so that best possible guidelines may be formulated to ensure pollution-free environment.

The project activities can broadly be divided into two categories :

- Construction of berth
- Coal handling operation and maintenance

Social and environmental aspects of these activities are discussed separately

6.2.1 Social and Environmental Aspects in Construction

Employment potential during construction of the jetty is limited. GPCL has to maintain a team of engineers adequately supported by administrative and other staff to carry out pre-construction activities (e.g. land development, finalisation of specification, preparation of tender documents, tender evaluation etc.) and supervision and monitoring the construction in close association with the consultant. The total staff requirement from GPCL side for

these activities would not be more than 23. A large number of construction workers would however work in this project. Although the basic responsibility to cater the needs of this large work force rests with the vendor awarded with the construction contract, it is necessary to provide basic arrangements to provide civic amenities like drinking water, electricity to these workers. They should also be provided with clean and airy accommodation and should not be exposed to hazardous living condition. GPCL must assure that child labour are not allowed to work in this project. Adequate medical support and safety device should be kept at site. During construction, care should be taken to ensure that construction activities do not contaminate the surroundings to any appreciable extent.

Construction should be as per schedule and inventory should be palnned accordingly. Unnecessary stacking of construction material for a long term should be avoided. The stacking of material might create dusty environment during windy season and particularly during rainy season, obnoxus particulates might percolate underground thereby contaminating the ground water.

To avoid dusty environment during construction, frequent sprinkling of water would be necessary. Provision for such service water should be kept at site.

6.2.2 Social and Environmental Aspects in Operation

GPCL may have to engage a group of about 30 personnel including officers and supporting staff for berth operation activities. They would stay in the staff colony of the power plant which is proposed in a location not far off from the port facility where excellent civic amenities and entertainment facilities will be provided. Health services, schooling facility

for the children and transport from the colony to the work place near the unloading berth has to be provided.

The first important environmental aspect arising during coal unloading is the influence of coal handling on other general cargo on the berth. The coal is considered as dirty cargo and coal handling operation should be well separated from the general cargo handling area. In this project a dedicated berth for unloading coal well be separated from other general purpose cargo berth of the port has been proposed. As such, the possibility of other cargo being contaminated by the dirty influence of coal does not arise.

The coal is generally shipped in primary crushed form and as such is susceptible to dust generation during unloading. In order to suppress/limit dust development, appropriate measures have to be adopted. Accordingly, the coal unloader should be equipped with water spraying system and the hoppers of the unloaders provided for feeding the conveyors belts should be cladded with dust protection wall.

The water spraying system in the unloader should be provided with a pump and a storage water tank to ensure assured supply of water during water spraying.

To collect coal dirt trickling down and accumulating in the system or in the quay, the unloader should be provided with spillage flaps.

Suitable supply points along the jetty should be provided to maintain adequate supply of service water for dust suppression and cleaning the jetty.

In order to avoid dust nuisance during transportation of coal from the jetty to the power plant, the belt conveyor system should be covered.

In addition to above precautionary measures, contamination levels and dust accumulation during unloading and transportation of coal should be closely monitored and all necessary precaution to limit the same must be adopted.

Maintenance of harbour and ship operation in harbour create some typical environmental problems. Although, the basic responsibility to mitigate such problems lies with the port authority, power plant group should maintain close contact and liason with them to ensure that prescribed environmental standards in port maintenance and operation are adhered to.

One of the most common environmental problem is the disposal of dredged material generated during capital and maintenance dredging. Disturbance in natural morphological and litoral process due to such dredging and disposal should be minimum and should not encourage island formation and/or shore errosion. Extensive model studies should be carried out to identify best method of dredging and best location for disposal. Even after construction, morphological and littoral changes at site should be closely monitored and suitable corrective actions should be undertaken where necessary.

Other environmental problems may be due to oil spillage from the ship at berth. Strict vigilance on ships calling the port should be kept to minimise and avoid such spillage. Moreover, ship refueling facility has been proposed at the harbour. The refueling machinery should be properly designed and maintained to avoid oil spillage during refueling operation. Other factor needing careful consideration is the disposal of service water from ship to the sea. International and national standards in this regard must be strictly adhered to.

Finally, considering the overall impact of the project on the society and surrounding environment the project authority must always be vigilant and would ensure strict

compliance of safety and environmental regulations at all stages of construction and operation. Adequate maintenance of operation and service equipment must be undertaken in order to arrest any environmental fall out due to malfunctioning of any equipment. Continuous monitoring of ambient air and water quality should be maintained to identify any possible bottle neck in environmental protection and for undertaking corrective measures whenever necessary.

Salient features of environmental and social aspects which might arise due to construction and operation of the cargo unloading berth are highlighted in **Annexure-6.1**.

Annexure - 6.1
Sheet 1 of 2

Environmental & Social Aspects During Port Construction And Operation

Name of the Project :

Coal Unloading Berth for 2 x 500 MW Coastal Power Plant for Gujarat Power Corporation Limited (GPCL).

Construction Phase :

1. Provide basic amenities, health and recreation facilities for construction workers.

2. Avoid employment of child labour.

3. Avoid stacking of construction material for a long time.

   Keep adequate provision for service water for generous sprinkling to suppress dusty environment created by stacked material and activities during construction.

Operation Phase :

1. Provide housing facilities, excellent civic amenities, medical services, entertainment facilities, transport facility and schooling facility for the children.

2. Segregate the coal unloading berth from other general cargo handling activities to protect the general cargo from possible harmful influence of dirty cargo like coal.

3. To suppress/limit dust development, the unloader should be equipped with water spraying systems and hoppers cladded with dust protection wall.

4. The water spraying system in the unloader should be provided with a pump and a storage water tank.

5. To collect coal dirt trickling down and accumulating on the system or on the quay, the unloader should be provided with spillage flap.

6. Suitable supply points along the jetty should be provided for adequate supply of service water for dust suppression and cleaning the jetty.

7. The belt conveyor system should be covered.

8. Contamination level and dust accumulation during unloading and transport should be closely monitored and all necessary precautions to limit the same must be adopted.

9. Power plant authority will maintain close association with port authority during disposal of dredged material during capital and maintenance dredging. Possible changes in coastal morphology and littoral processes must be carefully ascertained and closely monitored during port operation.

10. Sea water pollution due to oil spillage and discharge of service water should be minimized and should be governed by International and National Standards.

SECTION – 7

CONSTRUCTION FACILITIES

SECTION - 7

CONSTRUCTION FACILITIES

7.1 General

The construction of coal unloading jetty for the proposed 2 x 500 MW power plant need not commence at grass-root level. It is expected to receive adequate support from the Gujarat Pipavav Port Limited (GPPL) and can draw on the infrastructural facilities that are likely to be developed by GPPL in their overall port development programme. Nevertheless, every effort should be made to ensure timely and unhindered completion of construction of coal unloading berth so that planned power generation do not, in any way, suffer for want of the basic ingredient - the coal.

In planning the berth layout due care has been taken to ensure optimum utilisations of natural features and expected climatic conditions at site so as to arrive at a berthing and unloading facility which is not only safe for operation but also relatively cheap to construct.

The type of construction can broadly be divided into two classes. The former would consist of a thick reinforced concrete deck supported on heavy piles to ensure safe operation of heavy cargo unloading equipment on deck and withstand forces generated by the ship. The second type of structure would provide effective approach to the berth from the shore and also would support the conveyor belt carrying coal from the unloader to the power plant site. As the load from the conveyor belt and the access road would be conmparatively low, a relatively lighter construction in the form of a trestle bridge supported on piles has been proposed.

7.1.1 Site Investigation for Construction

The construction has to be carried out in the off-shore region. As such extensive site investigation would be necessary so that most appropriate technique for construction can be adopted.

The Site Investigation will consist of the following items of work :

- A hydrographic survey of the harbour and channel area.
- A topographic survey on-shore area adjacent to the marine terminal.
- Detailed soil investigation by making boring and/or other technique.
- Detail information on tide, current, wave and wind field at site through long term observation and analysis.

Extensive investigation on the above aspects have been carried out by GPPL over last few years. These information have to be compiled and made available to the contractors who will be called upon to submit bids for the construction so that they get clear idea about the subsoil and environmental conditions in which they are likely to work.

7.1.2 Construction Roads

For unhindered construction activity smooth flow of material and equipment to the site is vital. The proposed site is well connected by State and National Highway. As such, construction of approach roads to the site could be provided easily.

7.1.3 Construction Water

Water supply facility at GPPL site at Pipavav is already available. GPPL has also envisaged large scale constructional activity adjacent to the proposed jetty for coal unloading. This infrastructural facility has to be utilised to fulfil construction water requirement. However,

if this is not sufficient, the contractor has to make necessary arrangement for construction water.

7.1.4 Construction Power

The contractor has to draw his own power network from the power supply point to be provided at the site by GPCL.

7.2 Construction Equipment

The off-shore construction would necessitate specialised equipment for off-shore boring/drilling, pumping equipment for bentonite slurry etc. apart from conventional material handling, concrete mixing and other equipment. The contractor should provide all these equipment.

7.3 Construction Materials

The main construcional material are stone aggregate, sand, cement and steel. Gujarat, being the major producer of cement in India, adequate and timely supply of cement is assured. Steel may be obtained from any major steel stockyard in Gujarat. Local supply of stone aggregate and sand would be convenient and economic. Suitable stone deposits and sand beds has to be identified through local survey.

SECTION – 8

ORGANIZATIONAL SET-UP

SECTION - 8

ORGANIZATIONAL SET-UP

8.1 General

The organizational set-up for the port operation would be a part of the total set-up necessary to run the power plant operation as well as the coal unloading operation. It should preferably be headed by a General Manager, under the overall control of the Station Manager of the total project and will be responsible for all activities related to berth construction & commissioning during construction stage and subsquently for port operation, negotiation with potential supplier of coal, chartering of vessels in the operation stage. He would maintain close liason with Pipavav Port Authority to ensure pilotage, berthing of vessels, refueling of vessels and maintenance of the approach channel and harbour zone.

It is proposed to have two core groups under the General Manager in addition to the General Accounts and other service sections. The first group would be responsible for design engineering and construction activities and would be most active during design, construction and commissioning of the dedicated berth.

The second group would be responsible for the operation and maintenance of cargo unloader and other handling equipment and would work in close association with the Pipavav Port Authority during ship berthing and cargo unloading operation. The construction group may be partially or fully transferred to this group.

8.2 Design Engineering And Construction Set-up

The basic activities under this group may be divided under the following broad heads :

a. Selection of Consulting Engineer

b. Design, Engineering and Technical specification

c. Procurement of Equipment and Machinery

d. Selection of Construction/Erection agencies

e. Manufacturing and Delivery, Construction and Erection

f. Trial Run and Commissioning

g. Monitoring and Control

This group should be headed by a senior engineer preferably in the rank of Chief Engineer who would be assigned with the exclusive responsibility of commissioning the cargo unloading berth within scheduled time. He would directly report to the General Manager.

GPCL will engage a Consulting Engineer for design, engineering, preparation of Tender Specification, Evaluation of Tenders, review of Vendors' Drawings, witnessing required Shop Tests etc.

The Chief Engineer would be the man in overall charge of construction. He will be posted at site and would be responsible for all activities of construction, erection, administration, stores, security etc. from construction to commissioning stage. He will be assisted by a Deputy Chief Engineer who would be Incharge of all technical activities of the project. Deputy Chief Engineer would be provided with requisite numbers of engineering and technical personnel which would include two Construction Superintendent - one for civil

construction and the other for mechanical erection activities. Each of the Superintendents would be adequately assisted by Assistant Engineer and Junior Engineers.

Secretarial, accounts and other service facilities would directly be drawn from General Service group.

8.3 Berth Operation And Maintenance Set-up

This group would be mainly active only after commissioning of the berth. However, they will closely associate themselves with Design Engineering and Construction Group during precommissioning checks, trial runs and commissioning activities to acquaint themselves with various systems and subsystems of the berth and equipment operating thereon.

The main activity of this group may broadly be divided into two parts - supervision of berth operation, commercial activities and maintenance of jetty, handling equipment.

The operation group will be headed by Superintendent (Operation) who will directly report to the General Manager. Operation Superintendent will be assisted by one Liason Officer and one Commercial Officer. The Liason Officer will maintain close liason with Pipavav Port Authority regarding all aspects of ship operation. The Commercial Officer will be responsible for all commercial activities which include negotiation of coal price and selection of suitable agency for long term coal supply, chartering of vessels etc. Both these officers will be supported by adequate number of Commercial Assistants.

The maintenance of jetty and all jetty equipment including cargo unloading will be the prime responsibility of Superintendent (Maintenance) who will head the group and would directly report to the General Manager. The Maintenance Superintendent will be assisted

by Assistant Engineer from Civil, Electrical and Mechanical Wings. They will be adequately assisted by Overseer, Electricians, Welders, Mechanics and Pump Operators to perform routine and periodic maintenance of berth, equipment and essential supplies (e.g. water, electricity). In addition, there will be three unloader operators to unload coal from the vessel and feed to the conveyor belt.

Both the Operation Group and Maintenance Group will work in close association and would draw secretarial, accounts and other service facilities directly from the General Service group.

The proposed organizational set-up is shown in **Plate No.8.1.**

Table - 4.2B

EXPECTED WAVE HEIGHT AT PROPOSED BERTH LOCATION

Wave Height at Near Shore (M)	Expected Number of Days of Occurrence (Days)	Diffracted Wave Height at Berth (M)	Remarks
≤ 2 M	329	≤ 0.5 M	Ship berthing possible
> 2 M ≤ 3 M	19	> 0.5 ≤ 0.9 M	Berthing not advisable
> 3 M	17	> 0.9 M	Berthing not advisable

Note : About 329 days in a year berth will be available for coal unloading.

I N D E X

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

VOLUME - I

PORT FACILITIES

I N D E X

List of Annexures, Tables and Plates

SECTION - 4

SECTION - 5

SECTION - 6

SECTION - 8

Plate No.8.1 • Proposed Organization Set-up for Unloading Jetty

SECTION - 9

Plate No.9.1 • Project Schedule

SECTION - 10

Annexure-10.1 • Project Cost Estimate

Annexure-10.2 • Effect of Berth Installation on Cost of Coal

SECTION – 1

PRAOJECT ABSTRACT

SECTION - 1

PROJECT ABSTRACT

1.1 General

Project	:	Coal unloading berth for 2 x 500 MW Thermal Power Station
Owner	:	Gujarat Power Corporation Limited
Location	:	At Pipavav Port on the Saurashtra Coast in Gujarat

1.2 Inputs

Coal Requirement	:	2.5 Million Tonne/year
Coal Source	:	Imported
Transport Means	:	Water borne vessels.
Carrier Size	:	60,000 DWT Bulk Carrier
Draft	:	12.7 M
Water Depth Requirement	:	15.2 M
Unloading Port	:	Pipavav Port
Unloading Facility	:	Dedicated Berth
Climate at Berth	:	Mild
Number of Operating Days	:	300 days per year
Manpower	:	23 during construction and erection stage.
		30 during operation phase.

1.4 Project Particulars

Unloading Jetty	:	300 M x 28.5 M reinforced concrete deck supported on reinforce concrete piles.
Berthing Aids	:	Rubber fenders capable of absorbing berthing impact 80 Ton Metre at 10°.
Conveyor Bridge	:	300 M x 12 M trestle bridge supported on piles.
Coal Unloading System	:	Grab bucket unloaders of average unloading rate 1500 T/hour each (2 nos.).
Coal Conveyance to Power Plant	:	Belt Conveyor System with two-lines of width 1600 mm/1600 TPH capacity each
Interface with Power Plant	:	Control transfer point on conveyor line at 2.5 Kms offshore of the unloading jetty.

1.5 Infrastructure

Office Building	:	300 Sq.M built-up area to accommodate 30 Officers and staff members.
Jetty Approach	:	8 M wide approach road on conveyor trestle bridge.

1.6 Project Cost

Capital Cost	:	Rs.143.72 Crores

1.3 Construction, Operation And Maintenance

Approach Channel and Harbour	:	Gujarat Pipavav Port Limited (GPPL)
Berthing Structure	:	Gujarat Power Corporation Limited (GPCL)
Equipment - Procurement and Erection	:	GPCL
Navigational Aids	:	GPPL
Pilotage	:	GPPL
Ship Berthing	:	GPPL
Coal Unloading	:	GPCL
Coal Conveying	:	GPCL
Power Supply	:	GPPL
Drinking Water	:	GPPL
Scrvice Water	:	GPPL
Ship Refueling	:	GPPL
Berth Maintenance	:	GPCL
Equipment Maintenance	:	GPCL
Waterway Maintenance	:	GPPL
Harbour Maintenance	:	GPPL

SECTION – 2

NEED FOR THE PROJECT

SECTION - 2

NEED FOR THE PROJECT

2.1 Introduction

Gujarat Power Corporation Limited (GPCL) are exploring the feasibility of augmenting electric power generation in a large scale in the State of Gujarat. Industrial growth in the state in the past had been impressive as corroborated by rise in demand of electric power. Considering the potential of this part of the country, acclerated growth is anticipated with corresponding growth in demand of electric power.

Gujarat being a long distance away from domestic coal deposits, the existing coal fired power plants in the state have to incur considerable expenditure on transportation of coal. Moreover, Indian Railway is overloaded in most of the routes. The broad gauge tracks are also restricted in Gujarat. As such, setting-up power plants in Gujarat on low grade domestic coal is not an economically favourable proposition.

In keeping with the liberalized economic policy being persued and encouraged by the Government of India, GPCL intend to set-up a power plant of 2000 MW ultimate capacity based on imported coal. In the first phase 2 x 500 MW generation has been proposed. The coal requirement for the envisaged level of generation in the first phase will be of the order of 2.5 Million Tonne per year. It will be an extremely difficult proposition for any Port Authority to accommodate the unloading requirement of such huge cargo throughput in addition to other commitments of the port. Moreover, in order to avoid exposure of general cargo to the harmful and dusty environment of 'dirty' cargo like coal, an additional

operation area well separated from general cargo area would be desirable for handling bulk coal. Accordingly a dedicated berth would be necessary. Thus, the requirement of the power plant has created a commensurate requirement for a dedicated cargo unloading jetty with independent arrangement for coal unloading and subsequent conveyance to the power plant.

The need for the project thus arises from the requirement of compatible coal transportation and unloading berth to ensure steady supply of coal to the power plant at an economic rate.

The objective and scope of the project to delineate the above are given hereunder.

2.2 Objective

Basic objective of this project is to conduct necessary studies in order to provide an appropriate coal unloading jetty to ensure steady supply of coal to the power plant throughout the year at economical cost of unloading and subsequent transportation and handling.

2.3 Scope of Studies

- Selection of appropriate ship sizes to ensure steady supply of coal with optimum berth utilisation.
- Selection of a proper site for all-weather manoeuvring of coal carrying ships with minimum cost of development of supporting infrastructural facilities.
- To outline technical features of berthing, handling and conveying facilities.

- To suggest organizational set-up during construction phase and during operational stage.
- To outline project schedule and monitoring method.
- To assess the impact of the project on the surrounding environment.
- To arrive at broad economic evaluation.

The first two objectives outlined above have already been covered in depth in the Site Selection Report. Only the salient features of the same will be mentioned in this report. The remaining aspects will be covered in detail in this report.

SECTION – 3

BASIC REQUIREMENTS

SECTION - 3

BASIC REQUIREMENTS

3.1 Coal Carrier

Fundamental requirement is to select an efficient fleet of ships so that coal transportation can be achieved most efficiently and economically. The selection of design ship has been dealt with in detail in the Site Selection Report.

3.2 Dedicated Berth

The continuous supply of large volume of coal for smooth operation of the power plant can best be achieved by providing a dedicated port facility for the power plant. However, the large expenses of creating an artificial sheltered harbour for a single purpose is usually prohibitive. The cost of transportation of coal can be reduced to a significant extent through the use of an existing harbour where such facility is available. However, the large tonnage throughput for the power station might necessitate one or two dedicated berths round the year which could be a difficult proposition to accommodate without hampering other commitments of the port.

Moreover, in order to avoid exposure of general cargo to the harmful and dusty environment of 'dirty' cargo like coal, an additional operation area well separated from general cargo area would be desirable for handling bulk coal. This might create a serious constraint for the port authority to allow berthing facility for coal carrying vessels.

The best approach would thus be to construct a dedicated berth by the power plant authority in the sheltered zone of any port so that required objective can be achieved without hampering normal port activities. At the same time considerable economy can be achieved by availing the infrastructural facilities of the port. With this objective in view, a site selection programme was initiated as detailed in the Site Selection Report.

3.3 Compatible Location

The basic tenet of project formulation is generation of power using imported coal. This implies having coastal facility to unload coal and its onward transportation to the power plant. The power project would have a large generating capacity involving bulk handling of considerable quantity of coal annually. This would necessitate large capacity bulk carriers to call at the unloading berth, which in turn, would require a high capacity unloading and conveying system to release the carriers within a reasonable time.

The power plant should be located as near the unloading facility as possible to reduce the coal transportation distance and at the same time meeting other siting criteria.

The above interdependent aspects and other factors that would influence the process of selecting compatible sites for the coal unloading facility and the power plant may be broadly listed as given below.

- Availability of suitable draft for large bulk carriers for all-weather operation.
- Naturally protected location, if available, for lower cost.
- Minimum distance from unloading berth to shore for shorter access from land and transportation distance of coal.

- Availability of land for locating power plant in the closest vicinity of unloading berth.
- Availability of land for ash disposal within reasonable distance from the plant.
- Proximity to sea for condenser cooling water supply.
- Ground elevation of plant area in respect of sea level to enable direct cooling system, if possible.
- Power evacuation distance in 400 kV system
- Transportation of equipment
- Sites acceptable from environmental aspects and forest department regulations.
- Comparative costs of various alternatives

Some of the above factors are concerning the unloading facility, while others are related to the power plant. However, for justification of siting for the total project all the factors are to be considered together as have been dealt with in the Site Selection Report. Finding of the aforesaid report clearly identifies the Pipavav Site as the most ideal location for locating the unloading berth as well as the power plant.

For this project, Gujarat Pipavav Port Limited (GPPL) has offered suitable location to accommodate the requirement of the power plant. A dedicated berthing facility is to be constructed at this location. Construction and maintenance of the berth, installation and mainteneance of jetty equipment and machinery will be the responsibility of GPCL. Construction and maintenance of harbour, pilotage and berthing of ships and supply of power, water and refueling facility at the jetty be under the jurisdiction of Port Authority (GPPL).

3.4 Handling Equipment

Although there are specialised ships with self-unloading facility, their use is project specific and has to be on long term contract basis. The requirements of this report do not justify such specialised ships. A flexible set-up would be more desirable and accordingly conventional and well proven handling equipment have been proposed.

Therefore, ship unloaders of suitable capacity are to be provided on the berth/s. The type of equipment can be grab-bucket unloader or continuous unloader. Both these types of equipment are available in large capacities for clearing large bulk carriers in reasonable time. However, grab bucket unloader is easier to maintain. As such grab bucket type unloader is proposed for the project.

For large rate of transportation belt conveyors are most suitable, provided the distance of conveying is not excessive. In this project, the unloading berth and the plant will be located as close to each other as practicable. Belt conveyors have, therefore, been proposed to convey coal directly from the ship to the power plant stockyard.

3.5 Port Infrastructural Facility

For smooth and efficient operation, the shipping terminal will be equipped with standard utilities such as illumination, electric power for mechanical equipment for unloading of vessels, appropriate communication system for exchange of information between the ship's Captain on board and material handling equipment operator on the berth, power supply substation and distribution system, potable water supply, service water supply, fire protection system and other miscellaneous items. The berth recommended for docking and unloading coal for onward transmission to the power plant will be part of a large port

facility proposed to be developed by the GPPL. Accordingly, the above services will be a part of port infrastructural facility and may be availed by paying service charges.

Moreover, for pilotage, berthing and deberthing of ships services from the port authority have to be availed to ensure safe voyage, easy manoeuvring and efficient berthing of the ship. In addition, refueling and ballasting facility, if needed for the coal carriers calling at the port has to be availed from the existing port infrastructural facilities.

SECTION – 4

SELECTION OF HARBOUR SITE

SECTION - 4

SELECTION OF HARBOUR SITE

4.1 General Requirements

The selection of a suitable site for the construction of a cargo unloading berth has been covered in the Site Selection Report. General requirement is to identify a suitable location for the harbour which will provide sufficient manoeuvring space and adequate protection to the design ship with minimum operational difficulties and financial involvement. Further the harbour site should be close to the power plant site so that the construction cost of conveyor belt system for transportation of coal from port to power plant site as well as the cost of conveying are low. Accordingly, several locations of the harbour have been studied to determine the most naturally protected location involving little or no cost of developing breakwater and other protective devices, least amount of dredging requirement and with the most favourable bottom conditions as well as a shore area suitable for the development of the terminal facilities. Desirable site features are enumerated in Annexure-4.1. Various possible sites along the coast of Kutch and coast of Saurashtra have been studied and the dedicated berthing facilities offered by GPPL inside the harbour of the proposed Pipavav Port was found to be the best possible alternative.

All aspects of site selection has been covered in detail in the Site Selection Report. The salient features are reproduced from the aforesaid report.

4.2 Topography at Site

Further east of Veraval, along the coast of Saurashtra, lies the site for the proposed Pipavav Bandar. Hydrographic map of the offshore area indicates presence of rocky bets close to the shore which would provide some degree of protection to the shore against the on-coming sea waves. As such, the offshore region between the shore line and the rocky bets appears promising for the development of harbour facility.

Recognising the natural advantage of the Pipavav site, Gujarat Pipavav Port Limited (GPPL) has already initiated the process of study and development of an all-weather port facility at Pipavav.

Topographic maps exhibit potential features near the city of Jafrabad that can be exploited favourably for the development of the power plant. A subsequent site visit to gather first hand information about the region substantiated the preliminary findings and it was possible to identify one location near the western boundary of the cement plant of M/s. Larsen & Toubro under construction which appears to be suitable to accommodate the power plant as well as the ash dumping ground. The hydrographic map indicates that the available natural water depth at the harbour is of the order of 10-11 M. As such, the harbour has to be dredged suitably to accommodate the design vessel.

4.3 Climate at Site

In order to ascertain possible climate at site, DCL has carried extensive investigations. In addition, report of the Dutch Consultant M/s. DHV appointed by GPPL has also been referred.

The salient features of the probable climate at site is reproduced below. For details reference may be made to the Site Selection Report and its Addendum submitted to GPCL earlier.

4.3.1 Wind Climate

Expected wind pattern at site in tabular and graphical form is reproduced in **Table-4.1** and **Plate No.4.1** respectively. These documentation indicate that wind direction is predominantly westerly and most of the wind energy is concentrated within the band of 45° between west and north-west. Wind speed in general would be moderate and about 6% time in the year calm wind having speed less than 1 Knot is expected in the region. Exceedence of wind speed beyond 20 Knot would be very rare.

4.3.2 Wave Climate

Wave climate studies have been reported in detail in the Site Selection Report. Salient features of probable wave climate near shore region of Pipavav is reported in **Table-4.2A**. As can be seen there, for most part of the year (e.g. 200 days), the expected wave heights in near shore region would be less than or equal to 1 M in height. For 36 days in a year, near shore wave heights are likely to be more than 2 M (this waves will include higher waves e.g. 3 M, 4 M, 5 M waves as well) and for 17 days in a year, wave heights would cross 3 M mark. Accordingly, expected occurrence of waves greater than 2 M in height and less than or equal to 3 M would be 19 days in a year. The waves in the near

4.4 Conclusion

The site selected for the construction of a dedicated berth inside the proposed Pipavav Port harbour zone satisfies all the requirements enumerated in **Annexure-4.1**. However, capital dredging and subsequent maintenance dredging have to be undertaken to cater the need for the design vessel. Gujarat Pipavav Port Limited vide their letter GPPL:GPCL:461:93-94 dated March 24, 1994, the copy of which is appended as **Annexure-4.2**, has agreed to accommodate the above requirements.

Annexure-4.1
Sheet 1 of 1

Desirable Features of Site

As briefly mentioned earlier, the probable site should preferably possess the following desirable features.

- the natural water depth at site should be sufficient so that the design ship can be accommodated with little or no dredging.

- the location should be naturally protected and sufficient manoeuvring space should be available inside the harbour to cater the need of the design vessel.

- the harbour should be available for all-weather operation.

- shore area should be suitable for the development of terminal facilities and sufficient space of suitable topography near the port site should be available so that the power plant can be located as close to the port as possible.

- the hinterland should be well connected with roads

- amenities such as electricity, water supply etc. should preferably be available at least for construction phase.

GPPL
(A Joint Sector of Govt of Gujarat)

Gujarat Pipavav Port Limited

REF : GPPL:GPCL:461:93-94 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 Guja

(- 2 -)

(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

Table - 4.1

WIND PARTICULARS AT PIPAVAV SITE

WIND DIRECTION	% OF TIME WIND SPEED EQUAL TO OR EXCEEDING									
	1 Kn	3 Kn	5 Kn	10 Kn	15 Kn	20 Kn	25 Kn	30 Kn	50 Kn	75 Kn
N-N-EAST	1.7	1.3	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0
N-EAST	9.8	7.4	4.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
E-N.EAST	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EAST	0.6	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E-S-EAST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S-EAST	1.4	1.4	1.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0
S-S-EAST	1.1	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOUTH	3.0	2.3	1.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0
S-S-WEST	1.0	0.8	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0
S-WEST	6.4	5.8	5.4	3.0	0.8	0.3	0.0	0.0	0.0	0.0
W-S-WEST	5.4	5.2	4.8	3.1	2.0	0.8	0.0	0.0	0.0	0.0
WEST	24.5	23.6	21.9	15.7	4.2	0.6	0.1	0.0	0.0	0.0
W-N-WEST	16.8	16.7	15.4	11.0	1.8	0.0	0.0	0.0	0.0	0.0
N-WEST	14.1	12.7	10.9	5.4	0.8	0.1	0.0	0.0	0.0	0.0
N-N-WEST	3.5	3.0	2.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0
NORTH	4.4	3.0	2.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0
	% OF THE TIME CALM WIND PREVAILS IS 6.1									

Table - 4.2A

PREDICTED NEAR-SHORE WAVE CLIMATE AT PIPAVAV

Wave Height exceeding (M)	Number of days exceeding												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	9	16	20	18	26	23	29	22	18	8	6	5	200
2		1		2	3	6	17	6		1			36
3				1		3	11	2					17
4				1		2	4						7
5						1	1						2

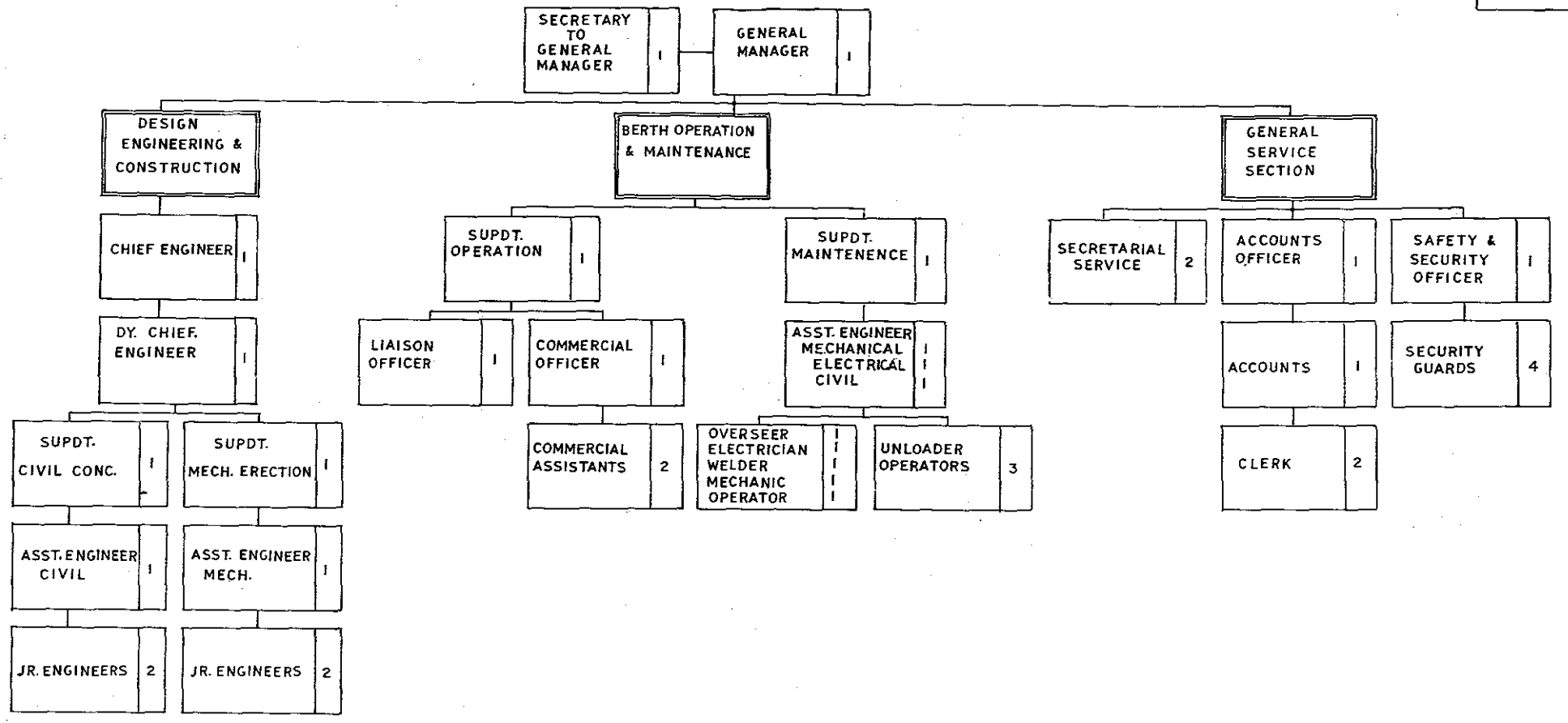
Table - 4.2B

EXPECTED WAVE HEIGHT
AT PROPOSED BERTH LOCATION

Wave Height at Near Shore (M)	Expected Number of Days of Occurrence (Days)	Diffracted Wave Height at Berth (M)	Remarks
≤ 2 M	329	≤ 0.5 M	Ship berthing possible
> 2 M ≤ 3 M	19	> 0.5 ≤ 0.9 M	Berthing not advisable
> 3 M	17	> 0.9 M	Berthing not advisable

Note : About 329 days in a year berth will be available for coal unloading. Keeping margin for safety, ship operation in the harbour may be taken as 300 days per year.

PLATE NO. 8.1



PROPOSED ORGANISATIONAL SET UP FOR UNLOADING JETTY.

GUJARAT POWER CORPORATION LTD.

2X500MW-COASTAL THERMAL POWER STATION BASED ON IMPORTED COAL.

DRN	CKD	DATE	JOB NO	SCALE
BSR	TS	4-1-95	9305	~

DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 9

PROJECT SCHEDULE
AND
MONITORING

SECTION - 9

PROJECT SCHEDULE AND MONITORING

9.1 Construction Programme

The time required for the completion of the unloading berth and coal conveyance system to power plant has been envisaged as 60 months from the date of approval of the project and financial allocation. However, the actual time of construction and commissioning of the jetty from the date of awarding civil construction contract, has been envisaged as 36 months. This date of order is considered as zero date, and the Consultant should be appointed 14 months prior to this date.

It is envisaged that the principal equipment, namely, ship unloader, conveyor system etc. would be ordered 6 months after the zero date. Normally, equipment like ship unloader are constructed and despatched in knocked down condition within a time span of 15 months. Thereafter 11 months have been envisaged for erection. Finally, about 4 months have been envisaged for testing and commissioning.

9.1.1 Engineering

The pre-bid engineering for the berthing structure and jetty equipment is scheduled to commence after the appointment of Consultant. During this stage, the single line flow diagrams, sizing of major structural members and equipment, parameters for utilities and services, the layout of berthing structure, site and soil details, which would from the basis for invitation of tenders for civil construction and equipment would be developed.

Further basic and detailed engineering work would proceed alongwith tender evaluation. This would involve basic and detailed design of structures and foundations, review of vendors drawing etc. Technical Specification for main equipment would also be finalised at this stage.

To shorten the project implementation period, it is proposed to divide the project into islands of work and responsibilities, so that, parallel action can be taken for each system. The basic engineering work would define the boundaries and interfaces of different islands.

The important activities covering floating enquiries, obtaining quotations, evaluation of the bids and placement of orders sometimes causes delay in execution of projects. It is envisaged that these important activities would be completed at the shortest possible time. Since the detail enginering work, like design of foundations and utilities for major equipment and system cannot commence before obtaining relevant data from the vendors, it is proposed that the contracts would specify submission of vendors' data within a stipulated period. This would ensure timely completion of design activities.

9.2 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 awarding berth construction contract.

b. Appointment of the consultant will be 14 months prior to the zero date.

c. Land needed for conveyor belt corridor would be acquired alongwith land acquisition for the power plant.

d. A site office is to be opened 18 months prior to the zero date to commence initial work viz. topographic survey, hydrographic survey, soil boring and/or to compile available data from GPPL.

e. The first activity to be started at site is the land development work. This activity will start 14 months prior to zero date and will continue for 10 months.

f. 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 (-)8th month and will be completed within 8 months time.

g. For major packages, the time period between issue of tender notice and issue of purchase order/awarding contract 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) Negotiation with Tenderers and placement of orders.

h. The date of awarding the construction contract is the zero date.

i. Major equipment and jetty machinery will be ordered 6 months after zero date.

j. Design, construction and despatch of equipment in knocked-down condition will take 15 months.

k. Fabrication and erection of equipment at site will take 11 months time.

l. Testing and commissioning activities will take another 4 months after erection.

m. The coal unloading berth will be commissioned within 36 months from the zero date.

9.3 Project Monitoring

9.3.1 A special group/cell headed by a Chief Engineer is proposed to be set up for 'Monitoring & Control' of the project. In order to have an effective management information system and overall control through all phases, an integrated 'CRITICAL PATH METHOD' schedule for engineering and design, material and equipment procurement, construction and start-up phases of the project, would be prepared. The schedule would be reviewed regularly to find out the actual status of the project. The reviews would identify the critical items. Necessary corrective measures would be taken up for completion of the project as per schedule.

9.3.2 The responsibility of this cell would be obtaining uptodate information on progress from design office, purchase section and vendors regarding manufacturing and delivery and field construction/erection work. Each vendor/contractor would be required to submit his detailed manufacturing and delivery/construction/erection programme to suit the master project schedule. It would be the responsibility of this cell to check the individual programmes and actual progress against the master schedule and suggest remedial measures to the concerned departments/agencies.

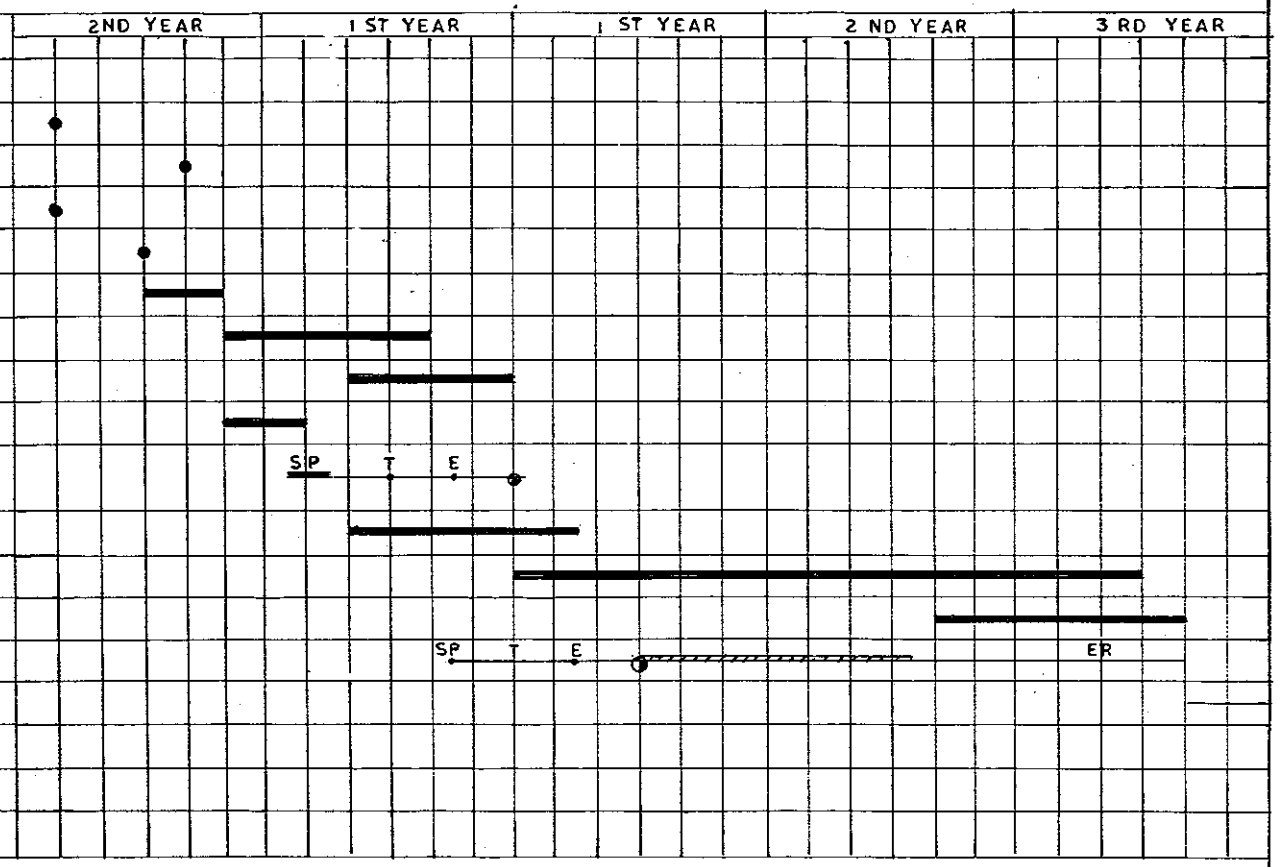
SP — PREPARATION OF SPECIFICATION
T — RECEIPT OF TENDERS
E — EVALUATION BY CONSULTANT
⊕ — PLACEMENT OF ORDER
▨ — MANUFACTURE & DELIVERY
ER — ERECTION OF PLANT & MACHINERY

PROJECT SCHEDULE

PROJECT: 2 X 500 MW COASTAL POWER PLANT AT PIPAVAV
OWNER: GUJARAT POWER DEVELOPMENT CORPORATION
LOCATION: PIPAVAV, GUJARAT

JOB NO. 93005
PLATE NO. 9.1

ITEM NO	DESCRIPTION OF ITEMS
1	SUBMISSION OF FEASIBILITY ITEMS
2	APPROVAL OF PROJECT & FINANCE ALLOCATION
3	APPOINTMENT OF CONSULTANTS
4	POSSESSION OF LAND
5	OPENING OF SITE ESTABLISHMENT
6	TOPOGRAPHIC, HYDROGRAPHIC SURVEY & SOIL INVESTIGATION
7	LAND DEVELOPMENT
8	CONSTRUCTION FACILITIES
9	BASIC ENGINEERING LAYOUT FINALAISATION
10	PREPARATION OF TENDER DOCUMENT FOR CIVIL CONSTRUCTION, TENDER EVALUATION & ORDER
11	BASIC & DETAILED DESIGN
12	CIVIL CONSTRUCTION
13	UTILITIES
14	JETTY MACHINERY
	a) CARGO UNLOADER
	b) CONVEYOR BELT
	c) MISCELLANEOUS EQUIPMENT
15	TESTING & COMMISSIONING



DEVELOPMENT CONSULTANTS LIMITED
CONSULTING ENGINEERS

SECTION – 10

PROJECT COST ESTIMATE
AND
FINANCIAL ASPECTS

SECTION-10

PROJECT COST ESTIMATE AND FINANCIAL ASPECTS

10.1 Basis of Estimates

To arrive at the project cost, scope of work has been restricted to the following :

- Construction of main berthing structure including utilities and service facilities on the jetty.

- Construction of trestle bridge to support conveyor belt and approach road to jetty in the offshore zone.

- Structural construction for coal conveyor system on ground upto second transfer point (TP2) which is the assumed battery limit of berthing facility. However, the conveyor operation would be the responsibility of Power Plant operation staff.

- Construction of site office and other temporary sheds and utilities to facilitate construction and subsequent operation.

- Procurement, erection and commissioning of coal unloading system.

- Procurement, erection and commissioning of conveyor belt system and its allied equipment.

- Major electrical equipment including transformer, substation cables, illumination and communication system.

In addition, some provisions have been kept for data collection and/or compilation, ground preparation and other miscellaneous works.

The estimated project cost have been worked out on the basis of following assumptions:-

a. Major Civil Engineering Construction :

- The main civil engineering works involved in the project is the construction of a cargo berth. To arrive at an appropriate dimension of the various structural members which include R.C.C. concrete slab, beams and piles, a preliminary design has been carried out based on expected environmental loads on the structure, berthing impact from ships, live load from heavy cargo handling equipment, dead load and other design loads. From these designs, quantities of various materials like concrete, steel etc. have been estimated. Unit cost for various items including material and construction cost for construction work in marine and offshore environment have been ascertained from appropriate agencies and finally the cost of the jetty and supporting structures have been estimated from known quantity of work and unit rates.

- An estimate for the cost of construction of the Trestle Bridge has been obtained in a similar manner as has been adopted in case of cost estimation for the main cargo berth.

- Main utilities necessary in the coal berth include a fendering system to absorb the impact of the berthing system. Expected berthing energy from a typical 60,000 DWT coal carrier have been calculated and a suitable fendering system has been designed. The cost quotation for budgetary purpose for commercial

rubber fenders has been obtained from leading international manufacturer and has been adopted as the basis for cost estimation of the fendering system.

Cost estimate for the installation of essential supply lines has been taken as lumpsum.

- The responsibility of conveying coal from the jetty upto certain distance on ground on its way to the power house has been entrusted on the core group to be set-up for port operation purpose. From this control transfer point power plant operation group will take over the control for conveying the coal upto the power house. Accordingly, the infrastructure necessary upto this transfer point from the unloading jetty comes under the perview of this current project. This include construction of 2.2 Kms long ground cross country conveyor system from the end of the trestle bridge upto the transfer point. Basis of cost estimate for this structure has been ascertained from the rates adopted in the report for Power Plant Complex.

a. Auxiliary Civil Engineering Construction :

Auxiliary structure like temporary sheds during construction phase and office building to accommodate 30 staff members necessary for port operation has been considered in this project. Prevailing rates as has been used in the report for Power Plant Complex has been adopted in this project.

c. Mechanical Equipment :

- The cost of grab bucket type coal unloader including its accessories, built-in environmental protection device, driving system etc. has been adopted based on budgetary price indications obtained from various agencies.

- Supporting rails with fixtures, customs duty, freight, erection and commissioning and other incidental charges have been adopted suitably.

- Basis of cost estimation for the belt conveyors from the jetty upto the transfer point has been adopted from the report for Power Plant Complex.

d. Electrical System :

Electrical equipment like transformer has been adopted from the available cost of similar system. Cost of supply cables, illumination and communication equipment have been adopted suitably.

e. Time Schedule :

The construction, erection and commissioning of the complete project will need 36 months from the zero date.

f. Manpower :

The following total manpower are required for construction phase and operation stage including O&M, administration and finance :

Construction Phase	:	23
Operation Stage	:	30

g. Taxes, Duties And 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% of F.O.B. price.

ii) Customs duty @ 20% for project import, port handling charges @ 1.5% and inland transportation and insurance @ 2.25%.

iii) Erection and commissioning of equipment is taken as 10%.

iv) The estimates have been prepared and presented in line with Central Electricity Authority (CEA) format.

10.2 Project Cost Estimate

The estimated capital expenses for the proposed coal unloading berth on the above basis comes to Rs.146.32 Crores. An abstract of the cost estimate is given below. Detailed Project Cost Estimates have been included in **Annexure-10.1** at the end of this section.

Abstract of Cost Estimate
for the Coal Unloading Jetty
for 1000 MW Power Project in Gujarat

Item	Description		Estimated Cost (Rs. in Cores)
1.	Preliminary Investigation & Land	-	0.40
2.	Civil works	-	52.71
3.	Mechanical work	-	73.70
4.	Electrical work	-	4.20
5.	Total Works Cost	-	131.02
6.	Overhead Construction Cost	-	8.77
7.	Contingency @ 3%	-	3.93
8.	Preliminary Capital Issue Expenses	-	2.60
9.	**Capital Expenses**	-	**146.32**

10.3 Financial Aspects

Following annual charges are payable over and above capital expenses for dredging and other maintenance of harbour and approach channel, pilotage charges during entry and exit of the ship from the harbour, berthing charges, charges for supplying drinking and service water for operation and ballasting of ship, charges for using refueling facility. These charges will be levied by Gujarat Pipavav Port (GPPL) Authority. In addition, provision for annual maintenance of jetty structure and equipment, operation and maintenance staff has to be provided for by GPCL.

Port Charges :-

a. Annual maintenance cost = Rs. 90 Lakhs

b. Service charges including pilotage, berthing, water electricity, refueling facility etc. @ Rs.50 per DWT = Rs.1350 Lakhs per year

c. Maintenance of jetty and equipment @ 1% of Works Cost.

d. Staff :

23 during construction phase
30 during subsequent operation and maintenance

In Annexure-10.2 the effect of berth installation on cost of coal is shown.

Annexure-10.1
Sheet 1 of 6

PROJECT COST ESTIMATE
FOR
COAL UNLOADING BERTH
FOR 1000 MW COAST BASED THERMAL POWER STATION
AT GUJARAT COAST

Base Date : August-1995

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
100	**PRELIMINARY INVESTIGATION** (Topographic & Hydrographic Survey, Soil Investigation, Compilation, Analysis)			LS	20.00
200	**LAND** (Eathwork, levelling and site preparation to facilitate construction works)			LS	20.00
300	**CIVIL WORKS**				5271.43
301	**Main Unloading Berth - General Civil Work**				2887.50
301.1	**Reinforced Concrete Deck**				366.00
301.1.1	R.C.C. (M-25) in marine environment including formwork	4500	CuM	5000	225.00
301.1.2	Reinforcement	550	MT	25000	137.50
301.1.3	Steel Embedments including Anchor Posts	10	MT	35000	3.50
301.2	**Reinforced Concrete Piles**				2521.50
301.2.1	Cased bored piles 1000 mm dia. 25 M long with RCC (M-20) including reinforcement in offshore zone complete with installation	354	Nos.	6 Lakhs	2124.00
301.2.2	Pile Anchoring into rock	530	M	75000	397.50

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
302	**Trestle Bridge Supporting Conveyor & Access Road**				681.25
302.1	**Reinforced Concrete Deck**				166.75
302.1.1	RCC (M-25) in Marine Environment including formwork	2050	CuM	5000	102.50
302.1.2	Reinforcement	250	MT	25000	62.50
302.1.3	Steel Embedments	5	MT	35000	1.75
302.2	**Reinforced Concrete Piles**				514.50
302.2.1	Cased bored piles 100 cm dia. 20 M average length with RCC (M-20) including reinforcements in offshore zone complete with installation	84	Nos.	5 Lakh	420.00
302.2.2	Pile Anchoring into rock	126	M	75000	94.50
303	**Utilities**				1398.40
303.1	**Berthing Fenders**				138.40
303.1.1	Rubber Fenders to absorb berthing impact (FOB)	10	Nos.	10 Lakh	100.00
303.1.2	Customs Duty, Freight, Marine Insurance & Port Handling Charges @ 28.4%				28.40
303.1.3	Installation and Commissioning Charges @ 10%				10.00
303.2	**Essential Supply**				60.00
303.2.1	Potable, Fire and Service Water Supply Pipelines from shore upto berth			LS	60.00
303.3	**Dredging in Approach Channel**	2.4	Mln. CuM	50	1200.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
304	**Coal Handling System (Civil Works)**				**153.03**
304.1	**Trestle & Ground Conveyor Foundation** (including cross country conveyor)				137.26
304.1.1	Excavation including backfilling	8800	CuM	120	10.56
304.1.2	PCC (M-10)	950	CuM	2000	19.00
304.1.3	RCC (M-20)	2000	CuM	2600	52.00
304.1.4	Formwork	6000	CuM	120	7.20
304.1.5	Reinforcement	170	MT	18000	30.60
304.1.6	Other miscellaneous expenses including water-proofing etc. @ 15%				17.90
304.2	**Conveyor Gallery**				15.77
304.2.1	Structural Steel including AC sheeting	(by vendor)			0.00
304.2.2	Pre-Cast Concrete Walkway (M-20)	200	CuM	3500	7.00
304.2.3	Reinforcement	22	CuM	18000	3.96
304.2.4	Anchor Bolts etc.	11	MT	25000	2.75
304.2.5	Miscellaneous expenses @ 15% on item 304.2.1 to 304.2.4			LS	2.06
305	**Temporary Construction**				**120.00**
305.1	Temporary Sheds for office including stores, security sheds and yard toilet	2000	SqM	4000	80.00
305.2	Construction Water Supply			LS	10.00
305.3	Construction Power Supply			LS	10.00
305.4	Service Road & Drainage			LS	10.00
305.5	Temporary Fire fighting			LS	5.00
305.6	Miscellaneous Facilities			LS	5.00

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
306	**Office Building**				31.25
306.1	Administration Building	200	SqM	6500	13.00
306.2	Canteen	100	SqM	8000	8.00
306.3	Gate House Complex, First-Aid & Safety Office	50	SqM	6500	3.25
306.4	Site Preparation, Landscaping and Horticulture, Boundary Wall, Drainage etc.			LS	7.00
307	**Total of Civil Works** (Items 301 thru' 306)				5271.43

Annexure-10.1

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
400	**MECHANICAL WORKS**				7370.57
401	**Coal Unloading Equipment**				3977.52
401.1	Grab type cargo unloader of 750 TPH sustained and 1500 TPH peak capacity with long travel mechanism, cross travel trolley mechanism, hold hoist mechanism, luffing mechanism, portal frame work and boom girders equipped with dust suppression mechanism	2	Nos.	1410 Lakh	2820.00*
401.2	Customs, Freight, Marine Insurance & Port Handling Charges @ 29.72%			LS	838.02
401.3	Erection & Commissioning @ 10%				282.00
401.4	Rails complete with fixtures	125	MT	30000	37.50
402	**Coal Conveyance System** (1600 TPH)				**3393.05**
402.1	Belt Conveyors from port upto transfer point 1600 mm wide 20° troughing angle, 1600 TPH capacity			LS	2352.00
402.2	Belt Weighers	2	Nos.	18 Lakh	36.00
402.3	Structural Steel including transfer points, chutes, ducts, liners etc.	1350	MT	35000 Lakh	472.50
402.4	Dust Extraction/Suppression, Ventilation and air conditioning (Dry type)			LS	50.00
402.5	Hoists, winches & other handling equipment			LS	20.00
402.6	Mimic & Control Panel			LS	45.00
402.7	Miscellaneous unforeseen items @ 10% on items 402.1 to 402.5				297.55
402.8	Design Engineering Charges			LS	120.00
403	**Total of Mechanical Works** (Item Nos.401 to 402)				7370.57

Annexure-10.1
Sheet 6 of 6

Item No.	Description	Quantity	Unit	Rate (Rs.)	Amount (Rs. Lakhs)
500	**ELECTRICAL WORK**				420.00
501	**Power Transformer**				420.00
501.1	HT Transformer (33 kV/6.6 kV) - 2 Nos. and LT Transformer (6.6 kV/433 V, 1600 kVA - 2 Nos.) Switchgear, MCC etc.			LS	150.00
501.2	6.6 kV & 433 V Supply Cable on Jetty, Supply & Installation of Control Cable			LS	120.00
501.3	Illumination, Grounding, Communication and other miscellaneous expenses			LS	150.00
502	Total of Electrical Works				420.00
600	**TOTAL WORKS COST** (Sum of Items 100 to 500)				13102.00
700	**OVERHEAD CONSTRUCTION COST**				876.63
	• Establishment, consultancy @ 5%				655.10
	• Tools & Tackle @ 0.5%				65.51
	• Training			LS	25.00
	• Audit & Accounts @ 1%				131.02
800	**CONTINGENCY @ 3% ON ITEM 600**				393.06
900	**TOTAL CAPITAL EXPENSES**				14371.69

Annexure - 10.2
Sheet 1 of 3

EFFECT OF BERTH INSTALLATION ON COST OF COAL

Estimation of Project Cost and Interest During Construction Period

(Figures in Rs. Crores)

PROJECT COST	AMOUNT
Preliminary Investigation	0.20
Land	0.20
Civil Works	52.71
Mechanical Works	73.71
Electrical Works	4.20
Instrumentation (included above)	
Preliminary Capital Issue Expenses	2.60
Overhead Works Construction Cost	8.77
Contingencies	3.93
T O T A L :	146.32

Annexure - 10.2
Sheet 2 of 3

Construction Months Construction Year	1-12 YR-1	13-24 YR-2	25-36 YR-3	Total
Foreign Loan	20.00	10.00	21.16	51.16
Interest	1.26 0.00 0.00	0.63 2.68 0.00	1.33 3.02 1.34	
Annual Interest	1.26	3.31	5.69	10.26
Rupee Loan	10.00	25.00	16.16	51.16
Interest	0.93 0.00	2.31 2.03 0.00	1.49 2.40 5.05	
Annual Interest	0.93	4.33	8.94	14.20
Total Interest	2.19	7.64	14.63	24.46
Equity	14.00	18.00	12.00	44
Forex Loan	20.00	10.00	21.16	51.16
Rupee Loan	10.00	25.00	16.16	51.16
Interest on FC Loan	1.26	3.31	5.69	10.26
Interest on LC Loan	0.93	4.33	8.94	14.2
T O T A L :	**46.19**	**60.64**	**63.95**	170.78

INTEREST DURING CONSTRUCTION PERIOD	:	24.46
CAPITALISED PROJECT COST	:	170.78
WORKING CAPITAL	:	0.50
TOTAL PROJECT COST	:	171.28

Annexure - 10.2
Sheet 3 of 3

(Values in Rs. Crores unless mentioned otherwise)

TOTAL PROJECT COST	:	171.28
ANNUAL FIXED EXPENSES :-		
• Interest on term loan - FC @ 12.6%)) (Average basis)	:	3.87
- LC @18.5%)	:	6.05
• O&M Expenses @ 1% on Works Cost	:	1.46
• Depreciation @ 7.84% on Works Cost	:	11.47
• Return on Equity @ 16%	:	7.04
• Total of Fixed Cost	:	29.89
ANNUAL VARIABLE EXPENSES :-		
• Annual Maintenance (to GPPL)	:	0.90
• Service Charges	:	13.50
• Total Variable Expenses	:	14.40
TOTAL ANNUAL EXPENSES	:	44.29
ANNUAL COAL TRANSPORTATION	:	2.26 Million Te
SPECIFIC EXPENSES ON A/C OF BERTH FACILITY	:	Rs.195.97 per Te