Gujarat Maritime Board
Ahmedabad

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT - Final Report

Volume I : Main Report

Frederic R. Harris, Inc.
in association with
I.I.T., Madras
I.C.T. Pvt. Ltd., New Delhi
W.I.I.T. Ltd., Mumbai

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT

CONTENTS

VOLUME I : MAIN REPORT

SECTION 1: SELECTION OF PROJECT SITE

SECTION 2 : COAL TERMINAL

SECTION 3 : LIQUID BULK TERMINAL

SECTION 4 : CONTAINER TERMINAL

SECTION 5 : UTILITIES & HINTERLAND CONNECTIONS

SECTION 6 : PORT OPERATIONS

SECTION 7 : PROPOSED INVESTMENT PLANS

SECTION 8 : PROJECT VIABILITY ANALYSIS

SECTION 9 : ADVICE ON FURTHER INVESTIGATIONS

ATTACHMENT - A : COMMENTS FROM GMB

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT

CONTENTS

SECTION 1: SELECTION OF PROJECT SITE

Chapter 1 : Introduction

1.1 BACKGROUND

During February - March 1996, GMB invited consultancy proposals under international competitive bidding for the preparation of these detailed project reports / pre-feasibility studies. It was also planned by GMB to award one site to one consultant.

After evaluating the offers GMB awarded the consultancy assignment of preparation of a detailed project report (DPR) for the Positra port development to M/s Frederic R. Harris Inc. and their associates during May 1996.

The assignment of preparation of DPR was divided into the following tasks and sub-tasks:

Task 1: Selection of Project Site including :

- Data collection and analysis
- Conceptual layouts of alternative sites and their evaluation

Task 2 : Development Plans i.e.

- Preparation of layout of port with berths and onshore facilities

Task 3 : Detailed Techno-economic Feasibility Study covering :

- Field investigations and model studies;
- Detailing of port structures and equipment;
- Aspects of port operations, statutory clearances;
- Cost estimates;
- Project implementation schedule;
- Project viability analysis
- Recommendations

Task 4 : Detailed Project Engineering covering :

- Layouts for number of structures and types of structures;
- Designs and tender drawings;
- Construction drawings

Out of the these, Task 1 and 2 have already been completed and reports submitted to GMB. This report covers Task 3 activities, including designs and tender drawings.

1.2 APPROACH

The report is divided into three volumes as hereunder:

Volume I - Main Report

Section 1 : Selection of Project Site
Section 2 : Coal Terminal
Section 3 : Liquid Bulk Terminal
Section 4 : Container Terminal
Section 5 : Utilities & Hinterland Connections
Section 6 : Port Operations
Section 7 : Proposed Investment Plans
Section 8 : Project Viability Analysis
Section 9 : Advice on Further Investigations
ATTACHMENT - A

Volume II - Drawings

Volume III - Reports on Field Investigations and Model Studies

Chapter 2 : Traffic Forecast

2.1 INTRODUCTION

The Positra Port is proposed to cater to the three commodities viz. Coal, POL products and Containers. These are primarily of import nature. Based on the cargo traffic studies by GMB, the following cargo volumes are envisaged to be handled at the port.

2.2 POL PRODUCTS

The POL products will comprise of Diesel, Kerosene, Gasolines and Naphtha.

Presently the shortfall in supply of POL products from local sources is made up by imports/coastal transport, and Kandla is the only port acting as the gateway for the northern states. In spite of the severe draught restrictions, this port has been forced to handle more than 5 million tonnes of petroleum products during the past few years.

After studying the present trend of traffic/demand of the above commodities in the regions, the POL products' throughput at Positra is taken as shown in the table below:

(Figures in MTPA)

Product	Year		
	2001	2006	2011
Diesel	3.00	6.00	9.00
Kerosene	0.75	1.50	2.25
Gasolines	0.50	1.00	1.50
Naphtha	0.75	1.50	2.25
Total	**5.00**	**10.00**	**15.00**

2.3 COAL

The total likely coal traffic has been indicated as 10 million tonnes per annum by year 2011. It has been assumed that the coal traffic will grow gradually starting from 5 million tonnes per annum in the year 2001 to 10 million tonnes by year 2011.

As per indications, the imported coal will have to be evacuated to the user destination partly by coastal shipment from Positra to Dahej in the Gulf of Khambhat and partly by rail. It has been assumed that the distribution between rail and coastal movement will be equal.

The coal traffic scenario is thus summarised as follows:

(Figures in MTPA)

Year	2001	2006	20011
Imports	5.0	7.5	10.0
Coastal Export	2.5	3.75	5.0
Rail Export	2.5	3.75	5.0

2.4 CONTAINERS

The container traffic proposed to be handled at Positra is estimated based on the potential diversion from Mumbai and Kandla.

Based on the estimated diversions, the import and export break-up of the traffic has been estimated as given hereunder:

(in million tonnes)

	2001	2006	2011
Import	1.17	2.29	4.38
Export	1.53	2.81	5.62
Total	**2.70**	**5.10**	**10.00**

The above traffic does not include transhipment traffic. Considering the locational proximity to Dubai which is currently serving as one of the leading transhipment ports in the Middle East for Indian sub-continent and also taking into account the potential of the hinterland of Positra, this port , if developed to attract mainline vessels passing by the region, can attract transhipment traffic as well, like JNPT. (During 1994-95 JNPT 's transhipment cargo formed 11% of the total container traffic).

However, many factors govern the success of a port in functioning as a load centre for container traffic. It requires a detailed study to assess the potential realistically. In the absence of such a study, if one assumes that the share of transhipment cargo will gradually increase from 10% in 2001 to 20% during 2006 and 30% during 2011, the total container traffic of Positra would increase as shown below:

(in million tonnes)

	2001	2006	2011
Import	1.17	2.29	4.38
Export	1.53	2.81	5.62
Transhipment	0.27	1.02	3.00
Total	2.97	6.12	13.00

These figures have been adopted for planning purpose.

Chapter 3 : Shipping Trends & Design Ship Sizes

3.1 GENERAL

The optimal vessel size to be considered for any port development is identified on the basis of economics of ship size. The larger the vessel size the lesser will be the freight rate; but the costs of ship-waiting time will increase. Hence, the optimum vessel size could be the one for which the savings in transport costs are equal to the increase in costs of ship-waiting time.

Moreover, the selection of the optimal vessel size has a bearing on the size of the transit storage at the port.

In order to carry out such an optimisation study, it is essential to know the following aspects:

- the trading route and the facilities available at the loading port;
- quantum of traffic to be handled and the likely parcel size as dictated by the requirements of the user agency;
- availability of a suitable vessel in the market; and
- size restrictions, if any, in the shipping route.

In the present case of Positra, the main cargo commodities have been identified as petroleum products, coal and containers. The various aspects as indicated above are examined in detail in the foregoing . While doing so, reference will be drawn not only to the global scenario and trends but also to the prevailing conditions in the Indian ports.

3.2 PETROLEUM PRODUCTS

After studying the world tanker fleet as well as Indian scenario, design tanker sizes were arrived at.

The product tanker fleet to serve the marine facilities has been taken as follows:

Class	Tanker Size
PT I	15 to 30,000 DWT
PT II	30 to 45,000 DWT

It should be noted that the proposed layout of the marine facilities will allow the use of product tankers up to 70,000 DWT, which will only be partially loaded when visiting the facilities at Positra.

The design product tanker sizes are summarised herebelow:

Size (DWT)	Overall Length (m)	Beam (m)	Loaded Draft (m)
30000	180	26.3	11.2
45000	209	27.1	11.3
70000	248	36.0	11.3

3.3 COAL

Coal is generally imported to India from major coal exporting countries such as Australia, Canada and South Africa. The recent entrants in the trade are Indonesia and China in the Asian region. Dry bulk carriers are deployed to transport coal in large shipments.

According to indications from the Australian Government during their initial talks with the Gujarat Government, they propose to deploy coal carriers upto 100,000 DWT. In view of these, it is recommended that 120,000 DWT size vessels would be more suited for coal movement between Positra and the likely overseas loading port. Moreover, for catering to the coastal movement from Positra to Dahej, it has been indicated that carriers of 40,000 DWT will be deployed. In case, coastal movement from the east coast coal port of Paradip (fed from the Talcher mines) is to be considered, the optimum size of 65,000 DWT will be deployed. Keeping in view all these factors into consideration, all these three sizes have been recommended for consideration for Positra.

The particulars of design coal carriers are given below:

Route	Size (DWT)	Overall Length (m)	Beam (m)	Loaded Draft (m)
Coastal Export	40000	190	31.0	11.6
Coastal Import	65000	225	32.0	13.0
Import from abroad	120000	260	42.0	16.0

3.4 CONTAINERS

The following points were kept in view before arriving at the design container ship for Positra

- Positra can be an alternate and competing port with the ports of the Gulf region, especially for the India bound traffic which are presently transhipped at these Gulf ports.
- To attract the trade, Positra should have matching facilities that are available at the Arabian Port.
- The mainline vessels calling at the selected regional ports in the Gulf are of 2,000 - 3600 TEU size and the feeder vessels are of size 500 TEU.

- The Arabian ports are geared up with post-Panamax cranes with 45 m outreach, hence, capable of attracting 5,000 - 6,000 TEU range vessels in future (which may, of course, require increased draft at the present berths).

Considering the above scenario, it is inferred that Positra should be developed with ultimate capacity to handle post-Panamax vessels of 5,000 - 6000 TEU capacity. However, the initial planning should focus on attracting third generation mainline vessels (2,000 - 3,600 TEU) and feeder vessels of size 600 TEU.

The dimensions of the containerships likely to call at Positra are as follows:

Size(TUE)	Overall Length(m)	Beam (m)	Loaded Draft (m)
600	142	18.9	8.2
2000/3600	288	32.0	13.0
6000	318	42.0	14.0

Chapter 4 : Site Conditions

4.1 GENERAL

Three alternative sites have been identified as possible locations for the new port development at Positra (refer Fig. 1.1):

Positra I, at the eastern side of Bet Shankhodhar, the island just east of Okha,
Positra II, at the northern side of the Positra headland, adjacent to Positra Bay,
Positra III, at the eastern side of the Positra headland, facing Pindara Bay.

4.2 TOPOGRAPHY AND HINTERLAND CONNECTIONS

The onshore area at all three sites is flat, about 4 m above mean sea level, and the intertidal zone is sandy with some rock outcrops.

At Positra I, the onshore area is at present not under cultivation: the area is covered by extensive cactus growth, and some shrubs and low trees at the southern part of the potential site.

A detailed topographic survey was carried out at Positra II & III. The survey report is enclosed vide **Appendix A.**

At Positra II and III some parts of the near-shore area are under cultivation, mainly with dry crops. The areas are mostly uninhabited. The land is sloping towards sea as seen from the contour map of the area at Positra II & III.

Access to the Positra headland, sites II and III, would require the construction of a rail road spur of about 20 km to connect with the broad gauge rail network near Mithapur, and the reconstruction/widening of the existing black top road from Mithapur to Positra village, about 15 km, and the extension of this road to the port sites, another 5 km.

Access to Positra I would require a road/rail bridge from the main land to the island Bet Shankhodhar, and the development of a new road and railway line to the port site. There are two options for the location of this bridge: a southern connection from Shankholia at the southern tip of the island to Mendarda (close to Rajpura Bandar), or a western connection from near Bet Dwaraka (Haji Karmia tomb) to just south of Okha. The southern location is under consideration by the Government of Gujarat, the western location provides a shorter crossing.

4.3 MARINE ACCESS

Vessels sailing from the Arabian Sea towards the Positra sites would follow the deep water channel (developed for the VLCC traffic to the SBM facilities at Vadinar) till a location north of Chandri Reef. Access to Positra I and II would be by a dedicated channel between Bet Shankhodhar and Paga Reef; access to Positra III would be by a dedicated channel between Paga Reef and Bural Reef.

4.4 METEOROLOGICAL DATA

4.4.1 Wind

The yearly wind rose diagram indicates that the general direction of the wind is from SW to NW.

During the months April through September, which includes the southwest monsoon, the predominant wind direction is SW to W and does not vary much from morning to evening. The mean wind speed is usually less than 30 kmph.

During the other months the wind direction changes from N-NE in the morning to NW in the evening. The wind speed is usually less than 24 kmph.

4.4.2 Cyclones & Depressions

Normally wind speed upto 60 kmph are described as cyclonic depression, those in the range of 60-80 kmph are classified as storms and wind speeds exceeding 80 kmph signal severe storm or hurricane conditions. Analysis of the available data indicates that the number of cyclonic disturbances in the Okha area increases from March to June, decreases to a minimum in August, increases to a maximum again in November and attains a minimum in February. Thus it has two maxima and minima.

4.4.3 Rainfall

Rainfall is relatively scarce in this area. The average rainfall for the month of July is 145.62 mm which is the wettest month of the year. The average of the 10% of the heaviest rainfall recorded during the period is 101.67 mm.

4.4.5 Temperature

The mean maximum temperature is of the order of 33°C while the mean minimum temperature is of the order of 18°C.

4.3.6 Relative Humidity

The relative humidity is maximum during the South West monsoon season and is around 85% and minimum during winter around 60%.

4.4.7 Visibility

Analysis of data between 1967 and 1985 on visibility reveals that, visibility less than 1 km in Okha area, during the months of March and June, has occured totally for 10 days only.

The meteorological data analysed at Indian institute of Technology, Madras is presented vide Appendix B..

4.5 OCEANOGRAPHIC INFORMATION

4.5.1 Waves

Offshore Wave Climate

There are no records of long time field observations of waves at Positra. Therefore, in order to assess the wave climate at the alternative port development sites, the Indian Institute of Technology, Madras, determined the wave climate off Positra, based on a detailed analysis of the wind climate, and this wave climate was used as input into mathematical model studies to investigate the wave propagation to the actual sites.

Taking a factor of 1.8 for the relation between the maximum wave height (Hmax) and the significant wave height (Hs), the monthly means of the maximum wave heights are worked out. The maximum wave heights vary from about 3.5 m to 7.5 m.

The report on analysis of wind climate is included vide **Appendic C**.

Wave Climate at the Positra Sites

The following offshore wave climates were used as input to the mathematical model studies to determine the wave climate at the Positra port development sites:

Monsoon	Hmax (m)	Wave period (sec)	Wave direction (degrees North)
SW	2.7	7	240
SW	4.5	7	240
SW	7.5	7	240
NE	2.7	5	30
NE	2.7	5	67.5
NE	4.5	5	30
NE	4.5	5	67.5
Non-monsoon	2.7	6	300
Non-monsoon	4.0	6	300
Non-monsoon	4.5	6	300

The results indicate that for a deep water Hmax of 7.5 m the maximum waves at the sites are about 0.60 m during SW monsoon.

During NE monsoon the maximum wave height can reach 2.0 m at Positra I and at Positra II and III the maximum wave height during these governing conditions is about 0.5 m. The wave height distribution during Non-monsoon indicate that with Hmax of 4.5m, the maximum wave height at Positra I, II and III will mostly be 0.5m. But occassionally it can reach upto about 1.5m at Positra I and 1.0m at Positra III.

4.5.2 Tides

The average tidal levels at the port of Okha are as follows (reference Chart Datum):

MHHW	+3.47 m
MLHW	+2.96 m
MSL	+2.04 m
MHLW	+1.20 m
MLLW	+0.41 m

At solstices, the spring tide levels are: MHHW +3.89 m, and MLLW -0.05 m.

During the site survey (November 1995 and January 1996), the Naval Hydrographic Office (NHO) determined that the tides at Bet Shankhodhar (Positra I) lagged by about 30 minutes behind the tides at the Okha passenger jetty. The recent current survey found that tides at Positra II lag by about one hour behind Okha.

4.5.3 Currents

General

The currents in the project area are mainly tide-driven. The current speeds are high and the current pattern is complicated due to the presence of shoals and reefs. The uneven topography of the sea bed causes rip currents, which vary with the stage of the tide and which may be considerably heavy at springs.

Earlier Current Surveys

NHO carried out a 25 hour tidal current survey off Positra I (22°, 27′, 39″ North; 69°, 10′, 48″ East) and NIO, while investigating a site at Positra III for the possible development of marine facilities for Tata Chemicals, took current measurements at location 22°, 23′, 45″ North; 69°, 13′, 30″ East.

Off Positra I, the maximum current speed was about 5 knots and the direction reverses from 150° (south-easterly) during flood to 330° (north-westerly) during ebb.

Off Positra III, at the location investigated for the possible development of marine facilities for Tata Chemicals, the currents ran south during flood and north during ebb. The maximum speed was about one knot during ebb and slightly less during flood.

Results of Present Current Survey

For the present project a current survey was carried out at one location at Positra I and two locations near Positra II during the period 21 to 26 January 1997, a high spring tide. (Refer **Appendix D** for the Current Survey Report.)

At Positra I the current speed was 2.5 knots both during flood and ebb, with the direction reversing from 150° to 330°, respectively. These results agree in general with the current speeds of 1.5 to 2 knots shown on Admiralty Chart 673 for this area, which is closer to the shore than the location of the NHO survey where current speeds of 5 knots were recorded.

At Positra II the current speeds are lower at 1.0 to 1.25 knot, but the direction does not reverse: during the flood tide the current sets E to ESE but during ebbing the current direction is towards Positra Bay, in SW direction.

4.6 GEOTECHNICAL CONDITIONS

As part of this consultancy assignment, geotechnical investigations - both offshore and onshore- were carried out at Positra II & III and along the proposed alignment of approach channel. In all 25 borings were carried out at different locations. The findings of the geotechnical investigations are summarised herebelow :

4.6.1 Marine Investigations

In all 14 marine boreholes were carried out at different locations at Positra at different locations as shown in figure no. 1.2. The detailed soil investigation report is included vide **Appendix E**. The findings are briefly described below:

<u>Eastern Channel</u> (Between Paga Reef and Bural Reef).

MB-1 : Borehole was extended upto 8.4 m below seabed. Weathered limestone rock was encountered right from beginning.

MB-2 : Borehole was extended upto 5.2 m below the seabed with limestone rock throughout the depth. Surface limestone rock was highly weathered in nature & light yellow to brown in colour with little or no recovery.

Western Channel (Between Paga Reef and Beyt Shankhodhar)

MB-3 : The borehole was drilled upto 6.32 m below seabed. A thin layer of 0.5 m of overburden soil consisting of cemented shells with traces of sand was encountered. The limestone rock strata that followed was highly to completely weathered with no recovery in the core runs. SPTs conducted in between the core runs indicated refusal (N > 100).

MB-4 : This borehole was drilled upto 3.8 m below seabed. A thin layer of approximately 0.5 m of overburden soil comprising of cemented shells and traces of sand was encountered. The overburden soil was followed by limestone stratification which was found to be very weak in nature with no recovery in the core runs.

Positra II (West of Positra point)

MB-7 : Investigations at this location extended upto 26.75 m below seabed. Overburden was encountered upto about 8.0 m and consisted of very soft marine clay. Limestone rock strata was encountered beyond 8 m and varied from dark yellowish and light greyish brown in colour with very low recovery except occasional core recovery of about 50.75% with very low RQD.

MB-8 : The borehole was extended upto 26.9 m below seabed. Out of this, overburden comprised of 8.7 m at top and consisted of soft silty clay. Limestone rock extending form 8.7 m onwards was light yellowish to yellowish brown in colour, completely weathered with very low recovery.

MB-9 : The borehole at this location was extended upto 14.5 m below seabed. The top layer of 6.5 m was very soft grey clay to clayey sand with traces of coral. This was followed by limestone rock which was completely weathered with no recovery in rock coring and varied in colour from light yellow to light yellowish brown.

Positra II (North of Positra point)

MB-10: Investigations at this location were extended upto 24.25 m below seabed. Overburden of about 1.1 m thickness consisting of soft clay with corals and traces of sand was encountered. Limestone, light yellow to yellowish brown was encountered below the clayey corally strata. Limestone is slightly weathered to completely weathered in nature, core recovery varying from 10% to 25% with very low RQD upto 6 m finally becoming completely weathered with no recovery.

MB-11: Investigations at this site were extended upto 25 m below seabed. Limestone rock was encountered at surface mixed with fine silty sand and broken shells. Light yellowish limestone, fine grained with very closely spaced fractures lies below the top layer of 0.1 m. Limestone rock became completely weathered with no recovery from 6 m onwards.

MB-12: Borehole depth at this location extended upto 18.55 m below seabed. Limestone rock was encountered with 70% to 90% RQD upto 4 m depth. The rock became completely weathered with no core recovery from 7 m onwards with a slight change in colour.

MB-13: The borehole was drilled to a depth of 31 m below seabed. Overburden of 0.5 m thickness existed consisting of dark grey marine clay followed by weathered limestone rock with little core recovery. Further the rock became completely weathered with no recovery and varying in colour from light yellow to dark yellowish brown.

Positra III (South East of Positra point)

MB-14 : Borehole was extended upto 26.25 m below seabed. The top layer - 9 m in thickness - consisted of dead corals and clayey shell fragments. This was followed by light grey, very soft to soft silty clayey strata extending upto 21 m below seabed. Completely weathered limestone was encountered at 22.5 m depth with traces of silty sand.

MB-15: The borehole was drilled upto 25.27 m below seabed. Overburden comprising of clayey shell fragments with traces of sand extended upto 5.6 m below bed level. Limestone, fine grained and in a completely weathered form was encountered at 5.6 m which was light yellow to dark yellowish in colour with no recovery in rock coring.

MB-16: Borehole was extended upto 25.21 m below seabed. the overburden extended upto 6 m below bed level and consisted of very soft marine clay with coarse sand shell fragments. Limestone rock, light yellowish and in completely weathered state, was encountered at 6.43m depth with no recovery during rock coring.

4.6.2 Onshore Investigations

11 borings were carried out under the onshore geotechnical investigations with their locations distributed as shown in Fig.1.3. Refer **Appendix F** for the detailed soil report. The salient features are given herebelow:

T-4 : This borehole was drilled upto 14.0 m below GL. The overburden soil comprising of dark reddish brown silty sand with clay was noticed upto 2.0 m depth. Limestone with RQD value between 17% and 54% were observed beyond this.

T-6 : The borehole extended upto 4.5 m below GL. Upto 0.5 m brownish silty fine sand with clay has been observed. After 0.5 m there is limestone with 40% core recovery upto 2.0 m depth. At 2.0 m SPT value showing refusal and at the end of hole i.e. 4.5 m, SPT value of 33 has been observed. The ground water level was at 3.65 m from ground level.

T-7 : Borehole was extended upto 13.95 m below ground level (GL). The overburden soil, extending upto 1.0 m, is mainly brownish fine silty clay with sand. After 1.0 m highly weathered limestone with low core recoveries has been observed for a depth of about 4.5 m. Beyond this completely weathered limestone with traces of silty sand and stiff clays have been noticed. In this zone SPT values ranged between 30 and 41. The ground water table was at 2.9 m below GL.

T-8 : This borehole was drilled upto 15.0 m below GL. Overburden soil has been observed for a depth of about 10.5 m below GL. It consists of reddish brown to greyish brown silty sand with stiff clay. The SPT values ranged between 30 and 45. After 10.5 m, limestone deposits were observed upto the end of the hole. The highest values of RQD have been observed at 13.5 m - 15.0 m run, in the range of about 23 to 35%. Ground water was found at 3.5 m depth.

T-9 : The borehole was drilled upto 13.85 m below GL. A thin layer of approximately 0.5 m of overburden soil comprising of dark brownish silty sand was encountered - followed by limestone stratification upto the end of hole. The RQDs between 12.3 m and 13.8 were about 27% to 43 %. Ground water table was found at 3.19 m below GL.

T-10 : This borehole was drilled upto 13.5 m below GL. Overburden soil comprises of dark brownish silty sand with clays upto a depth of 9.0m. Beyond this limestone with RQD between 18% and 58% was encountered. Ground water table was observed at 3.11 m depth.

LB-7 : This borehole was drilled upto 20.33 m depth below GL. The overburden soil comprising of dark reddish silty sand with clay extended upto 3.0 m. Afterwards highly fractured limestone followed by completely weathered limestone was observed upto the end of the borehole. Ground water table was encountered at 5.13 m depth.

LB-8 : This borehole was drilled upto 25.45 m below GL. The overburden soil comprised of light brownish yellow to greyish yellow fine silty sands with clay extending upto 4.70 m. Between 4.70 m and 6.5 m hard limestone strata was observed, beyond which completely weathered limestone with SPT values ranging between 17 and 42 have been observed till the end of the hole. Ground water was found at 5.98 m depth.

LB-9 : This borehole was drilled upto 12.40 m below GL. A thin layer of about 0.5 m overburden was observed with sandy soil. Afterwards upto the end of the hole dark brown to dark yellowish grey limestone with closely spaced fractures has been observed. The highest value of RQD 5.70 m - 6.5 run. Ground water was noticed at 4.79 m depth.

LB-10 : This borehole was drilled upto 18.45 m below GL. A thin layer of overburden, about 0.6m thick, was observed. It comprised of brownish coarse to fine grained sand with clay. From 0.6 m to 6.0 m hard limestone was observed with highest RQD of 57%. Completely weathered limestone with SPT values ranging from 18 to 35 were observed at 14.0 m and 14.5 m depths. Ground water was found at 5.17 m depth.

LB-11 : This borehole was drilled upto 19.29. m below GL. A thin layer of 0.22 m overburden was observed comprising of silty sand. Beyond this completely weathered limestone was observed with SPT values ranging from 17 to 43. At the end of the hole SPT refusal was observed. Ground water was found at 4.27 m depth.

In addition ten nos. bulk samples were collected from various locations and tested for grain size distribution, compaction and CBR values.

Chapter 5 : Planning Criteria and Considerations

5.1 TYPE OF BERTHS AND LOCATION OF BERTHING LINE

The coal berths and the oil/products berths would consist of a jetty-type structure, connected to the shore by an access trestle: this configuration involves relatively little dredging as the berths can be located further offshore by increasing the length of the access trestle. The optimum location is then determined by minimising the total costs of dredging and access trestle construction, including the capital cost and the operational cost of the conveyor belt system.

The container berths should be contiguous to the terminal land area, for ease of operation. If the sea bed material is readily dredgeable and suitable for land reclamation, then the berthing line should be located at the "break-even" contour, i.e., such, that the volume of dredged material matches the volume of the required fill. However, when the sea bed consists of rock that, although dredgeable by cutterhead dredger, is more expensive to remove, then the optimum location of the berthing line depends on the relative cost of dredging and reclamation with dredged material, and reclamation with material from land borrow sources.

5.2 BERTH ORIENTATION

Container berths are typically contiguous to the container terminal land area and, thus, when the berth line is more or less in the current direction, the currents will run parallel to the berths.

Oil/products berths and coal berths, when located offshore as free-standing, piled structures connected to the shore by an access trestle, do not guide the currents: at these berths the angle between the berth line and the current direction is dependent on the orientation of the berths and the direction of the current at any one time. This current angle may vary considerably with changes in current direction during ebb and flood, and at different phases of the tidal cycle and the lunar phase.

As there are no overall standards regarding limiting conditions for vessels to stay at berth when subject to currents, a number of mooring line arrangements were investigated for the coal carriers of 120,000 DWT and 45,000 DWT, and the tanker of 45,000 DWT. For the selected mooring line layout, consisting of three parallel lines at bow and stern (70 degrees) and two double spring lines, the mooring line forces were determined for various current velocities and directions using the (in-house) mathematical model Termsim. The (indicative) results are shown below, expressed as maximum allowable current velocity (m/s) for various current directions, under normal operating conditions (safety factor 2: the forces in the mooring lines are half of the line breaking strength). Because the relation between current velocity and forces in the mooring lines is not linear, the current forces which would cause the lines to part (safety factor 1) are also shown.

Maximum Allowable Current Velocities (m/s) for Normal Operating Conditions							
(Forces in mooring lines reaching 50 % of breaking strength: Safety Factor 2)							
Current Direction relative to the Berth Line (degrees)							
	-45	-30	-15	0	15	30	45
Coal Carrier							
120,000 DWT	3.5	2.2	3.2	2.5	1.1	0.8	0.7
45,000 DWT	2.8	1.9	2.6	2.3	1.2	0.9	0.8
Tanker							
45,000 DWT	3.1	2.2	2.9	2.3	1.2	0.9	0.8
Current Velocities (m/s) causing Mooring Lines to part							
(Forces in mooring lines reaching 100 % of breaking strength: Safety Factor 1)							
Current Direction relative to the Berth Line (degrees)							
	-45	-30	-15	0	15	30	45
Coal Carrier							
120,000 DWT	4.8	3.1	4.5	3.6	1.5	1.1	1.0
45,000 DWT	4.0	2.7	3.7	3.2	1.7	1.2	1.1
Tanker							
45,000 DWT	4.3	3.1	4.1	3.2	1.7	1.2	1.1

In the above results the negative current direction indicates the situation that the current pushes the vessel towards the berth. Further, the mooring line force calculations are based on the current conditions only and do not include effects of wind or waves.

The results indicate that for a current direction of 15 to 30 degrees off the berthing line the current velocity should not exceed 1.10 to 0.80 m/s for the 120,000 DWT coal carriers or 1.20 to 0.90 m/s for the 45,000 DWT coal carrier or tanker. Further, a comparison between the two tables clearly shows the sensitivity of the mooring line forces to current velocities and current directions: a slightly greater current velocity or greater angle to the berthing line causes a marked increase in the mooring line forces. With greater angle of attack, the difference between acceptable current velocities (safety factor 2) and velocities causing lines to break (safety factor 1) becomes rather small. This is of particular importance when current velocities are high and when current patterns are not very clear (qua direction and directional changes). In these conditions extra care must be taken in selecting the orientation of the berth line.

5.3 NAVIGATIONAL AND OPERATIONAL REQUIREMENTS

5.3.1 General

As a pre-requisite for the planning of the port facilities , it is essential to set the basic criteria for the design of the various components, the primary of these being the navigational and operational aspects for handling the different types of vessels likely to call at the port and for the loading/unloading operations. These criteria are related to the marine environmental conditions at the location of the port. These comprise the following aspects:

- vessel size and dimensions
- operational criteria
- navigational channel dimensions
- manoeuvring area dimension
- berthing area dimension

These aspects are further discussed in the foregoing paragraphs.

5.3.2 Vessel Sizes And Dimensions

The principal dimensions of the design vessels for different cargo considered for the development of Positra port are given in the following table. The oil/products facility must be able to accommodate a vessel of capacity of 70,000 DWT, lightly loaded to the draft of the 45,000 DWT capacity vessel.

Cargo	Vessel size	Overall length (m)	Beam (m)	Loaded draught (m)
PETROLEUM PRODUCTS	30,000 DWT	180	26.3	11.2
	45,000 DWT	209	27.1	11.3
	70,000 DWT	248	36.0	11.3
COAL	40,000 DWT	200	31.0	10.1
	65,000 DWT	225	36.0	12.0
	120,000DWT	260	42.0	16.0
CONTAINERS	600 TEU	142	18.9	8.2
	2,000 - 3,600 TEU	288	32.0	13.0
	6,000 TEU	318	42.0	14.0

5.3.3 Operational Criteria

In planning port facilities for the handling of various cargo, the operational criteria for vessels handling and ship-shore transfer of cargo need to be taken into account. These operational criteria affect the planning criteria for the port facilities. Vessel handling and/or ship-shore transfer of cargo operations can be interrupted due to one of the following reasons:

- Pilots cannot board arriving vessels due to rough sea and weather conditions
- Tugs are unable to assist in manoeuvring the vessels because of rough weather conditions
- Motions of moored vessels are too high to continue ship-shore cargo transfer operations
- Vessels have to leave the berth because of excessive mooring forces

These aspects are discussed in more details hereunder.

(a) Pilot Boarding

Vessels visiting the port terminal will need the services of a pilot in view of safe and efficient navigation to and from the terminal. This is especially required at Positra because of the presence of shoals and reefs on the approach. A pilot boarding station will be situated at some distance from the entrance of the navigation channel. A pilot will be taken from a shore based station to the pilot boarding area by a pilot launch. The governing criteria for pilot boarding are the acceptable sea conditions for the pilot launch when sailing to the pilot boarding area and when boarding the vessel. The operational criteria for pilot boarding is assessed as Hs = 2.5 m

(b) Tug Assistance

Vessels arriving at the port need the assistance of tugs during the stopping and berthing manoeuvre. Upon departure ballasted vessels need some tug assistance to deberth and line up for departure. Operational criteria for tug assistance are determined by the ability to fasten the tugs to the vessels and by acceptable forces in tow lines. The operational criteria for tug assistance for the sizes of vessels considered is assessed as Hs = 1.5 m (with the wave period as 8 sec.)

(c) Ship - shore cargo transfer limits (workability)

When motions of moored vessels become too great, cargo handling operations have to cease to prevent damage to the vessels and cargo handling equipment. Motions of moored ships are mainly induced by waves (i.e. swells) and by long period waves (over 30 sec.)

Maximum acceptable wave conditions are dependent on ship size and the wave direction at the berth. The acceptable wave heights increase as the size of the ship increases. The initial limit is lowest for beam sea and highest for head sea. The maximum significant wave height (Hs) for different wave directions before loading/unloading operations will have to be stopped are summarised in the table below:

Type of Ship	**Limiting wave height Hs (m)**	
	0° (head on or sterm on)	**45° - 90°**
Container Ship	0.5	
Coal Carrier - loading unloading	1.5 1.0	0.8 - 1.0
Tanker 30000 dwt 30,000-20000 dwt	1.5 1.5 - 2.5	1.0-1.2

The value refer to the heights of residual deep water waves with periods in the range of about 7 to 12 sec.

When either the wave height or the wave period criterion is exceeded, cargo handling has to be stopped. Waves with every long periods e.g. sciches can have disasters effects at much lower wave heights than indicated in the table above.

In addition to the above criteria, it should be mentioned that long waves with periods over 30 s may cause additional cargo handling downtime. The limiting wave heights for these long period waves range from 0.15 m for small vessels and up to 0.10 m for large vessels.

(d) Survival conditions

When mooring forces become too high, vessels have to leave the berth. The condition at which this occurs are defined as survival conditions and are dependent on vessel size and mainly wave conditions. Survival criteria are assessed as 1.5 times the acceptable wave height for cargo handling.

5.3.4 Navigational Channel Dimensions

The dimensions of the navigation channel to the terminal are dependent on the vessel size, the behaviour of the vessel when sailing through the channel, the environmental maritime conditions (winds, waves, currents) and the channel bottom conditions. Channel design activities focus primarily on estimating the safe channel width and depth for the design vessel of given dimensions. As part of design process, it is also necessary to consider the need of aids to navigation, tug assistance and vessel traffic control. Channel aids to navigation principally involve the use of visual aids such as ranges and buoys. The channel width requirements have been derived assuming good aids to navigation.

A number of American, British and International standards are available for channel design. However, the primary reference source is : Permanent International Association of Navigation Congresses (PIANC), International Association of Ports and Harbours (IAPH) : " Approach channels - Preliminary Guidelines " First report of the joint Working Group, April 1995.

(a) Channel width

The minimum width of a straight channel depends on the size and manoeuvrability of the vessel navigating the channel, the type of channel bank, the effects of other vessels in the channel and the effects of wind and currents. The required width comprises three main zones viz. manoeuvring lane, ship clearance lane and bank clearance. Additional channel widths have to be provided for the following considerations: vessel speed, cross winds, cross current, longitudinal current, significant wave height and length, aids to navigation, nature of sea bottom, depth of waterway, cargo hazard level, and traffic density.

In the present case, the width of the navigation channel is based on one-way traffic, which is considered acceptable in view of the relatively limited number of channel transits per year. The required width of the channel is normally determined as a multiple of the beam of the design vessel.

The required width of the channel considering all these aspects with specific reference to the environmental conditions prevailing at Positra is worked out as follows:

Basic manoeuvring lane (moderate manoeuvrability)	:	1.5 B
Wind effects (4 to 7 Bft)	:	0.5 B
Cross currents (moderate: 0.5 to 1.5 kn)	:	1.0 B
Wave action (Hs 1 to 3 m)	:	1.0 B
Aids to navigation system (average system)	:	0.5 B
Bank clearance (both sides sloping)	:	0.5 B
Bottom surface (rough and hard)	:	0.2 B
Depth of waterway (h/T 1.25 to 1.5)	:	0.2 B
Cargo hazard level (medium)	:	0.5 B
Total	**:**	**5.9 B**

Based on the above criteria the required channel width for the different sizes of vessels under consideration for Positra is summarized in the following table :

CARGO	VESSEL SIZE	BEAM (m)	CHANNEL WIDTH (m)
PETROLEUM PRODUTS	30,000 DWT	26.3	155
	45,000 DWT	27.1	160
	70,000 DWT	36.0	212
COAL	40,000 DWT	31.0	183
	65,000 DWT	32.0	189
	120,000 DWT	42.0	248
CONTAINERS	600 TEU	18.9	112
	2000 - 3600 TEU	32.0	189
	6,000 TEU	42.0	248

The required channel width ranges from 112 m for the smaller range of container ships (feeder vessels) to about 248 m for the latest generation of container vessels. Thus a channel width of 250 m has been considered as final design width to cater to the largest vessel size.

(b) Channel depth

The depth in the channel should be substantially greater than the static draughts of the vessels using the waterway to insure safe navigation. Generally, the depth in the channels are determined by the vessels' loaded draught; trim or tilt due to loading within the holds; ships' motion due to waves, such as pitch, roll and heave; character of the sea-bottom, soft or hard; wind influence of water level and tidal variations; and the sinkage of the vessel due to squat or bottom suction.

Considering the environmental conditions at Positra, the underkeel clearance is proposed to be kept at 15% of the loaded draft of the ship. Thus the required channel depth (below - CD) for the different sizes of vessels under consideration for Positra will be as indicated in the following table.

CARGO	VESSEL SIZE	LOADED DRAUGHT(M)	CHANNEL DEPTH (M)
PETROLEUM PRODUCTS	30,000 DWT	11.2	12.9
	45,000 DWT	11.3	13.0
COAL	40,000 DWT	11.6	13.4
	65,000 DWT	13.0	15.0
	120,000 DWT	16.0	18.4
CONTAINERS	600 TEU	8.2	9.5
	2,000 - 3,600 TEU	13.0	15.0
	6,000 TEU	14.0	16.1

Thus the channel depth in the ultimate stage would be 18.4 m below CD.

5.3.5 Manoeuvring & Berthing Area Dimensions

The location of the manoeuvring area, or the turning basin, required to swing and berth the vessels, is very important and its design must provide the proper configuration, the proper dimensions and easy access. The size of the manoeuvring area is a function of the length and manoeuvrability of the vessels and the time available for executing the turning manoeuvres. The optimum configuration of such a basin would be circular. Considering the environmental conditions at Positra and also the fact that the vessels will be assisted by tugs, the diameter of this circle is taken as 2.0 times the maximum vessel length. Since maximum length of the design ship (i.e. post panamax size container ship) is 318m, the diameter of the turning circle would be 636 m, say 650 m. The depth in the manoeuvring area is taken equal to 1.15 times the loaded draft of the largest vessel using the port facilities. As such the same depths as those proposed for approach channel will be provided in the turning basin also.

The space required for berthing of ships should be based on the dimensions of the largest design ship and the number and the type of ships using the port. This is the area in front of the berthing structure required to accommodate the vessel or vessels and attendant craft. As per normal practice the width of the berthing area should not be less than 1.15 times the beam of the design vessel. To this width the beam or beams of the attendant craft should be added. The underkeel clearance at the berth is proposed to be adopted as 10% of the loaded draft of the ship. Therefore the water depths in the berthing areas will be as follows.:

Berth	Vessel Size	Loaded Draft (m)	Water Depth (m)
POL	30000 DWT	11.2	12.4
	45000 DWT	11.3	12.5
Coal	40000 DWT	11.6	12.8
	65000 DWT	13.0	14.3
	120000 DWT	16.0	17.6
Container	600 TEU	8.2	9.0
	2000 - 3600 TEU	13.0	14.3
	6000 TEU	14.0	15.4

5.3.6 Deck Elevation

The deck elevation has been fixed on the following considerations :

Highest high water level (Based on the 1997 tide table for port Okha)	:	+ 4.2 m CD
Add for wave crest height (0.7 x 1.0 m)	:	0.7 m
Add for construction height	:	1.6 m
Add for air gap	:	0.3 m
Final Elevation	**:**	**+ 7.0 m CD**

Thus the deck elevation will be fixed at 7.0 m above chart datum for all the marine structures. The finished levels of onshore areas will also be +7.0 m CD.

Chapter 6 : Recommendation on Potential Sites

6.1 PROJECT REQUIREMENTS

The berth requirements have been worked out as follows. (The details are given in respective sections) :

Containers	:	5 berths x 330 m = 1650 m long berth berth
Coal	:	2 berths x 345 m (import) + 2 berth x 180 m (export) = 1050 m long berth line
POL	:	3 berths x 290 m = 870 m long berth line

Primarily three alternative sites viz. Positra I, Positra II and Positra III, are under consideration. These are described in detail in the following paragraphs.

6.2 EVALUATION CRITERIA

The evaluation of various project sites was dealt with extensively in the Task 2 report. The conclusions and recommendations are briefly covered in this section.

In all three main sites viz. Positra I, II & III and five variants thereof were evaluated.

The parameters governing the most optimum project site are :

- ease of manoeuvring to/from the port site
- ease of berthing/deberthing operations (downtime)
- tranquillity at the berths (downtime)
- ease of development of the onshore facilities (no constraints)
- hinterland connections
- construction phasing aspects
- environmental aspects

In order to determine which of the alternative sites provides "the best value for the money", the three sites are first evaluated on the above criteria, after which these relative scores are compared with the assessed differences in the development/ operating costs of the port and terminal facilities.

6.3 RESULTS OF THE RELATIVE EVALUATION

Positra III should be the preferred site for the port and terminal facilities, ranking first in each of the main criteria groups: marine operation aspects, onshore development aspects, and environmental impact considerations.

Positra II ranks second behind Positra III, mainly because berthing/deberthing would have to await slack tide and because of a greater impact on the nearby mangrove stands, and because of greater impact on live coral in the area in case an oil spill occurs which is not adequately contained.

Positra I ranks last. Compared to Positra II, the container berths are more exposed to waves and the currents are stronger, and, overall, the container terminal and especially the transportation corridor would cause considerable socio-environmental impact to the people on Bet Shankhodhar.

The relative cost evaluation indicates a difference of about Rs. 10000/- million between the development costs of Positra II and Positra III and about Rs. 11000/- million between Positra I and Positra III.

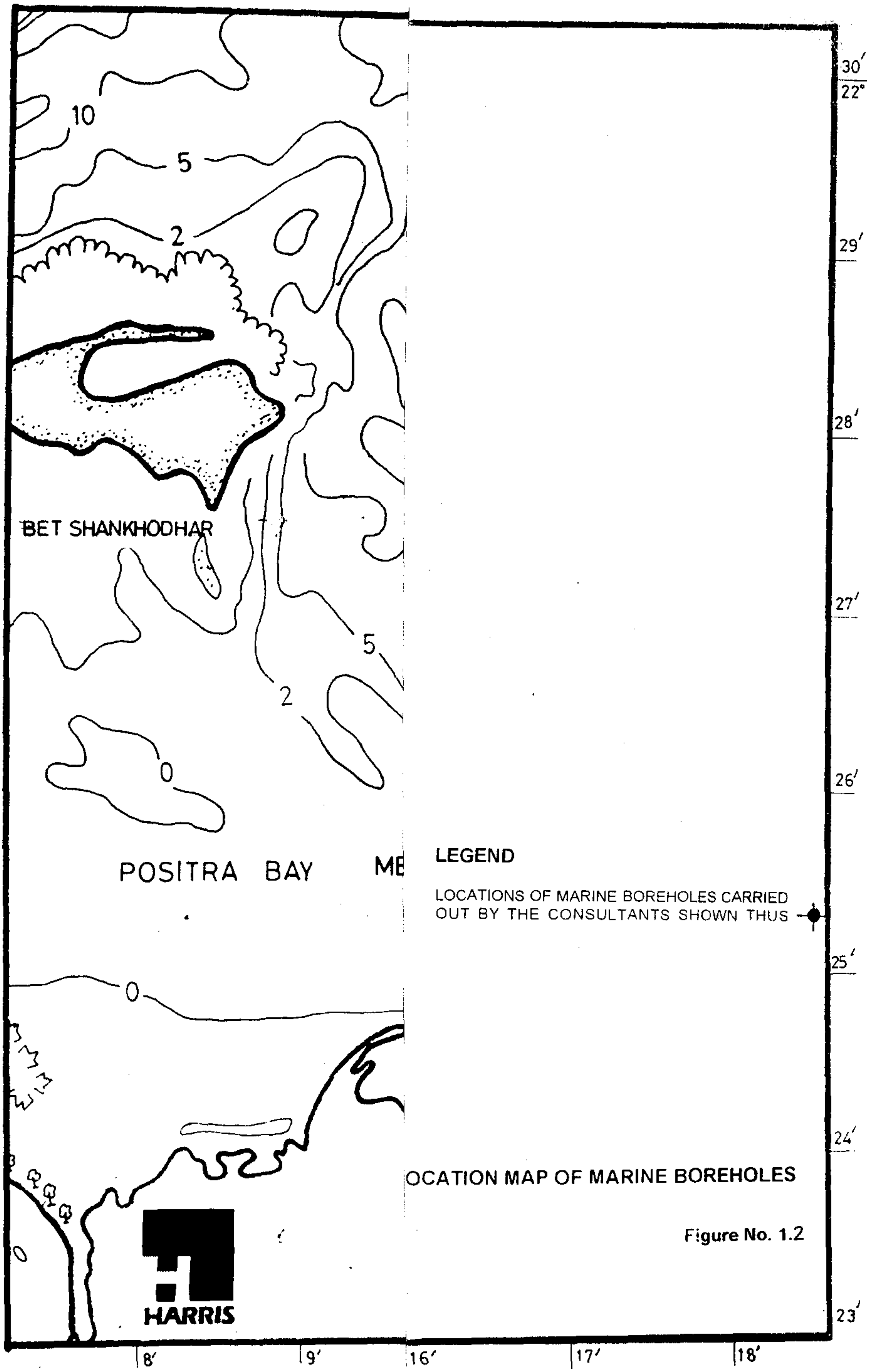
The evaluation between the three sites on main characteristics showed Positra III to be the preferred alternative on each of the criteria groups: marine operations, onshore development, and environmental impact.

Taking the assessed development costs into account, Positra III ranks first, Positra II ranks second, and Positra I is the least favourable site.

6.4 CONCLUSION

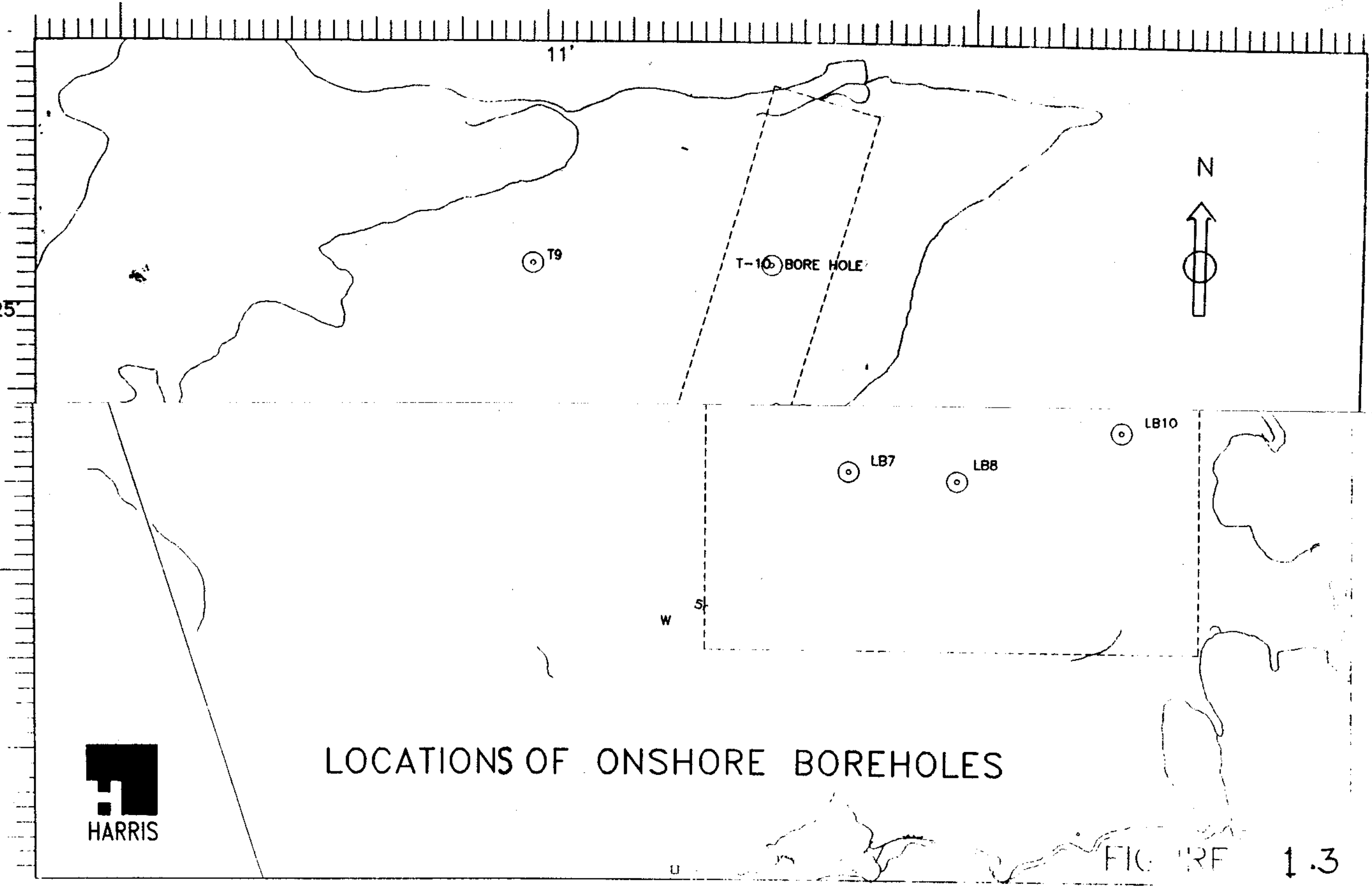
Positra III is the preferred site for the development of the port and terminal facilities for the container terminal, the coal terminal and the oil/products terminal.

FIGURES



OCATION MAP OF MARINE BOREHOLES

Figure No. 1.2



LOCATIONS OF ONSHORE BOREHOLES

FIGURE 1.3

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT

CONTENTS

SECTION 2 : COAL TERMINAL

Chapter 1 : Product Criteria

1.1 CARGO THROUGHPUT

The total traffic scenario as discussed in section 1 is summarised herebelow :

(Figures in MTPA)

Year	2001	2006	20011
Imports	5.0	7.5	10.0
Exports			
coastal movement	2.5	3.75	5.0
rail movement	2.5	3.75	5.0

1.2 CARGO CHARACTERISTICS

The imported coal will have the following physical characteristics:

type / grade	: thermal coal
bulk density	: 0.8 t / m^3
angle of repose	: 35^o - 40^o
material strength	: high
material protection requirement	: none
hazards imposed by	: fire and dust

Chapter 2 : Terminal Performance

2.1 COAL CARRIER FLEET COMPOSITION

For purposes of planning the marine facilities, the probable largest size of coal carrier has been taken. However, while examining the performance of the terminal, it is necessary to consider a range of sizes so that the terminal is able to accommodate a mix of different sizes of vessels without affecting the productivity. This is so because the composition of the fleet and mix will have a direct effect on the berth occupancy, waiting time and consequently on the throughput.

Coal imports:

Considering the current shipping trend in Indian ports, and also the trend world-wide, it is proposed to take two range of vessel sizes to assess the terminal performance. These two ranges are :

CC 1 : Coal carrier size : 40,000 DWT - 65,000 DWT

CC 2 : Coal carrier size : 80,000 DWT - 120,000 DWT

During the first phase coal carriers of category 1 (CC1) only are considered for planning purpose. But from second phase onwards a mix of CC1 and CC2 will call at Positra.

Coastal Exports:

The export of coal from Positra will be mainly for coastal transport to Dahej in the Gulf of Khambhat. For this purpose, the size of the coal carriers are assumed to range from 25,000 DWT to 40,000 DWT.

2.2 PARCEL SIZE AND UNLOADING/LOADING RATES

For assessing the performance of the terminal, the average parcel size is considered for each category of coal carriers under consideration as indicated hereunder:

CC 1 category of carriers : 50,000 tonnes
CC 2 category of carriers : 100,000 tonnes

For coastal carriers, the average parcel size is taken as 30,000 tonnes.

For ship-shore transfer of coal, the following handling rates have been taken :

Unloading rates for	- CC1 category of carriers	:	22,500 tonnes/day
	- CC2 category of carriers	:	30,000 tonnes/day
Loading rates for	- coastal carriers	:	15,000 tonnes/day

2.3 BERTH REQUIREMENTS

(i) General :

The number of berths required at the terminal is dependent upon the following parameters :

- the annual throughput;
- vessel fleet composition and utilization scenarios;
- unloading/loading rates; vessel turn-around time; and
- the terminal operational days in a year;

(ii) Coal carrier fleet utilisation:

Two category of ship sizes have been considered for the import of coal. A number of vessel utilization scenarios have been used to assess the varying pattern of vessel calls at the terminal and these are detailed hereunder:

Category/Av. Parcel size	Carrier utilisation scenarios				
	A	B	C	D	E
CC 1 - 50,000 tonnes	0	25%	50%	75%	100%
CC 2 - 100,000 tonnes	100%	75%	50%	25%	0

(iii) Turn-around time of vessels

The turn-around time of the different category of vessels is given hereunder. This considers 0.2 days per ship for peripheral activities covering pilotage, berthing, documentation, deberthing etc. The service time is derived from the parcel size and the handling rate, and given herebelow:

CC 1	:	= 2.4 days per ship call
CC 2	:	= 3.5 days per ship call
Coastal Export	:	= 2.2 days per ship call

(iv) Berth occupancy studies and berth requirements:

For the scenarios with different ship-size utilisation, the required berth occupancy for handling the projected traffic has been worked out in the Table 2.1 to 2.3 (for import vessels) and Table 2.4 (for coastal export).

Table 2.1 : Determination of BOF - Coal Unloading (Year 2001)

Item	Fleet Utilization Factor									
	A		B		C		D		E	
	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2
Cargo Throughput	5.0	MTPA	5.0	MTPA	5.0	MTPA	5.0	MTPA	5.0	MTPA
* Average parcel size (t)	50,000	100,000	50,000	100,000	50,000	100,000	50,000	100,000	50,000	100,000
Share	100%	0	100%	0	100%	0	100%	0%	100%	-
No. of shipcalls/year	100	0	100	0	100	0	100	0	100	-
Unloading Rate (TPD)	22,500	30,000	22,500	30,000	22,500	30,000	22,500	30,000	22,500	30,000
Turn around time per ship (days)	2.4	3.5	2.4	3.5	2.4	3.5	2.4	3.5	2.4	3.5
Turn around time per year (days)	240		240		240		240		240	
Operational time per year (days)	330		330		330		330		330	
B.O.F. (%)	73		73		73		73		73	

Table 2.2 : Determination of BOF - Coal Unloading (Year 2006)

Item	Fleet Utilization Factor									
	A		B		C		D		E	
	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2
Cargo Throughput	7.5	MTPA	7.5	MTPA	7.5	MTPA	7.5	MTPA	7.5	MTPA
* Average parcel size (t)	50,000	100,000	50,000	100,000	52,000	100,000	50,000	100,000	50,000	100,000
Share	0%	100%	25%	75%	50%	50%	75%	25%	100%	0%
No. of shipcalls/year	0	75	38	57	75	38	113	19	150	0
Unloading Rate (TPD)	22,500	30,000	22,500	30,000	22,500	30,000	22,500	30,000	22,500	30,000
Turn around time per ship (days)	2.4	3.5	2.4	3.5	2.4	3.5	2.4	3.5	2.4	3.5
Turn around time per year (days)	263		291		313		338		360	
Operational time per year (days)	330		330		330		330		330	
B.O.F. (%)	80		88		95		102		109	

Table 2.3 : Determination of BOF - Coal Unloading (Year 2011)

Item	Fleet Utilization Factor									
	A		B		C		D		E	
	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2	CC1	CC2
Cargo Throughput	10.0	MTPA	10.0	MTPA	10.0	MTPA	10.0	MTPA	10.0	MTPA
* Average parcel size (t)	50,000	100,000	50,000	100,000	50,000	100,000	50,000	100,000	50,000	100,000
Share	0%	100%	25%	75%	50%	50%	75%	25%	100%	0%
No. of shipcalls/year	0	100	50	75	100	50	115	25	200	0
Unloading Rate (TPD)	22,500	30,000	22,500	30,000	22,500	30,000	22,500	30,000	22,500	30,000
Turn around time per ship (days)	2.4	3.5	2.4	3.5	2.4	3.5	2.4	3.5	2.4	3.5
Turn around time per year (days)	350		383		415		448		480	
Operational time per year (days)	330		330		330		330		330	
B.O.F. (%)	106		116		126		136		145	

Table 2.4 : Determination of BOF - Coal Loading

Item	Value		
	Year 2001	Year 2006	Year 2011
Cargo throughput (MTPA)	2.5	3.75	5.0
Parcel size (t)	30,000	30,000	30,000
No. of shipcalls per year	84	125	167
Loading rate (TPD)	15000	15000	15000
Turn-around time per ship call (days)	2.2	2.2	2.2
Total turn around time per annum (days)	185	275	367
Operational time per annum (days)	330	330	330
BOF (%)	55	83	111

Based on the berth occupancy calculations for individual terminals viz. coal unloading and coal loading berths. The following scenario emerges for the combined operations.

Table 2.5 : Determination of Combined BOF

Item	Year					
	2001		2006		2011	
	Scenario A (Min)	Scenario E (Max)	Scenario A (Min)	Scenario E (Max)	Scenario A (Min)	Scenario E (Max)
Unloading Terminal BOF (%)	73	73	80	109	106	145
Loading Terminal BOF (%)	55	55	83	83	111	111
Total BOF (%)	128	128	163	192	217	256
No. of Berths Provided x Actual BOF (%)	**2 x 64**	**2 x 64**	**3 x 54**	**3 x 64**	**4 x 54**	**4 x 64**

Thus in the 1st stage of development 2 berths - one each for unloading and loading - will be provided. In the 2nd stage, one more berth will be added, taking the total number of berths to three. The middle berth will be common to both loading and unloading operations. The final stage of development will see addition of one more berth, taking the total number of berths to four - two unloading and two loading berths.

Chapter 3 : Coal Handling System

3.1 OPERATION OF THE SYSTEM

A fully mechanised coal handling system is planned at the import and (coastal) export berths so as to achieve a overall economy in the coal handling operation. The following major equipment are proposed to be deployed for the purpose :

- Rail mounted grab or continuous ship unloader at import berths.
- Rail mounted ship loader at export berths.
- Belt conveyors for transport of coal to and from the berths.
- Rail mounted stackers / reclaimers in the stackyard.

Rail mounted mobile wagon loader at the stacker.

The entire coal handling system has been planned taking into consideration the two important aspects : that the marine terminal is located offshore at a distance of about 2.7 km from the shore and that part of the imported coal is to be shipped back for coastal movement. It would be a waste of money and loss of productivity if the unloaded coal is to be taken all the way up to the stockyard and again re-conveyed back to the berths for loading on to the coastal vessels.

Hence, appropriate provision has been made at the marine terminal to enable direct loading of coal into coastal vessels while the import vessel is being unloaded. The major problem in interlinking the unloading conveyors with the ship-loading conveyors is the difference in the capacities of the two systems. To overcome this, a surge bin or a bunker is provided being located at the junction of the berth and the approach trestle. The surge bin could receive coal either from the berth conveyor serving the ship-unloader or the trestle conveyors connecting the berth with the stockyard. Thus when a ship is unloading coal, part of it could pass through the bin to the loading berth/ship and part could move to the stockyard. If there is no ship unloading at the terminal while a coastal vessel is at the berth waiting to be loaded, coal could be moved from the stockyard through the trestle conveyor and loaded into the ship.

The major components of the coal handling system are :

- coal unloader(s) at berths
- coal loader(s) at berths
- conveyors to stackyard
- conveyors from stackyard
- stacker(s) in the stackyard
- reclaimer(s) in the stackyard
- wagon loader

The following paragraphs describe the system in detail.

3.2 SHIP UNLOADER AT IMPORT BERTH

There are two types of unloading systems for coal : the grab unloading system and high capacity continuous unloading system. The salient features of these two systems are explained hereunder.

Grab unloaders:

The grab unloading system is a common, time-tested, proven and reliable concept. It has the advantages of flexibility, adaptability, reliability, and ease of maintenance. However, they have some serious disadvantages. A very significant disadvantage is the high accelerating forces, caused by the weight of the grab in combination with the batch-type operation. These forces limit the maximum throughput capacity and result in relatively heavy crane design. Another disadvantage is the need for trimming by front end loaders during unloading of the left-overs at the bottom of the hold of the vessel.

Modern rail mounted grab unloaders are generally of gantry type. The essential part of the unloader is the grab bucket. It has a relatively high self weight, usually equalling almost half the hoisting capacity of the crane. When unloading, a well-trained crane operator is capable of positioning the grab almost anywhere inside the hold, keeping the surface of the bulk cargo more or less level.

The filled grab bucket is hoisted out of the hold and brought back to the quay over a hopper between the crane's front legs. The grab load is discharged into the hopper, and from the hopper onto one of the belt conveyors running along the berth.

At the last stages of the unloading operation, part of the load will be left against the walls and in the corners of the hold. At that stage, filling the grab gets very difficult causing a significant reduction in the rate of unloading. To help collect the remaining coal (clean-up operation), front end loaders are lowered into the holds by the crane.

Grab unloaders upto a capacity of 50 t are now fairly common. The highest capacity grab unloaders built to date are upto 85 t. The payload of the grab bucket will be about 55% of the hoisting capacity. Nominal crane capacity will be approximately 60 working cycles per hour. The actual unloading rate will not be uniform and will vary considerably during operation. A normal unloading pattern will be :

60% of the load at 100% capacity (free digging)
25% of the load at 50% capacity
5% of the load at 15% capacity (clean up)

This unloading pattern gives an average unloading rate of 65% of the nominal capacity.

Continuous unloaders :

High capacity continuous unloaders are a relatively modern type of equipment, developed over the last 30 years. Initially these unloaders had little success, because effective capacities were disappointing and they were prone to mechanical breakdowns. However, over the past few years, there has been a clear trend in the market towards the bucket-wheel type continuous unloader which has proved to be a well functioning and fairly reliable system.

The basic concept of the continuous unloader is to replace the discontinuous grab operation by a continuous digging and elevating process. Thus variations in unloading rate are reduced, and accelerating forces are minimised resulting in smaller and lighter cranes.

As opposed to grab unloaders, there are many different continuous unloader designs. Presently, two essentially different types of high capacity continuous unloaders are available in the market:

- digging elevators, where the same element (eg. bucket elevator) is used for both digging and elevating.
- elevators with a separate digging element, using a screw, bucket wheel, etc. to feed the material to the elevating system.

Of these, as indicated earlier, the bucket wheel type continuous unloader has proved to be a functionally reliable system.

The digging element of the continuous unloader is a large bucket wheel, similar to the wheel of a stockyard reclaimer. The wheel discharges through a grid (removing oversize lumps and tramp iron) on to a vertical conveyor. This elevator moves the coal up to the boom conveyor, which then leads it to a surge bin between the legs of the unloader. From here the coal is discharged onto one of the belt conveyors along the berth.

Comparison of the two systems:

Loads on the berth: Continuous unloaders are only slightly lighter than grab unloaders. However, the corner loads of a continuous unloader are considerably smaller. This is due to the reduced forces from the continuous coal unloading as compared to the accelerating forces caused by discontinuous grab unloading process. As a result berth construction for using a continuous unloader can be lighter than what is required for a grab unloader.

Investment costs: Investment costs for a continuous unloader are about 10% lower than for a grab unloader of comparable capacity. When using a continuous unloader, the belt conveyors towards the stockpile will have a lower capacity (since cream digging rate is reduced), so investment costs for the belt conveyor are also lower. The reduction of loads on the berth through provision of a continuous unloader will reduce the berth construction costs.

Pollution control: A clear advantage of a continuous unloader is its excellent environmental control. The coal transportation from the hold to the quay conveyor is completely enclosed, minimising dust generation. Whereas, grab unloader operation is more likely to generate some pollution by coal, especially through leakage from the grab and during discharge into the receiving hopper. However, for modern grab unloaders pollution could be reduced to a very minimal level through a number of environmental measures. Most notably this involves windshields and anti dust skirts around and inside the unloading hopper.

Clean-up operation: In comparison with a grab unloader, the continuous unloader needs less clean-up work by front-end loaders. The good accessibility of the bucket wheel unloader to overhangs and corners enables a high percentage of the coal to be unloaded unassisted. Practical experience has shown the amount of front-end loader hours needed for a continuous unloader to be half of what is needed with a grab unloader.

Reliability: Both the grab unloader and continuous unloader have proved to be fairly reliable machines. Reliability is estimated at 93% to 99% depending upon the quality of maintenance and operating skills. However, in case of a major breakdown, repair of a continuous unloader will require more time resulting in longer downtime.

Maintenance and repair: The maintenance requirements of a high capacity continuous unloader are substantially higher than the requirements for grab unloader. Also continuous unloader maintenance will be a more complex and time consuming activity. For either unloader type, major breakdowns and damages are most likely to occur at components that have direct contact with the coal (ie. grab bucket, bucket wheel). In case of such a breakdown, changing the entire grab is a fairly simple operation. Changing the bucket wheel/elevator section or in-situ repairing it , is much more complicated and may result in a very long downtime of the continuous unloader.

Conclusion & Recommendation: This comparison covers aspects in favour of continuous unloaders as well as those in favour of grab unloaders. As a result, the choice is either unloader type will be highly dependent on the weight factor that is applied to each aspect. Under Indian conditions, emphasis should be put on the following aspects:

- proven design
- simple maintenance requirements
- ease of repair/ minimal risk of long downtime
- local manufacturing capability/good local availability of spare parts

Considering all these aspects, it is recommended that grab type unloaders should be used . Typical details of a grab unloader are shown in **Figure 2.1**.

Unloading Rate: To service ships of 40,000 DWT and above, it is necessary to provide an unloading rate of at least 30,000 Te/day. But in actual practice, it would be difficult to maintain this rate uniformly. The productivity would be normally high during the first two days of operation and towards the later stages, the output would gradually drop due to operational constraints. The scattered material on the floor of the holds have to be scraped and accumulated with the help of front-end loaders or dozers and when this is being done, the unloaders have to wait. Hence, it is preferable to have more unloaders of smaller capacity so that they can simultaneously operate in different holds.

Assuming 20 hours working per day, the average hourly productivity of the unloaders should be 1500 tonnes. The rated capacity of the unloaders should therefore, be at least 3,000 tonnes per hour. Hence, two unloaders of rated capacity of 1500 TPH each are recommended per berth. The broad specifications of a typical grab unloader are included vide **Annexure 2.1**.

3.3 SHIP LOADER AT EXPORT BERTH

It has been indicated that the ship sizes for coastal export will range from 20,000 DWT to 40,000 DWT. Due to inherent limitations to the operations, it is not possible to load these vessels at a very fast rate. The normal loading rate for such vessels will be in the order of 10,000 tonnes to 15,000 tonnes per day. Taking the average parcel size of such vessels as 30,000 tonnes, an average loading rate of 15,000 tonnes per day is assumed.

Considering 20 hours working per day, the average hourly productivity of the loaders will be 750 tonnes. The rated capacity of the loader would, therefore, be 1500 TPH. It is recommended to have one loader of this capacity per berth.

The ship loader is a relatively simple machine to operate and maintain and therefore no spare capacity is recommended. Refer **Figure 2.2** for typical features of ship loader.

The broad specifications of a typical ship loader are given in **Annexure 2.2.**

3.4 STACKERS

To receive coal from the main unloading conveyors and stockpile it on either side of the berths, two stackers each of 3,000 TPH capacity will be provided. The capacity of the stackers has to match the capacity of the main conveyors whose capacity, in turn, is designed to match the ship unloading rate. These can slew for about 270° to stockpile on either side of the track and can stack to a pile height of about 8 metres. The boom of the stackers will be so designed that the width of the stockpile at the base will be 30 metres with an angle of repose of 35°. The track gauge of the stackers will be 20 metres and the track will be laid on a berm specially laid for this purpose. It will be possible to lower the boom to the required height so that the height of fall could be regulated to avoid generation of dust. The travel length for the stackers will be so as to cover the entire length of the stockpile yard. Refer **Figure 2.3** for typical details.

The broad specifications of a typical stacker are included in **Annexure 2.3.**

3.5 RECLAIMERS

The stockpiled coal has to be reclaimed to be fed to the ship-loading system as well as to the wagon-loading system. Reclaimers are provided for this purpose. Bucket-wheel reclaimers are universally used because of their efficient functioning. The boom length will be so designed that it can cover the whole width the base of the stockpile and all the coal can be effectively cleared. The boom can slew 360° and it can be lowered to touch the ground so that the buckets will be able to scratch and collect the coal from the base of the stockpile.

The reclaimers will travel on separate tracks on a common berm along with the stackers. These will be able to pass the stackers while travelling along the track. Anti collision switches will be provided to prevent any possibility of accidental collision of these machines either during operation or during travel.

When two ships are at berth loading coal for coastal transport, the capacity of the loading conveyor is 3000 TPH to meet the requirements of the two ship loaders. The capacity of the reclaimers should be able to match this requirement. Hence it is recommended to have two reclaimers each of 1500 TPH capacity. For feeding the wagon loading system concurrently with the ship loading system, it may be necessary to have a third reclaimer. However, there is a flexibility in the ship unloading system in that the unloader could directly feed the loading system for loading a ship at the loading berth without the coal having to pass through the stockyard. In view of this, it may be possible to manage with two reclaimers. Refer **Figure 2.3** for typical details.

Refer **Annexure 2.4** for the broad specifications of a typical reclaimer.

3.6 CONVEYOR STREAMS

3.6.1 General

The conveyor system at the coal handling terminal could be classified into four streams serving different sections of the terminal, as follows :

(i) berth conveyors serving the ship unloader
(ii) interlinking conveyor on the approach trestle
(iii) stockyard conveyors
(iv) conveyors serving the wagon loading system

The most critical of these is the long conveyors on the approach trestle linking the stockyard onshore with the berths offshore.

While the unloading conveyor will go directly to the stockyard, the transfer conveyor and the loading conveyor will terminate at the surge bin. There will be two short conveyors leading from the surge bin to the loading berths. All the transfer points will be so designed that the conveyors will be able to discharge into any one of the parallel conveyors so that maximum flexibility is available during operation.

3.6.2 Berth Conveyors

Unloading

These conveyors will run parallel along the length of the berths. Two conveyors, each of 3000 TPH capacity, will be provided. Each conveyor will be connected to two of the ship unloaders with a total rated capacity of 3000 TPH. The coal unloaded from the ship could be transferred to either of the two trestle conveyors to be transported to the stockpile. One of the conveyors will be connected to the surge bin. Coal unloaded from the ship could partly be taken to the surge bin *(to be loaded on the ship at the loading berth)* and partly be taken to the stockyard , both activities being carried out concurrently. This will be possible because the capacity of ship loading is only 3000 TPH *(combined for the two ship loaders)* while the maximum unloading rate will be 6000 TPH.

Loading

For the ship loading operation, two separate conveyors will run parallel along the loading berth. Each of these conveyors will be connected to one of the ship loaders. As the belts are dedicated to each of the ship loader, it will not be possible to cross feed. However, either of these conveyors could be fed by the two conveyors from the surge bin. The capacity of each of these conveyors will be 1500 TPH to match the capacity of the ship loaders.

3.6.3 Interlinking Trestle Conveyors

There will be in all three conveyors running parallel along the approach trestle and each of these will be of 3000 TPH capacity. While two of these will connect the berth with the stockyard for unloading and stacking of coal, the third will connect the stockyard with the surge bin for reclaiming and loading of coal. All these conveyors will be connected to the two transfer towers at either end of the trestle where the transfer of coal from the berth conveyors to the trestle conveyor takes place at one end as also the transfer from the trestle conveyor to the stockyard conveyor takes place at the other end.

3.6.4 Stockyard Conveyor

The stockyard will have two stacker conveyors each of 3000 TPH capacity liking the ship unloaders and the stackers through the berth and trestle conveyors. Thus the coal unloaded from the ship could be directly carried to the stockyard.

In addition, the stockyard will have two more conveyors serving the reclaimers. These will be of capacity 1500 TPH each. Each of these conveyors will be linked to one of the reclaimers. Both these conveyors can deliver coal either to the shiploading conveyors through the trestle conveyors and the surge bin or to the wagon loading conveyors. Since the wagon loading capacity is only 1500 TPH, only one of the conveyors will be used at a time for wagon loading.

3.6.5 Wagon Loading Conveyor

This conveyor will carry the coal reclaimed from the stockyard to the wagon loading system. This conveyor will be of 1500 TPH capacity to match the capacity of the wagon loading system. This will be connected to a bin in the system, so that the wagon loading activity will proceed uninterrupted even if there is some dislocation in the supply from the reclaimers.

Broad Specifications of belt conveyors are included in **Annexures 2.5.**

3.7 WAGON LOADER

The quantity of coal to be moved by rail is estimated to be 5 million tonnes per annum in the final phase (i.e. year 2011). Assuming 360 working days for the rail loading, and a full rake of 50 wagons, each of 55 tonnes capacity, the terminal would have to handle about 5 full rakes per day. Taking 20 hours available for loading operations, each rake has to be serviced within 4 hours. Of this, the effective time available for loading is estimated to be 3 hours which means that the loading rate has to be about 920 tonnes per hour. To achieve this average loading rate, a loader of at least 1500 TPH capacity is required. This capacity matches with the capacity of the reclaimer.

The wagon loading system will have one wagon loader of capacity 1500 TPH and linked to the two conveyors serving the two reclaimers. The wagon loading system will be located adjacent to the stockyard leaving out sufficient space for future expansion. Two railway sidings each capable of accommodating one full rake each will be provided. The wagon loader will have sufficient reach to load wagons on both the tracks. For stabling the wagons, another siding of equal length will be provided.

To meet contingencies when the wagon loader is out of commission for some reason, an additional railway siding is proposed where loading of coal could be carried out with the help of payloaders. This siding will be capable of accommodating a full rake. This will only be a standby arrangement, so that the rakes are loaded and released without incurring any demurrage under any circumstances.

Refer **Figure 2.5** and **2.6** for the process flow diagram of coal unloading and loading system respectively.

Broad specifications for a mobile wagon loader are included in **Annexure 2.6.**

Chapter 4 : Terminal Location

The coal terminal is proposed to be located in Positra III at the north-eastern corner of Positra headland facing Pindara bay. The foreshore is very shallow for almost 2 km and the seabed suddenly drops down to 18-20 m below chart datum. The intertidal zone is sandy with scattered rock outcrops. The onshore area is almost flat and about 4m above mean sea level. Refer drawing no. GMB/DPR/SEC2/01 for locations.

This location is a marine tranquil area, well protected from waves penetrating to the site. The maximum waves would be locally generated waves from the longest fetch direction, 30° north. The mean wind speed from this quadrant is generally less than 24 km/hr, and the resulting wave height is expected to be less than 0.5 m maximum.

At this location, the flood and ebb currents reverse about 180°, running south and north respectively, and the maximum current velocity as observed by NIO was about 1 knot.

Chapter 5 : Jetty Configuration

5.1 GENERAL

The primary operating requirements of the marine structures are to provide a safe berth and safely resist the berthing and mooring forces imposed by the ship as well as providing the necessary run-way or turn table support for loads imposed by the ship loader or unloader both in the operating condition and in the storm anchored condition. It is also necessary to provide access from the shore for personnel, vehicles and routine maintenance equipment.

Other important requirements are :

- Provision of adequate flat deck areas for carrying out routine maintenance work on the ship loader, unloaders and other accessories.
- Generous falls to flat deck surfaces to shed water or permit hosing down.
- Designing in material and with details that reduce or avoid future maintenance problems.

5.2 PLANNING CONSIDERATIONS

5.2.1 Layout

Refer drawing no. GMB/DPR/SEC2/02 for the overall layout of the coal jetty structure.

As can be seen from the jetty configuration, the structure comprises of three main components viz.

- Coal unloading berths (for coal import)
- Coal loading berths (for coastal export of coal)
- Approach trestle

The planning criteria of these are discussed in detail in the following paragraphs.

The size of the pier would be decided on the basis of the dimensions of the largest vessel it is required to handle, the quayage area required to accommodate, the crane tracks, truck lanes, mooring facilities and utility services. The design of such berths would have to be closely co-ordinated with the design of the equipment to be used.

5.2.2 Unloading Berths

As discussed in the earlier paragraphs, it is proposed to provide two berths in the final stage to handle imported coal.

The size of the largest coal carrier expected to call at Positra would be 120000 DWT.

The corresponding dimensions of the design vessel are :

LOA	:	260 m
Beam	:	42 m
Loaded Draft	:	16.0 m

A continuous length of 630 m can safely accommodate two design vessels with a safety distance of about 25 m on either side of the vessel.

Rail mounted grab unloaders are proposed to be provided on the pier. They are generally of gantry type. Taking into account rail gauge of 20 m and a vehicle/ carriage way of 8 m, space for mooring facilities, it is proposed to provide a deck with overall width of 30m. Unloading conveyors will be accommodated within the span of unloaders. Refer drawing no. GMB/DPR/SEC2/03 for details.

Bollards will be provided @ 20.4 m c/c-on the deck for mooring purpose. Supercell rubber fenders spaced @ 20.4 m c/c will be provided along the berthing face. The fenders will be provided with frontal facia to account for the large tidal range and to restrict the hull pressure within allowable limits. Ladders suitably recessed into the structure will be provided along the pier as a safety measure.

The deck elevation will be kept at 7m above CD.

5.2.3 Loading Berths

Two shallow draft loading berths (in the final stage) exclusively for handling the coal meant for coastal export will be provided in continuation with the unloading deep draft, berths.

The size of the design vessel expected to call at the loading berths is 40000 DWT. The dimensions of the design ship are :

LOA	:	190m
Beam	:	30 m
Loaded Draft	:	11.6 m

It is proposed to provide a 420 m long berthing face contiguous to the unloading berths. This will allow for a safety margin of about 20 m on either side of the design vessels. The berths will accommodate ship loaders with rail span of 14m c/c. The conveyors will run between the rails parallel to loader. Refer drawing no. GMB/DPR/SEC2/03 for details.

Bollards will be provided @ 20.4 m c/c on the deck for mooring purpose. Super call rubber fenders with a frontal facia @ 20.4 m c/c will be provided.
Large tidal range and maximum allowable hull pressure will be taken care of by provision of frontal facia on the rubber fender. Ladders suitably recessed into the structure will be provided along the pier as a safety measure. The deck elevation will be fixed at 7 m above CD.

5.2.4 Approach Trestle

As can be seen from the coal terminal layout, the coal berths are located at about 2.7 km from the shore.

The trestle is designed to accommodate :

- vehicle carriageway ;
- 1.0 m wide footpath ;
- conveyors from unloading berths to coal stockyard ; and
- conveyors from coal stockyard to the loading berths.

23 m wide approach jetty will be sufficient to accommodate the above facilities.

5.3 DESIGN BASIS

5.3.1 Introduction

This section specifies the criteria for the design of the works for the coal terminal facilities at Positra III.

5.3.2 Design Policy

All structures shall be designed to perform at the following levels of design load combinations as described below :

Operational Condition

This condition corresponds to the combination of permanent loads, live loads and all possible accidental loads resulting from events of high exceedence probability. Under this condition the facility will function normally and without stoppage.

Non-Operational Condition

This condition corresponds to the combination of permanent loads, live loads and all possible accidental loads resulting from events of low exceedence probability. Under this condition the facility may cease to function or operate, but deflections and stresses will remain within the specified limits.

Impact Condition

This condition corresponds to the combination of permanent loads, live loads and all possible accidental loads resulting from events of high exceedence probability. Accidental impact shall be considered in this load combination. Operational wind, wave and current loads shall be considered. Berthing loads shall not be combined with impact loads. The cranes shall be assumed in the non-lifting position. Under this condition the facility will function normally and without stoppage.

Earthquake Condition

This condition corresponds to the combination of permanent loads, factored live loads, operational wind, wave and current loads. The cranes and mobile crane shall be assumed in the non-lifting condition.

Construction Condition

This condition corresponds to the combination of dead load, construction loads, non-operational wind, wave and current loads.

Design Life

The design life of the facilities is to be taken as 60 years. For items susceptible to normal wear and tear such as ropes, ladders, timbers, grating and the like, for which a design life of 60 years cannot reasonably be met, the design and construction must be so as to permit easy replacement.

5.3.3 Dredged Depth

The dredged depth in front of the coal berths will be 17.6 m below CD with tolerance of 0.5 m for overdredging.

5.3.4 Vessel Sizes and Dimensions

Table 5.1 presents the design values and principal dimensions for the vessels to be handled at the jetty :

Table 5.1 : Properties of Design Bulk Carrier

Parameter	Unit	Value
Coal Carrying Capacity	tonne	120000
Displacement	tonne	141000
LOA	m	260.00
Beam	m	42.00
Depth moulded	m	22.10
Draft laden	m	16.00
Draft ballast	m	8.70

5.3.5 Design Loads

a. General

The loads and / or combinations as shall be used in the detailed design of the marine facilities are described in this section.

b. Dead Load

Dead Load comprises the structure self weight plus superimposed loads of a permanent nature.

c. Loadings from Rail Mounted Cranes

The weights and general data of the equipment are given in **Tables 5.2** to **5.4**.

These loadings are indicative only, and the final design will be based on the loadings from selected equipment / machinery.

Table 5.2 : Crane Particulars

Number of wheels	
- Quay side	22
- Rear side	16
Distance between wheels	0.9-1.0 m

The initial design loads are based on a maximum operational wind load of 0.25 kN/m^2 and a maximum non-operational wind load of 1.5 kN/m^2.

Table 5.3 : Corner Loadings from Crane

Loading Condition	Quay side		Rear side	
	Maximum	Minimum	Maximum	Minimum
Operational wind with grab and hopper full	5,200 kN	2,600 kN	3,000 kN	1,400 kN
Non-Operational wind and boom lifted	5,500 kN	1,000 kN	4,800 kN	1,000 kN

The final loadings shall be as per the manufacturer's data.

Table 5.4 : Horizontal Forces on Rails

Loading	Quay Side Rails	Rear Side Rails
Longitudinal Forces		
- Operational Wind	620 kN	420 kN
Transverse Forces		
- Operational Wind	660 kN	400 kN
- Non-Operational Wind	660 kN	560 kN

d. Vehicle and Mobile Crane Loads

Vehicle Loading

For design of the quay deck and approach trestle the vehicle loading shall conform to IRC Class AA/Class 70R.

Mobile Crane

A mobile crane with a 150 kN lifting capacity shall be considered in the design for accessible areas on the quay. The mobile crane loading corresponding to the operating (lifting) condition shall not be combined with extreme wind.

An impact factor of 1.25 shall be applied to the immediate structural support element. Braking forces shall be considered. Crane working areas on the quay shall also be verified against outrigger loadings. The mobile crane data shall be based upon manufacturers data.

Notes :

1. Loading from either the vehicle or the mobile crane shall be combined with the crane working condition.

2. The vehicle loading together with the mobile crane in lifting condition shall also be considered.

e. Loadings from Utilities

For the structural design, the loadings from utilities shall be taken into account in the design.

f. Live Loads

On the quay an uniformly distributed live (UDL) load of 20 kN/m^2 shall be used.

The approach trestle shall be checked for an UDL load of 10 kN/m^2.

g. Wind Loads

Wind loads (in accordance with IS : 875) shall be calculated for the design wind speed as applicable. Maximum permissible wind speed with arm in stored condition will be 50 m/s. Maximum permissible wind speed for arm in operation condition will be 20 m/s.

h. Thermal Loads

The mean maximum temperature and the mean minimum temperature are of the order of 33°C and 18°C respectively. The maximum temperature variation upto $\pm$20°C shall be considered.

i Construction Loads

Due account shall be made of all construction loads, including those likely to be incurred during fabrication, transportation and creation of structural elements, as well as loads arising from construction equipment, vehicles and cranes, etc.

j Criteria for Earthquake Resistant Design

The design value for the horizontal seismic coefficient α_h shall be computed according to the following expression:

$$\alpha_h = b * I * \alpha_o$$

where

α_h = Design horizontal seismic coefficient

α_o = Basic Horizontal seismic coefficient

b = Coefficient depending upon soil foundation system

I = Coefficient depending upon importance of the structure

The design of structures shall be done in accordance with IS:1893, "Criteria for Earthquake Resistant Design of Structures". Positra falls under Zone IV as per seismic map of India shown in IS : 1893-1984. Basic Horizontal Seismic Coefficient of will be 0.05. Importance factor of 1.5 has been considered for this structure in view of this being a service point. Therefore the design horizontal seismic coefficient is taken as 0.075 for calculation of earthquake force on the structure.

The horizontal seismic force shall be considered to act in any one direction at a time. Where both horizontal and vertical seismic forces are taken into account, horizontal force in any one direction at a time may be considered simultaneously with the vertical force.

k. Horizontal Impact Loads

Conveyor Trestle

The trestle shall be designed for an accidental impact load of 100 kN acting on any point of the trestle or its supports transverse to the trestle axis.

l. **Berthing Energies and Fender Reactions**

The design berthing energy imparted to the coal berth works out to 710 kNm for normal operation, and 1420 kNm for accidental impact. The design berthing energy is based on the berthing of the design vessel of 120000 DWT, approaching the jetty at an angle of 10^0, with approach velocity of 0.10 m/s under normal operating conditions.

For absorbing the berthing energy of the vessels SUC 2000 H (RO grade) fender has been selected. The corresponding berthing force to the coal berth, at the ultimate stage works out to 1857 kN in the transverse direction and 550 kN in the longitudinal direction (The friction co-efficient between the vessel's hull and fender pad has been assumed as 0.3).

m. **Mooring Loads**

The bollard pull shall be taken as 200 t per bollard.

The mooring forces shall be applied at 0.6 m above the deck level. Bollard loads are assumed to act in any direction within 180° around the bollard in the horizontal plane at the sea side, and from horizontally to 30° and above in the vertical plane shall be considered.

n. **Wave loads**

The design wave height shall be taken as 1.0 m for a return period of 50 years.

Marine growth of 50 mm on the radius of the piles shall be used for the assessment of wave forces.

o. **Current loads**

The current loads shall be applied on the submerged parts of the structure / ship assuming the maximum current speed of 0.5 m/sec. Maximum angle of deviation of flow from mean direction is taken as (±) 10°.

p. **Stability Load**

Stability of the structures under maximum horizontal loadings and minimum vertical loadings shall be checked.

q. **Load Combinations**

All structures shall be designed for the load combinations specified in **Table 5.6**. Critical load combinations derived from the table shall govern the design of the structures. Due account shall be made of those cases where the most unfavourable effect occurs when one or more of the contributing loads is not acting.

Load Components :

a - Dead Load of Structures
b - Crane and Conveyor Loads
c - Vehicle and Mobile Crane Loads
d - Loads from Utilities
e - Live Load
f (i) - Wind Load (Operational)
f (ii) - Wind Load (Non-Operational)
g - Thermal Load
h - Loads during Erection/Construction
k - Earthquake Loads
l - Impact Loads
m - Berthing Loads
n - Mooring Loads/Lean-on Loads
p (i) - Wave Load - Operational
p (ii) - Wave Load - Extreme
q - Current Load

Table 5.5 Load Combinations

Loading condition	a	b	c	d	e	f (i)	f (ii)	g	h	k	l	m	n	p (i)	p (ii)	q
Operational	x	x	x	x	x	x	-	x	-	-	-	x	x	x	-	x
Non-Operational	x	x1	-	x	x	-	x	x	-	-	x		x	-	x	x
Impact	x	x2	x	x	x	x	-	x	-	-	x	x	x	x	-	x
Earthquake	x	x2	x 3	x	x4	x	-	x	-	x	-	-	x	x	-	x
Construction	x	-	-	-	-	-	x	-	x	-	-	-	-	-	x	x

Remarks :

(1) Crane in stowed position
(2) Wind, wave and current load on moored vessels shall be considered
(3) Crane in non-lifting position
(4) Reduced live load as per Code

5.3.5 Deflection Limitations

a. <u>Crane Support Beams</u>

Maximum vertical deflection = SPAN/1000
Maximum rotation = 0.01 radians

b. Conveyor Trestle Support Beams

Maximum vertical deflection = SPAN/600
(Under live load plus mobile
Crane or vehicle loads)

c. Conveyor Trestle Pile Bents

Maximum lateral deflection = (shortest adjacent span/500)

5.3.6 Materials

Concrete

Design

All concrete structures shall be reinforced concrete structures. The use of prestressed concrete may also be considered if necessary. The design of concrete structures shall be in accordance with Indian and / or internationally recognised codes and standards.

Unit Weight

Unit weights of concrete shall be taken as the following for design purposes :

- Un-reinforced concrete : 22 kN/m^3
- Reinforced concrete : 24 kN/m^3
- Highly reinforced concrete : 25 kN/m^3

Strength

The grade of concrete for reinforced concrete unless otherwise specified shall be M30 for marine structures.

Reinforcement

Steel reinforcement shall be high yield strength deformed bars conforming to IS:1786-1979 (grade fe 415).

Cover

The minimum concrete cover on the outer reinforcement shall be in accordance with IS:456 and IS:4651 (Part 4).

Structural Steel

Design

The design of steel structures shall be in accordance with IS:800.

Strength

Unless otherwise specified, the steel shall conform to IS:226 or IS : 2062.

Thickness

Minimum thickness of all structural steel elements shall be 10 mm and the maximum thickness shall not exceed 50 mm.

Connections

All permanent steel connections shall be made with full strength butt welds.

Corrosion

The corrosion allowances of 2 mm shall be assumed for steel surfaces.

5.4 ALTERNATIVES CONSIDERED

5.4.1 Approach Trestle

The approach trestle can be partly an earthern bund (mole) nearshore and balance on deep R.C.C. foundation, depending on prevailing site conditions such as water depth, currents, sub-soil profile.

As can be seen from the bore logs at Positra III (MB 14, 15 and 16), the sub-soil is predominantly soft clay over a considerable depth. From engineering point of view it is a very week soil, susceptible to large settlements and shearing failures. In addition, the soil may also under-go lateral flow under the weight of earthern bund. Thus, the ground conditions do not permit construction of an earthern bund resting directly on the bed soil.

There are a few ways of overcoming this problem, such as :

- vertical drains and preloading ;
- replacement of weak soil with stiffer material/provision of stone columns.

Vertical drains with preloading :

The drains provide vertical drainage outlets for water squeezed from the soil by the weight of surcharge or fill. The objective of consolidation by such artificial means is to decrease the moisture content thereby increasing the shear strength and reducing settlement characteristics.

This technique is not recommended in the present case, because installation of vertical drains is effective only if the strata is allowed to consolidate by stagewise loading. Our construction schedule may not permit for such stagewise loading.

Replacement by stronger material / provision of stone columns:

(a) provision of stone columns is making boreholes in the clay and filling stone chips or gravel or a mixture of this and compacting them in the bore either by drop hammer method or by vibratory method.

(b) replacement by stronger material is dredging a trench and replacing the soft clay with sand fill, if necessary vibro compacted.

A preliminary analysis of the above alternative solutions, revealed that these are not cost effective vis-a-vis an R.C.C. piled approach jetty. Moreover stones, chips, sand are not readily available nearby and we have to be ferried from a considerable distance by road. The construction will also be quite cumbersome and expensive, particularly installing stone columns below sea bottom from a floating barge in varrying water depths and over a considerable depth.

Therefore, it is recommended to provide an earthern approach bund were the height of earth fill is less than 3 m and a piled approach jetty beyond the height of 3m.

5.4.2 Berths

The following alternative designs have been considered :

- box caisson ;
- open pile structure.

The box caisson (a rigid reinforced concrete structure) requires the presence of a competent foundation base ; the present soil conditions with a top layer of predominantly loose silty clay offers insufficient, stability and bearing strength. An expensive soil improvement will have to precede any caisson installation.

The open piled structure comprises a pile supported reinforced concrete deck with minimum reflection of waves between structure and vessel. The deck slab is supported by a system of interconnected transverse and longitudinal beams which transfer the load to the piles.

Therefore open piled structures are proposed to be adopted for all the marine works.

Taking into account the encountered soil conditions and design loads the following pile types have been considered.

- bored (cast-in-situ reinforced) concrete piles ;
- driven steel tubular piles.

Pile installation procedures of bored piles result in a preference for vertical piles only, since :

- the pile bearing capacity of a raker is likely to be affected by difficult cleaning procedures of the pile section ;
- both the diameter of the raker piles (diameter $\leq \varphi$ 1000 mm) and the rake angle ($\leq 4:1$) is limited due to pile installation constraints.

Steel piles can either be used as vertical piles or as raker (maximum rake angle 4:1).

The alternative with driven tubular steel piles has been rejected due to the high cost as the required steel piles will have to be imported from abroad involving transportation costs, etc.

Vertical bored cast-in-situ reinforced concrete piles are recommended for foundation. Horizontal loads (viz. berthing impact, bollard pull, seismic forces, etc.) will be transmitted through the deck into the bearing layers by means of bending moments in vertical piles. The piles will be socketted into rock for sufficient depth.

5.5 DESCRIPTION OF SELECTED SCHEME

5.5.1 Coal Berths

Four number of coal berths - 2 for unloading and 2 for loading purpose - are proposed to be provided at Positra III by year 2011.

The width of berths has been fixed at 30 m keeping in view the rail span of coal unloader @ 20 m, a carriage way of 8 m and a clearance of 2 m from rail centre towards berthing edge.

Super cell rubber fenders (SUC 2000 H - RO grade) Bridgestone or equivalent make will be provided. Bollards will also be provided to withstand a mooring force of 200 t.

1500 dia bored in situ concrete piles will be provided. The piles are proposed to be socketted into rock. The pile foundations support a grid of longitudinal and transverse RCC beams.

The crane rail track will be supported by RCC longitudinal beams, suitably placed so as to match the crane leg spacings. All the longitudinal beams directly rest on piles. All the piles are tied together at top by transverse beams. The slab will be cast monolithically with the grid (i.e. longitudinal and transverse) of beams.

Refer drawing no. GMB/DPR/SEC2/04 for structural arrangement of coal berths.

5.5.2 Approach Trestle

An approach trestle about 2.7 km long will be required providing an access to the coal berths from the shore. The trestle will essentially carry belt conveyors and vehicular approach road in addition to services and other utilities. The cable tray under the footpath will carry electric cables, etc.

A 23 m wide approach trestle including 6 m wide carriageway and 15.25 m wide conveyor gallery will be provided.

1500 dia bored in situ RCC piles will support the deck carrying vehicular carriageway, footpaths and belt conveyor gallery. Superstructure will be made of a system of longitudinal and transverse RCC beams and RCC slab. Pile bents will be spared @ 6 m c/c.

Refer drawing no. GMB/DPR/SEC2/05 for the general and structural arrangement of approach jetty.

Chapter 6 : Onshore Works

6.1 COAL STACKYARD

The total import traffic in coal will be 10 million tonnes per annum by year 2011. Out of this 50% is proposed to be evacuated through coastal shipping. The number of import vessels varies from a minimum of 100 for 100% larger vessels and 200 for 100% smaller range . The service time at the berth per vessel varies from 48 hours to 70 hours. There is a provision in the handling system for directly loading the vessel for coastal export. The number of vessels for coastal export is estimated to be 167. The service time at the export berth per vessel is about 44 hours. Under such circumstances, the possibility of the two vessels -one unloading and the other loading - working concurrently exists with a higher probability. With the different scenarios, it may not be possible to quantify the coal transfer directly to the loading vessel. Nevertheless, on a conservative estimate, 50% of the quantity for coastal export could be directly loaded without the need to pass through the stockyard.

It is not possible to carry out direct loading of wagons from the unloading ship because of the non-compatibility of the rates of handling between the main unloading conveyors and the wagon loading conveyors. Hence this option is not considered.

With these assumptions, the traffic quantum to be considered for planning the stockyard will be 7.5 million tonnes per annum. The stockyard capacity is usually taken as 10% of the annual traffic. Accordingly, in the present case, the stockyard capacity should be about 7.5 lakh tonnes, in the final stage.

A 30 metre wide and 8 metre high stack for a length of 2000 metre can hold about 1.8 lakh tonnes of coal. Four such parallel stockpiles could meet the ultimate storage requirement of this terminal 10 m wide service roads will be provided around the stock pile. Considering the area required for the berms, roads, drive houses and for the stacking and reclaiming operations, the width of the stockyard is taken as about 250 metres. Additional area will be earmarked for future expansion , if found necessary at a later date. Refer drawing no. GMB/DPR/SEC2/06 and GMB/DPR/SEC2/07 for layout of coal stackyard.

The stackers and reclaimers travel along rails. The yard conveyors are located between the legs of the stackers and reclaimers. The rails will be fastened to RCC cross beams. The cross beams rest on a suitably made ballast bed. On either side of the foundation bed, a concrete trench will provide for the drainage of rain water. The yard conveyor supports in the form of RCC cross beams are also founded on the same foundation bed as the stackers and reclaimers.

6.2 BUILDING REQUIREMENTS

6.2.1 Functional Purpose

The buildings and their purpose as required for the coal terminal are :

- Operations Building : This building to provide space for offices of personnel engaged in managerial and departmental activities related to terminal operations and their support staff. In this building also space to be provided for utilities. This building is envisaged to have two floors for offices.

- Control Room : This single storeyed building to provide an all round view of the coal terminal. Will be erected on top of operations building.

- Canteen Building : This building to provide space for offices of catering personnel and for messing facilities for all terminal personnel and for utilities.

- Gate House : This building to provide space for offices for terminal security personnel and for utilities.

- Maintenance Building : This building to provide space for offices of engineering staff of the terminal and for utilities.

- Workshop and Annex : This building consists of two parts, a workshop and annex. The annex to provide space of offices of the workshop foremen, mechanics, electricians, technicians and the storekeepers and rooms for off duty operational personnel and maintenance labour. Space for utilities also to be provided. The workshop and storeroom are for the first line regular maintenance activities.

- Yard Office/Control Room: The building to provide space for off-duty stacker / reclaimer operators, supervisors conveyor operators, terminal supervisors, train loading supervisors, labour and also for utilities. This building is envisaged to have two floors with the yard control room located on the upper floor.

- Quay Office : This building to provide space for offices of the shore bosun, off duty loader / unloader operators, quay conveyor system supervising personnel, bulk berth supervisors, time keepers and the foreman of the cleaning gang. Rooms for cleaning gang labour and bulldozer operators are also provided for in this building including provision of utilities.

- Store Room for Spares : This building to provide space for storage of spares and material required for operation and maintenance including fuels and lubricants.

- Belt Storage Shed : A separate storage shed with automatic sprinklers and EOT crane will be provided for maintaining the required inventory of belt conveyors.

- Pump Houses : These will be required to house the pumps for fire fighting and water sprinkler purpose, though separately.

- Substation : This building will house transformer and other equipment.

6.2.2 Building Sizes

The building areas are dictated by the personnel requirement, space for storages, machinery, utilities etc.

The sizes of the buildings are determined on the basis of required floor area and application of the building module. The resulting building dimensions are given in the table below.

Table 6.1 : Building Sizes

Building	Area (Sq. m)	Size (m x m)
Operations building	600	2 flrs. x 12.5 x 24.0
Control room	125	12.5 x 10.0
Canteen	650	20.0 x 32.5
Gate house	75	6.0 x 12.5
Maintenance building	250	12.5 x 20.0
Maintenance workshop	1050	30.0 x 35.0
Yard office cum control building	475	12.5 x 38.0
Electrical substation	600	20.0 x 30.0
Pump house (2 nos.)	200	10.0 x 20.0
Belt storage shed	450	15.0 x 30.0
Store room for spares	450	15.0 x 30.0
Sewage treatment plant	100	10.0 x 10.0

Refer drawing no. GMB/DPR/SEC2/08 to 17 for layout plans of buildings.

6.2.3 Specifications

The general specifications for all the building works shall be as follows :

1. The foundations shall be designed taking the safe bearing capacity as 15 T/Sqm.
2. The work shall be carried out as per General Technical Specifications for building works of Gujarat state with up to date additions / modifications.
3. The grade of concrete shall conform to M 20 (1:1:5:3) fpr columns foundations and superstructure conforming to IS : 456 - 1978.
4. The reinforcement shall be high strength deformed bars of grade Fe415 conforming to IS : 1786 - 1985.
5. All structural Steel shall conform to IS : 226 / IS-2062 - Grade A.
6. Slab on Grade shall be provided for Industrial Buildings (Flooring).
7. Proper Anti Corrosive Treatment (ACT) shall be done for the reinforcement before placing.
8. The foundations shall mainly be Isolated Footing Type depending on the load.
9. Plinth beams shall be provided for buildings exceeding the length of 40 meters.
10. Construction joint shall be provided for buildings exceeding the length of 40 meters.
11. Loose Pockets in foundations shall be removed and filled up with PCC mix (1:4:8).
12. Back filling shall be done with granular soil in layers not exceeding 200 mm and each layer shall be well compacted as per Specifications.
13. Suitable water proofing admixture shall be provided in concrete for under ground water tank and over head tanks.
14. All reinforcement shall be sheared only. Flame cutting is not permitted, all bars shall be bent at normal temperature.
15. The walls shall be of course rubble stone masonry with 1:4 mix in foundations and superstructure. Alternatively white stone Bela masonry of appropriate thickness shall be provided in superstructure. The joints shall be raked.
16. The flooring shall be 40 mm thick Kota stone polished, with under layer of 30 mm thickness in cement concrete mortar 1:2:4, as per Specifications.
17. All outdoor paved areas shall be of cement concrete 1:2:4 - 40 mm thick laid in one layer, finished with floating coat of neat cement as per Technical Specifications.
18. All wood work shall be of teak wood.

19. All doors and windows shall be of steel duly painted with anti corrosive paint.
20. Electrical fittings and wiring shall be provided as per Specifications.
21. The internal water supply lines shall be galvanized steel of medium class conforming to IS:1239.
22. All sanitary (waste water and soil) pipes will be sand cast iron / PVC of 100 mm diameter and those for wash basins will be of 75 mm diameter (heavy type).
23. All R.C.C. slabs for roofing shall be provided with water proofing treatment.

6.3 ROAD PAVEMENTS

The general technical specifications for road works shall be as per "Specifications for road and bridge works", third revision (reprinted in January '97) and issued by the Ministry of Surface Transport (Roads Wing), Government of India and published by the Indian Road Congress.

The composition of a typical road crust recommended is as under :

A. Pavement Layers	**Compacted Thickness (mm)**
Granular Sub-Base Grading-I	150
Wet Mix Macadam	250
Dense Mix Macadam	100
Bituminous Concrete	40
Total Thicknesses	**540**
B. Paved Shoulders (1.5 m wide)	**Compacted Thickness (mm)**
Wet Mix Macadam	370
Mix Seal Surfacing	

6.4. SECURITY SYSTEM

Security system to the port area is required to serve the following objectives :

- protection against sabotage ;
- protection against pilferage and thefts ;
- protection against encroachments by unauthorised persons ;
- prevention of thoroughfare by trespassers and antisocial elements.

Keeping in view the importance of various areas in the Port, the following proposals are made :

- A rubble masonry wall 2.4 m high with barbed wire fencing - 1 m high.
- A security office and check post at the entrance to the terminal.
- Provision of watch towers at suitable intervals for manual monitoring.

The watch towers will be connected to the central security control room by means of telephone and walkie - talkie system. They will also be provided with sirens to warn about sabotage or fire incidence to enable the central security agency to take immediate action. Regular watch and ward staff will be utilised for routine rounds in the area.

Chapter 7 : Safety and Pollution Control

7.1 POLLUTION CONTROL

7.1.1 Possible Pollution from Coal

The handling of coal in bulk can cause environmental problems by emanating coal dust or by contaminating the water-flow during rainy season. Protection measures need to be taken to prevent both these causes. If the coal produced from the mines are crushed, screened and washed before it is transported to loading stations and terminals, the moisture retained in the material would control the generation of dust to a large extent. Presently most of the coal terminals ensure that the moisture content in the coal is about 10% and the dust generation is minimal while loading. While unloading and stacking at the receiving terminal, the moisture evaporates and there is need to replenish the moisture content periodically so that its level does not go below 7-8% . If this is ensured most of the dust generation during handling operations could be avoided. The problem becomes acute only when the coal is not processed and washed.

7.1.2 Dust Suppression System:

In a coal handling system, there are different areas and transfer points where dust is generated. These areas are listed hereunder:

i) ship's hold
ii) ship unloaders, loaders, stackers and reclaimers
iii) conveyor system
iv) stockyard

It is proposed to provide integrated protection at all these areas. Since the coal brought in the ship will have some amount of moisture, the main thrust in the protection system will be to replenish the moisture content and arrest/control the dust generation rather than to extract the dust after it is formed. The entire system, therefore, is based on water sprinkling. It will be necessary to provide sufficiently clean water to sustain the system. The water used should preferably be free of salts.

i) Dust suppression in the ship's holds:

If the coal brought in the ship is already having sufficient moisture, no large scale dust generation is expected while being unloaded. However, water sprinkling jets will be provided at the bottom of the boom of the unloaders so that the operator will be able to activate the sprinklers as and when necessary while the unloading operation is going on. Automatic sprinkling system by provision of sensors need not be provided on the unloader. Once sufficient moisture level is ensured inside the hold, the problem down the stream could be manageable.

ii) Dust suppression at the handling equipment - unloader/loaders/stacker/ reclaimer:

All the coal handling equipment such as ship unloaders, loaders, stackers, reclaimers and wagon loaders will have dust suppression system at the transfer points.

Dust extraction systems will not be effective if moisture content already exists in the coal as the dust collectors (bags) get clogged easily. It is very important that the sprinklers are properly designed so that only minimum quantity of water is sprayed in mist form so as to avoid problems arising out of surplus water affecting the performance of these handling equipment.

iii) Dust suppression for the conveyor system:

It is proposed to have the entire length of the conveyors covered as a protective measure to avoid coal dust being blown over by wind, even though such a provision will be costly. All the transfer points in the conveyor system will have dust suppression sprinklers so that the moisture that is lost due to evaporation in transit up to the next transfer point is suitably replenished. This will also control excessive moisture content being developed.

iv) Dust suppression system in the stockyard:

The possible area where maximum dust generation could take place is the stockyard. Hence, an effective and efficient dust suppression system is proposed in the stockyard area. The entire stockyard will be covered by sprinklers located at intervals and with suitable height. For this purpose, the entire area will be divided into sections. Each section will have sprinklers along with sensors located at various points. The sprinklers in each section will be supplied with water at high pressure through a pipeline system provided with electrically operated valves. High pressure pumps supply water to the system. The sensors, valves and the pumps are all connected to a computer in the control room.

The sensors located at various points continuously monitor the dust level in the specified area and give the signal to the computer. The computer is so programmed that when the level of dust in the atmosphere reaches the permissible limits, the pumps are activated, the electrically operated valves open and all the sprinklers in that section operate for a predetermined period. If necessary, the computer repeats the cycle until the dust level is reduced to permissible levels. Thus the dust level in each section is monitored through the computer and the sprinkler system in a particular section alone is activated to bring down the dust level.

The sprinklers are provided with different settings so that the type of spray could be changed from misty condition to water sprinkling. Since the whole system is controlled by a computer, it is operated only when it is required and only where it is required. Because of the selected use, there is a saving of water to a large extent.

7.1.3 Water Recycling System

When contaminated water flows down through the area, it gets mixed with the general water table and causes deterioration in the quality of subsoil water. The water sprinkling system used for dust control will contribute to this deterioration to some extent. In order to avoid such deterioration of the quality of subsoil water, a recycling system is proposed.

Provision of two collection and sedimentation tanks with system of proper drainage will ensure that the contaminated water is collected and allowed to settle. After allowing for the solids to settle down, the clear water is recycled into the dust suppression system. This system serves the dual purpose of avoiding contamination of subsoil and also conserving water.

7.2 SOLID WASTE DISPOSAL

In the port area, the main source of pollution is coal. The solid wastes contain more of coal dust, sand and some quantity of organic matter like paper, dry leaves, etc. Periodical cleaning and collection in mobile containers is recommended. Organic waste matter from the ships shall be discharged into the deep sea. However provision is also to be made for collection of garbage from the ships when necessary. This is proposed to be achieved by deploying the mobile vans into which the garbage from ships will be loaded by means of a suitable device. The containers can be towed away to suitable disposal site for land filling using tractors. Private agencies could be employed for this purpose.

7.3 FIRE FIGHTING SYSTEM:

7.3.1 Design Basis :

a. Design Philosophy

Provision of sprinkler based dust control system, by itself, affords an efficient fire retarding effect on the entire system. The chances of a fire emanating from the wet coal are remote. However, it is necessary that fire protection system is provided to cover vital areas of operation.

The fire water system shall be designed to cope with the following risks :

- Fires involving a berthed bulk.
- Fires on the quay, paved areas or roads.

The design of the Port fire water system is based on the following criteria and conditions of occurrence :

- Simultaneous outbreak of fires on more ships is considered a remote chance, mainly because explosion hazards are low in comparison with for instance with an oil port. Therefore the system is designed for suppression of a fire on a bulk carrier.

- The tugs serving the coal Port should be fitted with fire fighting equipment, capable of suppressing a large fire on board a ship. The tugs will normally assist the shore operated system.

- The main purpose of the fire fighting system is to protect the Port facilities and secondly to cover third party liabilities. Therefore, ships on fire will be towed away from the berth and if possible be taken out of the Port to the anchorage where the tugs would assist with the fighting of fires on special request of the ship's owner. Obviously this does not apply when small fires are involved which can be extinguished at the berth.

On the basis of the analysis it is concluded that the maximum required capacity will occur when the system should deal with a fire abroad 120000 DWT bulk carrier being the largest ship envisaged to visit the Port.

b. <u>Design Flow Rate and Pressure</u>

A flow rate of 450 m^3 / hr is required for design of the fire water system covering the maximum demand, i.e. simultaneous use of three hydrants, each of 150 m^3 / hr capacity when fighting a fire aboard a berthed bulk carrier.

The design pressure of the system will be determined by the throw required to combat a fire aboard a bulk carrier.

c. <u>Description of the System</u>

The fire water will be supplied from the pump station which is located along the approach trestle with a system of pumps and pipelines.

In order to ensure reliability of the supply, two pumps, each capable of supplying 100% of the design capacity will be installed. The fire water pumps will be of the vertical turbine type each capable of supplying water @ 450 m^3/hr at design pressure at the discharge flange.

One pump will be driven by electric motor, the other by diesel engine, so that in case of power failure the supply of adequate quantities of fire water is ensure.

An electric motor driven jockey pump of 50 m^3/hr is included to maintain a constant pressure on the fire water system through an accumulation vessel. The capacity of the accumulation vessel is such that opening of the hydrant valve will cause the start of the jockey pump top make up for the water drawn off.

In case of fire when two or more hydrant valves are opened, the electric driven main pump will be switched on. When the electric driven pump fails to start, the diesel engine driven pump will automatically start within 20 seconds.

The fire fighting system in different areas is described herebelow :

7.3.2 Berths and Approach Trestle

At the berths, double-headed hydrants will be provided at every 50 metres and along the approach trestle at every 100 metres.

7.3.3 Conveyor System

The conveyor belts which are rubber based have a tendency to catch fire due to excessive heat. This may be either due to the coal on it getting ignited or due to the heat generated by the rubbing of the belt on the structure. The resultant damage consequent to any fire on the conveyors will be considerable - direct costs due to damage to the conveyor belt and indirect costs due to the system down-time. Hence automatic water sprinkling system is provided for the full length of the conveyor galleries.

The system consists of a main pump with a pipeline system running along the conveyor. A pressure maintenance pump ensures that the water in the pipeline is always kept under pressure. Heat sensing bulbs will be provided at intervals along the pipeline. The main pump has an auto-starting device which will enable it to start automatically when the pressure in the pipeline drops. When heat is generated due to fire at any point, the heat-sensitive bulb will burst and will open up the vents activating the sprinkler at that point. When the water flows out, the pressure in the line drops, the main pump automatically starts and the flow of water is maintained. If the fire is not localised and tends to spread, more points will be activated allowing water to flow from more sprinklers along the line and control the fire effectively.

7.3.4 Stockyard

A precaution to be taken to prevent fire at the stockyard is to restrict the height of the stack to about 8 metres and to ensure that the stocks are dispersed frequently. This precaution should be part of the operating instructions and shall be strictly enforced. Nevertheless, a large number of buried hydrant points will be installed all along the stockyard to combat fire at any place in the stockyard. The hydrant system will be supplied water by a separate pump. Hoses with quick-fix coupling will be provided to cover the entire area of the stockyard.

The buried fire water lines will be of glass fibre reinforced epoxy, whereas adequately coated heavy wall cabin steel will be used for above ground lines and lines installed in the concrete ducts.

7.3.5 Office Buildings

Provisions for office buildings are proposed in conformity with National Building code and also IS:4651 (Part V). The proposed system includes :

- Underground tanks for storage of potable, water.
- Portable fire extinguishers in all buildings.
- Fire tenders with all accessories.
- Ambulance vans.
- Hose reels and carts kept in shelters.

The underground storage tanks, to be common between a group of buildings, will be always kept full. In case of fire, the mobile fire brigade units stationed nearby will be pressed into service to draw water from these tanks. Garages are provided for the fire tenders and ambulances. Since the onshore facilities do not include any building of more than two storeys except control room, elaborate provisions like fire alarms, sprinkler system, etc. are not recommended. However, hydrants are proposed at appropriate locations along the potable water supply lines as a standby measure. The proposed fire station will be provided with three fire tenders with all equipment and two ambulance vans. The fire station will be connected by telecommunications with all the buildings inside the port area.

ANNEXURES

- The required control equipment and communication devices ;
- The electrical power feed and power distribution equipment and lighting ;
- The required weighting devices ;
- The required safety devices ;

The unloader will be suitable for hoisting of a bulldozer, which is required for the final clean-up of the hold, into and out of the vessel's hold.

Performance Parameters

Product to be handled	:	Coal,
Type and size of vessel to be unloaded	:	Gearless Bulk Carrier, 120,000 DWT
Unloading capacity		

- rated : 1500 t/h
- average : 750 t/h

Operational Aspects

• Rail span	:	20 m
• Lift above top of rail upto grab bottom	:	20 m
• Lift below top of berth	:	27 m
• Total lift	:	47 m
• Hoist Load		
a) Inclusive of grab	:	65 T
b) Pay load (Taken as 55%)	:	35 T (44 cum)
• Out reach from centre of water side rail	:	34 m
• Back reach from centre of land side rail	:	8 m
• Trolley Travel	:	62 m
• Minimum clearing height under portal beam	:	8 m
• Distance between crane legs	:	20 m
• Nominal capacity	:	60 cycles / hour
• Average capacity	:	30 cycles / hour
• Max. hoist speed with load	:	] to be designed to meet the nominal
• Max. trolley travel speed with load	:	] capacity of 60 cycles / hr.
• Class of duty	:	continuous (24 hrs. / day)
• Climate conditions	:	tropical

Control Functions

The unloader will be controlled by the crane operator, from the operator's cabin. The operator's cabin can be positioned at any position along the grab carriage runway, independently from the carriage movements.

The operator can choose from the following two modes of operation :

- *Manual*

  The operator can control all the crane functions, with the exception of boom hoisting, from the operator's cabin. Boom hoisting will be manually controlled from a separate local cabin situated near the engine room. Tower travelling can be controlled from the operator's cabin as well as from the local cabin.

- *Semi-automatic*

  In this mode the grab hoisting and grab travelling will be controlled by means of a programme logic controller (PLC), in such way that the grab will travel along a trajectory resulting in the shortest grab travelling time. The semi-automatic mode will be engaged and disengaged by the operator from the operator's cabin.

The unloader operator will receive instructions through appropriate communication devices from the quay control room attendant.

Interlocks and safeties will be provided, amongst others to ensure that starting of the unloader takes place only when the receiving conveying system is operational. The operational situation of the unloader and any failures therein will be signalled to the central control room through appropriate control cables.

<u>Norms and Standards</u>

The unloader will be designed and constructed in accordance with the latest state of the art, and the applicable Indian and other norms and standards such as ISO, BS, DIN, FEM (Federation Europeeene de la Manutention), etc.

<u>Special Requirements</u>

Personnel Safety and Access :

The unloader will be provided with all personnel safety features and protections as prescribed in the applicable norms. The operator's cabin will be designed in such manner,to allow the safe escape of the operator, in any position of the cabin, to the walk way on top of the carriage supporting structure. Stairs as well as a personnel lift will be provided giving access to the various levels and locations of the unloader.

The unloader shall be designed for the following maximum wind forces :

Maximum wind forces :

- Maximum operating wind force : Beaufort 8, wind speed 20 m/s.
- Maximum wind force for structural design: A maximum wind speed of 50 m/s.

Other safety and control devices such as rail clamps; holding down device; aenemometer; rail sweeps; guards for all rotating shafts; interlocks; emergency stops; rope slack sensor; overload tripper for trolley travel; boom hoist and gantry travel; overspeed detection for main hoist and boom hoist with tripping device; overhand protection for all motors; and limit switches shall be provided.

General Note

In this duty specification descriptions and characteristics are included which are based on one possible design of the unloader. Other designs could also be acceptable, subject to approval of the Consultant, provided they offer identical functional, operational and technical features.

ANNEXURE 2.2

SPECIFICATIONS - SHIP LOADER

Type

Rail mounted travelleing type

Number

1st Stage - 1 no.
2nd Stage - 1 no.

General Description

To load coal into the coal vessels, the quay will be equipped with one rail mounted ship loader per berth. The loaders will travel on the supporting rails, which are fastened longitudinally to the top of the quay. Thus, in general, each loader will operate on one vessel. Thus the travel length of each loader should be sufficient to reach all holds of the coal vessel.

Each loader will mainly consist of the following parts :

- A steel portal structure, supported on four (4) wheel bogie arrangements located under the corners of the crane.
- Shuttle boom, boom conveyor, tripper car, mast structure.
- An operator's cabin with the required controls providing an ample view on operating areas inside and outside of the vessels hold.
- Electrical house ; travelling , luffing and shuttle boom mechanism.
- Deflector chute with drive.
- The required control equipment and communication devices.
- The electrical power feed and power distribution equipment and lighting.
- The required weighing devices.
- The required safety devices.

Performance Parameters

Product to be handled : Coal

Type and size of vessel to be loaded : Gearless Bulk Carrier, 40,000 DWT

Loading capacity

- rated : 1500 t/h
- average : 750 t/h

Operational Aspects

Functional requirement	:	to discharge coal with moisture content upto 10% into ship's holds at a rated capacity of 1500 TPH.
• Type	:	shuttle boom, portal type, rail mounted traversing, luffing type.
• Rail span	:	14 m
• Luffing angle	:	(+) 12° (-) 15 °
• Discharge boom conveyor		
– Belt width	:	1200 m
– Speed	:	4 m/sec
– Troughing angle	:	35°
• Max. outreach required from seaside rail	:	22 m
• Class of duty	:	continuous (24 hrs. / day).
• Climate conditions	:	tropical

Control Functions

The loader will be controlled by the crane operator, from the operator's cabin. The operator can control the operations by means of a programmable logic controller (PLC).

The operator will receive instructions through appropriate communication devices from the quay control room attendant.

Interlocks and safeties will be provided, amongst others to ensure that loading takes place only when the discharging conveying system is operational. The operational situation of the loader and any failures therein will be signalled to the central control room through appropriate control cables.

Norms and Standards

The loader will be designed and constructed in accordance with the latest state of the art, and the applicable Indian and other norms and standards such as ISO, BS, DIN, FEM, etc.

Special Requirements

Personnel Safety & Access :

The loader will be provided with all personnel safety features and protections as prescribed in the applicable norms. The operator's cabin will be designed in such manner, to allow the safe escape of the operator, in any position of the cabin. Access will be provided to various levels and locations of the loader.

Other safety and control devices such as rail clamps, rail sweeps, anemometer, interlocks, storm anchors, rope slack sensors, overload detectors for shuttle and hoist, overload protectors for all motors, limit switches, clectro-hydraulic brakes, group centralised automatic lubrication system, etc. shall be provided for.

Maximum wind forces :

The ship loader shall be designed for the following maximum wind forces.

- Maximum operating wind force - Beaufort 8, wind speed 20 m/s.
- Maximum wind force for structural design - A maximum wind speed of 50 m/s.

General Note

In this duty specifications, descriptions and characteristics are included which are based on one possible design of the loader. Other designs could also be acceptable, subject to approval of the consultant, provided they offer identical, functional, operational and technical features.

ANNEXURE 2.3

SPECIFICATIONS - STACKERS

Type

Rail mounted portal type luffing, slewing boom with fixed counter weight mast.

Number

1st Stage - 1 no.
2nd Stage - 1 no.

General Description

For discharging and stacking of the coal received from preceeding conveyor through tripper car continuously at normal capacity.

The stacker will travel on supporting rails, which are fastened to sleepers supported by ballast beds.

Each stacker will be fed with coal from a belt conveyor, running between the travelling rails of the machine. The stacker will operate at either end of its track, stacking coal on both sides.

Each stacker will have the following major components ;

- Portal structure ;
- Slewing super structure ;
- Mast structure ;
- Boom conveyor with drives ;
- Counter weight ;
- Operator's cabin ;
- Electrical house ;
- PLC ;
- Travelling, luffing and slewing mechanism ;
- The electrical power feed and power distribution equipment and lighting ;
- A coal chute for discharge of coal ;
- The required safety devices.

Performance Parameters

• Product to be handled	:	Coal
• Stacking capacity - rated	:	3000 TPH
• Class of duty	:	Continuous (24 hrs./day)
• Maximum stock pile height above rail level	:	8 m
• Angle of luffing	:	(-) 10° (+) 14°

• Slewing angle	:	200° (i.e. 100° on either side of track)
• Maximum reach required from centre of rotation	:	50m
• Discharge conveyor		
– Belt width	:	1600 mm
– Speed of belt	:	4 m/sec
– Troughing angle	:	35°
• Track gauge	:	12 m
• Track variation (i.e. one rail to another)	:	± 25 mm
• Maximum gradient of track	:	1 in 200
Maximum wheel load	:	20 to 22 tonnes
Climate conditions	:	tropical

Control Functions

The stacking operations will be controlled by the machine operator, from the operator's cabin.

The operator can choose from either manual or semi-automatic mode of operation.

In the manual mode, the operator can control all the stacker functions from the operator's cabin.

In the semi-automatic mode, the stacking operation can take place in a pre-determined fashion. Once the method has been chosen by the operator, the travel distance and initial boom inclination and further system parameters have been selected by him, a programmable logic controller (PLC) will control the machine in such a way that it will travel back and forth automatically, forming a regular pile along the stacking distance chosen.

The operator will receive instructions, through appropriate communication devices, from different parties. Main instructions such as pile locations to be operated will be given by the central control room attendant. Other working instructions will be given by the quay control room attendant.

Interlocks and safeties will be provided, amonst others to ensure that starting of the stacker takes place only when the relevant conveying system is operational. The operational situation of the stacker and any failures therein will be signalled to the central control room through appropriate control devices.

Norms and Standards

The stacker will be designed and constructed in accordance with the latest state of the art, and the applicable Indian and other norms and standards such as ISO, BS,DIN, FEM, etc.

Special Requirements

Personnel safety and access :

The stacker will be provided with allthe personnel safety features and protections as prescribed in the applicable norms. Stairs will be provided giving access to the various levels and locations of the stacker. The stacker will be provided with all the required design features and safeties to prevent toppling over of the machine in case of overland.

All the safety and control devices such as rail clamps, rail sweeps, aenemometer, inter locks, emergency stops, rope slack sensor, overland detection device for boom hoist, over load protection for all motors, limit switches, electro hydraulic brakes, programmable logic control (PLC), group centralised and automatic lubrication system, etc. shall be provided.

Maximum wind forces :

The stacker shall be designed for the following maximum wind forces :

- Maximum operating wind force - Beaufort 8, wind speed 20 m/s.
- Maximum wind force for structural design - Maximum wind speed of 50 m/s.

General Note

In this duty specification, descriptions and characteristics are included which are based on one possible design of the stacker. Other designs could also be acceptable, subject to approval of the consultant, provided they offer identical functional, operational and technical features.

ANNEXURE 2.4

SPECIFICATIONS - RECLAIMER

Type

Portal type, rail mounted, travelling, full slewing, luffing boom with fixed counter weight mast and with variable speed bucket drive.

Number

1st Stage - 1 no.
2nd Stage - 1 no.

General Description

To reclaim coal with moisture content the yard will be equipped with reclaimers with variable speed bucket drive. The reclaimer will travel on supporting rails, which are fastened to sleepers supported by ballast beds.

The belt conveyor running between the travelling rails of the machine, will receive the coal from the machine after reclaiming. The reclaimer will operate at either side of the track, reclaiming coal piles on both sides.

Each reclaimer will mainly consist of the following major parts :

- Portal structure.
- Slewing superstructure.
- Mast structure.
- Boom conveyor with drives.
- Counter weight.
- Operator's cabin.
- Electrical house.
- PLC.
- Travelling, luffing and slewing mechanism.
- Bucket wheel with variable speed.
- The electrical power feed and power distribution equipment and lighting.
- The required safety devices.

Performance Parameters

Product to be handled	:	Coal
Reclaiming capacity	:	
• rated	:	1500 t/h
• average	:	750 t/h
Class of duty	:	Continuous (24 hrs. / day).

Operational Aspects

• Maximum stack pile height about rail level	: 8 m
• Maximum reach of bucket required from centre of rotation	: 42 m
• Slewing angle	: 360°
• Bucket type	: without cells
• No. of buckets, size and speed of bucket wheel	: to be designed by the manufacturer to achieve the rated throughput.
• Boom conveyor	
- Belt width	: 1200 mm
- Speed of belt	: 4 m/s
- Trough angle	: 35°
• Track width	: 14 m
• Track variation from one rail to another	: ± 25 mm
• Maximum gradient	: 1 in 200
• Design range of luffing	: (+) 14° (-) 10°
• Luffing (hoisting) mechanism connected	: by hydraulic push up cylinders to the mast through boom conveyor structure
• Maximum wheel load	: 20 to 22 tonnes
• Climate conditions	: Tropical

Control Functions

The reclaiming operations will be controlled by the machine operator from the operator's cabin. The operator can choose from either the manual or semi-automatic mode of operation.

In the manual mode, the operator can control all the reclaimer functions from the operator's cabin.

In the semi-automatic mode, use of PLC will enable reclaiming the coal pile automatically, once the required system parameters have been set up by the operator.

The reclaimer operator will receive instructions, through appropriate communication devices, from different partices. Main instructions such as about pile locations to be operated will be given by the central control room attendant. Other working instructions will be given by the quay control room attendant or the train loader operator.

Interlocks and safeties will be provided, amongst others to ensure that starting of the reclaimer only takes place when the relevant conveying system is operational. The operational situation of the reclaimer and any failures therein will be signalled to the central control room through appropriate control cables.

Norms and Standards

The reclaimer will be designed and constructed in accordance with the latest state of art, and the applicable Indian and other norms and standards such as ISO, BS, DIN, FEM (Federation Europeenne de la Manutention), etc.

Special Requirements

Personnel Safety and Access :

The reclaimer will be provided with all personnel safety features and protections as prescribed in the applicable norms. Stairs will be provided giving access to the various levels and locations of the reclaimer. The reclaimer will be provided with all required design features and safeties to prevent toppling over of the machine in case of overload, such as when the bucket wheel is "buried" in the coal pile.

Other safety and control devices such as rail clamps, rail sweeps, aenemometer, inter locks, emergency stops, overload detectors for hydraulic cylinders, overload protection for all motors, limit switches, electro-hydraulic brakes, PLC, group centralised automatic lubricatin-system, etc. shall also be provided.

Maximum wind forces :

The reclaimer shall be designed for the following maximum wind forces :

- Maximum operating wind force - Beaufort 8, wind speed 20 m/s.
- Maximum wind force for structural design - Maximum wind speed of 50 m/s.

General Note

In this specification descriptions and characteristics are included which are based on one possible design of the reclaimer. Other designs could also be acceptable, subject to approval of the Consultant, provided they offer identical functional, operational and technical features.

ANNEXURE 2.5

SPECIFICATIONS - BELT CONVEYORS

General Description

• Ship unloading conveyors	:	Capacity 3000 TPH
	:	Belt width 1600 mm
	:	Speed 4 m/s
• Ship loading conveyors	:	Capacity 1500 TPH
	:	Belt width 1200 mm
	:	Speed 4 m/s
• Wagon loading conveyors	:	Capacity 1500 TPH
	:	Belt width 1200 mm
	:	Speed 4 m/s
• Idlers for all conveyors		
- On carrying side	:	1. 3 Roll garland type metallic idlers in horizontal portion and 3 roll metallic idlers with support frames in inclined portion. 2. Troughing angles 35°. 3. Impact idlers with rubber discs in impact area.
- On return side	:	1. Two roll garland type metallic idler in 1-horizontal portion & two roll garland type metallic idlers with support frames in inclined portion. 2. Trouging angle 10°.
• Safety & control devices	:	1. Under speed switches 2. Antisway switches 3. Metal detectors 4. Brakes 5. Self aligning idler supports 6. Interlocks 7. Belt tension indicators 8. Belt scrapers

Operational Aspects

Product to be handled	:	Coal
Operating hours	:	24 h / day.
Climatic conditions	:	Tropical.

Control Functions

The belt conveyors will be provided with the follwing control functions ;

- *Remote controls*

  In normal operation the belt conveyor system will be controlled remotedly, from a central control room. For this purpose, the belt conveyor system will be provided with the required interlocks, safeties and alarms, which enable the proper and safe sequential starting and stopping of the conveyors, preventing the overloading of the transfer chutes.

The central control room will be equipped with all required control equipment, boards and instruments, which provide the operator with all required operational data.

- *Local controls*

Locally, for maintenance and testing purposes, each belt conveyor will be provided with key operated control switches, enabling starting and stopping of a single conveyor after clearance by the central control room operator.

Design Standards and Norms

The belt conveyors will be designed and constructed in accordance with the latest state of art, and the applicable Indian (IS:11592, IS:8598, etc.) and other norms and standards such as ISO, BS, DIN, FEM (Federation Europeenne de la Manutation), etc. In particular, specific standards for belt conveyors, such as the "Recommended Practice for Troughed Belt Conveyors", issued by the British Mechanical Handling Engineers' Association, will be followed.

Safety and Environmental Requirements

Personnel Safety and Access

The belt conveyors will be provided with all personnel safety features and protections as prescribed in the applicable norms. The design will include the provision of easy and safe access to all areas and locations, as required in accordance with the applicable operational and maintenance standards.

Environmental Standards

The belt conveyor system will be designed in such a way that a minimum of environmental damage and nuisance is emitted to the surrounding areas. This relates in particular to the emission of dust which should be minimized as much as possible. therefore, the belt conveyor systems will be installed in closed housings and galleries and transfer points will be provided with dust collection systems with automatic dust feed-back.

Maximum wind forces :

The belt conveyors shall be designed for the following maximum wind forces :

- Maximum operating wind force - Beaufort 8, wind speed 20 m/s.
- Maximum wind force for structural design - A maximum wind speed of 50 m/s.

ANNEXURE 2.6

SPECIFICATIONS - MOBILE WAGON LOADER

Type

Mobile wagon loader

Number

1st stage : One

General Description

A mobile wagon loader will be provided at the stackyard to load stationary empty open wagons of any type with coal, continuously at normal capacity with an accuracy of 1% of the stipulated load per wagon. The wagon loader travels on rail tracks fastened into the ground.

Each wagon loader will consist of :

- Superstructure.
- Tripper.
- Intermediate conveyor.
- Belt feeder.
- Bigfurcated / swing chute.
- Belt-conveyor system.
- Operator's cabin.
- Drives and hoists for various operations.
- The required control equipment and communication devices.
- The electrical power feed and power distribution equipment and lighting.
- The required weighing devices.
- The required safety devices.

Performance Parameters

• Product to be handled	:	Coal, lumpsize 0-100 mm, bulk density 700 kg/m^3
• Size and type of wagon to be loaded	:	55 t Capacity stationary, empty, open type wagon.
• Loading capacity		
- rated	:	1500 t/h
- average	:	920 t/h
• Operating hrs.	:	24 hrs/day

Operational Aspects

• Track guage	:	6 m
• Travelling		
a) While not loading	:	15 to 20 m/min.
b) While loading	:	Variable speed with auto adjustment as required for operating condition
• Tripper		
a) Belt width	:	1200 mm
b) Speed of belt	:	4 m/sec.
• Climate conditions	:	Tropical

Control Functions

The mobile wagon loader will be controlled by the operator, from the operator's cabin. The wagon loader travelling will be controlled by means of a programmable logic controller (PLC).

The operator will receive instructions through appropriate communication devices from the control room attendant. The operational situation of the wagon loader and any failures therein will be signalled to the central control room through appropriate control devices.

Norms and Standards

The mobile wagon loader will be designed and constructed in accordance with the latest state of the art, and the applicable Indian and other norms and standards such as ISO, BS, DIN, FEM, etc.

Special Requirements

Personnel Safety and Access :

The loader will be provided with all personnel safety features and protections as prescribed in the applicable norms. The operator's cabin will be designed in such a manner, to allow the safe escape of the operator, in any position of the cabin. Access will be provided to various levels and locations of the wagon loader.

Maximum Wind Forces :

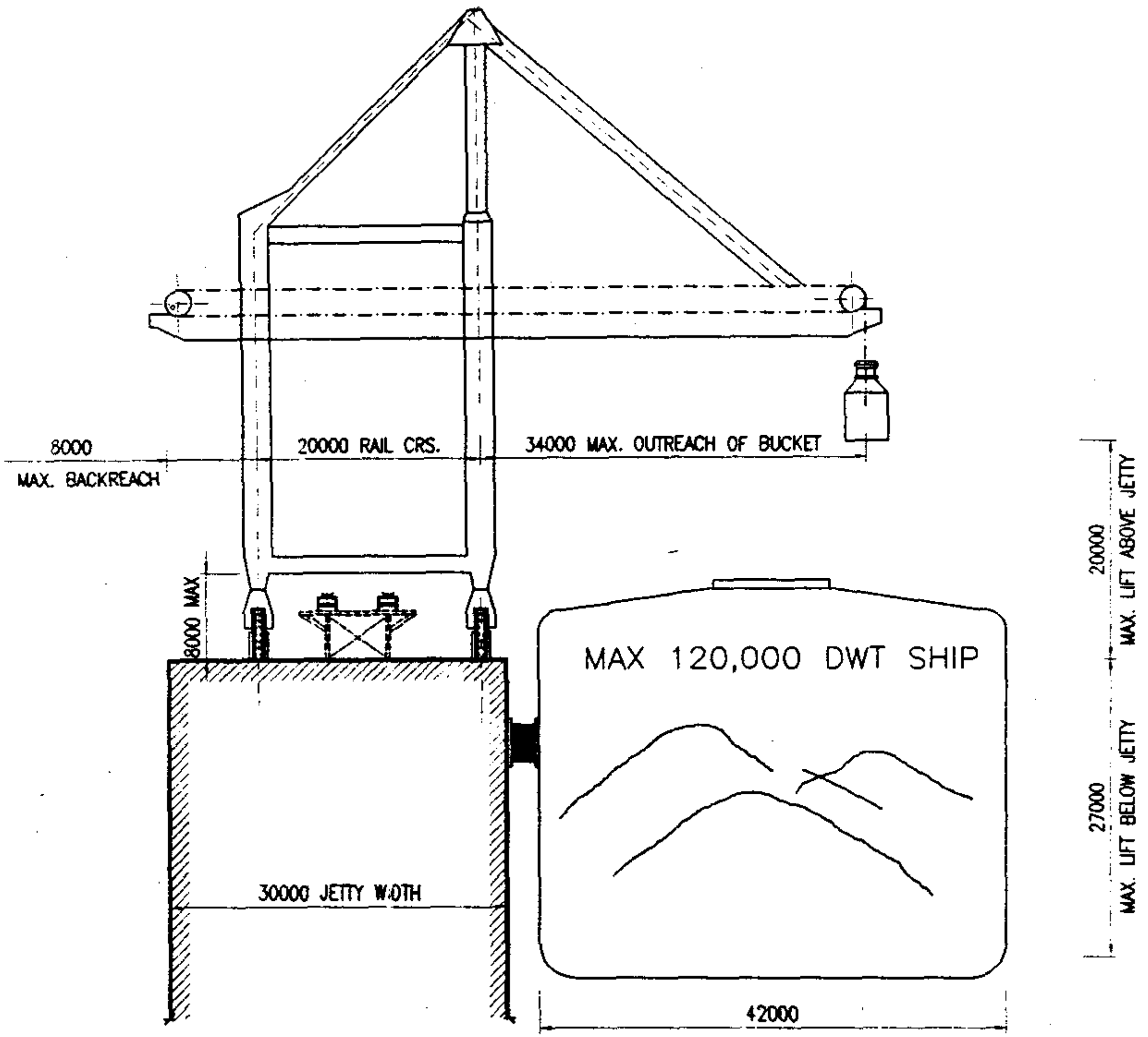
The loader will be designed for the following maximum wind forces :

- Maximum operating wind force : Beaufort 8, wind speed 20 m/s.
- Maximum wind force for structural design : A maximum wind speed of 50 m/s.

General Note

In this duty specification descriptions and characteristics are included which are based on one possible design of the mobile wagon loader. Other designs could also be acceptable, subject to approval of the consultant, provided they offer identical functional, operational and technical features.

FIGURES



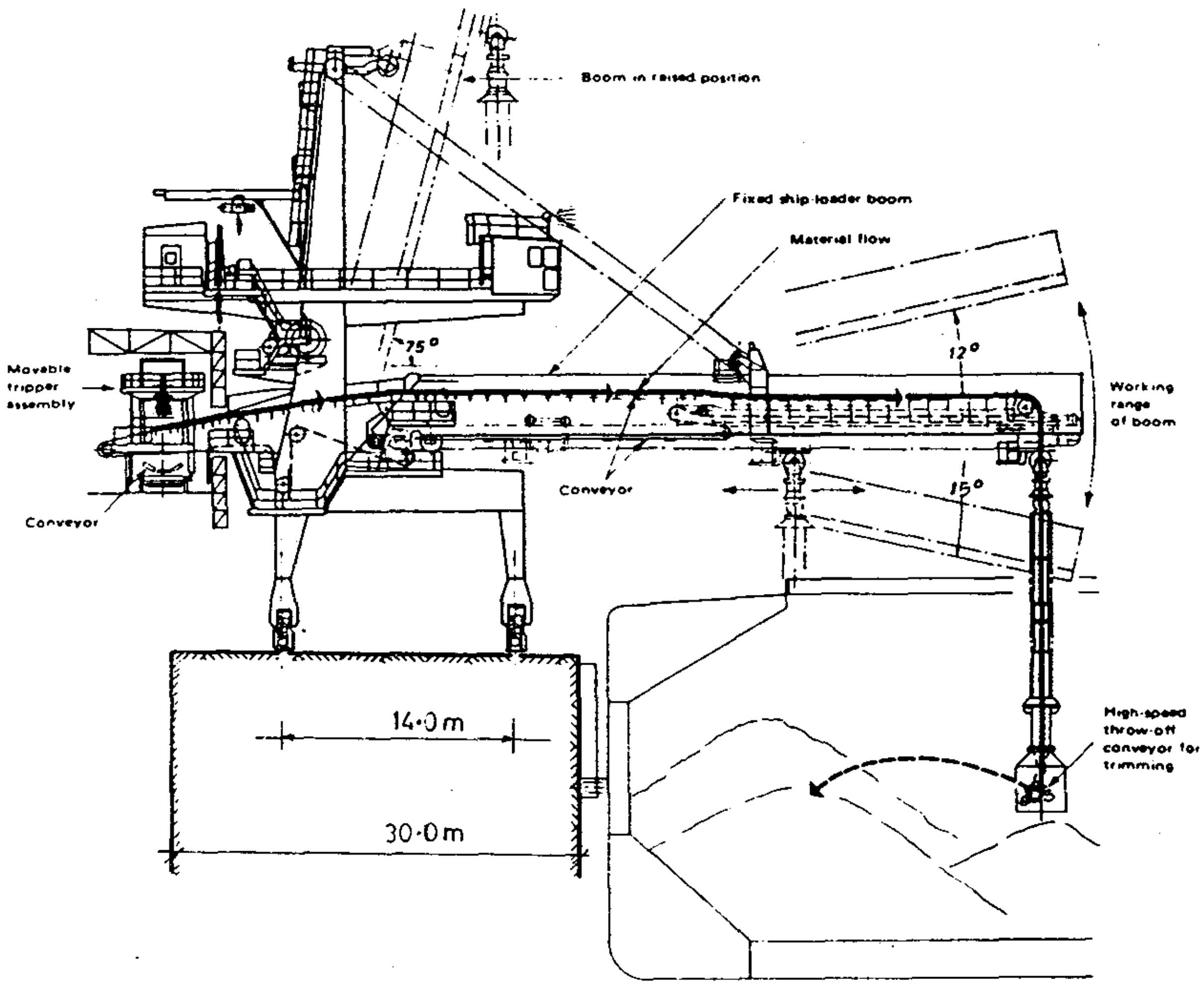
NOTES :

- ALL DIMENSIONS ARE IN mm.
- MATERIAL HANDLED : COAL
- STACKING CAPACITY : 1500 TPH (RATED)

HARRIS

TYPICAL DETAILS OF GRAB TYPE SHIP UNLOADER

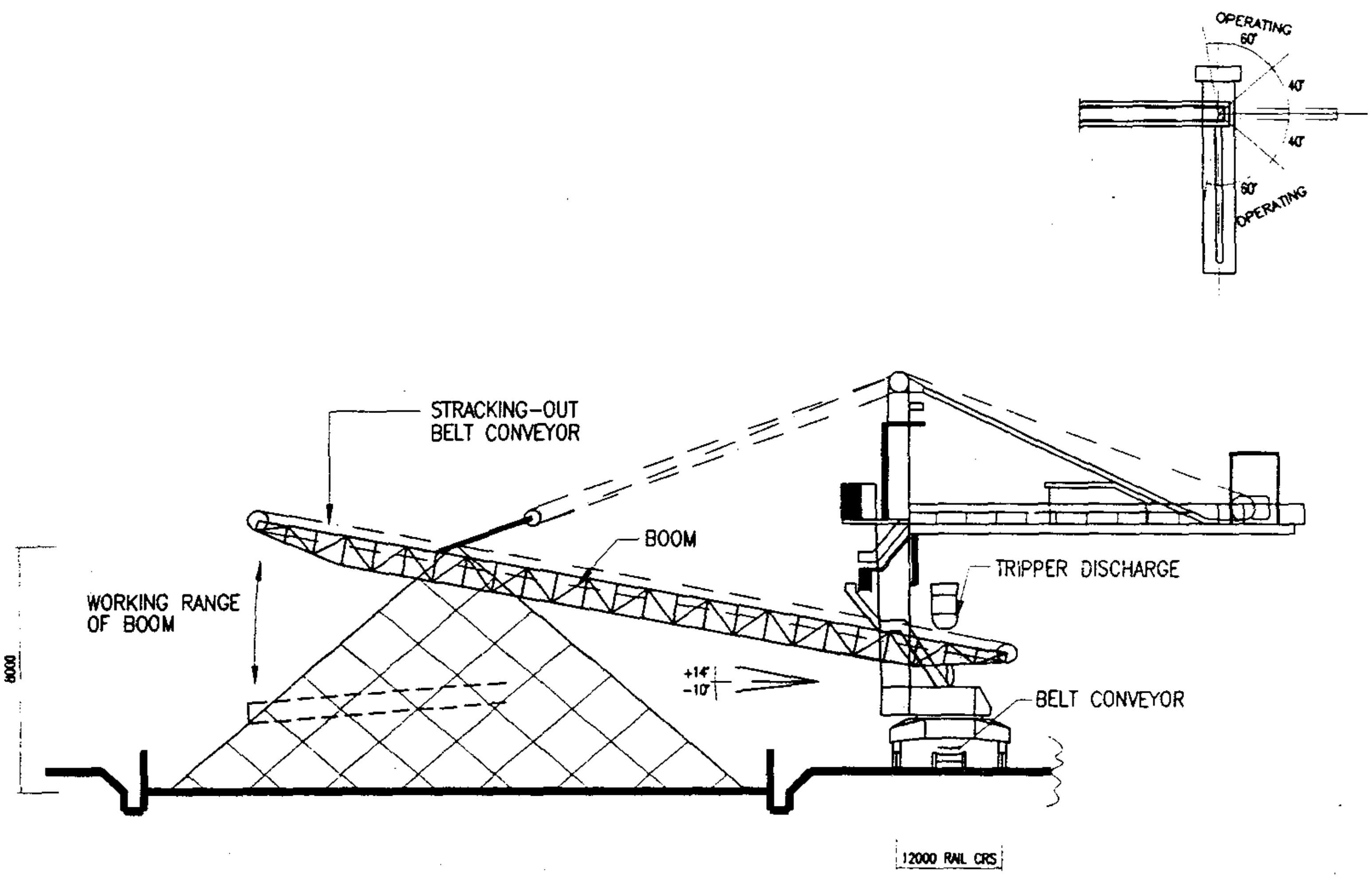
FIGURE NO. 2.1



TYPICAL DETAILS OF SHIP LOADERS

HARRIS

Figure No. 2.2



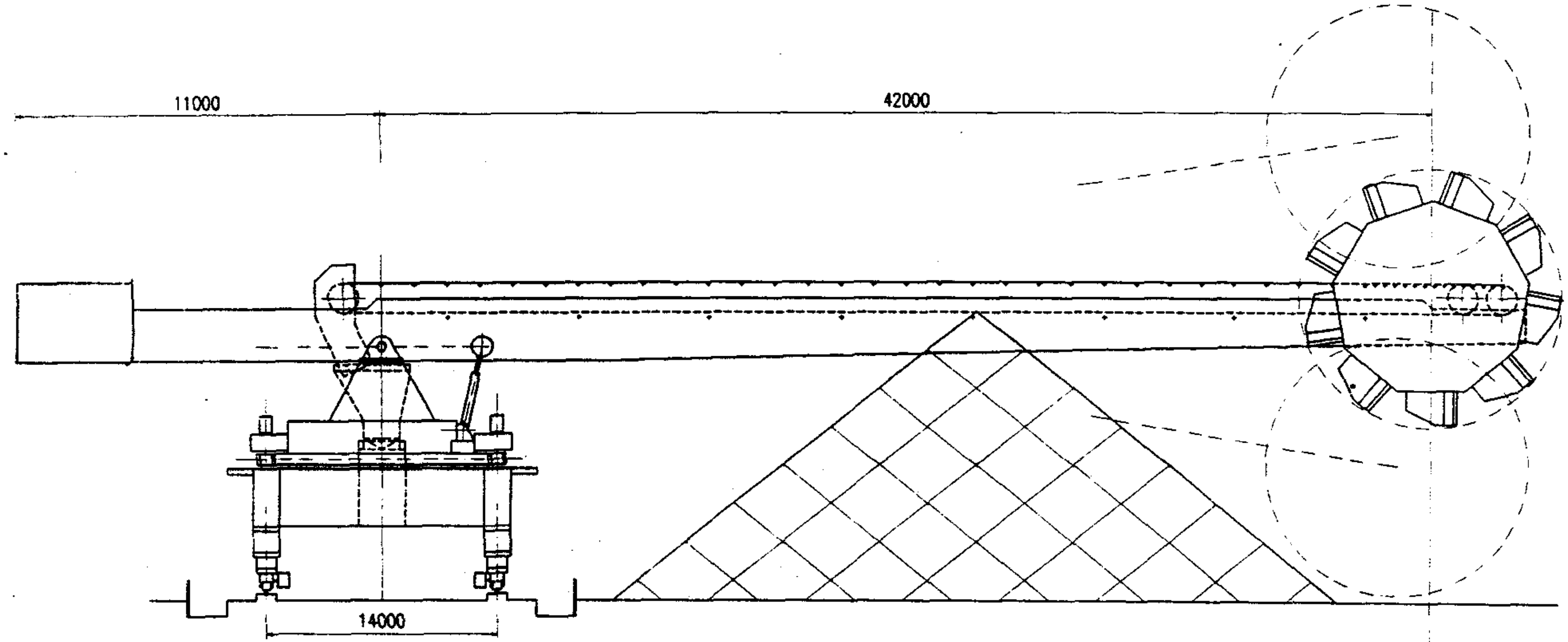
TYPICAL DETAILS OF STACKER

NOTES :

- ALL DIMENSIONS ARE IN mm.
- MATERIAL HANDLED : COAL
- STACKING CAPACITY : 3000 TPH (RATED)

FIGURE 2.3

HARRIS



TYPICAL DETAILS OF RECLAIMER

NOTES :

- o ALL DIMENSIONS ARE IN mm.
- o MATERIAL HANDLED : COAL
- o RECLAIMING CAPACITY : 1500 TPH (RATED)

FIGURE 2.4

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT

CONTENTS

SECTION 3 : LIQUID BULK TERMINAL

Chapter 1 : Product Criteria

1.1 GENERAL

The liquid bulk terminal is mainly planned for handling bulk petroleum products which will be imported, stored in transit storage tankages and then evacuated for internal distribution. The terminal, accordingly will have the following components :

- Berthing facilities to handle the tankers and also to enable ship-shore transfer of products
- Transfer facilities to transport the products from the berth to the transit storage tank farm
- Storage tanks at the tank farm
- Product evacuation facilities for outward movements of products through road, rail and pipelines
- Administration and control, utilities, safety and other infrastuctural facilities

The detailed technical description of these components with their planning, design basis and broad specifications are enumerated in this section.

1.2 TERMINOLOGY

The special terminology and terms used in the text are common for the Indian oil industry circle and are as follows :

MS	:	Gasoline / Petrol
HSD	:	Diesel oil
SKO	:	Kerosene
TLF Gantry:	:	Tank lorry filling gantry
TWL	:	Tank wagon loading
KL	:	Kilo litre (1000 litres)
Lorry / truck	:	Road tanker - usually of 12 KL cap
OISD	:	Oil Industry Safety Directorate
CCOE	:	Chief Controller of Explosives
BIS	:	Bureau of Indian Standards

1.3 PRODUCT CLASSIFICATION

Petroleum products have been classified by Indian statutory authorities like BIS, CCOE and OISD, according to their flash points. Products proposed to be handled at the terminal have the following classification :

Class A Petroleum products -
Liquids which have flash point less than 23° C -- Naphtha and MS

Class B Petroleum products -
Liquids which have flash point 23° C
and above but below 65° C. -- HSD and SKO

Class C Petroleum -
Liquids which have flash point 65° C
and above but below 93° C. - Not proposed

Excluded Petroleum products -
Liquids which have flash point 93° C and above. - Not proposed

1.4 PRODUCT SPECIFICATIONS

The products, as listed above, proposed to be handled are generally classified as white products. Their properties are summarised hereunder:

Product	Density (te/m3)	Viscosity (centistokes)	Pumping temperature
HSD	0.85	7.5	ambient
SKO	0.82	8.0	ambient
Naphtha	0.74	less than 1	ambient
MS	0.73	less than 1	ambient

1.5 PRODUCT THROUGHPUT

The quantum of products to be imported through the marine facilities at Positra have been estimated as follows:

Year 2001 : 5 million tonnes per annum
Year 2006 : 10 million tonnes per annum
Year 2011 : 15 million tonnes per annum

The product wise composition of this total traffic for these years, has been considered as follows in the absence of any other specific information :

Product	% share	Year : 2001	Year : 2006	Year : 2011
HSD	60%	3.00 MTPA	6.0 MTPA	9.00 MTPA
SKO	15%	0.75 MTPA	1.5 MTPA	2.25 MTPA
Naphtha	15%	0.75 MTPA	1.5 MTPA	2.25 MTPA
MS	10%	0.50 MTPA	1.0 MTPA	1.50 MTPA
Total	**100%**	**5.00 MTPA**	**10.0 MTPA**	**15.00 MTPA**

Chapter 2 : Terminal Performance

2.1 TANKER FLEET COMPOSITION

The composition of the product tanker fleet and mix will have an effect directly on the berth occupancy, waiting time and consequently on the throughput of the marine oil terminal . This will have a sequential effect on the sizing of the marine facilities and also on the onshore product storage that will have to be provided. All these will affect the construction and operational costs involved.

Considering the current industrial practice and also the shipping trend for the marine transport of petroleum products, the size of the tanker fleet for Positra has been taken as follows:

Class PT 1 Tanker size: 15,000 DWT - 30,000 DWT
Class PT 2 Tanker size: 30,000 DWT - 45,000 DWT

However, the proposed layout of the jetties will allow handling of product tankers upto 70,000 DWT partly loaded to the equivalent draught for a 45,000 DWT tanker.

2.2 PARCEL SIZE AND PUMPING RATES

Since the proposed traffic in petroleum products are to be primarily bulk imports, the average parcel sizes for these tankers could be the maximum they can carry and these for the different tanker classes are as follows:

Class PT 1 : 20,000 tonnes
Class PT 2 : 35,000 tonnes

The unloading rates for product tankers will depend upon the capacity of the ships' pumps, available pressure at the tanker manifold, size and length of the pipelines between the tanker berth and onshore product storage tanks, and the pressure drops across the unloading arms. The following maximum product unloading rates from the tankers are considered.

<u>Maximum unloading rate per berth</u>

Product	Maximum unloading rate per berth			
	Class PT1 Tankers		Class PT2 Tankers	
	cu.m/hr	te/hr	cu./m	te/hr
Diesel	2000	1700	3000	2550
Kerosene	2000	1640	3000	2460
Naphtha	2000	1480	3000	2220
Gasolines	2000	1460	3000	2190

The average pumping rates used in this study have been taken to be 70% of the above indicated rates for the whole pumping period, which will allow for product start-up and stripping operations.

2.3 BERTH REQUIREMENTS

i) General

The number of berths at the marine terminal is dependent upon the following factors :

- product traffic
- tanker fleet composition
- tanker utilisation scenarios
- unloading rates
- tanker turn-around time
- downtime and terminal operational days

ii) Tanker fleet and utilisation

The product tanker fleet will comprise two tanker classes - PT 1 and PT2. A number of tanker utilisation scenarios, as shown hereunder, have been considered to represent varying patterns of tanker calls.

Tanker Size (dwt)	Tanker utilisation scenarios				
	A	B	C	D	E
15,000 - 30,000	-	25%	50%	75%	100%
30,000 - 45,000	100%	75%	50%	25%	-

The number of tanker calls for these tanker utilisation scenarios are indicated in the **Table 2.1.**

iii) Downtime and terminal operational days

The weather conditions have been reviewed and on a conservative estimate the downtime due to adverse weather conditions will be about 25 days in a year. This, taken together with the down time for maintenance and holidays at 5 days each, gives the total downtime of the terminal as 35 days. This gives the terminal operational period of 330 days in a year.

iv) Tanker turn - around time at the terminal

The tanker turn-around time is comprised of the actual pumping time and the time for the peripheral activities which include berthing, connection/ disconnection of arms, customs formalities and documentation, deberthing etc. The break-up of the time for the peripheral activities is as follows:

Piloting, arrival	1.0 hour
Swinging, berthing	1.0 hour
Connection/documentation	1.0 hour
Disconnection/sailing off formalities	3.0 hour
Deberthing	0.5 hour
Departure	0.5 hour
Total	7.0 hour

The turnaround time will be the actual pumping time (which depends upon the parcel size and discharge rates) plus 7 hours for peripheral activities.

Table 2.1 : Number of Product Tanker Calls at Port Berths

Product Tankers DWT	Tanker Utilization Scenarios A	B	C	D	E
	Product Tanker Utilization Percentage				
15,000 to 30,000		25.00%	50.00%	75.00%	100.00%
30,000 to 45,000	100.00%	75.00%	50.00%	25.00%	
Throughput Scenario 'I"- 5,000,000 tpa- Year 2001					
15 to 30,000 tankers					
Diesel		38	75	113	150
Kerosene		9	19	28	38
Nephtha		9	19	28	38
Gasolines		6	13	19	25
Sub-total		63	125	188	250
30 to 45,000 tankers					
Diesel	86	64	43	21	
Kerosene	21	16	11	5	
Nephtha	21	16	11	5	
Gasolines	14	11	7	4	
Sub-total	143	107	71	36	
Total	143	170	196	223	250
Throughput Scenario 'III"- 10,000,000 tpa - Year 2006					
15 to 30,000 tankers					
Diesel		75	150	225	300
Kerosene		19	38	56	75
Nephtha		19	38	56	75
Gasolines		13	25	38	50
Sub-total		125	250	375	500
30 to 45,000 tankers					
Diesel	171	129	86	43	
Kerosene	43	32	21	11	
Nephtha	43	32	21	11	
Gasolines	29	21	14	7	
Sub-total	286	214	143	71	
Total	286	339	393	446	500
Throughput Scenario "V"- 15,000,000 tpa - Year 2011					
15 to 30,000 tankers					
Diesel		113	225	338	450
Kerosene		28	56	84	113
Nephtha		28	56	84	113
Gasolines		19	38	56	75
Sub-total		188	375	563	750
30 to 45,000 tankers					
Diesel	257	193	129	64	
Kerosene	64	48	32	16	
Nephtha	64	48	32	16	
Gasolines	43	32	21	11	
Sub-total	429	321	214	107	
Total	429	509	589	670	750

v) Berth occupancy studies

Under various throughputs and tanker utilisation scenarios, the berth occupancy has been worked out to determine the number of berths required. The results are indicated in the **Annexure 3.1**. Summary of these results are indicated hereunder:

Throughput Scenarios	Tanker Utilisation Scenarios				
	A	B	C	D	E
Scenario I (2001) - 5.0 MTPA					
No. of berths	1	1	1	1	1
Berth occupancy	50%	57%	64%	71%	77%
Scenario II - 7.5 MTPA					
No. of berths	2	2	2	2	2
Berth occupancy	37%	42%	48%	53%	58%
Scenario III (2006) - 10.0 MTPA					
No. of berths	2	2	2	2	2
Berth occupancy	50%	57%	64%	70%	78%
Scenario IV - 12.5 MTPA					
No. of berths	2	2	3	3	3
Berth occupancy	62%	71%	53%	59%	65%
Scenario V (2011) - 15 MTPA					
No. of berths	3	3	3	3	3
Berth occupancy	50%	57%	64%	71%	78%

vi) Berth requirements

Based on the berth occupancy studies, it can be seen that the occupancy for a single berth during the first stage goes up to 77% for the case where the entire traffic is considered to be transported in tankers of PT 1 class only. Even for the case with 50/50 mix of class PT1 and PT2, the occupancy is high at 64%. The ideal occupancy for a single berth is normally 40 to 45% to keep the pre-berthing detention within acceptable limits. Hence it is suggested that even at the initial stages, two berths be provided. This can take care of the second stage also upto year 2006. During the third stage, the third berth could be added. Accordingly the berth requirements for the various stages are as follows:

Year	2001	2006	2011
No. of Berths	2	2	3

Chapter 3 : Product Receipt and Transfer

3.1 GENERAL

The ship-shore interface for transfer of cargo will be the service platform of the jetty. The principal components of this transfer system are ships' pumps, marine unloading arms, pipeline manifold and the set of pipelines. The products from the tankers berthed at the jetties will be transferred to the onshore tankage by ships' own pumps through marine unloading arms and through pipeline system. The unloading arms will be connected to the pipeline system through a pipeline manifold on the service platform. The manifold will have the necessary valves for interchanging the flow of products from one line to the other in case of multi-use of the same pipeline for different products.

3.2 MARINE TERMINAL OPERATIONS

The unloading system has been designed keeping in mind the possible cargo traffic at Positra, the product mix and other operation needs. The piping system will facilitate the following expected operations :

- A tanker at any berth, can unload any one OR more products at a time. In other words if it is carrying four products, all four can be unloaded simultaneously. However, in this case, all four pipelines will be in use and it will not be possible to do unloading at other berths.
- Unloading rate will be 1050 KL/hr per arm. The capacity of each of the four pipelines from Berths to the tank farm is however 2100 KL/hr. Two unloading arms can be used together for unloading any product at any berth.
- In view of larger quantity of HSD to be handled, it has been anticipated that occasionally, there could be two tankers discharging HSD. Therefore, the pipeline system has been designed to make use of SKO line from berths to the tank farm for HSD service as well. Thus, HSD can be unloaded at two berths simultaneously.
- Similarly, HSD line can be used for SKO service, facilitating unloading of two SKO tankers at a time.
- When two tankers are discharging either SKO or HSD simultaneously, the third berth can not be used for class B product since both HSD and SKO pipelines from berths to oil terminal are in use.
- MS and naphtha pipelines from berths to tank farm are dedicated lines. It implies that two naphtha or two MS tankers can not unload together. However, one naphtha tanker and one MS tanker can unload at a time.
- Products from pipelines can be carried to various storage tanks in the terminal as follows :

Berth - Terminal Pipeline (Line No. - Designation)	Service	To Storage Tanks
1 - HSD	HSD	Any HSD tank
1 - HSD	SKO	Any SKO tank
2 - SKO	SKO	Any SKO tank
2 - SKO	HSD	Any HSD tank
3 - Naphtha	Naphtha	Any Naphtha tank
4 - MS	MS	Any MS tank

- When unloading is being carried out at all three berths at a time, the following possibilities can not exist :
  - all three tankers of either HSD or SKO
  - two tankers of HSD and one of SKO
  - two tankers of SKO and one of HSD
  - more than one tanker of MS
  - more than one tanker of Naphtha

Normally, HSD and SKO lines are dedicated lines. Only when two tankers of the same product are to be unloaded at the same time, then HSD line is to be used for SKO or SKO line for HSD. In such cases, the line content (estimated 425 KL) of the earlier products is to be displaced by the following product. No pigging for such operation is envisaged. Inter phase of HSD and SKO will be taken into HSD tank.

The manifolding of marine unloading arms with the pipelines from berths to the tank farm will be done near the berths and manifolding of the transfer lines with the tanks' inlets will be done near the tank farm.

As per requirement, there will be three berths available by ultimate stage and arrangements exist for discharging any of the designated product from a given berth. The operational sequence is described hereunder.

- The tanker will be brought alongside the berth and moored securely
- Samples will be drawn from the tanker as per the operating practice and the pre-discharge test will be carried out to establish that the products on-board meet the specifications
- Marine unloading arms will be connected to the tanker manifolds. Two marine arms will be used for each tanker.
- Pipeline system will be made through to receive the product in the designated tank. It shall be ensured that the pipeline contents are of the same product as the one proposed to be discharged from the tanker.
- Ullage readings will be recorded for the ship's tanks as well as for the designated tanks onshore.

- Discharge operations shall be commenced and at regular intervals, the quantity discharged from the tanker will be checked with the quantity received onshore. Similarly, the discharge pressure record shall be maintained so as to ensure that there is no loss of product due to any leakage during discharge operations.
- Proper pumping pressure shall be maintained to ensure discharge of product at designed capacity and as such ensure efficient discharge operations.
- Entire product from the tanker will be discharged and the unloading arm disconnected.
- The quantity as per Bill of Lading and as received in the onshore tank will be compared and any discrepancy brought to the notice of the Master of the ship in writing and acknowledgement obtained.
- The entire tanker discharge operations shall be carried out as per the Operating Manuals and thereafter the tanker will be released for sailing out.

When there are three tankers at all the three berths with three different products, the operations as explained above will be followed.

3.3 MARINE UNLOADING ARMS

3.3.1 General

It is proposed to provide hydraulically operated metal arms for ship-shore transfer of the products. This is the modern way of handling liquid bulk at the berths and these have the following advantages over the old system of flexible hoses, viz.,

- these have the operational ease and flexibility
- lesser pollution hazard because of the provision of safety system
- ability to adjust with the tanker position with changing free-board,
- changing tide levels and the drift caused by currents and wind.

Petroleum products will be unloaded from the tankers using tanker's pumps and marine unloading arms. On each of the three berths, there will be four unloading arms of size 300 NB. Of these four unloading arms, two have been manifolded together to be used for unloading class-A products i.e. Naphtha and MS. Similarly, the other two arms have been coupled to unload class B products HSD and SKO. It will also be possible to use these four unloading arms for the four products separately.

Technical specifications of the marine unloading arm are enclosed vide **Annexure 3.2.**

3.3.2 Operating Envelope

The marine loading arms are required to move in consonance with the tankers' movement due to tidal variation, wave motion, drift due to currents and wind and variation in tanker's deck elevation during product discharge. The arm should also accommodate the change in position of the tanker due to sway and surge. The other factors are the physical characteristics of the tanker manifold, the fender stand-off at the berth, the set- off of the arm from the face of the service platform, etc.

The proposed marine unloading arms are therefore designed for an operating envelope based on the following conditions:

- the highest position of the tanker manifold considering the largest tanker at near empty condition during high tide

- the lowest position of the tanker manifold considering the smallest tanker fully loaded during the lowest tide

For the highest position, a 70,000 DWT tanker with a moulded depth of 18.0 m and a light draught of 4.0 m with the highest high water level of + 4.2 m CD has been considered.

For the lowest position, a 15,000 DWT tanker with a moulded depth of 11.7 m and a loaded draught of 8.8 m with the lowest low water level of - 0.17 m CD has been considered.

Figure 3.1 represents above two conditions.

The Oil Companies International Marine Forum (OCIMF) has recommended certain standards to ensure conformity in manifold arrangements for all ocean-going tankers. Relevant extracts are furnished hereunder:

i) Center of cargo manifold

The center of the cargo manifold shall be located at the mid-length of the ship or as near thereto as possible, but in no case shall the center be more than 3.0 m forward or aft of the mid-ship.

ii) Height of manifold above the deck

The height of the centers of the manifold flanges above the deck in way of manifold shall be 0.90 m or, if more than this, a working platform shall be provided, permanently fixed to the deck, to give this 0.90 m height. But the height above deck main level shall not exceed 2.10 m.

iii) Number, size and spacing of flanges and distance from the ship's side

The ship shall be able to present the following flanges for loading and discharging at the cargo manifold on each side of the ship :

Four flanges each of 16" diameter spaced not less than 1.4 m (for tankers of size 15,000 to 60,000 DWT) or 2.1m (for tankers of size 60,000 DWT and above) center to center and with flange face 4.6 m inboard from the tanker's side.

In addition, all these ships shall be provided with sufficient steel reducing pieces to enable them to present the flanges as required.

3.3.3 Construction of Marine Unloading Arms

These arms shall conform to the " ***Design and Construction Specification for Marine Loading Arms"*** issued by the OCIMF. The material of construction will be in accordance with ASTM Standards and the piping and flange will conform to ANSI Standards (B 31.3).

The unloading arms will be of all steel construction fully balanced and will typically consist of the following major components :

- Riser pipe, inboard and outboard arms
- Electro-hydraulically operated quick connecting and disconnecting couplers (QC/DC) at the end of the outboard arm
- Requisite numbers of swivel bends and swivel joints so that the arm can be connected to the tanker and the arm can ride with the movement of the tanker due to load variation, tide and drift
- Counter-weight for balancing the arm in any position
- Base plate and foundation bolts and supporting structure if required
- Drive units with one main and another standby
- Control console at control tower as well as pendent control remote and electrically operated and also a radio control
- Manually operated vacuum breaker for draining of each leg of the arms
- Control tower
- Audio and visual alarms
- Storm lock

All fittings and units are required to be intrinsically safe and flame proof to handle class 'A' petroleum products. The unloading arms shall be designed taking the following aspects into consideration:

- low connection and disconnection time
- easy and smooth operation with no difficult and strenuous manoeuvring
- ensure clean working area both on the jetty platform and on board with no drip losses and spillage
- least number of operating personnel; typically, it should be possible to handle the arm with only 2 to 3 personnel while the actual operation of control console will be by one person

3.3.4 Operation of the arms

Prior to connecting the arms to the tanker, the power pack units (both main and standby) will be checked by keeping them running for about five minutes to satisfy that the hydraulic pressure is steady. If any unsteady pressure is noticed the system needs bleeding to remove air trappings. The storm lock will be released after ensuring that the riser, inner and outer arms are empty and the vent valve provided in the outer arm apex is closed.

When the tanker's manifold flange is ready for connection, the marine arm is carefully brought down to the tanker's rail area by operating the control. The arm is then brought in alignment with the tanker's manifold exactly and the QC/DC coupler is operated so that the outboard arm gets locked to the tanker's manifold. This operation is carried out without any interference with the tanker or shore installations.

Once the connection is complete, the arm is brought into neutral position which ensures free-wheeling of the arm so that the inboard and outboard arms will freely move in consonance with the tanker's movements.

When the discharge of the product is completed, the arm is emptied of its contents. For this purpose, the jetty head pipeline is isolated by closing the valves between it and the unloading arm. The vent valve is then opened to ensure that the oil contained in the arm will flow into the tanker. The remaining oil content will be collected into a slop tank provided on the jetty. After ensuring that the oil is emptied, the QC/DC coupler is disconnected by operating the control unit.

Ensuring that any residual oil present in the outer arm falls into the dip tray at the tanker's manifold, the arm is then withdrawn and folded back. After fully retrieving the arm to stationary position, the storm lock is activated. The drain and vent valves are finally closed.

3.3.5 Method of Operation

The operation of the marine arm can be by any one or combination of the following methods :

- manual
- hydraulic system from top of control tower on the jetty
- electric pendant control from a place either on the jetty or on the tanker deck
- radio control either from the berth or from the tanker deck

It is proposed to have a combination of the last three modes when the location of the tanker's manifold is not easily visible from the jetty level and in case it is possible to easily get on board the tanker, the operation could be done either from radio control or electric pendant control. The electric pendant control can be a standby when radio control fails. When the tanker's manifold is easily visible without getting on board, the connection could be effected from the jetty level itself through the same controls.

Alternatively, the connection could be effected from the top of control tower located on the jetty from where a commanding view of the tanker's manifold is possible.

3.3.6 Safety System

The marine arms shall be provided with safety system to meet safety requirements while handling petroleum products. These shall include the following minimum systems :

- the arms shall have powered/semi-automatic emergency release coupler to be operated from the jetty with a separate hydraulic circuit. When this coupling is operated, mating ends shall be closed before separation to restrict any product spillage to the minimum
- fail-safe devices for automatic release and storage of arms in case of failure of electric power or hydraulic power unit
- connection and disconnection safety signals

3.4 PIPELINES

The product transfer from the berth to the tank farm is proposed through a pipeline system. Such a system will have to cater to the following situations:

There will be four lines, one for each product, from berths to the oil terminals. Each line will be of size 600 NB. The pipelines will be laid on the approach trestles by the side of the roadway.

Drawing no. GMB/DPR/SEC 3/01 & 02 depicts the pipeline arrangement at the POL berths and product flow diagram respectively.

Chapter 4 : Berthing Facilities

4.1 TERMINAL LOCATION

The liquid bulk terminal is proposed to be located in Positra III adjacent to coal terminal at the north-eastern corner of Positra headland facing Pindara bay. The foreshore is very shallow for almost 2 km and the seabed suddenly drops down to 18-20 m below chart datum. The intertidal zone is sandy with scattered rock outcrops. The onshore area is almost flat and about 2 to 4m above mean sea level.

Refer drawing no. GMB/DPR/SEC3/03 for location of the terminal.

This location is a marine tranquil area, well protected from waves penetrating to the site. The maximum waves would be locally generated waves from the longest fetch direction, 30° north. The mean wind speed from this quadrant is generally less than 24 km/hr, and the resulting wave height is expected to be less than 0.5 m maximum.

At this location, the flood and ebb currents reverse about 180°, running south and north respectively, and the maximum current velocity as observed by NIO was about 1 knot.

4.2 LAYOUT OF JETTIES

The liquid bulk jetties are aligned in almost N-S direction at Positra III with the berthing faces of all the three jetties in line. The jetties are spaced at 290 m centres. These jetties have a common approach from the shore which carries the pipeline rack as well as a carriage way. Each jetty has been designed to accommodate tankers of size ranging from 15,000 DWT to 70,000 DWT. The inter-spacing of the jetties has been done in such a way that there is a clear distance of minimum 40 m between the two largest tankers berthed on adjacent berths.

The layout of the jetties is shown in the drawing no. GMB/DPR/SEC3/04.

4.3 PLANNING ASPECTS

4.3.1 General

The layout of each individual jetty comprises the following components:

- breasting dolphins
- mooring dolphins
- service platform
- interconnecting walkways
- approach trestle

4.3.2 Breasting Dolphins

Breasting dolphins are required to absorb the kinetic energy during berthing of the vessels and they are positioned such that the vessel's flat sides are in contact with the fenders while staying moored at the berth. The recommended optimum spacing of the breasting dolphins ranges from a minimum of 0.25 LOA to a maximum of 0.4 LOA. When the range of vessel sizes to be accommodated is large, more than two berthing dolphins may be required.

The proposed jetties are expected to handle tankers in the range of 15,000 DWT to 70,000 DWT (partially loaded). In order to cater to this range of vessels, it is proposed to provide four berthing dolphins. The inner pair of dolphins will be spaced at 45 meter centres and the outer pair will be spaced at 75 meter centres.

The fendering system will have to take into consideration the tidal range at this location. Hence it is proposed to provide cell type rubber fenders with a frontal facia frame so that sufficient contact area of the hull of the vessel is available at any time of the tide. Fender panels will be of steel frame construction with PTFE or nylon pads, with a low friction coefficient, at the face. The fender system will be provided on the berthing face of all the four berthing dolphins.

The deck elevation of the berthing dolphin will be of same elevation as that of service platform, i.e. + 7 m CD.

Quick release mooring assembly with twin hooks, each hook having a capacity of 600 kN will be installed on the dolphins to accommodate the spring lines of vessels at berth. For the handling of mooring ropes, an integral electric driven capstan with a pull capacity of 15 kN at a hauling speed of 30 m/min. will be provided for each quick release hook assembly.

Timber curbing will be provided at the front edge of the dolphins so as to prevent the chafing of mooring ropes. The inner pair of dolphins will also accommodate fire-fighting monitor towers.

Access to the dolphins from the service platform will be by catwalk interconnecting these two.

4.3.3 Mooring Dolphins

Mooring dolphins are required to hold the vessel in position while at the berth. The number of mooring dolphins are governed by the size range of tankers to be handled. The distance between the outer mooring dolphins is generally taken as the ship's length plus the distance taken by the head and tail lines under a maximum angle of 15° relative to a line perpendicular to the berthing line. Inner mooring dolphins are positioned such that the lengths and angles of mooring lines are approximately the same to the various mooring dolphins. The positions are taken such that the forces in the mooring lines remain below acceptable limits. The number of mooring lines normally carried by a vessel has also to be taken into account.

It is proposed to provide four mooring dolphins. The centre point of the mooring dolphins will be set at 45 meters behind the berthing face. The deck level of the mooring dolphin is kept the same as that of the service platform and the berthing dolphins i.e. + 7 m CD. The access will be through catwalks interconnecting the dolphins and the service platform.

Each mooring dolphin will be equipped with quick release hook assembly with twin hooks each having a capacity of 1,000 kN. Each mooring hook assembly will have its own electrically operated integral capstan with a pull capacity of 15 kN at a hauling speed of 30 m/min.

Timber curbing will be provided at the front edge of the dolphins to avoid chafing of the mooring lines.

4.3.4 Service Platform

The size of the service platform is governed by the number and size of the marine unloading arms to be installed, the size of the pipeline manifold and the area required for all other equipment and utilities to be installed for safe and proper ship/shore cargo transfer operations.

The size of the service platform has been fixed as 22 m x 28 m. This will accommodate 4 marine unloading arms, pipeline manifolds, pipe racks, jumbo curtain nozzles, fire-fighting monitor towers and sufficient manoeuvring area for fire-tenders and other service vehicles.

The deck level of the service platform has been fixed at +7.0 m CD.

Hand railings will be provided along the periphery of the service platform except at the front.

The layout of the service platform is shown in the drawing no. GMB/DPR/SEC3/05.

4.3.5 Approach Trestle

The jetties are located offshore at about 2.5 km from the shore. The access to the jetties is provided through an approach trestle which carries a roadway and the pipe racks.

The approach trestle accommodates a 4.0 m wide carriageway and 1.2 m wide walkway. The cable trays under the side walk adjacent to the roadway facilitate the separation of electrical power cables. Hand railing and crash barriers will be provided on the trestle. The pipelines will be carried along the approach trestle as a 5.8m wide pipe rack.

This approach trifurcates near the jetties to provide access to individual jetties.

The layout of the approach trestle is shown in the drawing no. GMB/DPR/SEC3/04.

4.3.6 Personnel walkways :

For access to the breasting and mooring dolphins from the service platform, interconnecting walkways are provided. These will have a width of 1.5 meters with hand railing on either side.

The walkways are mainly designed for inter movement of personnel between the dolphins and the service platform. In addition, these also accommodate cables, pipes etc.

4.4 DESIGN BASIS

4.4.1 Introduction

The structural design of the jetty will be based on the following parameters and criteria:

4.4.2 Design Policy

All structures shall be designed to perform at the design load combinations as described below:

Operational Condition

This condition corresponds to the combination of permanent loads, live loads and all possible accidental loads resulting from events of high exceedence probability. Under this condition the facility will function normally and without stoppage.

Non-Operational Condition

This condition corresponds to the combination of permanent loads, live loads and all possible accidental loads resulting from events of low exceedence probability. Under this condition the facility may cease to function or operate, but deflections and stresses will remain within the specified limits.

Impact Condition

This condition corresponds to the combination of permanent loads, live loads and all possible accidental loads resulting from events of high exceedence probability. Accidental impact shall be considered in this load combination. Operational wind, wave and current loads shall be considered. Berthing loads shall not be combined with impact loads. The cranes shall be assumed in the non-lifting position. Under this condition the facility will function normally and without stoppage.

Earthquake Condition

This condition corresponds to the combination of permanent loads, factored live loads, operational wind, wave and current loads. The cranes and mobile crane shall be assumed in the non-lifting condition.

Construction Condition

This condition corresponds to the combination of dead load, construction loads, non-operational wind, wave and current loads.

Design Life

The design life of the facilities is to be taken as 50 years. For items susceptible to normal wear and tear such as ropes, ladders, timbers, grating and the like, for which a design life of 50 years cannot reasonably be met, the design and construction must be so as to permit easy replacement.

4.4.3 Dredged Depths

The POL berths are designed for a dredged depth of 12.5 m below CD with tolerance of 0.5 m for scour and over dredging.

4.4.4 Design Vessel Sizes

Table 4.1 presents the design values of size and principal dimensions for the vessels to be handled at the jetty :

Table 4.1 : Particulars of Design Product Tanker

Parameter	Unit	Value	
Carrying Capacity	tonne	45000	70000 **
Displacement	tonne	56000	-
LOA	m	209	248
Beam	m	27.1	35.7
Depth moulded	m	15.5	18.0
Draft laden	m	11.3	11.3
Draft ballast	m	5.9	6.70

** Partially loaded so as to restrict the laden draft to 11.3 m only.

4.4.5 Design Loads

a. Dead Load

Dead load comprises the structure self weight plus superimposed loads of permanent nature.

b. Loadings from Unloading Arms

(1)	Arm Weight	: 26,000 kg (Empty) 31,000 kg (Full)
(2)	Horizontal Load at deck level	: 3,200 kg
(3)	Bending Moment at deck level	: 55,000 kg.m

The final loads shall be as per the manufacturer's data.

c. Vehicle Loads

For design of the service platform deck and approach trestle the vehicle loading shall conform to IRC Class B.

d. Loadings from Utilities

For the structural design, the loadings from utilities shall be taken into account in the design.

e. Live Loads

On open deck areas of the service platform a uniformly distributed live (UDL) load of 20 kN/m^2 shall be used.

The approach trestle shall be designed for a UDL load of 10 kN/m^2.

The walkways shall be designed for a UDL load of 5 kN/m^2 or a point load of 10 kN placed in the most unfavourable condition.

f. Wind Loads

Wind loads (in accordance with IS : 875) shall be calculated for the design wind speed as applicable. Maximum permissible wind speed with arm in stored condition will be 50 m/s. Maximum permissible wind speed for arm in operation condition will be 20 m/s.

g. Thermal Loads

The mean maximum temperature and the mean minimum temperature are of the order of 33°C and 18°C respectively. The maximum temperature variation upto $\pm$20°C shall be considered.

h. Construction Loads

Due account shall be made of all construction loads, including those likely to be incurred during fabrication, transportation and creation of structural elements, as well as loads arising from construction equipment, vehicles and cranes, etc.

i. Criteria for Earthquake Resistant Design

The design value for the horizontal seismic coefficient α_h shall be computed according to the following expression:

$$\alpha_h = b * I * \alpha_o$$

where

α_h = Design horizontal seismic coefficient

α_o = Basic Horizontal seismic coefficient

b = Coefficient depending upon soil foundation system

I = Coefficient depending upon importance of the structure

The design of structures shall be done in accordance with IS:1893, "Criteria for Earthquake Resistant Design of Structures". Positra falls under Zone IV as per seismic map of India shown in IS : 1893-1984. Basic Horizontal Seismic Coefficient will be 0.05. Importance factor of 1.5 has been considered for this structure in view of this being a service point. Therefore the design horizontal seismic coefficient is taken as 0.075 for calculation of earthquake force on the structure.

The horizontal seismic force shall be considered to act in any one direction at a time. Where both horizontal and vertical seismic forces are taken into account, horizontal force in any one direction at a time may be considered simultaneously with the vertical force.

j. Berthing Energies and Fender Reactions

The design berthing energy imparted to the breasting dolphin works out to 888 kNm for normal operation, and 1776 kNm for accidental impact. The design berthing energy is based on the berthing of the design vessel of 45000 DWT, approaching the jetty at an angle of 10^0, with approach velocity of 0.15 m/s under normal operating conditions.

For absorbing the berthing energy of the vessels SUC 2000 H (RS grade) fender has been selected. The corresponding berthing force to the breasting dolphin, at the ultimate stage works out to 2800 kN in the transverse direction and 840 kN in the longitudinal direction (The friction co-efficient between the vessel's hull and fender pad has been assumed as 0.3).

k. Mooring Loads

The bollard pull shall be taken as 200 tonne. The mooring forces shall be applied at 0.6 m above the deck level. Bollard loads are assumed to act in any direction within 180° around the bollard in the horizontal plane at the

sea side, and from horizontally to 30° and above in the vertical plane shall be considered.

l. Wave loads

The design wave height of 1 m has been considered for the design of the structures.

The operational significant wave heights shall be taken as 1.0 m.

Marine growth of 50 mm on the radius of the piles shall be used for the assessment of wave forces.

m. Current loads

The current loads shall be applied on the submerged parts of the jetty structure assuming the maximum current speed of 0.5 m/sec. Maximum angle of deviation of flow from mean direction is taken as 10°.

n. Stability Load

Stability of the structures under maximum horizontal loadings and minimum vertical loadings shall be checked.

o. Load Combinations

All structures shall be designed for the load combinations as specified in **Table 4.2**. Critical load combinations derived from the table shall govern the design of the structures. Due account shall be made of those cases where the most unfavourable effect occurs when one or more of the contributing loads is not acting.

Load Components :

a	-	Dead Load of Structures
b	-	Unloading Arm Loads
c	-	Vehicle Loads
d	-	Loads from Utilities
e	-	Live Load
f (i)	-	Wind Load (Operational)
f (ii)	-	Wind Load (Non-Operational)
g	-	Thermal Load
h	-	Loads during Erection/Construction
k	-	Earthquake Loads
l	-	Impact Loads
m	-	Berthing Loads
n	-	Mooring Loads/Lean-on Loads
p (i)	-	Wave Load - Operational
p (ii)	-	Wave Load - Extreme
q	-	Current Load

Table 4.2 : Load Combinations

Loading condition	a	b	c	d	e	f (i)	f (ii)	g	h	k	l	m	n	p (i)	p (ii)	q
Operational	x	x	x	x	x	x	-	x	-	-	-	x	x	x	-	x
Non-Operational	x	x	-	x	x	-	x	x	-	-	x		x	-	x	x
Impact	x	x1	x	x	x	x	-	x	-	-	x	x	x	x	-	x
Earthquake	x	x1	x	x	x2	x	-	x	-	x	-	-	x	x	-	x
Construction	x	-	-	-	-	-	x	-	x	-	-	-	-	-	x	x

Remarks :

(1) Wind, wave and current load on moored vessels shall be considered
(2) Reduced live load as per Code

p. Materials

Concrete

All concrete structures shall be reinforced concrete structures unless otherwise specified. The design of concrete structures shall be in accordance with Indian and / or internationally recognised codes and standards.

Unit Weight

Unit weights of concrete shall be taken as the following for design purposes :

- Un-reinforced concrete : 22 kN/m^3
- Reinforced concrete : 24 kN/m^3
- Highly reinforced concrete : 25 kN/m^3

Strength

The grade of concrete for reinforced concrete unless otherwise specified shall be M30.

Steel Reinforcement

Steel reinforcement shall be high yield strength deformed bars conforming to IS:1786-1979 (grade fe 415).

Structural Cover

The minimum concrete cover on the outer reinforcement shall be in accordance with IS:456 and IS:4651 (Part 4).

Steel Design

The design of steel structures shall be in accordance with IS:800.

Strength

Unless otherwise specified, the structural steel shall conform to IS:226 or IS : 2062.

Thickness

Minimum thickness of structural steel elements shall be 10 mm and the maximum thickness shall not exceed 50 mm.

Connections

All permanent steel connections shall be made with full strength butt welds.

Corrosion

The corrosion allowances 2 mm shall be assumed for steel surfaces.

4.5 FOUNDATION ALTERNATIVES

4.5.1 Approach Trestle

The approach trestle can be partly an earthern bund (mole) nearshore and balance on deep R.C.C. foundation, depending on prevailing site conditions such as water depth, currents, sub-soil profile.

As can be seen from the bore logs at Positra III (MB 14, 15 and 16), the sub-soil is predominantly soft clay over a considerable depth. On engineering considerations it is a very week soil, susceptible to large settlements and shearing failures. In addition, the soil may also undergo lateral flow under the weight of earthen bund. Thus, the ground conditions do not permit construction of an earthen bund resting directly over the sea bed.

This could be overcome by:

- provision of vertical drains and preloading ; or
- replacement of weak soil with stiffer material, or
- providing stone columns.

Vertical drains with preloading :

The drains provide vertical drainage outlets for water squeezed from the soil by the weight of surcharge or fill. The objective of consolidation by such artificial means is to decrease the moisture content thereby increasing the shear strength and reducing settlement characteristics.

This technique is not recommended in the present case, because installation of vertical drains is effective only if the strata is allowed to consolidate by stagewise loading. Our construction schedule may not permit for such stagewise loading.

Replacement by stronger material :

This technique comprise of dredging a trench and replacing the soft clay with sand fill, if necessary, vibro compacted.

Stone columns :

This can be affected by provision of stone columns i.e. making boreholes in the clay and filling stone chips or gravel or a mixture of this and compacting them in the bore either by drop hammer method or by vibratory method.

A preliminary analysis of the above alternative solutions, reveal that these are not cost effective as compared to an RCC piled approach jetty. The construction will also be quite cumbersome and expensive, particularly installing stone columns below sea bottom from a floating barge in varying water depths and over a considerable depth.

Therefore, it is recommended to provide an earthen approach bund nearshore where the height of earth fill is less than 3 m, and a piled approach jetty beyond the height of 3 m.

4.5.2 Berths

The following alternatives could be considered :

- box caisson ;
- open pile structure.

The box caisson (a rigid reinforced concrete structure) requires the presence of a competent foundation base ; the present soil conditions with a top layer of predominantly silty clay offers insufficient stability and bearing strength. An expensive soil improvement will have to precede caisson installation.

The open piled structure comprises a pile supported reinforced concrete deck with minimum reflection of waves between structure and vessel. The deck slab is supported by a system of interconnected transverse and longitudinal beams which transfer the load to the piles.

Therefore open piled structures are proposed to be adopted for all the marine works.

Taking into account the encountered soil conditions and design loads the following piles types have been considered.

- bored (cast-in-situ reinforced) concrete piles ;
- driven steel tubular piles.

Piles installation procedures of bored piles result in a preference for vertical piles only, since :

- the pile bearing capacity of a raker is likely to be affected by difficult cleaning procedures of the pile section ;
- both the diameter of the raker piles (diameter $\leq \varphi$ 1000 mm) and the rake angle ($\leq 4:1$) is limited due to pile installation constraints.

Steel piles can either be used as vertical piles or as raker (maximum rake angle 4:1).

The alternative with driven tubular steel piles has been rejected due to the high cost as the required steel piles will have to be imported from abroad involving transportation costs, etc.

Vertical bored cast-in-situ reinforced concrete piles are recommended for foundation. Horizontal loads (viz. berthing impact, bollard pull, seismic forces, etc.) will be transmitted through the deck into the bearing layers by means of bending moments in vertical piles. The piles will be socketted into rock for sufficient depth.

4.6 DESCRIPTION OF SELECTED SCHEME

4.6.1 Breasting Dolphins

The structural arrangement of the breasting dolphin is shown in Drawing No. GMB/DPR/SEC3/06.

The breasting dolphins are 10.8 m x 19.8 m in size. These are designed to absorb berthing impact of the design vessels. 15 number of 1500 dia bored cast-in-situ piles will be provided to support the RCC deck. The piles are founded at -30 m CD into rock. The superstructure will be made of 1.8m thick RCC slab with finished level at +7.0 m CD.

Cell type rubber fenders, SUC 2000 H (RS grade) of Bridgestone make or equivalent, with frontal frame will be provided to absorb the berthing impacts. The fenders will be fixed on the frontal facia wall extending upto a level of +1.0 m CD to allow berthing of vessels at all stages of tides. Double quick release hooks with each hook having a capacity of 60 t to take ship's spring and breast lines will also be provided.

4.6.2 Mooring Dolphins

The structural arrangement of the mooring dolphin is shown in Drawing No. GMB/DPR/SEC3/07.

The mooring dolphins (10.8 m x 10.8 m) are designed to withstand a mooring force of 200 t, and shall consist of 9 number of 1500 m dia bored in situ RCC piles. The piles are founded in rock at -30 m CD. The piles support 1.8m thick RCC deck slab with finished top level at + 7.0 CD.

4.6.3 Service Platform

The structural arrangement of the service platform is shown in Drawing No. GMB/DPR/SEC3/08.

In addition to the UDL of 20 KN/m^2 the service platform is designed to support the loadings from unloading arms, utilities, etc.

The substructure will be of RCC bored in situ piles of diameter 1300 mm spaced @ 5 m x 6.5 m c/c. There will be in all 25 piles founded in rock at a level of -30 m CD. The superstructure shall consist of RCC beams and slab. The service platform is set behind the face of the berthing dolphins so that it is not subjected to any impact from the product tankers.

4.6.4 Approach Trestle

The structural arrangement of the approach trestle is shown in Drawing No. GMB/DPR/SEC3/09.

The approach trestle will have a 4.0 m wide carriageway, 1.2 m wide footpath and 5.8 m wide pipe rack.

The piled approach jetty will be supported by vertical RCC bored piles. All the piles will be 1300 dia with 2 piles per pile bent. The pile bents are spaced at 8 m c/c. The piles will be embedded into rock with the founding level at -30 m CD.

The superstructure will be made up of RCC beams supporting the roadway slab, footpaths with cable trenches underneath and pipe rack.

4.6.5 Walkway

A 1.5 m wide walkway made of RCC beam and slab will be provided between the service platform and berthing dolphin and also between two berthing dolphins.

The walkway between mooring dolphins and between breasting & mooring dolphins will be made of steel trusses.

To take up relative movement between the dolphins, the catwalk has one end as a pin bearing and the other end as a sliding bearing. The deck level is flush with the structures on either side of catwalk.

Chapter 5 : Onshore Tank Farm

5.1 PLANNING NORMS

Tank farm layout will be planned generally in conformity with OISD 118 and CCOE norms and shall cover the following:

- product storage tanks
- product loading/unloading facilities
- utilities generation and distribution
- control room
- effluent treatment facilities
- administrative and service buildings
- safety requirements
- expansion needs

In this particular case , the tank farm has been developed considering the following aspects:

- the layout to follow the sequence of operating scheme.
- the truck loading facilities are to be located near the product movement gate and not to pass through the storage areas.
- inter-space between the storage tanks are to be kept as per OISD requirements.
- main electrical sub-station is to be close to the boundary limit so that overhead lines do not pass through the tank farm area.
- flare system, if any, is to be located upwind of the storage units so that any vapour from the storage does not travel to the flare.
- fire station and fire water storage are to be kept away from the product storage area.
- effluent treatment plant is to be located away from the product storage area.
- environmental requirements such as minimum elevation above high water line, peripheral green belt etc. are to be catered to.
- sufficient provision for future expansion needs.

The disposition of individual storage tanks has been done based on the following aspects:

- storage tanks are grouped according to the class of petroleum products and compatibility in dyked enclosures
- the dyked enclosures are to be able to contain the whole contents of the largest tank
- tanks are to be arranged in a maximum of two rows only so that each tank is accessible from the road
- the type of tank is to be suitable for the product to be stored i.e., fixed roof tank for Diesel/Kerosene and floating roof tank for Naphtha/Gasoline

Based on the considerations as indicated so far, the plot plan has been developed for the proposed tank farm and is presented in the drawing no. GMB/DPR/SEC/10.

5.2 LAND REQUIREMENT

Pipelines from the berth to the tankfarm will carry the products to the designated tanks. This area of land should be located at a reasonable distance from the berths.

The onshore storage facilities will depend on the number of products to be stored, the size of the tankers, the estimated throughput and the mode of evacuation- road, rail and cross-country pipeline.

There should be sufficient land area available for the tank farm. The tanks could be in groups of varying sizes from 10,000 KL to 45,000 KL each. The land area required for providing storage facilities for these capacities with attendant evacuation facilities by road/rail/cross-country pipeline would be about 100 hectares in the ultimate stage as described below:

UNIT / FACILITY	AREA (Ha)
Storage tanks	24
Railway siding & tank wagon loading gantry	8
Tank truck loading gantry	2
Truck parking	3
Green belt and gardens	18
Infrastructural units, roads, etc.	10
Miscellaneous	5
Future expansion	30
Total	**100**

Thus a plot of size 1000x1000 m will be sufficient for development of the tank farm.

5.3 STORAGE REQUIREMENTS

5.3.1 Criteria

In the terminal, petroleum products, viz. HSD, SKO, Naphtha and MS will be stored in above ground vertical tanks.

Total storage capacity, nos. of tanks and sizes of tanks have been worked out on the following basis :

Phase	Product	
	HSD	SKO/Naptha/MS
Phase 1	2 tankers + 15 days' volume	1 tanker + 30 days' volume
Phase 2	2 tankers + 10 days' volume	1 tanker + 20 days' volume
Phase 3	2 tankers + 7 days' volume	1 tanker + 15 days' volume

The maximum parcel size considered is 35000 MT.

Estimated Monthly traffic (MT)			
Product	2001	2006	2011
HSD	250,000	500,000	750,000
SKO	62,500	125,000	187,500
Naphtha	62,500	125,000	187,500
MS	42,000	83,000	125,000
Total	**417,000**	**833,000**	**1,250,000**

5.3.2 Phase 1

During Phase 1, the tankage at the terminal has been planned based on throughput in the year 2001, as above. Provision will be kept for addition of tanks to handle increased volumes in the years 2006 and 2011.

The tankage planned, on the aforesaid basis, for various products is as under :

Product	Tankage Capacity (KL)
HSD	229,400
SKO	118,900
Naphtha	131,800
MS	105,500
Total	**585,600**

There are two types of above ground cylindrical vertical tanks - floating roof type and cone roof type. Fixed cone roof type are used for storing low volatile products. Hence these are proposed for HSD and SKO. In floating roof type tanks, as the name implies, the roof of the tank floats over the product and thus, eliminates the vapour space in between the liquid level and tank roof. These type of tanks are used for storing products with high vapour pressure to reduce evaporation losses. These tanks which have increased operational safety too are recommended for storing Naphtha and MS.

The sizes and storage capacities of tanks are indicated below :

Tank No.	Nos.	Product	Capacity (KL each)	Size m dia. x ht.
T1	1	Naphtha	12000	32 x 15
T2	1	Naphtha	20700	42 x 15
T3 and T4	2	Naphtha	29400	50 x15
T5	1	Naphtha	42400	60 x 15
T6 & T7	2	MS	11200	32 x 14
T8, T9& T10	3	MS	29400	50 x 15
T11,T13,T15 and T17	4	HSD	42400	60 x 15
T12,T14 and T16	3	HSD	11200	32 x 14
T18	1	HSD	29400	50 x 15
T19 and T21	2	SKO	42400	60 x 15
T20 and T 22	2	SKO	19300	42 x 14

Tanks will be designed and constructed according to IS: 803 and The Petroleum Rules 1976. Design of floating roof will conform to API : 650. Tanks will be in fabricated mild steel plate construction. Their bottom will be concave shape with slop towards the centre for easy collection and removal of water. The design data, material of construction and nozzle schedule of cone roof and floating roof tanks are given in drawing no. GMB/DPR/SEC3/11 & 12 respectively. Tanks will be tested according to codes before commissioning. Cone roof tanks upto 22m diameter will be columnless type whereas the tanks bigger than 22m dia. will have columns to support roof. Joint efficiency of tanks will be 0.85 and corrosion allowance 1.5mm. All above ground main storage tanks (T1 to T22) will have RCVs (remote controlled valves) at inlets and outlets. Tanks will be painted with aluminium paint after cleaning by sand blasting and application of primer.

In addition to 22 above ground vertical tanks, there will be 5 underground cylindrical horizontal tanks. These tanks, buried near the gantry, will be used as facility tanks. For example unloading a sick tanker or any other tanker, draining main storage tank after TLF pump has emptied it, draining pipelines, product from TPI separator etc.. The capacities and sizes of these tanks will be as under :

TANK NO.	NOS.	SERVICE	CAPACITY (KL each)	SIZE (m) dia x ht
UT-1	1	HSD	70	3 x 10
UT-2	1	SKO	70	3 x 10
UT-3	1	Naphtha	70	3 x 10
UT-4	1	MS	70	3 x 10
UT-5	1	Slop	70	3 x 10

The design of tank foundations will be primarily governed by the soil data and the availability of construction material at the location. A typical sand pad foundation for tanks is shown in the drawing no. GMB/DPR/SEC3/13.

5.3.3 Phase 2 & 3

The storage capacity, number of tanks and sizes of the tanks for second and third phases, have been worked out on the following basis :

Product	HSD	SKO, Naphtha & MS
Phase 2	2 tankers + 10 days volume	1 tanker + 20 days volume
Phase 3	2 tankers + 7 days volume	1 tanker + 15 days volume

The maximum parcel size considered is 35,000 MT.

Phase 2

Product	Additional Capacity KL	Tanks (Nos.- Capacity in KL)	Tank size (Dia.xHt.) m
HSD	49000	1 - 29400 1 - 19300	50 x 15 42 x 14
SKO	25400	1 - 29400	50 x 15
Naphtha	28100	1 - 29400	50 x 15
MS	18200	1 - 19300	42 x 14

Phase 3

Product	Additional Capacity KL	Tanks (Nos.- Capacity in KL)	Tank size (Dia.xHt.) m
HSD	24500	2 - 12000	32 x 15
SKO	12700	1 - 11200	32 x 14
Naphtha	14100	1 - 12000	32 x 15
MS	9900	1 - 11200	32 x 14

While selecting number and sizes of additional tanks, following points were considered :

- Sizes of the tanks should be from among the ones in Phase 1 i.e no new sizes.
- Tanks' total capacity to match, as nearly as possible, with the capacity required.
- Prefer one larger tank instead of two or three smaller ones to achieve the desired capacity.
- Deficit between the tankage 'selected' and that 'required' in Phase 3 for SKO and Naphtha will be compensated by the excess capacity provided for these products in Phase 2.

5.4 PRODUCT EVACUATION FACILITIES

5.4.1 Phase 1

Petroleum products from the terminal will be despatched to various destinations by road, rail and pipeline. Evacuation by cross country pipeline will be to the extent of 50% and balance 50% by road and rail.

Despatch facilities by tank wagons and by tank lorries have been designed for the year 2001 throughput, as follows :

Throughput of the terminal	Per year MT per month KL per month	5 million tonnes 417,000 512330	
Evacuation	By pipeline By rail By road	50 % 17.5 % 32.5 %	
Estimated monthly traffic	HSD SKO Naphtha MS Total	250,000 MT 62,500 MT 62,500 MT 42,000 MT 417,000 MT	294118 KL 76220 KL 84459 KL 57534 KL 512331 KL
Evacuation per month	By pipeline By rail (2 rakes per day) By road	256,165 KL 90,000 KL 166,165 KL	

A. Evacuation By Road

a. TLF Gantry

It has been estimated that, on an average, 6646 KL of products will have to be despatched by road every day. Based on two shift operation of the TLF gantry, 25 days in a months, the number of bays and filling points have been worked-out as under :

Product-wise despatch by road per shift (2 shift operation)	HSD SKO Naphtha Gasoline **Total**	1,906 KL 494 KL 547 KL 376 KL **3,323 KL**
Tank trucks movement per shift (12 KL per truck)	HSD SKO Naphtha Gasoline **Total**	159 41 46 31 277

Notwithstanding the above analysis, naphtha evacuation by road will be very limited. Most of it will be by pipeline and by rail. Therefore, while working out the bay configuration in TLF gantry, this aspect has been borne in mind.

Actual filling time of the tank truck while parked in the bay will be 12 minutes. But considering the other procedural activities involved before starting filling and after the filling has been completed, it is normally experienced that the vehicles remains in the bay for average 20 minutes. Thus, in a shift of 8 hours, it should be possible to load 24 tank trucks in each bay. However, to account for efficiency of the system, time for change of shift crew on the gantry and several other factors, it has been assumed that each bay can handle maximum 14 tank trucks in a shift (60 % efficiency assumed). Therefore, to handle nearly 277 tank trucks in a shift, a 20 bay gantry has been planned.

Theoretically, the bays can be made dedicated depending upon product volume. But in order to have flexibility in allocating bays to tank trucks, a number of bays will have two loading points as detailed below :

Product	No. of dedicated bays	No. of shared bays	Total loading points
HSD	10	5	15
SKO	2	4	6
Naphtha	0	2	2
MS	1	3	4
Total	**13**	**14**	**27**

The gantry configuration is shown in the enclosed drawing no. GMB/DPR/SEC3/14.

The 20 bay TLF gantry will be a covered shed of size 10m x 100m in structural steel and AC sheet roofing structure. The cross section of the gantry is attached vide drawing no. GMB/DPR/SEC3/15. In each dedicated bay there will be one loading point and in others, two each. There will be product headers (4 Nos.) on the top from where 80 NB tappings will be taken at each bay for the designated loading point(s). The pipeline from overhead header is connected to the loading arm via a positive displacement meter, strainer and set stop valve.

The gantry operation is fully automised as explained later in this chapter.

b. TLF Pumping System

Pumps used for transporting petroleum products from tanks to TLF gantry will be located close to tank farms in two Pump Houses - one for Class A products viz. Naphtha and MS and the other for Class B products viz. HSD and SKO. Instead of one, two pump houses have been provided in order to have shorter suction lines.

The number of pumps, sizes thereof and the pipeline system has been designed on the basis of following considerations :

- All lines will be dedicated.
- Filling of a tank truck of 12 KL capacity in 12 minutes.

- Maximum simultaneous filling of : HSD in 10 bays, SKO in 4 bays, Naphtha in 2 bays and MS in 2 bays.
- One stand-by pump for each product.
- At any time only one tank will be used for feeding a particular product to the gantry. For example, tank T2 for Naphtha and tank T17 for HSD and so on.
- Pumps for filling trucks can also be used for recirculation or for taking a product from one tank to the other (but no inter product transfers).
- In order to achieve uniform filling rate in all bays, delivery manifold in the gantry will be ring-main type.

The piping system is shown in the Flow Diagram enclosed vide drawing no. GMB/DPR/SEC3/16. The schedule of pumps for TLF operation is as under :

Tag No.	Nos. (Working+Standby)	Service	Capacity m3/hr.	KW
P 01 A/B	1+1	Naphtha	120	18.5
P 03 A/B	1+1	MS	120	18.5
P 05 A/B/C/D	3+1	HSD	240	40.0
P 07 A/B/C	2+1	SKO	120	15.0

The number of pumps in operation for filling a product will be automatically controlled on the basis of flow sensing. For example, if HSD is being filled in two or three bays, only one pump P 05A will operate. If more loading points are opened, more HSD pumps will be pressed into service based on low flow rate sensing. Similarly, when number of filling points reduce, the pumps are stopped on sensing high flow rate. For simultaneous filling of HSD in 10 bays, all three pumps will operate in parallel. The fourth one is a standby.

All pumps will have in-line strainers on the suction side and non-return valves in the delivery lines.

c. Pump House for UG tanks

There are four underground tanks, one for slop and one for each product, near the gantry. A Pump House near these tanks has been envisaged which will house following pumps for transfering oil from the underground tanks :

Tag No.	Nos. (Working+Standby)	Service	Capacity m3/hr.	KW
P 09	1 + 0	HSD	72	15
P 10	1 + 0	SKO	72	15
P11	1 + 0	Naphtha	72	15
P12	1 + 0	MS	72	15
P13	1 + 0	Slop	72	15

B. Evacuation By Rail

a. TWL Gantry

It has been envisaged that evacuation by rail will be to the extent of 2 rakes (3000 KL) per day at 2001 throughput operation. Three full-spur railway sidings have been planned in the part of Terminal which will be totally isolated by a low height compound wall. Each spur will be able to accommodate 80 conventional wagons or 50 BTPN wagons (8 wheelers).

There will be a two way gantry in the middle of two spurs to service wagons on both sides. For the third spur, another full length gantry has been planned.

It will be possible to load any product in any wagon irrespective of its location. To facilitate this operation, there will be four loading points for each wagon location. In other words, for all three spurs, there will be 80x4x3 = 960 loading points.

The loading points will be looped for filling by meters as in the case of TLF gantry.

Typical cross-section of TWL gantry is shown in drawing no. GMB/DPR/SEC3/17.

b. TWL Pumping System

Time is an important factor in TWL operation. Normally, Railway authorities allow a definite time for filling of wagons after they have been placed on the spurs inside the terminal. For a full rake, this time can be as little as 4 hours. TWL pumps and other associated facilities have been sized accordingly.

A rake comprising of 60 to 80 wagons can either be a single product load or a mixed load. Since HSD constitutes 60 % of throughput, there could be occasions when two rakes of HSD or one HSD and one mixed load rakes, are simultaneously loaded. Similarly, naphtha may be loaded in a single rake. TWL pumping system has been designed to facilitate such operations.

In addition, the following aspects have been considered while designing pumping system:

- Simultaneous loading of 9 wagons of HSD and 9 wagons of Naphtha.
- At a time filling of SKO and MS in 6 wagons each.
- Filling time for one wagon : 30 minutes
- All lines will be dedicated.
- One stand-by pump for each product.
- At any time only one tank will be used for feeding a particular product to the gantry. For example, tank T8 for MS and tank T21 for SKO and so on.

- Pumps for filling wagons can not be used for recirculation or for taking a product from one tank to the other. For such operations TLF pumps will be used.
- In order to achieve uniform filling rate in all wagons, delivery manifold will be ring-main type.

The flow diagram is shown in drawing no. GMB/DPR/SEC3/16.

The schedule of pumps for TWL operation is as under :

Tag No.	Nos. (Working+SB)	Service	Capacity m3 / hr.	KW
P 02 A/B	1 +1	Naphtha	600	67.5
P 04 A/B	1 +1	MS	400	37.0
P 06 A/B	1 +1	HSD	600	67.5
P 08 A/B	1 +1	SKO	400	45.0

All pumps will have in-line strainers on the suction side and non-return valves in the delivery lines.

5.4.2 Phase 2

Product evacuation will continue to be by three means, i.e. by pipeline, by rail and by road. And, their proportion with respect to volume will also be same. Pipeline will evacuate 50 % of all products and the balance 50 % by rail and road.

In view of 100 % increase in volume from Phase 1 to Phase 2, the corresponding despatches by three means (pipeline, rail and road) will also double.

A. Evacuation by Road

Given below is the data in respect of product despatches by tank trucks in Phase 2 :

Product	Monthly Volume KL	Per shift Volume KL	No. of Tank Trucks
HSD	190618	3812	318
SKO	49410	988	82
Naphtha	54749	1095	91
MS	36869	737	62
Total	331646	6632	553

The number of tank trucks to be filled in a shift will increase from 277 to 553. To handle double the number of trucks, another 20-bay gantry called TLF-2 will be added. The bay configuration of this additional gantry will be identical to the one provided in Phase 1.

To service this new gantry, the number of pumps will have to be doubled as indicated below :

Product	Pump Cap./KW	Phase 1 Nos.	Phase 2 Nos.	Total After Phase 2
HSD	240 / 40	3 + 1	3 + 1	6 + 2
SKO	120 / 15	2 + 1	2 + 1	4 + 2
Naphtha	120 / 18.5	1 + 1	1 + 1	2 + 2
MS	120 / 18.5	1 + 1	1 + 1	2 + 2

The second set of 11 pumps will exclusively serve Gantry TLF -2.

B. Evacuation by Rail

After Phase 2 expansion, instead of two, four rakes will have to be loaded every day. Evacuation by rail will thus increase from 3000 KL per day to 6000 KL per day.

In Phase 1, three full spur siding has been planned. The same facilities will be adequate to load four rakes every day. Therefore, no augmentation is considered necessary in :

- the number of railway spurs
- pumping and pipeline system
- headers and number of loading points
- automation scheme.

5.4.3 Phase 3

Yearly product evacuation in Phase 3 will increase from 10 mmt to 15 mmt i.e. from 833,000 KL/month to 1,250,000 KL/month. Proportion of evacuation by pipeline, rail and road has been planned to be retained as in Phase 1 & Phase 2.

A. Evacuation By Road

The monthly volume will increase three times vis-a-vis Phase 1 volume. Accordingly, the number of tank trucks to be filled in a day will also increase proportionately, as indicated below :

Product	Monthly Volume KL	Per shift Volume KL	No. of Tank Trucks
HSD	285,976	5,720	477
SKO	74,099	1,482	124
Naphtha	82,119	1,642	137
MS	55,616	1,112	92
Total	497,800	9956	830

It will be extremely difficult to handle 830 tank trucks in a day of two shifts. It would amount to servicing one truck every minute. In view of several problems anticipated due to increase in tank truck traffic, it has been planned to switch over to three shift operation of TLF gantries from Phase 3. The requirement of a third 20 bays gantry to run two shifts to cater to the additional volume of Phase 3, will be made good by operating the existing two TLF gantries for the third shift.

Thus, in Phase 3, there will be no need to augment tank truck loading facilities.

B. Evacuation by Rail

After Phase 3 expansion, product evacuation by rail has been planned to increase to 6 rakes per day. In Phase 2, no expansion of rail loading facilities was envisaged. However, in Phase 3, augmentation, in the following manner, of TWL has been planned :

- Addition of the fourth spur
- Expansion of the TWL gantry, presently serving spur 3, to cover spur 4 as well.
- Addition of the headers and 320 additional loading points for spur 4.
- Augmentation of pumping facilities.

5.4.4 Design Aspects

The following aspects will be taken care of while carrying-out piping - Phase I

- All lines from tanks' outlet onwards will be dedicated
- The TWL pumps will have bypass from their delivery to suction
- The pipelines from berths to oil tankfarm will be laid on trestles. They will have expansion loops and thermal relief valves at suitable intervals. A separate pipeline of suitable size will collect discharge from vents of these valves to the slop tank.
- Pipelines will have drain points at their lowest elevations and other pockets. Drains will be collected in respect underground tanks.

Pumping and pipeline system will be designed as follows in Phase 2 and Phase 3 and as shown in the flow diagram:

New tanks will be connected to the manifold. Thus, oil unloaded at the berths can be taken to any of the new tanks with the same flexibility and constraints.

In Phase 2, for each product, a new manifold will be provided for TLF service connecting the outlet of all tanks. Thus, the pumps for TLF-1 can not be used for TLF-2 and vice-versa.

One tank can not cater to both TLF gantries simultaneously. For example, if HSD is being withdrawn from Tank T-12 for TLF-1, another tank say T-15 or T-18 must be used for feeding HSD to TLF-2.

Similarly, one tank can not supply product for both TLF and TWL gantries. The rule is: One tank for loading in TLF-1 or TLF-2 or TWL.

Recirculation lines of pumps for TLF-1 and TLF-2 are connected. It means, product from any tank can be transferred to any other tank meant for the same product. Inter-product transfer of products from one tank to the other is not possible since.

All manifolds on TWL gantries are connected to their respective product delivery lines.

The operation of pumps connected in parallel for TLF and TWL, is automatically controlled based on flow sensing.

For tank wagon loading, product can be drawn from two tanks simultaneously.

There will be no change in underground tanks and the pumping system therefor in Phase 2 and Phase 3.

Specifications for pumps and pipeline systems are included vide **Annexure 3.3.**

The number of pumps for TWL will increase as under :

Service	Capacity m3 / hr.	Phase 1 & 2 (Nos.)	Phase 3 Addition	Nos. After Phase 3
Naphtha	600 - 67.5	1 + 1	1	2 + 1
MS	400 - 37	1 + 1	1	2 + 1
HSD	600 - 67.5	1 + 1	1	2 + 1
SKO	400 - 45	1 + 1	1	2 + 1

5.5 PROPOSED LAYOUT OF TANK FARM

5.5.1 Area Requirements

Various units in the terminal will be as under :

Unit	Area (sq.m.)	Remarks
Gate Office/Security	35	One near each gate (2 Nos.)
Truck Parking	30,000 approx.	Sufficient for 500 trucks
Car Parking	250	For staff and visitors' 25 cars
Cycle Stand	250	For cycles and bikes
Administrative Block	600	For housing port offices
Control Room	50	For interacting with truckers for documentation, allotting bays and authorising product loading.
Canteen	150	Will include kitchen, toilet, separate dining halls for officers and workers.

Unit	Area (sq.m.)	Remarks
Amenity Block	450	Will include locker/change room, wash, toilets, rest room and welfare.
Stores	600	Will comprise of two sections - one for storing spares and other for carrying out repairs etc.
Toilets	35	One near the gantry and the other in the truck parking area for use by truckers.
First aid and medical	50	For first aid and health care use.
Laboratory	50	For carrying out routine tests on petroleum products being handled.
Central Control Room	150	For housing control panels, terminals, instrumentation for tank farm management and gantries' automation.
Fire station	200	For storing fire protection equipment and mobile units etc..
Switch Room/DG Set	450	For installation of MCC panels and other electrical control equipment in one section and DG set in the other.
TLF Gantry	1000	20 bay tank truck loading facility
Pump House - 1	60	For underground tanks
Pump House - 2	180	For class-B products
Pump House - 3	120	For class-A products
Tank Farm - MS	34,000	5 tanks in dyked enclosure
Tank Farm - Naphtha	37,500	5 tanks in dyked enclosure
Tank Farm - HSD	96,000	4 dyked enclosures of 24,000 sq.m each. 2 tanks in each enclosure.
Tank Farm - SKO	72,000	2 dyked enclosures of 24,000 sq.m each. 2 tanks in each enclosure.
Underground Tanks	400	For 5 tanks - one for each product and one for slop.

5.5.2 Specifications

Buildings

For general arrangement of the buildings refer drawing nos. GMB/DPR/SEC3/18 to 30. The general specifications for all the building works shall be as follows :

1. The foundations shall be designed taking the safe bearing capacity as $15t/m^2$.
2. The work shall be carried out as per General Technical Specifications for building works of Gujarat state with up to date additions / modifications.
3. The grade of concrete shall conform to M 20 (1:1:5:3) fpr columns foundations and superstructure conforming to IS : 456 - 1978.

4. The reinforcement shall be high strength deformed bars of grade Fe415 conforming to IS : 1786 - 1985.

5. All structural Steel shall conform to IS : 226 / IS-2062 - Grade A.

6. Slab on Grade shall be provided for Industrial Buildings (Flooring).

7. Proper Anti Corrosive Treatment (ACT) shall be done for the reinforcement before placing.

8. The foundations shall mainly be Isolated Footing Type depending on the load.

9. Plinth beams shall be provided for buildings exceeding the length of 40 meters.

10. Construction joint shall be provided for buildings exceeding the length of 40 meters.

11. Loose Pockets in foundations shall be removed and filled up with PCC mix (1:4:8).

12. Back filling shall be done with granular soil in layers not exceeding 200 mm and each layer shall be well compacted as per Specifications.

13. Suitable water proofing admixture shall be provided in concrete for under ground water tank and over head tanks.

14. All reinforcement shall be sheared only. Flame cutting is not permitted, all bars shall be bent at normal temperature.

15. The walls shall be of course rubble stone masonry with 1:4 mix in foundations and superstructure. Alternatively white stone Bela masonry of appropriate thickness shall be provided in superstructure. The joints shall be raked.

16. The flooring shall be 40 mm thick Kota stone polished, with under layer of 30 mm thickness in cement concrete mortar 1:2:4, as per Specifications.

17. All outdoor paved areas shall be of cement concrete 1:2:4 - 40 mm thick laid in one layer, finished with floating coat of neat cement as per Technical Specifications.

18. All wood work shall be of teak wood.

19. All doors and windows shall be of steel duly painted with anti corrosive paint.

20. Electrical fittings and wiring shall be provided as per Specifications.

21. The internal water supply lines shall be galvanized steel of medium class conforming to IS:1239.

22. All sanitary (waste water and soil) pipes will be sand cast iron / PVC of 100 mm diameter and those for wash basins will be of 75 mm diameter (heavy type).

23. All R.C.C. slabs for roofing shall be provided with water proofing treatment.

Road Pavements

The general technical specifications for road works shall be as per "Specifications for road and bridge works", third revision (reprinted in January '97) and issued by the Ministry of Surface Transport (Roads Wing), Government of India and published by the Indian Road Congress.

The composition of a typical road crust recommended is as under :

A. Pavement Layers	**Compacted Thickness (mm)**
Granular Sub-Base Grading-I	150
Wet Mix Macadam	250
Dense Mix Macadam	100
Bituminous Concrete	40
Total Thicknesses	**540**
B. Paved Shoulders (1.5 m wide)	**Compacted Thickness (mm)**
Wet Mix Macadam	370
Mix Seal Surfacing	

5.6 INSTRUMENTATION AND AUTOMATION

5.6.1 General

The instrumentation scheme of the Oil Terminal can be divided into four sections depending upon their function and application, as follows :

i) Automation of gantries
ii) Tank farm management system
iii) Pump house automation
iv) General instrumentation

There are two control rooms in the terminal - one near the gate office for interaction with truck drivers and the central control room outside the licensed limits of TLF gantry. The latter is so located that trucks drivers can complete after-loading formalities, like collection of challans etc. at this control room counter and exit the premises from gate presently marked 'Emergency Gate'. This system can be opted for when the truck traffic increases and it becomes desirable to resort to one-way traffic at the entry gate for trucks.

5.6.2 Automation of Gantries

Product evacuation by road and rail has been envisaged to be automated, as far as possible, keeping in mind certain constraints, practical aspects of implementing the scheme and economics.

Tank Lorry Filling Gantry

A typical Tank Lorry Filling Shed automation scheme works in the following manner :

- On arrival, the tank truck reports at the gate office for registration.
- Truck arrival checking is done at the gate office on Terminal Documentation Computer (TDC) and Operator Interface Console (OIC). Commercial verification includes : amount paid, party particulars, product and load requirement, credit position, etc.
- After verification of the truck stated above, the compartment wise product allocation, assigning bay no. etc. is done through the main computer called Loading Rack Computer (LRC) installed in the Central Control Room.
- Filling Advice Notes and Magnetic Cards are generated at the Gate Office and handed over to the driver who takes his vehicle to the allotted bay.
- Vehicle is earthed.
- The driver inserts the magnetic card into the card reader which transmits information to LRC in the Control Room. LRC verifies the authenticity for loading with Filling Advice Note and grants prompt to Batch Controller installed in the bay for filling.
- All safety interlocks are checked by LRC. If found OK, the status lamp glows on the Local Panel giving instructions to the driver to prepare for loading. The loading arms are then connected to the respective compartments. Once the loading preparations have been completed, the driver pushes 'Acknowledge Push Button' at the local panel. The LRC then prompts for 'start loading' which the driver does by pushing start button on the panel.
- LRC monitors the loading operation right upto its completion. Through the system of interlocks, in case of failure of any system, the filling is discontinued.
- The seals and seal numbers are given by the Operation Officer at the gantry. Seals numbers are entered and transmitted to LRC.
- LRC completes all data including compartment wise quantity filled, density, temperature, seal numbers and communicates to the computer at the gate for preparing delivery challans.
- Challans are collected, signed and the truck drives away.

For facilitating the gantry automation on the above lines, the following sub-system of instruments in the control rooms and field are incorporated:

- Supervisory level computer in the control room.
- Flow automation system which consists of a batch controller connected to various field instrument like flowmeter, temperature probe, earthing device, loading arm position and overfill protection.
- Access control sub-system having magnetic readers for personnel and product identification.

All sub-systems are integrated together on data highway.

For carrying out these functions in the 20-bay gantry having 27 loading points, following instruments and computers are installed in the field and in the control rooms :

Instrument	Function	Nos.
Main Field Instruments		
Strainer cum air eliminator with DP gauge	To remove solid particles and entrapped air from product	27
Positive displacement metre	A flowmeter of high accuracy (± 0.1%)	27
Pulse transmitter	Converts metered volume to electrical pulses and transmits them to Batch Controller	27
Set stop valve (Digital control valve)	Controlled by Batch Controller, it cuts-off supply of product to tank truck.	27
Temperature sensor	To sense temperature of product and send proportional signal to Batch Controller.	4
Density Meters	To sense density of product and send proportional signal to Batch Controller	4
Batch controller	A microprocessor which collects all data from field, processes and controls. Also communicates with computer in the control room.	27
Grounding unit	Provides earthing interlock i.e prevents filling unless truck/wagon is earthed. Interfaces with Batch Controller.	27
Local Control panel	Mounted at each bay, its signals the acknowledge, start and stop of loading operation.	20
Magnetic card readers	Reads magnetic card and transmits it to processing system. After checking, it prompts to proceed with further loading sequence.	20
Magnetic cards	Cards provided to driver for identification and for loading control.	200
Control Room Instruments		
Computer (LRC)	Computes and displays gantry operation parameters. Prepares various information reports.	2
TDC & OIC	Computer used for truck data entry. Displays gantry operation and generates challans etc..	2
Communication Processing Unit	Device to concentrate the data received from field instruments and control room instrument. It converts data and transfers it to respective devices.	2

Tank Wagon Loading Gantry

The system of loading wagons is identical to that of tank trucks except the instrumentation required for interacting with driver. Thus, in this system there will be no need for magnetic cards and card readers, local control panels, operator interface consoles etc..

Further, one set of field instruments i.e. flowmeter, pulse transmitter and batch controller will control four filling points.

Thus, in Phase-1, for 960 loading points, there will be 240 sets of field instruments. In the central control room there will be two computers (LRCs) and nine communication processing units.

Specifications of control room and field instruments comprising the gantrys' automation are given in the **Annexure 3.4**. The architecture of the instruments is enclosed, vide drawing no. GMB/DPR/SEC3/31.

5.6.3 Tank Farm Management

The tank farm management system automates the level and temperature functions of all tanks. Monitoring and control of these functions is done through field instruments and computer in the control room.

Instrument	Function	Nos.
Field Instruments		
Servo Gauge	Motor driven perforated SS tape. Its sensing head has facility to measure all parameters viz. level, temperature, water level, density and tank bottom. This data is transmitted to computer by the built-in transmitter.	22
Tank side indicator	Connected with the servo gauge and mounted by the side of the tank, it indicates level, temperature and alarms.	22
Control Room Instruments		
Communication Converter	This card receives current loop data from field transmitters and transfers it to computer.	1
Computer with printer	Collects all data and processes it. It also displays all parameters, generates alarms and provides reports.	1

Specifications of control room and field instruments comprising the tank farm management system are given in the **Annexure 3.5**.

Overall system softwares are available for integrating all functional nodes i.e. tank farm computer system, loading rack computer, etc.,

5.6.4 Pump House Automation

For filling tank trucks in the gantry, a number of loading points for each products have been provided. It is possible that at a given time, none or several loading points would be in use. These loading points are serviced by one or more pumps (installed in parallel). For example, there are 15 loading points for HSD and, to service these, three working plus one standby pumps have been provided. The automation system envisaged for the pump house will facilitate starting of first pump when loading commences at one filling point. One pump can service four loading points. Therefore, as long as loading of HSD does not exceeds four points, only one pump will be functional. Once a situation is reached when more than four loading points are in use, the second HSD pump will start. Thus, as more and more loading points are being put to use simultaneously, more pumps will start to increase flow. In a peak situation, filling of HSD would be done, at a time, at all the 15 loading points and then, all four pumps will be operational.

Similarly, when the number of filling points simultaneously in use, start dropping, the pumps will start switching off one by one.

This system is available for all products for TLF operation.

5.6.5 General Instrumentation

The following field instruments provided in the product pipelines and on tanks are independent of the above automation schemes :

- Pressure gauges
- Thermal relief valves
- Level switches

Chapter 6 : Fire Protection System

6.1 BASIS OF DESIGN

Fire Protection System includes (i) fire prevention (ii) fire detection and raising alarm, whether manually or automatically and (iii) fire fighting.

Fire protection facilities will be designed as per :

OCIMF Document 'Guide on Marine Terminal Fire Protection & Emergency Evacuation'

OISD standard 117 - Fire Protection Facilities for Petroleum Depots & Terminals

OISD standard 156 - Fire Protection Facilities for Port Oil Terminals

The salient features of the standards are :

- Single largest fire risk to be considered for the design
- Fire water storage should sustain 4 hours requirement for the pumps
- Fire water pumps to have minimum 50% standby
- Fire water system should have 7 kg/cm^2 pressure at the remotest point of application
- Portable fire extinguishers to be located at convenient and accessible places.
- Fire alarms / sirens to be provided suitably

Fire fighting system for the berths and for the oil tankfarm are independent of each other. However, provision will be made to connect the hydrant lines of the two system, in case of emergency. All along the Jetty road, there will be hydrant line and hydrant points. Half the length of this road is serviced from Berth end and the other half from the shore end. In the middle both are connected with an isolation valve which will normally remain closed.

Sea water will be used for fire fighting system for berths and ground water or water from municipal source for fire fighting system at the tankfarm.

In case of fire on ship, it is assumed that the ship will be towed to the open sea and that the fire fighting services from the shore to the ship will be treated as first-aid till towing is done.

One single largest risk is considered for providing fire-protection facilities at the jetty. The 100% stand-by arrangement will be available for additional protection.

The water network is laid to ensure multi-directional flow wherever possible. Isolation valves are provided in the network to enable isolation of any section of the network and for directing full water pumping capacity to the affected area.

In this chapter various abbreviations used mean as under :

LPM	Litres per minute	mWC	Metres water column
DOL	Direct-on-line	RCC	Reinforced cement concrete
IS	Indian Standard	ERW	Electric resistance welded

6.2 FIRE FIGHTING SYSTEM AT BERTHS

Fire fighting system at the Berths will consist of the following :

- Hydrant System including water curtains and monitors
- Foam System

6.2.1 Hydrant System

a) Fire Fighting Pumps

The pump selection is based on the following water consumption data :

Water Consumption Point	Consumption (LPM)
Two tower mounted foam monitors of 3000 LPM capacity	6000
One water monitor - 3000 LPM	3000
Two hydrants of 600 LPM capacity	1200
Eight water curtains of capacity 600 LPM	4800
Water outlet for tugs	3000
Total	18000 LPM or 1080m^3/hr

Fire water supply for berths is divided into two systems. One system consisting of one main pump and one standby pump caters to monitors and the other system of identical two pumps feeds water to water curtains, tugs and hydrants. Provision exists for connecting these two water supply systems in the pump house and at berths too. All four pumps (two working and two standby) will be diesel engine driven vertical turbine pump of capacity 600 cum/hr at 140 mWC.

Two 30 cum/hr, 140 mWC vertical turbine jockey pump, electric motor driven , have been proposed to maintain pressure in two water supply systems separately.

The fire fighting system is provided with auto start facility. Pressure sensors are fitted in all delivery lines in the pump room. These sensors are connected to the starting circuit of the self starter circuit of the prime movers. These sensors are set at a predetermined level to actuate the starter panels in case the pressure in the line falls below the set level. Jockey pump maintains the pressure at this level. As soon as the monitor line valve at the berth is opened, either from the control panel or locally, the monitor will start functioning with the existing line pressure maintained by jockey pump. When the pressure drops below the set level, due to large outflow of water, it will not be possible for the jockey pump to restore pressure. Main pump will then start automatically restoring the full pressure in the monitor line. The sensors do not have a stop signal. The jockey pump is automatically switched off when the pump develops the full pressure.

Fire water pump house will be located 60 m away from the central berth i.e. Berth No. 2. The piping arrangement is shown in the drawing no. GMB/DPR/SEC3/32.

b) Water Curtains

Water curtain, as the name implies, provide protection to the installation /unit by creating a mist of water between the fire and the unit. It is a nozzle, having fine holes / notches along half its circular periphery. High pressure water passing through these nozzle makes a water curtain.

Eight water curtain nozzles have been provided at each berth - two at each monitor structures and four at the unloading arms to protect them from heat radiations from fire in their vicinity. The height of the water curtain attained is 18-20 metre by mounting the nozzles at two levels at the jetty. Water is fed to it at 7 to 8 kg/cm^2 pressure. The angle of spray is 170 deg.

c) Tower Monitors

Each berth will be provided with 3 Nos. Tower monitors. Two monitors will be mounted on towers of 20 m height and the third will be mounted on a 3 m high tower. The monitors at 20 m level will have foam induction arrangement while the third monitor will be provided with water connection only. All the operations of the monitors will be carried out from the control room remotely. Local operating stations will also be provided at the berth.

d) Hydrant Hoses and Branch Pipes

Four double hydrants have been provided at each berth and two on the roads leading 10 berths. A double hydrant, at 1.4 m height is a two valve unit on the hydrant ring main. Near each hydrant, there will be an FRP box containing two 15m long rubber lined hoses and one triple purpose nozzle. This nozzle can provide water in the form of a jet or spray. It can also provide foam by connecting a small nozzle on it to the foam compound supply.

Each double hydrant can discharge 2 x 36 m^3 /hr water at 7 kg/cm^2 pressure.

Six numbers 200 NB outlets have been provided on the edge of each berth facing sea to supply water to the tugs in case of emergency.

e) Hydrant Ring & Piping

Carbon steel ERW pipes conforming to IS:3589, cement lined from inside have been proposed for jetty hydrant system. From pump house, 450mm size pipes will supply water to the hydrant rings of each berth. Water supply for fire fighting is brought to each berth by two manifolds of size 450 NB. One manifold caters to the monitors through one hydrant ring and the other to water curtains, hydrants and tugs through the second hydrant ring. On each berth, there are two hydrant rings of 250 mm size. One ring caters to the hydrant points, water curtains and outlets for tugs. The other hydrant ring supplies water exclusively to three monitors.

Provision is made for connecting the two hydrant rings at each berth, if the need rises.

It is recommended to encase the hydrant rings in concrete in order to protect them from damage due to mechanical causes and heat radiation's.

For quick and easy operation gear operated butterfly valves have been provided in the piping. They are located in such a manner so that 50% of the fire fighting equipment is available for use when the other 50% is under maintenance.

On each berth, one water monitor is provided. It will be installed on a three metre high structure. Capacity of this monitor will be 3000 LPM.

6.2.2 Foam System

Foam solution supply to three berths is centralised. It consists of two SS tanks of capacity 10 KL each. Each tank has inlet, outlet, drain, vent, manhole for cleaning and a level indicator. Motor driven pump (capacity 14 m^3/hr at 14 kg/cm^2) connected to the outlet of the tank supplies foam compound to three berths. Two pumps (one working and one standby) have been considered. Foam supply pipe is connected to the Foam Proportionator fixed on the inlet of the Foam Monitor. The foam compound received through the barrels will be pumped into storage tanks located at a centralised platform near the pumphouse. For injecting foam solution into the main line leading to the monitors there will be 2 nos. of electrically operated pumps with foam compound inductors. Suitable effective system to supply the correct proportion of foam and water at any given time of the operation will be provided.

Two foam monitors have been provided at each berth. They are located on 20 metre high structure. The water capacity of the monitor is 3000 LPM at 9-10 kg/cm^2 pressure. Foam expansion ratio is 1:6 to 8. Thus, each monitor will discharge 18000 to 24000 LPM of foam. The monitor shall be remote controlled. It will be operated from control room. The rotation of the monitor shall be 350 deg in horizontal plane, 30 deg (elevation) to 70 deg (depression) in the vertical plane.

All equipment, pipe and valves for foam compound service shall be in SS-304.

6.2.3 Portable Fire Extinguishers

For extinguishing small fires in and around the area, it is proposed to have 10 portable fire extinguishers of 10 kg. capacity, dry powder, stored, pressure type. They will be located on the central unloading platform and breasting dolphins and at required points on each of the three jetties. Two CO_2 portable fire extinguishers (4.5 kg) shall be installed in the control room.

6.2.4 Fire Alarm System

Two Hooters/Alarms shall be provided - one in the Pump House and the other in the Control Room. Eight switches shall be provided on each berth including one on every dolphin. In case of any fire the personnel available on the berth should be able to push the switch so that, the persons in the pump house and the persons in the Control Room will be made alert for fighting the fire.

6.2.5 Remote Controlling System

The fire fighting system comprising of (1) monitors (2) water curtain (3) foam supply pumps (4) sea water pumping systems are proposed to be operated by a remote control panel board located in the control rooms provided about 60 meters away from the jetty head. Since the pipeline will always be under pressure for throwing water/foam through the monitor/corresponding motor actuated valves provided on the water riser pipe will be opened through the remote control system and due to this action the pressure in the main pipe line will drop down. The main pumps will automatically start when the pressure drops down below 8 kg/cm^2. By any chance if the pumps are not started the operation of pumps has to be switched over to manual.

The foam pump is to be started through the remote control system and the foam solution shall then be pumped through foam regulators into the main water stream to the monitor. The horizontal and the vertical movement of the foam monitor shall also be controlled through the control panel board to achieve the required orientation. Hydrant system and water curtain system shall also be operated through the control panel board by operating motor controlled valves.

6.3 FIRE FIGHTING SYSTEM AT TANK FARM

The fire fighting system at the tank farm consists of the following :

- Fire Hydrant System
- Foam System
- Medium Velocity Water Spray System

Refer drawing no. GMB/DPR/SEC3/33 for the fire fighting system at tankfarm.

6.3.1 Fire Hydrant System

Water Requirement

Water requirement and thus the water reservoir capacity have been determined based on the risk of fire on tank in dyke containing HSD tanks T17 and T18 of diameter 60m and 50m respectively, as follows :

Hydrant system	4 hydrants and one water in use at a time	4800 LPM
Foam system	For tank T17	14130 LPM
MV water sprinkler system	T18 @ 3 LPM T17 @ 1 LPM	12725 LPM 2355 LPM
		34010 LPM or 2041 m^3/hr

To provide 2041 m^3/hr of water supply four pumps of capacity $616 m^3/hr$ have been considered. Further, the water reservoir capacity based on four hours water requirement, has been worked out as 10812 m^3 or 11,000 m^3.

Water Reservoir

Water reservoir of capacity 11,000 m^3 capacity will be an open concrete basin of size 50 m x 40 m x 5.5 metre depth. It will have two compartments to facilitate maintenance in one section while water remains stored in the other. RCC tank will be partly under ground and partly above ground. There will be walkway with steel pipe railing all around it.

Fire Water Pumps

Four pumps of capacity 616 m^3/hr at 15 kg/cm^2, horizontal centrifugal, two electric motor driven and two diesel engine drive will be installed in the Fire Water Pump House near the water reservoir. In addition, there will be two standby pumps of same capacity, both diesel engine driven.

Two Jockey pumps (one working + one standby) of capacity $40m^3/hr$ at 15 kg/cm^2, both electric motor driven have been proposed.

Hydrant System

All around the tank farms and gantries, there will be a network of 450mm and 300mm underground pipes. The water ring mains will also cover the truck parking area, plant and non-plant buildings. The pipes will be of carbon steel IS:3589. They will be coated and wrapped as per IS: 10221 before laying in ground at a depth of one meter from the finished ground level (top of the pipe to be one metre below the ground level). For road crossings, concrete pipes will be used for casing hydrant lines. Depending upon the soil analysis, cathodic protection of underground pipes is recommended.

Fire hydrant / monitor mains shall be laid in loops so as to make available entire pumping capacity to any part of the complex. The system has been designed to permit use of part of the system / loop in case of repairs or break down in the other part.

Material of construction of water pipes used in the fire protection system shall be as per the following standards :

Underground 150 NB and below 200 NB and above	 IS:1239 black heavy IS: 3589 ERW
Above ground 150 NB and below 200 NB and above	 IS: 1239 GI heavy IS: 3589 Galvanised steel

All flanges shall be of carbon steel plate IS:226, slipon type with rubber gaskets. Pipe fittings shall be of carbon steel (IS:1239 upto 150 NB and API 5L/ IS:226 for 200 NB and above).

Gun metal branch pipe with nozzles shall conform to IS: 903.

Water monitors considered for the tankfarm shall be of fixed superjet type having capacity of water flow 2500 LPM at 7 kg/cm^2 and 2250 LPM at 5 kg/cm^2 pressure. Material of construction of the water monitors will be as under :

Body	MS tube anticorrosive treated
Swivel joints	Gun metal to IS: 318. Nozzles : Aluminium alloy A-B-WD.
Rotation	360 deg horizontal and 75-105 deg vertical

Hydrants shall be located at a distance of minimum 15m from the tank shell. The inter distance between the hydrants / monitors shall be 30 m in the tank farm and gantry area. This distance shall be made 45 m in the area of utility and administrative buildings. Double headed hydrants shall have two landing valves of size 100 NB.

The layout of the hydrant system is shown in the drawing no. GMB/DPR/SEC3/34.

6.3.2 Medium Velocity Spray System

In this system, water is sprayed on the body of the tank from the spray nozzles fitted on the pipe rings around the tanks.

Automatic medium velocity water spray system (MVWS) has been proposed for all tanks in the tank farms. Water supply for the MVWS system is drawn from the hydrant main. A deluge valve is provided at the upstream and downstream for each tank. Spray nozzles of type IC-32, 110deg. at a distance of 1.8 metre have been considered. This will not leave any pocket of the tank outside the spray pattern. Hydraulic detection piping of size 25NB fitted with quartzoid bulb detectors, is also provided parallel to the spray rings. This pipeline is pressurised. Detection of temperature more than 70 deg. C will burst the quartzoid bulb and the pressure of the ring will drop. This will create imbalance of pressure across the diaphragm of the deluge valve which, in turn will open water supply to the spay system of the tank from the hydraulic main. For cooling of the roof of the cone roof tanks, a revolving head has been considered at the top. For cooling of the roof of the cone roof tanks, a revolving head has been considered.

There will be two water supply headers for each tank, connected to different sections of the hydrant main.

6.3.3 Foam System

a) Fixed System for Tanks

Foam system has been considered for all tanks in the tank farms. For floating roof tanks, foam water application rate considered is 12 LPM /m^2 for annular foam seal. The width of the seal would be 600mm for tanks upto 42 m dia and 800mm for tanks larger than 42 metre dia. Foam dam height shall be 610 mm. For floating roof tanks, foam application shall be restricted to foam seal area by providing a foam dam. Suitable drain spouts shall be provided to drain the degenerated foam liquid from the foam dam area. Foam deflectors have been considered to guide the foam smoothly along the tank shell.

For fixed roof tanks, foam application rate of 5 LPM /m^2 of liquid surface area has been considered.

Three foam tanks of capacity 4000 litres each have been proposed to be placed at suitable locations in the tank farm area. Foam pourers are located at the top of the tanks.

Foam makers shall have vapour seal chambers to prevent escape of hydro carbon vapours through dry foam piping to the road side.

b) Semi-fixed Foam System for Gantries

There will be two mobile foam tenders which will be carried to the gantries. Double headed hydrant will provide the water supply for generating foam. Hose and triple purpose branch pipe stored in the FRP Hose Box will be used for directing foam to the fire.

6.3.4 Fire Alarm System

Two hooters of 2 km range, a control panel and a number of alarm activating switches installed all over the terminal will constitute the Alarm System. In case of fire in any area, the operator shall activate the switch. In addition to sounding of the siren, the control panel will flash the location of the fire. The main panel will be in the gate office.

The fire alarm system of the jetty will be independent.

6.3.5 Portable Fire Extinguishers

In addition to portable fire extinguishers which must be placed at strategic locations, following additional safety items must be kept in the Fire Station Building.

Item	Quantity.
10 kg dry chemical powder type portable fire extinguisher to IS 2171	30
4.5 kg CO_2 portable fire extinguisher	4
Explosive Meter	1
Resuscitator	2
Water jel blanket	1
Jet nozzle with branch pipe IS:903	4
Fog nozzles IS: 952	4
Universal nozzle IS 2871	4
Foam branch pipe with pick-up tube IS:2097	4

6.4 JETTY ROAD

All along the product pipelines from pump house to the tankfarm, there will be a hydrant line of size 450 NB laid close to the road. Half the length of this line will be hooked to the tankfarm hydrant system and the other half towards the berth side, to the jetty fire fighting system. There will be provision to connect the two in case of emergency. Double headed fire hydrants will be installed on the pipeline at a distance of 60 metres. Near each hydrant point, there will be an FRP hose box containing two hoses and a nozzle.

The specifications of various items/units of the fire fighting equipment are given in the **Annexure 3.6.**

Chapter 7 : Pollution Control & Safety Measures

7.1 SPILL OIL CONTAINMENT AND RECOVERY

At the POL terminal all measures have been proposed to prevent the spillage of oil. The ship-shore transfer of oil through flexible hoses is a probable source of oil spillage. With the provision of solid marine unloading arms, the possibility of spillage will be minimised to a large extent. Even then, there are chances of oil spillage if the arm is accidentally disconnected during operation. To avoid this, the arms shall have emergency release coupler and when this is operated, the mating ends shall be closed before separation to restrict spillage. Moreover, the pipelines will be provided with and controlled by a leak detection system so that in case of leakage or rupture of the pipeline, the flow could be immediately stopped.

Notwithstanding all these precautions, there are still other accidental causes of oil spill for which measures have to be taken to contain and recover the spilled oil. Oil, when spilt on the sea (unless it is highly viscous or dense) will float and spread. If early control measures are not taken, the slick will cover a wide area in a comparatively short period of time making clean-up operations more difficult. In order to avoid such a situation, oil should first be prevented from spreading .

Booms are used for the purpose of containing such spilled oil as well as for collecting and deflecting it. There are different kinds of booms. Though structurally they may differ, basically they have in common the following components:

- freeboard to prevent or reduce splashover
- subsurface skirt to prevent or reduce escape of oil under the boom
- floatation by air or some buoyant material
- longitudinal tension member (chain/wire) to withstand effects of wind, waves and currents.

The different types of booms are described briefly hereunder:

1) **Solid floatation boom**: In this type, the floatation consists of buoyant material such as plastic foam, and the skirt is made of oil and water resistant fabric ballasted along its lower edge. These booms are usually supplied in 15 m to 20 m lengths to facilitate handling and the units are joined by connectors.

The advantages of this type are that inflation is not necessary and minor damage may not affect buoyancy. The disadvantages are that it requires large storage space and is susceptible to deformation during storage.

2) **Inflatable boom**: This type of boom consists of inflatable air chamber or tubes. In most cases the air is supplied from a low pressure blower but some inflatable booms contain internal springs and non-return valves

which permit self inflation. The skirt is made of oil and water resistant fabric. Some large inflatable booms have independent buoyancy to keep them afloat during deployment and inflation.

Floating/submerging booms have a similar structure but usually employ longer unit lengths and fewer connections. These are used in fixed locations such as at oil terminals and, when not in use, are deflated and rested on the sea-bed.

The advantages of this type are that it has good wave following characteristics and requires relatively little storage space. The disadvantages are that unless self-inflatable, it takes time to deploy and inflate and rips and tears can cause loss of buoyancy.

3) **Fence booms**: Boom of this type consists of a single sheet of material which constitutes both freeboard and skirt; floats and ballast weights are attached at intervals.

The advantages of this type are similar to those of the solid floatation type and in addition it requires less storage space. The disadvantages are that a long span of the boom tends to lay over under the influence of current or strong winds.

4) **Pneumatic barriers**: This type of boom employs a screen of air bubbles released below the water surface, usually from a fixed pipe on the sea-bed. Rising air bubbles generate an upward water flow which diverts horizontally at the surface. This surface current flows in both directions away from the bubble stream and can retain oil under low currents.

The advantage of bubble barriers is that they do not obstruct shipping traffic and are easily activated. The disadvantages include limited effectiveness in deep water and strong currents, and they are subject to clogging by silt.

In addition, there are several other types of booms and barriers also such as: booms constructed of netting to facilitate retention of viscous oils : boom system incorporating a weir or gate through which oil is collected and pumped within the boom to a reception vessel : boom system which has an external tension member which relieves stresses upon the boom itself and improves its sea keeping properties.

Of all these types, the pressure inflatable booms are rated better than the rest considering their capacity to function under specific environmental conditions, their performance and physical characteristics.

As a precautionary and protective measures, such booms are placed encircling a tanker moored to the berth and discharging oil. These may be moored by conventional anchors or concrete blocks or to a wharf or ship's hull by special attachments at the end.

Specialised oil recovery vessels are deployed to collect the oil contained within the boom enclosure. These are specially purpose designed and comprise the following components: oil skimmers, storage tank for recovered oil, equipment to transfer recovered oil to onshore storage facilities, machinery system and debris removal equipment.

It is recommended that for the marine oil terminal at Positra, inflatable type containment boom with an oil skimmer be provided. The boom can be of individual sections each of 25 metres length. It shall be designed to withstand drag forces of current upto 3 knots. The units should have a minimum freeboard of 330 mm and a draft of about 500 mm. The material of construction should be polyamide fabric coated with weather and oil resistant polymer. The boom segments shall be designed to become rigid after inflation and float vertically . The boom assembly will be accompanied by suitable compressor for air inflation and suitable system for towing and handling during installation. Individual units should be able to be wound on motorised rail and should be easily deployed using carrier launch.

The skimmer shall be of weir type suitable for harbour oil spillage clean up operations. It shall have the following accessories :

- pump unit with three pontoon floating frame with special inlet weir
- special cutting knives fitted in both the inlet and outlet unit of pump unit in order to handle all types of oil .
- the skimmer unit shall be powered from diesel driven hydraulic power pack through hydraulic hoses.
- the recovered oil should be able to be discharged to the collecting tank through hoses

7.2 OILY WASTE RECEIPT AT BERTHS

Source of oily wastes

When a tanker sails empty to a loading port, it must take on some sea-water to ensure stability during navigation. Likewise, when a tanker discharges its cargo, it must take in sea-water to make up for part of the weight lost. The added weight provides stability and manoeuvrability. Ships used to take this water into empty cargo tanks. This mixed with the oil and constituted dirty ballast.

Ships carrying petroleum products generally have considerable quantities of scale on the surface of the cargo tanks. It is necessary to remove these scales regularly and this is usually done by washing the tanks with hot water. These tank washings constitute another source of oily wastes.

In the case of product tankers carrying mixed cargo, the ship's lines will also have to be washed . This is done by connecting the deck service line and pumping hot water through the system or by flushing with sea-water with the ship's pumps. This is the third source of oily wastes.

Discharges of oil or oily mixture from machinery space bilges and discharges from cargo pump-room bilges form another source of oily wastes.

Regulations on disposal

In the earlier days, these oily wastes and dirty ballast were simply discharged overboard. The hazards of the marine environment due to such discharge attracted the attention of the authorities and various regulatory measures have been taken over the years to control/prevent the discharge of oily wastes into the sea.

The first convention regulating pollution from ships was adopted almost four decades ago in 1954. Since then, the International Maritime Organisation (IMO) has numerous conventions, codes and recommendations aimed at protecting the marine environment. The most influential was MARPOL adopted in 1973 and its protocol of 1978. Under MARPOL regulations, the discharge of oil or oily wastes from tankers is forbidden in environmentally sensitive areas such as enclosed seas and strictly limited elsewhere. Ports handling these tankers are required to provide facilities for receiving these oily wastes and treating them for further disposal.

Tanker modifications

The MARPOL regulations stipulated certain modifications in tanker construction as well as provision of special equipment control generation and disposal of oily wastes. Some of the requirements are as follows:

Segregated ballast tanks (SBT) : This requires sufficient tanks for carrying only ballast water so that, under ordinary circumstances, ballast water does not enter the cargo tanks. This measure was adopted for new buildings.

Clean ballast tanks (CBT) : In existing ships, these are cargo tanks dedicated to carrying ballast. This option is available for existing tankers.

Crude oil washings (COW) : This is the cleaning of cargo tanks with high pressure jets of crude oil while the ship is discharging. The crude oil pumped through the ship's tank washing machines acts as a cleaning agent and removes oil residues which are then pumped ashore with cargo.

In addition, tankers of 10,000 GRT and above are required to be fitted with oily-water separator system and with an oil discharge monitoring and control system.

In view of all these requirements, the capacity of the reception facilities at the ports handling such tankers has been considerably reduced.

Reception facilities

Under MARPOL regulations, reception facilities shall be provided in

a) all ports and terminals in which crude oil is loaded into oil tankers where such tankers have immediately prior to arrival completed a ballast voyage of not more than 72 hours or not more than 1200 nautical miles;

b) all ports and terminals in which oil other than crude oil in bulk is loaded at an average quantity of more than 1000 metric tons per day;

c) all ports and terminals which handle ships provided with sludge tanks as required by these regulations;

d) all ports in respect of oily bilge waters and other residues, which cannot be discharged in accordance with the regulations;

e) all loading ports for bulk cargoes in respect of oil residues from combination carriers which cannot be discharged in accordance with the regulations.

The capacity of the reception facilities should be matching with the requirement for retention of oil on board the tankers. MARPOL regulations stipulate that " adequate means shall be provided for cleaning the cargo tanks and transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank. The arrangement of the slop tank or combination of slop tanks shall have a minimum capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks shall not be less than 3% of oil carrying capacity of the ships."

Taking into consideration that at Positra, only imports of products are contemplated and that the maximum size of the tankers would be 45,000 DWT, the possible maximum discharge of oily wastes per tanker could be about 1300 tonnes. Considering the frequency of the tankers' call and discharge of oily wastes, the period of retention in the storage tanks and the rate of flow through the TPI separators, it is concluded that reception tanks of 1700 m^3 capacity would be sufficient. Since the onshore tank-farm is nearby the port terminal, and as this is provided with an TPI separator system, two above ground vertical cylindrical tanks, each with capacity of 850 m^3, would be provided at the tankfarm. The oily wastes from the tankers could also be processed through the same system which are designed to take care of the requirements of both the onshore tank-farm as well as the oily wastes from the tankers.

7.3 EFFLUENTS AND THEIR TREATMENT

Petroleum products will be received, stored and despatched from Positra Oil Terminal. There will be no processing operation of any kind, in the terminal. Therefore, there will be no air pollutants except the exhaust from the DG set as and when it runs.

Liquid pollutants will be as under :

- Sanitary drainage from toilets, canteen, amenity block
- Oil spills at pipeline manifolds, pump houses, gantries and tank farms

The handling and treatment of these pollutants is discussed subsequently in this chapter.

7.3.1 Drainage Systems

The terminal will have three systems of drains :

- Storm water drains
- Sanitary drains
- Oily water drain

Three systems are not connected.

Storm water and sanitary drain systems are discussed separately under "Utilities". Therefore this chapter confines itself to only oily water drain.

Oily Water Drain

Oil spillage will take place in the following areas :

- Tank farms
- Manifolds
- Pumps Houses
- Gantries

Floor washings from all these areas will be collected and taken to the treatment plant. The drains bringing oily water to the central treatment plant will have no connection anywhere enroute with storm water drains and sanitary drains. However, storm water collected in the aforesaid areas will find its way into the oily water drainage system. This portion of the storm water will go through the effluent treatment system as oily water.

Tilted Plate Interceptor

Oily water drains from all areas will be taken to an RCC chamber fitted with tilted plates. In this chamber oil will be separated from water and collected. Water free from oil will be discharged into the municipal mains.

The Tilted Plate Interceptor (TPI) works in the following manner :

<u>Principle of Separation</u>

Separation by gravity utilises the density difference between the oil and water. An oil globule in water will attain a constant rising velocity when the resistance to motion caused by the water is equal to the rising force created by the density difference.

The important characteristics for a separator using this principle are :

a) the distance through which the oil globules travel between the two plates of the plate pack.
b) the rate at which the oil globules through this distance.

These two factors govern the resistance time in a separator and therefore, its size. For efficient operation, the vertical distance travelled by the oil droplet should be made as short as possible.

The rising velocity is increased by the agglomerating small globules, thus creating larger, faster rising oil globules (coalescence).

Any break-up of these oil globules by even slight local or general turbulence will reduce the efficiency of the separator. Consequently, the flow through the unit and in the upstream piping system should be as laminar as possible.

By using parallel corrugated plates inclined at 45 - 60 deg. the TPI optimises the conditions of short vertical travél under stable laminar flow and maximum separating surface area.

The plates are used 'counter-current' mode to obtain a compact installation.

Process Flow

. The drawing of the RCC pit in which the TPI will be installed is enclosed vide drawing no. GMB/DPR/SEC3/35. The important parts of the unit are :

- Plate pack
- Plate pack support
- Outlet weir
- Sludge outlet
- oil skimmer
- Flow baffle

The oil contaminated water is fed into the primary distribution compartment. It is distributed over the full flow area by flow distribution baffles. Oil and solid separation takes place in the cross flow plate pack. Oil droplets are intercepted and coalesced into larger droplets. They leave the pack rapidly by moving upwards at the top of the corrugations to the surface of the tank. The separated oil constitutes a comparatively dry floating layer which is removed over the weir. The clean water flows over the outlet weir into the water discharge compartment. Settleable matter / sludge, if present, is discharged via a sediment pipe connection.

Oily water at the inlet of the TPI unit will have upto 2% oil concentration. The clean water coming out of it will have maximum 10 ppm oil which is as per the norms of the Pollution Control Board. The treated water can be connected to the municipal mains for disposal if there is no use of it in the terminal.

Specifications of oil water separator are given in the **Annexure 3.7.**

7.3.2 Gaseous Emissions

There are no gaseous emissions from the terminal except for the leaks from weathered glands of Naphtha and MS pumps. These are too small and insignificant to affect even in the localised area. However the floating roof tanks are to be periodically tested with explosive meter for seal leaks. In case of persistent presence of hydrocarbon, the roof seal of the tank should be repaired/ replaced.

Another source of gaseous emission is the Diesel Generator which will run when the power supply from the mains is interrupted. Such emissions shall be within the prescribed limits.

7.3.3 Tank Sludge

Over a period of time sludge gets deposited on the bottom of product storage tanks. Therefore, the tanks are cleaned periodically depending upon the extent of deposition - say once in five years.

The sludge removed from the tank is first washed with plenty of water. This is done by using water hoses. The sludge is then carted away to a remote area of the terminal where it is buried underground.

7.3.4 Disaster Management Plan

Disaster is an undesirable occurrence of events of such magnitude and nature which adversely affects the project, environment and human life. Risk assessment forms an integral part of Disaster Management. Project Owners may consider to undertake, in due course, a detailed risk assessment study of the project through an authorised third party agency. The Disaster Management Plan should be formulated during project implementation stage.

7.4 EMERGENCY SHUT - DOWN SYSTEM

During tanker discharge operations, emergencies occur as a result of major loss of containment (leaks) or a consequence of fire or explosion in the tanker or jetty or at the receiving tank - farm.

Emergency system at the jetty

In case of major leaks at the jetty end or leaks at the onshore terminal either on the tanker discharge line or at the pipeline manifold, the tanker discharge operations are immediately shut down using the ROV close buttons in the jetty control room or in the onshore terminal control room, depending upon where the leak/fire is first noticed. The tanker also shuts down its pumps thereafter.

The oil tanker may remain at the berth and after the source of leak is rectified, the discharge operations resume. The oil spill clean up operations are initiated.

In the case of fire, the tanker is also towed away by the port authorities after shutting down the unloading operations and after the unloading arms are de-coupled from the tanker manifold. Further operations on the tanker will be taken over by the Master of the vessel.

Emergency system at the onshore terminal

Depending upon the location and nature of the emergency, the emergency shut - down operations involve one or more of the following:

a) shut down of the tanker discharge operations as described earlier
b) shut down the tank truck loading operations using the remote shut down buttons for the truck loading pumps in the control room or at the gantry and closing the tank outlet (pump section) ROV from the control room
c) a similar procedure for the tank wagon loading operations

For any emergency at the jetty, only the first item need to be carried out whereas for any emergency at the loading gantries, the second and third items are to be carried out evacuating all other trucks and, if possible, other wagons also from the terminal.

In the case of emergencies elsewhere in the terminal, all the three shut down systems are activated.

For minor emergencies such as high level alarm in the receiving tanks, only the tanker discharge operations are shut down and the activity restored after appropriate tank switching.

Prior to executing the project, a risk analysis study is required to be carried out. In addition to risk reduction measures, a detailed Disaster Management Plan (DMP) is also to be prepared in accordance with "Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989"

7.5 SECURITY SYSTEM

Security system to the port area is required to serve the following objectives :

- protection against sabotage ;
- protection against pilferage and thefts ;
- protection against encroachments by unauthorised persons ;
- prevention of thoroughfare by trespassers and antisocial elements.

Keeping in view the importance of various areas in the Port, the following proposals are made :

- A rubble masonry wall barbed wire fencing around the tankfarm
- A security office and check post at the entrance to the terminal.
- Provision of watch towers at suitable intervals for manual monitoring.

The watch towers will be connected to the central security control room by means of telephone and walkie - talkie system. They will also be provided with sirens to warn about sabotage or fire incidence to enable the central security agency to take immediate action. Regular watch and ward staff will be utilised for routine rounds in the area.

ANNEXURES

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario I (Year 2001) - Tanker Utilization Scenario A									
Import of Oil Products	[ktpa]	5,000							
Diesel	[ktpa]					*3,000*			
Kerosine	[ktpa]						750		
Naphtha	[ktpa]							750	
Gasoline	[ktpa]								500
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]					86	21	21	14
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]					2,281	586	633	426
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Products	[-]					0.29	0.07	0.08	0.05
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]					0.44	0.11	0.12	0.08
Combined Berth Requirement	[-]	0.76							
Actual Number of Required Berths	[-]	1	49.56%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario I (Year 2001)- Tanker Utilization Scenario B									
Import of Oil Products	[ktpa]	5,000							
Diesel	[ktpa]	*750*				*2,250*			
Kerosine	[ktpa]		188				563		
Naphtha	[ktpa]			188				563	
Gasoline	[ktpa]				125				375
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	38	9	9	6	64	16	16	11
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	893	229	247	166	1,711	439	474	320
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Products	[-]	0.11	0.03	0.03	0.02	0.22	0.06	0.06	0.04
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.17	0.04	0.05	0.03	0.33	0.09	0.09	0.06
Combined Berth Requirement	[-]	0.87							
Actual Number of Required Berths	[-]	1	56.54%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosene	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosene	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario I (Year 2001)- Tanker Utilization Scenario C									
Import of Oil Products	[ktpa]	5,000							
Diesel	[ktpa]	*1,500*				*1,500*			
Kerosine	[ktpa]		375				375		
Naphtha	[ktpa]			375				375	
Gasoline	[ktpa]				250				250
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	75	19	19	13	43	11	11	7
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	1,786	458	493	332	1,140	293	316	213
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.23	0.06	0.06	0.04	0.14	0.04	0.04	0.03
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.35	0.09	0.10	0.06	0.22	0.06	0.06	0.04
Combined Berth Requirement	[-]	0.98							
Actual Number of Required Berths	[-]	1	63.53%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosene	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosene	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario I (Year 2001)- Tanker Utilization Scenario D									
Import of Oil Products	[ktpa]	5,000							
Diesel	[ktpa]	*2,250*				*750*			
Kerosine	[ktpa]		563				188		
Naphtha	[ktpa]			563				188	
Gasoline	[ktpa]				375				125
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	113	28	28	19	21	5	5	4
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	2,678	687	740	498	570	146	158	107
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.34	0.09	0.09	0.06	0.07	0.02	0.02	0.01
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.52	0.13	0.14	0.10	0.11	0.03	0.03	0.02
Combined Berth Requirement	[-]	1.08							
Actual Number of Required Berths	[-]	1	70.51%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario I (Year 2001) - Tanker Utilization Scenario E									
Import of Oil Products	[ktpa]	5,000							
Diesel	[ktpa]	*3,000*							
Kerosine	[ktpa]		750						
Naphtha	[ktpa]			750					
Gasoline	[ktpa]				500				
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	150	38	38	25				
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	3,571	916	986	664				
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.45	0.12	0.12	0.08				
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.69	0.18	0.19	0.13				
Combined Berth Requirement	[-]	1.19							
Actual Number of Required Berths	[-]	1	77.49%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario II - Tanker Utilization Scenario A									
Import of Oil Products	[ktpa]	7,500							
Diesel	[ktpa]					*4,500*			
Kerosine	[ktpa]						1,125		
Naphtha	[ktpa]							1,125	
Gasoline	[ktpa]								750
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]					129	32	32	21
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]					3,421	878	949	639
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]					0.43	0.11	0.12	0.08
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]					0.66	0.17	0.18	0.12
Combined Berth Requirement	[-]	1.14							
Actual Number of Required Berths	[-]	2 37.17%							

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario II - Tanker Utilization Scenario B									
Import of Oil Products	[ktpa]	7,500							
Diesel	[ktpa]	*1,125*				*3,375*			
Kerosine	[ktpa]		281				844		
Naphtha	[ktpa]			281				844	
Gasoline	[ktpa]				188				563
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	56	14	14	9	96	24	24	16
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	1,339	343	370	249	2,566	659	712	479
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.17	0.04	0.05	0.03	0.32	0.08	0.09	0.06
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.26	0.07	0.07	0.05	0.50	0.13	0.14	0.09
Combined Berth Requirement	[-]	1.30							
Actual Number of Required Berths	[-]	2	42.41%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario II - Tanker Utilization Scenario C									
Import of Oil Products	[ktpa]	7,500							
Diesel	[ktpa]	*2,250*				*2,250*			
Kerosine	[ktpa]		563				563		
Naphtha	[ktpa]			563				563	
Gasoline	[ktpa]				375				375
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	113	28	28	19	64	16	16	11
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	2,678	687	740	498	1,711	439	474	320
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.34	0.09	0.09	0.06	0.22	0.06	0.06	0.04
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.52	0.13	0.14	0.10	0.33	0.09	0.09	0.06
Combined Berth Requirement	[-]	1.47							
Actual Number of Required Berths	[-]	2	47.64%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario II - Tanker Utilization Scenario D									
Import of Oil Products	[ktpa]	7,500							
Diesel	[ktpa]	*3,375*				*1,125*			
Kerosine	[ktpa]		844				281		
Naphtha	[ktpa]			844				281	
Gasoline	[ktpa]				563				188
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	169	42	42	28	32	8	8	5
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	4,017	1,030	1,110	747	855	220	237	160
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.51	0.13	0.14	0.09	0.11	0.03	0.03	0.02
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.78	0.20	0.22	0.15	0.17	0.04	0.05	0.03
Combined Berth Requirement	[-]	1.63							
Actual Number of Required Berths	[-]	2	52.88%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario II - Tanker Utilization Scenario E									
Import of Oil Products	[ktpa]	7,500							
Diesel	[ktpa]	*4,500*							
Kerosine	[ktpa]		1,125						
Naphtha	[ktpa]			1,125					
Gasoline	[ktpa]				750				
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	225	56	56	38				
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	5,357	1,374	1,480	996				
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.68	0.17	0.19	0.13				
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.04	0.27	0.29	0.19				
Combined Berth Requirement	[-]	1.79							
Actual Number of Required Berths	[-]	2	58.12%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario III (Yaer 2006) - Tanker Utilization Scenario A									
Import of Oil Products	[ktpa]	10,000							
Diesel	[ktpa]					*6,000*			
Kerosine	[ktpa]						1,500		
Naphtha	[ktpa]							1,500	
Gasoline	[ktpa]								1,000
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]					171	43	43	29
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]					4,561	1,171	1,265	852
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]					0.58	0.15	0.16	0.11
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]					0.89	0.23	0.25	0.17
Combined Berth Requirement	[-]	1.52							
Actual Number of Required Berths	[-]	2	49.56%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario III (Year 2006) - Tanker Utilization Scenario B									
Import of Oil Products	[ktpa]	10,000							
Diesel	[ktpa]	*1,500*				*4,500*			
Kerosine	[ktpa]		375				1,125		
Naphtha	[ktpa]			375				1,125	
Gasoline	[ktpa]				250				750
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	75	19	19	13	129	32	32	21
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	1,786	458	493	332	3,421	878	949	639
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.23	0.06	0.06	0.04	0.43	0.11	0.12	0.08
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.35	0.09	0.10	0.06	0.66	0.17	0.18	0.12
Combined Berth Requirement	[-]	1.74							
Actual Number of Required Berths	[-]	2	56.54%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario III (Year 2006) - Tanker Utilization Scenario C									
Import of Oil Products	[ktpa]	10,000							
Diesel	[ktpa]	3,000				3,000			
Kerosine	[ktpa]		750				750		
Naphtha	[ktpa]			750				750	
Gasoline	[ktpa]				500				500
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	150	38	38	25	86	21	21	14
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	1,700	1,640	1,480	1,460	2,550	2,460	2,220	2,190
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	3,571	916	986	664	2,281	586	633	426
Berth Occupancy Factor (BOF)									
Available Time	[days]	365	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Products	[-]	0.45	0.12	0.12	0.08	0.29	0.07	0.08	0.05
Allowable BOF	[-]	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.69	0.18	0.19	0.13	0.44	0.11	0.12	0.08
Combined Berth Requirement	[-]	1.95							
Actual Number of Required Berths	[-]	2	63.53%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario III (Year 2006) - Tanker Utilization Scenario D									
Import of Oil Products	[ktpa]	10,000							
Diesel	[ktpa]	*4,500*				*1,500*			
Kerosine	[ktpa]		1,125				375		
Naphtha	[ktpa]			1,125				375	
Gasoline	[ktpa]				750				250
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	225	56	56	38	43	11	11	7
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	5,357	1,374	1,480	996	1,140	293	316	213
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Products	[-]	0.68	0.17	0.19	0.13	0.14	0.04	0.04	0.03
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.04	0.27	0.29	0.19	0.22	0.06	0.06	0.04
Combined Berth Requirement	[-]	2.17							
Actual Number of Required Berths	[-]	2	70.51%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario III (Year 2006) - Tanker Utilization Scenario E									
Import of Oil Products	[ktpa]	10,000							
Diesel	[ktpa]	*6,000*							
Kerosine	[ktpa]		1,500						
Naphtha	[ktpa]			1,500					
Gasoline	[ktpa]				1,000				
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	300	75	75	50				
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	7,142	1,832	1,973	1,328				
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.90	0.23	0.25	0.17				
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.39	0.36	0.38	0.26				
Combined Berth Requirement	[-]	2.38							
Actual Number of Required Berths	[-]	2	77.49%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit				Via Port at Positra Product Tanker Type				
		PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario IV - Tanker Utilization Scenario A									
Import of Oil Products	[ktpa]	12,500							
Diesel	[ktpa]					*7,500*			
Kerosine	[ktpa]						1,875		
Naphtha	[ktpa]							1,875	
Gasoline	[ktpa]								1,250
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]					214	54	54	36
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]					5,702	1,464	1,582	1,065
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]					0.72	0.18	0.20	0.13
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]					1.11	0.28	0.31	0.21
Combined Berth Requirement	[-]	1.91							
Actual Number of Required Berths	[-]	2	61.95%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario IV - Tanker Utilization Scenario B									
Import of Oil Products	[ktpa]	12,500							
Diesel	[ktpa]	*1,875*				*5,625*			
Kerosine	[ktpa]		469				1,406		
Naphtha	[ktpa]			469				1,406	
Gasoline	[ktpa]				313				938
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	94	23	23	16	161	40	40	27
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	2,232	572	617	415	4,276	1,098	1,186	799
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.28	0.07	0.08	0.05	0.54	0.14	0.15	0.10
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.43	0.11	0.12	0.08	0.83	0.21	0.23	0.16
Combined Berth Requirement	[-]	2.17							
Actual Number of Required Berths	[-]	2	70.68%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario IV - Tanker Utilization Scenario C									
Import of Oil Products	[ktpa]	12,500							
Diesel	[ktpa]	3,750				3,750			
Kerosine	[ktpa]		938				938		
Naphtha	[ktpa]			938				938	
Gasoline	[ktpa]				625				625
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	188	47	47	31	107	27	27	18
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	1,700	1,640	1,480	1,460	2,550	2,460	2,220	2,190
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	4,464	1,145	1,233	830	2,851	732	791	533
Berth Occupancy Factor (BOF)									
Available Time	[days]	365	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.56	0.14	0.16	0.10	0.36	0.09	0.10	0.07
Allowable BOF	[-]	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.87	0.22	0.24	0.16	0.55	0.14	0.15	0.10
Combined Berth Requirement	[-]	2.44							
Actual Number of Required Berths	[-]	3	52.94%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Product Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario IV - Tanker Utilization Scenario D									
Import of Oil Products	[ktpa]	12,500							
Diesel	[ktpa]	*5,625*				*1,875*			
Kerosine	[ktpa]		1,406				469		
Naphtha	[ktpa]			1,406				469	
Gasoline	[ktpa]				938				313
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	281	70	70	47	54	13	13	9
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1.533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	6,696	1,717	1,850	1,245	1,425	366	395	266
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7.920
Berth Occupancy Factor (BOF) Produ	[-]	0.85	0.22	0.23	0.16	0.18	0.05	0.05	0.03
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.30	0.33	0.36	0.24	0.28	0.07	0.08	0.05
Combined Berth Requirement	[-]	2.71							
Actual Number of Requirec Berths	[-]	3	58.76%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario IV- Tanker Utilization Scenario E									
Import of Oil Products	[ktpa]	12,500							
Diesel	[ktpa]	*7,500*							
Kerosine	[ktpa]		1,875						
Naphtha	[ktpa]			1,875					
Gasoline	[ktpa]				1,250				
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	375	94	94	63				
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	8,928	2,290	2,466	1,661				
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	1.13	0.29	0.31	0.21				
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.73	0.44	0.48	0.32				
Combined Berth Requirement	[-]	2.98							
Actual Number of Required Berths	[-]	3	64.58%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario V (Year 2011) - Tanker Utilization Scenario A									
Import of Oil Products	[ktpa]	15,000							
Diesel	[ktpa]					*9,000*			
Kerosine	[ktpa]						2,250		
Naphtha	[ktpa]							2,250	
Gasoline	[ktpa]								1,500
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]					257	64	64	43
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]					6,842	1,757	1,898	1,278
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	355	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]					0.86	0.22	0.24	0.16
Allowable BOF	[-]	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]					1.33	0.34	0.37	0.25
Combined Berth Requirement	[-]	2.29							
Actual Number of Required Berths	[-]	3	49.56%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Product Tanker Type							
Throughput Data based on Scenario V (Year 2011) - Tanker Utilization Scenario B									
Import of Oil Products	[ktpa]	15,000							
Diesel	[ktpa]	*2,250*				*6,750*			
Kerosine	[ktpa]		563				1,688		
Naphtha	[ktpa]			563				1,688	
Gasoline	[ktpa]				375				1,125
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	113	28	28	19	193	48	48	32
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	2,678	687	740	498	5,132	1,317	1,423	959
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.34	0.09	0.09	0.06	0.65	0.17	0.18	0.12
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	0.52	0.13	0.14	0.10	1.00	0.26	0.28	0.19
Combined Berth Requirement	[-]	2.61							
Actual Number of Required Berths	[-]	3	56.54%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	Via Port at Positra Prouct Tanker Type PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario V (Year 2011) - Tanker Utilization Scenario C									
Import of Oil Products	[ktpa]	15,000							
Diesel	[ktpa]	*4,500*				*4,500*			
Kerosine	[ktpa]		1,125				1,125		
Naphtha	[ktpa]			1,125				1,125	
Gasoline	[ktpa]				750				750
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	225	56	56	38	129	32	32	21
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	2,550	*2,460*	2,220	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	5,357	1,374	1,480	996	3,421	878	949	639
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	0.68	0.17	0.19	0.13	0.43	0.11	0.12	0.08
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.04	0.27	0.29	0.19	0.66	0.17	0.18	0.12
Combined Berth Requirement	[-]	2.93							
Actual Number of Required Berths	[-]	3	63.53%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit	PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
		Via Port at Positra Prouct Tanker Type							
Throughput Data based on Scenario V (Year 2011) - Tanker Utilization Scenario D									
Import of Oil Products	[ktpa]	15,000							
Diesel	[ktpa]	*6,750*				*2,250*			
Kerosine	[ktpa]		1,688				563		
Naphtha	[ktpa]			1,688				563	
Gasoline	[ktpa]				1,125				375
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	338	84	84	56	64	16	16	11
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	*2,220*	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	8,035	2,061	2,219	1,495	1,711	439	474	320
Berth Occupancy Factor (BOF)									
Available Time	[days]	*365*	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	1.01	0.26	0.28	0.19	0.22	0.06	0.06	0.04
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	1.56	0.40	0.43	0.29	0.33	0.09	0.09	0.06
Combined Berth Requirement	[-]	3.25							
Actual Number of Required Berths	[-]	3	70.51%						

Positra Port Facities - Gujarat

Determination of Berth Occupancy Factor (BOF) for Oil Products

Parameter	Unit				Via Port at Positra Product Tanker Type				
		PTI Diesel	PTI Kerosen	PTI Naphtha	PTI Gasoline	PTII Diesel	PTII Kerosen	PTII Naphtha	PTII Gasoline
Throughput Data based on Scenario V (Year 2011)- Tanker Utilization Scenario E									
Import of Oil Products	[ktpa]	15,000							
Diesel	[ktpa]	*9,000*							
Kerosine	[ktpa]		2,250						
Naphtha	[ktpa]			2,250					
Gasoline	[ktpa]				1,500				
Tanker Data									
Tanker Type	[-]	PT-1	PT-1	PT-1	PT-1	PT-II	PT-II	PT-II	PT-II
Tanker Size - minimum	[DWT]	15,000	15,000	15,000	15,000	30,000	30,000	30,000	30,000
Tanker Size - maximum	[DWT]	30,000	30,000	30,000	30,000	45,000	45,000	45,000	45,000
Average Parcel Size	[tonne]	20,000	20,000	20,000	20,000	35,000	35,000	35,000	35,000
Number of Tankers Calls/year	[-]	450	113	113	75				
Turn-Around Time at Terminal									
Piloting, Arrival Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Swinging, Berthing Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection, Documentation Time	[hrs]	*1.0*	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Unloading Time	[hrs]	16.8	17.4	19.3	19.6	19.6	20.3	22.5	22.8
Maximum Unloading Rate	[tph]	*1,700*	*1,640*	*1,480*	*1,460*	*2,550*	*2,460*	2,220	*2,190*
Efficiency Factor	[-]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Effective Unloading Rate	[tph]	1,190	1,148	1,036	1,022	1,785	1,722	1,554	1,533
Disconnection, Documentation Time	[hrs]	*3.0*	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Deberthing Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Departure Time	[hrs]	*0.5*	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Turn-around-time/Product Tanker	[hrs]	23.8	24.4	26.3	26.6	26.6	27.3	29.5	29.8
Total Turn-Around-Time Tankers/year	[hrs]	10,713	2,747	2,959	1,993				
Berth Occupancy Factor (BOF)									
Available Time	[days]	365	365	365	365	365	365	365	365
Down-Time	[days]	35	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Weather	[days]	25	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Holidays	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Other	[days]	5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Operational Time	[days]	330	330.0	330.0	330.0	330.0	330.0	330.0	330.0
Operational Time	[hrs]	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920
Berth Occupancy Factor (BOF) Produ	[-]	1.35	0.35	0.37	0.25				
Allowable BOF	[-]	*0.65*	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Number of Required Berths	[-]	2.08	0.53	0.57	0.39				
Combined Berth Requirement	[-]	3.58							
Actual Number of Required Berths	[-]	3	77.49%						

ANNEXURE 3.2

TECHNICAL SPECIFICATION

A. MARINE UNLOADING ARM

a. Type .... Hydraulic Operated
b. Size .... 12 ″
c. Product .... Petroleum Products
d. Maximum design temperature .... 85° C
e. Minimum design pressure .... 16 bar
f. Connection shipside .... 12 ″ ANSI 150$ WN FF flange
Connection inside .... 12 ″ ANSI 150$ WN RF flange
g. Balancing system .... Single Rotating Counterweight mechanism Mechanically linked
h. Sweivel joints : 6 off, type SAN 812
I. Materials :
- product wetted parts .... Carbon Steel
- sealing surface innerbody swiveljoint .... Stainless Steel
- Swivel productseals .... PTFE-C
- Construction parts .... Carbon Steel
j. Arm length dimensions
- Standport/ riser .... 6000 mm.
- Inboardarm .... 8000 mm.
- Outboardarm .... 5000 mm.
k. Surface preparation
- Carbon Steel parts .... 40 mm zinc phosphate primer.
l Other accessories .... as indicated below

Unloading arm shall be equipped with following accessories :

- Drain at triple swivel assembly & Drain at riser
- Vacuumbreaker at apex with ventline to triple swivel assembly (ended with valve)
- hydraulic cylinders for hydraulic operation
- Manual / Hydraulic double locking mechanism
- In-situ seal replacement at apex and trunnion
- In-situ seal replacement at trunnion
- Electrical isolation flange
- Support jack
- Earthing jack
- Earthing lug at base of the riser
- Stainless steel nameplate

B. ELECTRIC/ HYDRAULIC CONTROL, SYSTEM

Electric/ hydraulic control system (suitable for controlling 4 unloading arms) shall consist of :

- Hydraulic valve block one on each arm, mounted on the risers for controlling inboard, outboard and rotation movements.
- Single alarm system
- Power pack for hydraulic power supply
- Jetty Head Console
- Remote control pendant
- Hydraulic piping for a total running length of 3 m.

ANNEXURE 3.3

TECHNICAL SPECIFICATIONS OF PUMPS AND PIPELINE SYSTEMS

All pumps will be horizontal, foot mounted, centrifugal, split casing with upward discharge. Casing shall be CI to IS:210 Gr. 25, impeller and wearing rings made in bronze ASTM - B584, Shaft : EN-8 and shaft seal : Mechanical (Durametalic/Sealol), Shaft sleeves in 18-8 SS.

Motors for the pumps will be totally enclosed, fan cooled, suitable for full voltage star/delta starting and hazardous environment. Motors shall be flame proof conforming to IS:2148, Div. I Groups IIA and IIB. Protection shall be IP-55.

Motors shall conform to the Indian Standards IS:2148, 4691, 325, 1237, 4029 and 4278.

Pumps and motors will be directly coupled with a flexible coupling and mounted on a fabricated steel frame.

Pipes shall be ERW or submerged are welded pipes conforming to API-5L or IS:1978 or IS:1978 or IS:3589.

Flanges will be MS slip-on type conforming to B 16.5, class 150 # with raised face having serrations but without neck.

Gate valves will be cast carbon steel, bolted bonnet, rising spindle, B:16.5 class 150 #, conforming to API 600, class 150. Material of construction of main parts will be as under:

Body, bonnet	ASTM A 216 Gr. WCB, carbon steel
Seat ring and wedge	13% Cr. Steel ASTM-182 Gr. F6
Stem	SS (AISI 410)
Gasket	Spiral wound metallic SS-304 filled with asbestos
Bonnet bush	13% Cr. Steel
Stem packing	Machine braided metallic wire reinforced asbestos
Hand wheel	Malleable iron

Valves will be hydrostatically tested. Body to 450 psi and seat 300 psi.

Swing check valves will be cast carbon steel, bolted cover, B:16.5 class 150 #, conforming to API 600, class 150. Material of construction of main parts will be as under:

Body	ASTM A 216 Gr. WCB, carbon steel
Seat ring, disc nut, hinge pin	13% Cr. Steel (410 SS)
Disc	ASTM 217 Gr. CA, 15 SS
Hinge, bracket, cover	ASTM A-216 Gr. WCB, cast carbon steel
Gasket	Spiral wound metallic SS-304 filled with asbestos

RCVs will be remote controlled motor operated gate valves with above specifications.

Plus valves for loading wagons will be lubricated CI Audco valves.

ANNEXURE 3.4

INSTRUMENT SPECIFICATIONS

A. Tank Lorry Filling Gantry Automation

1. Basic Requirements

Products	HSD, SKO, Naphtha and MS
Density	0.73 to 0.85 MT/m³
Viscosity	HSD : 7.5 cs ; SKO : 8.0 cs ; Naphtha and MS : less than 1
Working pressure	3 kg / cm²
Design pressure	10 kg / cm²
Accuracy	± 0.05 %
Hazardous area class	Division - I

2. Flowmeter

Type	Positive displacement
Size	80 NB
Accuracy	± 0.05 %
Repeatability	± 0.02 %
Mounting/ connections	Horizontal, flanged
Body & cover	CS
Rotor and wetted parts	SS 304

3. Set Stop Valve

Type	Diaphragm or piston, solenoid controlled, hydraulic operated
Size	80 NB
Construction	Body : CS, Internals : SS 304
Control	Multistage cushioned
Solenoid valve	SS 304, port size 1/4"
Enclosure	FLP as per IS : 2148 for Gr IIA/IIB Weatherproof as per IS : 2147 for IP-65

4. Strainer & Eliminator

Type	Wire mesh basket
Size	80 NB
Mesh	SS 40
Air eliminator	Float actuated pilot operated
Material	Body : CS, Float : SS 316

5. Loading Arm

Type	Top loading
Size	80 NB
Material	Aluminium pipe with steel swivels
Balancing	Torsion spring
Working envelope	4 m x 6m x 1m (vertical)
Overspill protection	Yes
Other features	- Vacuum breaker and position limiting sensor. - Aluminium spout to be 1.5m long

6. Pulse Transmitter

Type	Duel pulse electronic
Security	IP 252 Level A
Mounting	On the output shaft of flowmeter
Enclosure	FLP Gr. II-A and II-B

7. Resistance Temperature Detector (RTD)

Type	PT-100, 3 wire simplex
Output	Current signal proportional to 0 - 70 deg C.
Mounting	Threaded connection
Thermowell	SS 316
Enclosure	FLP Group II-A and II-B

8. Magnetic Card Reader

Type	Electronic proximity switch decoder, IC based
Communication Link	RS 232 C serial link to RIT
Enclosure	FLP Group II-A and II-B & IP-65

9. Local Panel

Type	Microprocessor based
Inputs	Serial data from Batch Controller Acknowledge / start / stop key commands
Outputs	Three display lamps ; Compartment No.; Capacity; Delivered Quantity
Communication Link	RS 232 C serial link to Batch Controller
Enclosure	FLP Gr II-A & II-B, Weather proof IP-65

10. Batch Controller

Type	Microprocessor based
Inputs	Pulse from pulse transmitter
	Temperature
	Density
	Interlocks inputs
	- grounding unit
	- loading arm position
	- overspill protection
	Start / stop command from RIT
	Calibration
	Totaliser reset mode
	Completed / uncompleted delivery mode
	Serial IP from RIT
Outputs	Control signal to solenoid valve
	Compartment No.
	Delivered quantity
Display	LCD type
Diagnostic & Alarms	Pulse transmitter failure
	Temp. probe open
	Overspeeding and underspeeding of flowmeter
	Interlock failure
	Emergency stop command from RIT
Serial Communication	RS 485 multidrop link to RIT
Meter Linearisation	10 point over 10 -100 flow rating of meter
Enclosure	FLP Gr. II-A and II-B, weather proof IP-65

11. Loading Computer (LRC)

PC 80 586 Pentium processor, IBM compatible

Type	32 bitprocessor
Hard disc	1.2 / 2.1 GB HDD
Floppy	1.44 MB 3-1/2"
Memory RAM	32 MB
Ports	2 x 232 serial and
	1 x parallel port
Operating System	UNIX / OS-2
LAN driver	Required
CD ROM	Optional
Key Board	101 key board
Monitor	Super VGA colour 14" with high resolution card with 2 MB memory
Mouse	Microsoft with pad and software

LRC is to be interfaced with TDM computer on TCP/IP communication protocol.
LRC is also to be interfaced with Tank Farm Management system computer.
It should have provision of duel ethernet.

12. Operating Interface Consoles

PC 80 586 Pentium processor, IBM compatible

Type	32 bit processor
Hard disc	510 MB HDD
Floppy	1.44 MB 3-1/2"
Memory RAM	32 MB
Ports	2 x 232 serial and 1 x parallel port
Operating System	UNIX / OS-2
LAN driver	Required
CD ROM	Optional
Key Board	101 key board
Monitor	Super VGA colour 14" with high resolution card with 2 MB memory
Mouse	Microsoft with pad and software

13. Printers

Type	DOT Matrix
Print columns	132
Speed	300 cps or above
No. of character type	256 character set
Paper type	fanfold continuous
Paper width	381 mm
Paper feed	Friction

14. Grounding Unit

Type	Dual channel, electronic grounding with cable and crocodile clamp
Supply	230 VAC
Interlock	Interlock with Batch Controller
Enclosure	FLP Group II-A and II-B

15. Densitymeter

Type	S-mass microprocessor based
Principle	Corriolie
Range	0.25 to 2.5 gms/cc
Accuracy	+ 0.0005 gm/cc
Output	Digital
Communication	RS232
Wetted parts	SS 316
Mounting	On main pipe header
Enclosure	FLP Gr. II-A and II-B

16. Uninterrupted Power Supply System

Type	On line thysirotorised UPS
Capacity	Double the requirement of TLF loading automation system
Wave form	Pure sinusoidal
Harmonic distorsion	Less than + 5 %
Transient-response	+ 5 %
Input voltage	230 V
Output	2 Nos. 230 V with suitable isolation
Others	Provision for manual changeover from UPS to regular power supply

17. Seal Entry Device

Type	Microprocessor based
Input	Signal from Batch Controller
Features	Provision of alfa numerical key pad for feeding S.No. and ID No. of TLF supervisor and card swiping facility
Output	Signal to LRC
Display	LCD for status of tank truck

18. Software

Design is to be based on 'Open Architecture' approach where all sub-systems are built around standard state of art hardware and software module. It should have following minimum features :

- Continuous barograph and display of TT loading data for single bay or in groups.
- Display of volume loaded with respect to 15° C and at ambient.
- Auto printing of TT loading data.
- Out-of-turn report generation and printing.
- Viewing of logged TT loading data.
- Bay allocation logic

LRC is to be interfaced with TDM computer on TCP/IP communication protocol and software for the same will be provided by the vendor.

LRC should also be interfaced with tank farm monitoring system.

19. Proving System

Type / capacity	Portable type / 3000 litres
Neck	Top graduated neck
Vent & Drain	Connection required
Gauge Glass	Required
Construction	Steel, internally epoxy painted
Master meter	Required
Code	System should conform to relevant code

20. Ball Valves

Type Class	Lever operated, regular port, anti blow out stem with anti static device / 150#
Size	80 NB
Construction	Single piece with body and insert of CS. Ball and stem of SS 316.
Seat	PTFE
Ends	Flanged to B 16.5
Code	Fire safe API 607 & BS 5351

ANNEXURE 3.5

SPECIFICATIONS OF TANK FARM MANAGEMENT

1. Basic Requirements

The tank farm management is required for petroleum oil storage tanks in Zone 1 and group II-A and II-B.

Products to be stored are HSD, SKO, Naphtha and MS. Density varies from 0.73 to 0.85 MT/m³. Viscosity in centistokes : HSD - 7.5 ; SKO - 8.0 ; Naphtha and MS - less than 1.

2. Servo Gauge

Operation	Level, temperature, base sediment and water (BSW), density and tank base
Range	0 - 20 m
Accuracy	+ 1.0 mm
Sensitivity	+ 0.1 mm Repeatability 0.1mm
BS&W	+ 2.0 mm
BS&W min. level	10.0 mm
Density	+ 2 kg/m³
Sensor speed	40 mm/ sec
Level alarms	3 software programmable plus one external
Temperature	upto 50 deg C
Accuracy	+ 0.2 deg C
Mounting	Ground mounting
Material	Cast aluminium
Tape	Tefzel coated stainless steel
Enclosure	FLP Gr. II-A and II-B, Weather proof IP-65
Data security	IP level 3
Local display	LCD
Protection against lightening & surge	To be provided
Baud Rate	300 - 2400

3. Tank Side Indicator

Indication	Level, temperature, alarm status, servo check
Data transmission	Digital type fidelity and data security to level 3
Baud rate	300-2400 BD
Housing	Gr. II-A and II-B ; Weather protection IP-65
Switches	Magnetic pen

4. Tank Data Receiver / Communication Converter Card

Type	2 wire bi-directional microprocessor based
Capacity	22 tanks plus provision for adding 10 more
Communication	RS 232

5. Computer

PC 80 586 Pentium processor, IBM compatible

Type	32 bitprocessor
Hard disc	1.2 / 2.1 GB HDD
Floppy	1.44 MB 3-1/2″ 1.2 MB 5-1/4″
Memory RAM	16 MB
Ports	2 x 232 serial and 1 x parallel port
Operating System	UNIX /OS-2
LAN driver	Required
CD ROM	Optional
Key Board	101 key board
Monitor	Super VGA colour 14″ with high resolution card with 2 MB memory

6. Printer

Type	DOT Matrix
Print columns	132
Speed	300 cps or above
No. of character type	256 character set
Paper type	fanfold continuous
Paper width	381 mm
Paper feed	Friction

7. Software Features

- Continuous barograph and digital display of tank data for single tank and group of tanks.
- Automatic volume calculations using tank strapping tables and ASTM tables for volume and density corrections.
- Display of total, gross, net at 15 deg C and ullage volume for current levels in the tanks.
- Auto printing of tank farm data at specified intervals.
- Autologging of tank farm data at specified intervals.
- Out-of-turn report generation and printing.
- View of previously logged data and history of tank.
- Manual data entry of free water level, sample density (with temperature), alarm values and corresponding alarm relay number.
- Shift variation and daily variation calculation for tanks. Inventory calculation for a product.

ANNEXURE 3.6

SPECIFICATION OF FIRE FIGHTING EQUIPMENT / SYSTEM

1. Monitors

The Monitors shall be suitable for both foam and sea water. Each monitor shall be capable of discharging 18,000 LPM of expanded foam or 3,000 LPM of sea water at 10 kg/cm^2 inlet pressure over a range of 90 metres in horizontal direction. The monitor shall be capable of producing good quality foam including AFFF and fluoro-protein foam. The materials used for different parts of the monitor shall be as under :

Barrel	SS 316
Body	Gun metal IS: 318 Dr. 2
Worm and Worm Wheel used for vertical and horizontal rotation of monitor	Phosphor bronze
Horizontal and vertical Swivel	Gun metal IS : 318 Gr. 2
Base flange	- do -
Bolts and Nuts and Washers	SS 304

The Monitor shall be capable of 360° rotation in either directions in horizontal plane and 30° (elevation) and -70° (depressions) in vertical plane. Suitable electric/electro hydraulic electronic equipment shall be mounted on the monitor so that rotation of the monitor can be achieved by remote control. In case of failure of remote control system, it shall also be possible to rotate the monitor manually from the base of the tower. The manual arrangement provided with mechanical linkages shall be such that it should be capable of being operated by one person. The monitor assembly shall be designed to resist the nozzle reaction force experienced during the operation of the monitor. The monitors shall be provided with a change over valve of suitable design for instantaneous switch over from foam to water or vice-versa. The entire assembly shall be shock tested to a internal hydraulic pressure of 20 kgs./cm^2.

2. Foam Compound Induction.

Foam induction system shall be balanced pressure proportioning system to ensure proper mixing of foam concentrate and right proportion of foam concentrate. The foam compound inductor shall be able to supply correct proportion of foam to the monitor line depending upon the flow of water. A flexible rubber pick up tube of suitable length and having a strainer at the end shall also be supplied. The strainer shall be of brass, chrome plated. A foam compound control valve shall be provided which shall be able to induce and meter 0 to 6 per cent of foam compound.

3. Remote Control System

Remote control is required to be provided for rotation of foam monitors in horizontal and vertical plane. The rotation of monitors is to be controlled from the control room. The remote control system shall be electrical/electronically operated or pneumatic/hydraulic operated. The equipment used for remote control system, shall be explosion proof and the wiring shall be by heat resistant cables. The essence of the working of the monitors depend upon the reliability of this system. Therefore, the latest practices to increase its reliability must be adopted. The remote control system should also control the electrically operated valves in the tower monitor lines and the hydrant/water curtain lines. The foam injector system also should be controlled by this system. The cables used must be able to withstand temperature of at least 1000°C.

If electro-hydraulic system is used for remote control of monitor. the same shall consist of hydraulic power packs, hydraulic equipment on the monitors and the electric control panel and inter-connecting piping. Hydraulic power pack for each monitor shall be located in a room provided at the base of the respective tower and the electric control panels shall be installed in the control room over pump room. Additional local control stations shall be provided at the jetty head platform at ground level.

The hydraulic power pack shall comprise the following :

i) Flame proof electric motor with DOL starter.
ii) Tank, pump with pressure relief valve, safety valve, regulator, directional control valves, flame proof solenoid valves, pressure gauge etc.

The inter-connection of hydraulic equipment shall be done by heavy duty stainless steel tubings.

The electric control panel in the con trol room over the pump room and on the central unloading platform shall have the necessary controls for the following operations :

i) 'Start' and 'Stop' of hydraulic pump (power pack).
ii) Right, left, up and down movement for each monitor.
iii) Motor actuated valves on water riser pipes at towers.
iv) Valves for drenchers/water spray nozzle system.
v) Foam pumps and valves.

A flow chart of the entire fire fighting system shall be provided in the control room.

All the electrical equipment/accessories used in the control panel shall be flame proof and suitable for use in Zone I. Group II hazardous areas as per IS:2148. The cables (HR insulated and FRLS sheathed) shall be laid in trenches, pipeducts or cable trays. The entire electrical system shall be totally waterproof so that, during the fire fighting operation no short circuit can develop.

4. Fire Water Pumps

4.1 Fire water pumps shall be designed for sea water services and materials of construction would be as follows :

Discharge elbow, column	13.5 to 17.5% Ni Cl IS:2749 or ASTM A436 type I
Pump Casing	13.5 to 17.5% Ni Cl, IS:2749 of ASTM A436 Type I.
Impeller	Stainless Steel ASTM-296/CF 8 or IS:1570 - 1961.
Suction bowl / bell mouth	13.5 to 17.5% Ni Cl IS:2749, or ASTM A 436 Type I.
Shaft / shaft sleeves	Stainless Steel. ASTM A 437
Shaft protection tube	13.5 to 17.5% Ni Cl IS:2749 or ASTM A436 Type I.
Shaft couplings	Stainless Steel ASTM A 432
Couplings for pumps	Forged Steel.
Line bearings	Cutless Neopren rubber in SS retainers.

4.2 The fire fighting system consisting of :

a) Main water pumps (electric and diesel) - Vertical Turbine type as per IS:1710.

b) Jockey pump Vertical Turbine type as per relevant I.S. code.

Prime mover for all of the main pumps shall be diesel engine, suitable for these pumps. Gear box should be according to AGMA 460.5. The vertical pump is to be lowered into the open sea and hence should be capable of absorbing thrust ensuing from waves in the sea. A jacketing pipe with corrosion inhibitor or any other suitable protection for the pump and also protection against marine growth shall be provided.. Suitable strainer with cleaning arrangements shall be provided at the bottom.

The drive rating shall be equal to or more than the rating required to operate the driven equipment at any point off its performance curve.

4.4 The jockey pump shall be of vertical turbine type with electric motor as prime mover.

5. Foam Supply Tank

Two foam supply tank of 10 cubic meters capacity fabricated out of minimum 10 gauge stainless steel -304 quality sheets shall be supplied and mounted on suitable supports. To give sufficient strength to the tank, suitable baffles/ reinforcement of stainless steel shall be provided. The tank shall have 450 mm.

dia. inspection man hole with cover, expansion dome and air vent. The expansion done shall be designed with a capacity of 3% of tank capacity so that normal thermal expansion and contraction of the foam compound occurs within the dome. As overflow vent with suitable fixtures shall be provided to the tank. The tank shall have filler cap of 150 mm dia. with strainer. A breather valve and a sludge trap shall be fitted to the tank. The sludge trap shall have cleaning hole and 25 mm dia. drain pipe with a valve and plug. The bottom of the tank shall have a slight slope towards the sludge trap. Necessary lifting hooks shall be provided on the tank. The design, fabrication and testing shall conform to IS-2825.

6. Hand Pump

Semi-rotary hand pump shall be supplied and fitted at a suitable place for filling of foam compound from drums/barrel to the overhead foam supply tank. The Contractor shall carry out necessary piping along with valves etc., from this pump to the tank.

7. Foam Supply Pumps

Two electrically operated foam liquid pumps (one stand-by) each capable of delivering sufficient quantity of foam to the line supplying water to the three monitors at the required pressure so as to obtain 1:6 ratio suitable for fire fighting operation. The pumps shall be of positive displacement herringbone rotor type in stainless steel construction. The pump will be used for pumping the required foam liquid into the sea water line. The electric motors, star-delta starters and other electrical equipment shall be flame proof and suitable for use in Zone I. Group II hazardous areas as per IS:2148. The material composition of various parts of the pumps shall be compatible with foam liquid. The suction and delivery piping, pipe fittings and valves shall be suitable for foam liquid.

8. Foam Proportionating System

Foam concentrate to be used shall be tested and approved quality AFFF or flouro protein foam concentrate.

Correct foam liquid proportioning is necessary to produce optimum quantity and quality of foam for extinguishing flammable liquid fires. The foaming liquid should be as proportioned that normally 6% foam/water mixture is available. The pump capacity mentioned above has to be designed so as to discharge foam liquid suitable for maximum quantity of foam solution requirement (viz., when three foam monitors being operated simultaneously). However, depending upon the exigencies of operation such as either three or two monitors or one monitor are working, the flow requirements will vary. Orifice plates should, therefore, be provided to con trol the flow of the foam liquid into water so that correct foam proportioning is achieved in a given operating condition. The excess portion of the foam liquid shall return to the foam supply tank.

9. **Jumbo Curtain Nozzles.**

The jumbo curtain nozzles shall be able to produce dense water curtain of 12 metres radius through 170° angle in vertical plane at discharge rate of 1000 LPM of sea water at inlet pressure of 8 kg/cm². The nozzles shall be gun metal as per IS:318 Grade 2. To obtain coverage upto 20 m height, the nozzles will be mounted at two levels.

10. **Valves**

The control valves to be incorporated in the pipeline system, shall be of 300 class flanges and ball valves of reputed make confirming to IS:7801, 2906. The materials composition of the various components of the valve shall be as under :

Body	2.5% Ni CI: IS 210
Stem	SS 316
Ball	SS316
Main seal, body gasket, gland seal	Teflon
Handle	2.5 % Ni, CI : IS 210
Actuator Motor (wherever used)	Intrinsically safe
Nuts and Bolts	Stainless steel

12. **Towers**

Two nos. RCC monitor towers on berthing dolphins and one no. RCC tower for ground monitor shall be provided on the berths. The monitors on the berthing dolphins shall be 20 m high from the deck level. The height of the ground monitor on loading area platform shall be 3 m from deck level.

13. **Pressure Relief Valve**

The pressure relief valve shall be of reputed make with double flanged ends. This valve shall be fixed on the main salt water pipe line. The set pressure for this valve shall be 15 kg/cm². This valve has to relieve any excess pressure that may develop over and above the set pressure.

14. **Fire Hydrants**

These shall generally conform to IS:5290. They are double headed and flow shall not be less than 36m³/hr at 7kgs./cm² from each. This shall be tested to 18 kgs/cm² as per relevant IS. Code. The ends shall be fixed with male couplings. Material of construction of hydrant valve, branch pipes and coupling shall be SS:316.

15. **Hose Pipes**

The pipes shall be of reinforced rubber lined with the best quality cotton and nylon jacketted fire fighting Hose pipes 63mm. dia. in standard lengths tested to a burst pressure of 37 kg/cm² seamless woven and rot proofed by mystox treatment, manufactured as per IS:639/79 fitted with gunmetal 63 mm. size male and female hose couplings as per IS:903.

16. Surface Preparation & Painting

a) Sand blasting shall be carried out for all steel structures, pipes, supports, ladders, before installation.

b) All outer steel surfaces to be sand-blasted and then shall be painted.

c) The sand-blasting should be done during day time and in dry weather using dry river sand of appropriate size.

d) The sand-blasting should be done to achieve a grey or near-white surface conforming to SA 2.5 standard after the sand blasting operation.

e) The first coat of zinc-rich primer should be applied within a hour of sand-blasting.

The sand blasted surface should be painted with one coat of zinc-rich primer and two coats of coaltar epoxy, the thickness of coat of the zinc-rich primer shall be not less than 40 microns and the thickness of each coat of coaltar epoxy shall be not less than 100 microns. The total dry film thickness of the total painting shall be not less than 240 microns.

The zinc-rich primer paint shall have 92% zinc-rich content. Both the zinc-rich primer and the coaltar epoxy paint shall be compatible and the paint shall be of reputed makes.

All over ground lines shall be sand blasted and epoxy painted whereas the underground lines shall be double coated and double wrapped.

ANNEXURE 3.7

SPECIFICATIONS OF OIL - WATER SEPARATOR

In the normal course, oily water of the floor washings will be received at the effluent treatment unit. At several times during the day, there will be no input to the unit as washing would be going-on in the areas hooked to the unit. It will then remain dry. The maximum flow will occur when it rains.

The unit will have the capacity to handle 250 m^3/hr of flow which is based on the rainfall in the areas vulnerable to oil leakages and connected to the unit.

Specifications of Tilted Plate Interceptor

Flow rate	250m^3/hr
Flow direction	Counter current
Plates	
- type	Corrugated
- no. of bays	2
- no. of packs per bay	4
- no. of plates per pack	42
- installed surface area/pack	77 m^2
- angle of inclination	45 deg
- plate spacing	20 mm
- rising rate	0.7 m/hr.
- size of plate	1750 x 1000 mm
Overall size of the unit	9.5 m x 5 m x 4 m
Material of Construction	
- basin or pit	RCC
- plate pack	FRP
- frame box	FRP
- support frame work	Mild steel (epoxy painted)
- baffles	FRP
- weirs	Mild steel (epoxy painted)
- skimmer assembly	Mild steel (epoxy painted)
- oil discharge pipe	Mild steel (epoxy painted)
- nuts and bolts	SS 304

FIGURES

DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILED PROJECT REPORT

CONTENTS

SECTION 9 : ADVICE ON FURTHER INVESTIGATIONS

Chapter 1 : Advice on Further Investigations

1.1 INTRODUCTION

As a follow up to this Detailed Project Report (DPR) , it is suggested that a few more investigations be carried out at Positra III before construction of the port is taken up. These supplementary studies will be necessary so as to firm up the basic data assumed during the preparation of DPR. The additional studies/ investigations suggested are described in the following paragraphs.

1.2 SEABED ENGINEERING SURVEYS

i) Bathymetric Surveys

The sea bed contours are essentially based on the British Admiralty Chart no. 43 published in 1979. Apart from being old one, the scale of the drawing (i.e. 1:150,000) is also too small to be used for accurate siting of berths. Therefore it is proposed that a fresh detailed hydrographic survey be carried out in the port area and the approach channel. The depths shall be recorded on a grid of 50m x 50m. The soundings shall be plotted to a scale of 1:5000. This will give an accurate profile of the seabed in and around the port area.

The surveys shall extend upto -20 m contour.

The area proposed to be covered by bathymetric surveys is marked on drawing no. GMB/DPR/SEC9/01.

ii) Shallow Seismic Profiling

Shallow seismic profiling of the project area will be necessary to obtain continuous profiles of the seabed around the proposed port area . It can establish hard rock levels, sub-surface stratigraphy, individual stratigraphic units and their thicknesses including interfaces thereof.

The surveys shall extend upto -20 m contour.

The area proposed to be covered by shallow seismic profiling is shown on drawing no. GMB/DPR/SEC9/01.

iii) Side Scan Sonar Surveys

Side scan sonar surveys are undertaken to track any hidden underwater obstacles, wrecks, etc. in the vicinity of the project area.

The surveys shall extend upto -20 m contour.

The area to be covered by side scan sonar surveys is marked on drawing no. GMB/DPR/SEC9/01.

iv) Oceanographic Surveys

These include field measurement of sea currents (i.e. intensity, direction and variations thereof) and tides (i.e. mean water levels and tidal fluctuations including predictions of HHWL & LLWL) at the port site.

v) Collection & Analysis of Seabed And Water Samples

A few seawater and seabed soil samples shall be collected and analysed for the following properties:

a. Shallow soil samples

- gradation analysis and classification ;
- ' C ' & ' ϕ ' analysis ;
- liquid limit ;
- plastic limit ;
- plasticity index ;
- in-situ moisture content ;
- in-situ dry density ;
- specific gravity ;
- void ratio ;
- chemical analysis (i.e. pH, sulphate and chloride content)

b. Water samples

- pH ;
- chlorides in ppm & % ;
- sulphates in ppm expressed as SO3 & SO4 ;
- organic content ;
- total salinity.

1.3 GEOTECHNICAL INVESTIGATIONS

As a part of the consultancy assignment to prepare the Detailed Project Report (DPR) for development of port facilities at Positra, extensive onshore and offshore investigation were carried out at Positra. Since sub-soil profile was one of the most important parameters governing the site selection, the investigations were spread over a wide area viz. Positra II (north of Positra point) - 4 boreholes; Positra II (west of Positra point) - 3 boreholes; Positra III - 3 boreholes ; eastern channel (between Paga Reef and Bural Reef) - 2 boreholes; western channel (between Paga Reef and Bet Shankhodhar) - 2 boreholes. Thus in all 14 marine boreholes were completed. In addition eleven onshore borings were carried out.

Since Positra III was found to be the most suitable site, additional subsoil investigations will be necessary before the construction is taken up. It is proposed to carryout 170 marine and 18 onshore borings for the entire port development in the final stage. The locations of the recommended boreholes are shown on drawing no. GMB/DPR/SEC9/02.

The following field & laboratory tests shall be carried out on the soil samples :

a. Field Tests

- Standard penetration tests in the boreholes;
- In-situ vane shear tests;
- Static cone penetration tests; (SCPT)

b. Laboratory Tests

- Grain size distribution;
- Atterberg limits;
- Consolidation tests;
- Natural water content;
- Bulk & dry density;
- Specific gravity & void ratio;
- Triaxial tests;
- Unconfined compression tests on soil samples;
- Point load index tests on rock samples;
- Unconfined compression tests on rock samples.

ATTACHMENT - A
COMMENTS FROM GMB

Telex : 0121-6375 GMB IN
Gram : "PRINCPORT"

Tel. No. : (O) 376270 376506
376513 376189
376276 376590

GUJARAT MARITIME BOARD

Block No. O-20, New Mental Hospital Compound, Meghaninagar, AHMEDABAD-380 016.

No.GMB/N/PVT/121(10)/P/II/1471 26th May 1998
Fax No. 011 -6460186

Frederic R. Harris Inc.
41, Zamrudpur Community Centre
Kailash Colony
New Delhi

Sub:- DPR for development of port facilities at Positra
....

Sir,

Please refer to this office letter dated 17th March 1998 submitting concluding remarks of Netherland Experts on Task-2 report submitted by you. Now, we are in receipt of remarks on Task-3 reports which may please find enclosed herewith.

You are requested to incorporate the compliances of all the relevant observations made by Netherland experts and submit draft final report for aproval of Gujarat Maritime Board at the earliest.

Yours faithfully,

Executive Engineer(C)

Encl: As above

Frederic R Harris (I) Pvt. Ltd.
41 Zamrudpur Community Centre,
Kailash Colony,
New Delhi-110 048.
Tel 91-11-662-2244, 623-4060
Fax 91-11-646-0186
HARRIS
RECEIVED
June 1, 1998

Department	Int.	File No.
Tech	AK	

4. Review of additional information of Positra

Port and transport economy

a) The traffic forecast, as applied during Task 1 and 2, has been unchanged. Consequently, the conclusion can be maintained that traffic forecasts can be judged rather overestimating, which reduces the validity of all financial calculation, as included in Task 3. According to the CES traffic forecast Positra may be expected to handle some 20 million tonnes in 2011, whereas the feasibility study assumes an additional 18 million tonnes, accumulating to a high 38 million tonnes.

b) Construction costs, annual operating costs and major assumptions for Positra have been indicated in the table below. Compared to other Greenfield locations, the total envisaged investments in Positra exceed all other locations. Taking into account the proposed cargo volume, the total investment amount seems in line with most other Greenfield ports.

	Investments in US$ mill.	Cargo vol. 2011	Incl. design superv.	Incl. import tax	Incl. land acq.	Annual oper. costs
Phase I	540					21
Phase II	221					32
Phase III	237					40
Total	998	38	y	?	n	

Table 1

c) The financial forecast has been prepared in a correct and orderly manner. The methodology followed is correct and does not comprise inconsistencies. However, on the level of the figures applied, a number of observations should be mentioned:
   - Since all operational flows have been expressed in constant prices, the assumed interest rate on the loan seems rather high. A real interest rate of some 13 percent would be considered rather excessive if all flows would be expressed in current prices. Although it is acknowledged that a substantial premium will be payable for additional risks, the interest rate should not exceed some 7 percent.
   - The same rate applies to the required rate of return on invested capital. In view of the risk profile of the project and the financial construction, a 18 percent required rate of return seems appropriate as long as current prices are involved. In case of constant prices, a 12 to 14 percent required rate of return on invested capital should suffice.

d) In addition, it should be mentioned that all costs related to common marine facilities are born by the coal terminal. By assuming this financial construction, the financial performance of the coal terminal is underestimated, whereas by POL and container terminal are overestimated.

e) Therefore, the following remarks on the conclusions should be made:
   - In view of the above made remarks, the attractiveness of the investments in Positra should be judged more positively than mentioned in the report. However, it should be underlined that a more moderate traffic forecast would reduce the attractiveness of the proposed investments.
   - The financial performance of the coal terminal is slightly underestimated, whereas both POL and container terminal have been overestimated.

Port operations and nautical aspects

a) The selection of the design vessels has been treated carefully. They are based on trade considerations and the choice of design vessels allows for future expansions.
b) A number of different lay-outs have been proposed. The selection of Positra III is correct in view of financial and operational advantages. The current data on which berth orientation has been based should be extended by means of an extensive survey in view of the effect that currents may have on vessels moored at the liquid and coal terminal jetties.
c) As Positra III can be regarded as a protected site, downtime of the terminal due to wave action is not expected to influence port operations to a significant extent.
d) Berth occupancy has been taken into account in a number of ways and optimum berth occupancy guidelines differ for the different commodities. No proper explanation has been given by consultant for these differences. More specifically we conclude that the treatment of berth occupancy for the coal terminal is inappropriate. Apparently consultant assumes that the process of ship arrival can be planned in case of the coal terminal. However no reasons have been given for this assumption. The resulting occupancy figures are very high and tend to result in long waiting times for the vessels. For the liquid terminal berth occupancy has been treated in a thorough way and the resulting occupancy figures guarantee a smooth operation. The treatment of this subject for the container terminal is also rather limited. The resulting occupancy figures for the longer term do not guarantee an operation that can be considered as competitive for deep-sea liners.
e) The selected solutions for cargo handling and storage are adequate for all different commodities. The resulting throughput figures for the container terminal are relatively high and for coal throughput relatively low compared to international standards.
f) The operational consequences of some of the selected options (e.g. bunkersystem on the coal terminal, trade-off between operational rules and berth occupancy on the liquid terminal, no track-side storage on the container rail terminal) could be clarified by means of simulation models. The use of this type of modelling could also be helpful in determining over-all berth occupancy.
g) The criteria that have been applied for the determination of nautical dimensions can be regarded as internationally accepted. Channel width allows for one-way traffic, which might have to be extended to two-way traffic in future. Possibilities for this extension should be verified.

h) In view of the wave conditions in the unprotected reaches of the channel, an overdepth of 2.5 m can be considered as too small for the largest vessels under consideration. An overdepth of about 20% of the ship's draught is generally accepted as minimal. However, considerable savings could be attained in the protected reaches, where an overdepth of about 10% of the ship's draught might suffice. These items deserve further attention in the optimisation of the design.

i) In the determination of the turning circle area a miscalculation has been made. The diameter of the turning circle should be 650 m instead of 350 m. Consultant should consider the effect of currents during turning manoeuvres as they might necessitate a somewhat larger turning circle diameter.

j) Consultant is not clear as far as downtime during manoeuvring to and from the port site is concerned: It is unclear where pilots will board the vessels and where tugs will make fast. If these processes are expected to take place in the unprotected reaches of the channel considerable downtime might result in view of the wave conditions. If, on the other hand, they are expected to take place in the protected channel, the width should be extended to allow for decellerating manoeuvres.

k) It is also unclear how consultant proposes the vessels to traverse the area with cross currents of up to 5 knots mentioned in earlier reports. A generally accepted design rule states that, while sailing through cross currents the vessel speed should be 3 to 4 times the current velocity. Consequently the vessel speed should be 15 to 20 knots. In our opinion this is an improbable option. As a consequence vessels should traverse the area at slack tide. This restriction limits the effective operation of the port to a large extent.

l) Navigational procedures should be based on better understanding of the current pattern within the different bays. The proposed procedure of limiting entrance, exit and berthing manoeuvres to slack tide poses a probably unnecessary heavy burden on port operations.

m) The determination of the required number of tugs should be clarified. Taking into account that the channel is a one-way channel, in our opinion the above-mentioned restriction blocks the development of the port up to the 2011 projections. Consultant should make clear that it is possible to transit a one-way channel with a length of about 10 miles with 6 vessels entering and 6 leaving each day while maintaining the slack tide manoeuvring restriction.

Coastal engineering aspects

a) The method of determination of the offshore wave climate tends to underestimate operational wave conditions. Using the average monthly wind speed does not account for daily or hourly fluctuations, what can seriously affect most certainly the waves related shipping procedures. Other sources indicate that the selected wave period (5-6 s) is rather small for monsoon conditions. It is strongly recommended to set up an wave survey before any further steps will be taken.
b) The current survey provided results that can be taken as a starting point for preliminary design purposes. For detailed design of channel and manoeuvring areas more extensive surveys are required.
c) The same general considerations about the decklevel as made for Bedi are valid here. This results in a minimum decklevel because of dynamic wave impacts of about 4.2+0.6*1.0/2+1.6=6.1m. Due to overtopping a minimum decklevel should be about 4.2+1.5*1.0/2=5.0m.
d) To find the optimal design, as well for operations as for influence on the investments it is necessary to have more accurate wave data at the specific location.
e) The negative effect of port development at the Positra III location to the marine life nearby (coral on the Boria Reef and two other adjoining reefs) does not appear so clearly because of scoring socio environmental and environmental effects together as being one subject in the multi criteria analysis. From an economical point of view it might be unfeasible, but from an environmental point of view it would be better only to develop a container terminal for Positra (for which Positra III looks most favourable).

	Conclusions on Positra port
Consultancy work	• Moderate
Prospects port	• The Positra location looks to be an unique location for a container terminal that has the potential to become a perfect feeder terminal for the larger ports in the area. • Since captive cargo is limited, the location of Positra is less attractive than suggested in the study. A phased development of Positra may prove economically attractive.

5. Concluding remarks.

Studying the additional information about Bedi and Positra resulted in a lot of information but does not change much the earlier written conclusions and recommendations in the evaluation report.

Compared to earlier Interim Reports, the major operational change is that containers are no longer handled at Bedi port. In our earlier evaluation report successful container transhipment in Bedi has been doubted already.

There are still doubts about the economical feasibility of the agricultural port of Bedi. The internal rate of return has been based on rather optimistic traffic forecasts. Furthermore since the capital investments have not been taken into account, the internal rate of return is currently overestimated.

For Positra III, the most favourable location near Positra, still some problems about manoeuvring to and from the port site should be solved. If indeed the vessels should traverse the area at slack tide the effective port operation will be restricted to a large extent.

For Positra it should be underlined that a more moderate traffic forecast would reduce the attractiveness of the proposed investments.

Conclusions on a final ranking of Greenfield port locations still require the input of the transport-economic elements for which the "helicopter assessment study" has been drafted.

Frederic R. Harris, Inc.
300 East 42nd Street
New York, NY 10017
212-973-2900
Telex: 12409 FRH
Fax: 212-953-0399

HARRIS

31st July, 1998

Gujarat Maritime Board
New Civil Hospital Compound
Meghaninagar
Ahmedabad - 380 016

Attention : **Mr. V.K. Bhavdasan, Executive Engineer (C)**

Subject : **DPR for Development of Port facilities at Positra.**

Dear Sir,

Kindly refer to your letter no. GMB/N/Pvt/121(10)/P/II/1471 dated 26th May, 1998 and your subsequent reminder fax dated 31st July, 1998 regarding the comments of the Netherland Experts on Task 3 report.

Please find enclosed our detailed response to the comments made and the points raised. You may please note that there is no implication on the final report we had already submitted to you. Yet, you may kindly go through our response and indicate your views. If you agree with us, you may please give your clearance for the final report and we would make copies and submit to you.

We sincerely regret the delay in our response which was caused by the necessity to get the inputs from our experts at our Holland office .

Thanking you and assuring of our best service always,

Very Truly Yours,
for *Frederic R. Harris Inc.*

(S. Jagannathan)
Project Manager

Encl : Response to comments of Netherland Experts

Response to the comments of Netherland Experts on Task No. 3 Report forwarded by GMB vide their letter no. GMB/N/PVT/121(10)/P/11/1471 dated 26th May, 1998

1. ***Port and transport economy :***

(a) It has been commented that the traffic forecasts "can be judged rather overestimating."

It may be noted that the traffic forecasts were furnished by GMB to the consultants to be adopted since an exclusive traffic study was not part of the scope of this consultancy.

(b) No response is required.

(c) The following observations have been mentioned :
"Since all operational flows have been expressed in constant prices, the assumed interest rate on loan seems rather high."
" The same rate applied to the required rate of return on invested capital."

The International Funding in Indian projects are regulated based on policy guidelines of the Govt. of India, according to which a portion of project finance is quantified in domestic market. The interest rate for domestic borrowing is linked to PLR and is in the range of 13% to 15%.

In the case of Euro projects, where finances are available in any Euro currencies, the interest rate of 7 % may be reasonable since exchange rate is not much affected. However, external borrowings for Indian projects should have a cushion for exchange fluctuations. Considering the above conditionalities the interest rate of 13 % in our opinion is reasonable.

Working out IRR at constant prices is the 'standard' for evaluating project viability, accepted in Indian environment. It is true that some of the International Consultants arrive at operational flows, duly providing some escalation formulae based on certain indicators. In the absence of an unbiased, composite indicator, covering all variables (also giving due weightage for each such variable) , it is felt that it will be more prudent to work out IRR at constant prices. Incidentally this also helps evaluation of project in competitive conditions or in different alternative options.

(d) It is mentioned that all costs related to common marine facilities are borne by the coal terminal.

Costs relating to common facilities (channel, navigational aids, etc.) are charged to coal terminal since the other terminals are only offshoot of this primary and first terminal. Distribution of these costs to other terminals may be one approach, but such allocation can materialise only if and when the other terminals are commissioned. Pending such an event, the costs of these common facilities cannot be left unrecovered.

2. *Port operations and nautical aspects*

(a) No response required.

(b) A suggestion has been made for an extensive current survey in the area which has already been recommended by the consultants.

(c) No response required.

(d) It is commented that 'apparently the consultant assumes that the process of ship arrival can be planned in case of the coal terminal. However no reasons have been given for this assumption.'

It has been presumed that the coal supply will be based on a long term contract with a single supplier. (It was also indicated by GMB that talks are on between the Govt. of Gujarat and the Govt. of Australia for supply of coal on bilateral agreement). In such a case it would be possible to plan the ship arrivals. Since it is a question of optimising the capital costs, this presumption is necessary as otherwise taking random arrival of ships would result in the provision of additional berths and consequently additional costs.

In the final phase of the development by year 2011, the requirement is for two dedicated offloading berths and two dedicated loading berths. At that time, the berth occupancy for the offloading berths will range from 56% if only large vessels are used (Scenario A) to 63% in case the fleet mix is half larger vessels and half smaller vessels (Scenario C). At that time, depending on the actual throughput volumes and the fleet mix, and the coal handling rates achieved, further development actions will have to be determined. For the loading berths the berth occupancy (by 2011) will be about 56 %.

Overall, the recommended development is for two berths for the first phase, one offloading berth and one loading berth, and further development of the additional berths should await the overall (successful) commercial operation of the terminal.

(e) No response required.

(f) It has been suggested that "the operational consequences of some of the selected options could be clarified by means of simulation models."

This could be taken up at the detailed design phase for optimising the facilities.

(g) It has been suggested that the possibilities of extending the channel width to two-way traffic in future should be verified.

In case two-way traffic has to be handled in the future, the navigation channel would have to be widened. This additional width can be determined as follows:

Passing lane (moderate sailing speed)	: 1.6 B
Encounter traffic density (moderate)	: 0.2 B
Total additional width	: 1.8 B

For a design vessel with a beam of 42 m (cape size bulk carriers, 6000 TEU container vessels) this results in an additional channel width of 75 m. This additional width could be provided along the proposed alignment of the channel. The only constraint will be the type of bed material to be removed. Since for most of the length of the approach channel, the bed material is limestone, the cost of dredging will be too high to be economically sustainable.

(h) It has been commented that an overdepth of 2.5 m could be considered as too small in the unprotected reaches of the channel, whereas in the protected reaches an overdepth of 10% of the ship's draught might suffice. It has also been suggested that these items deserve further attention in the optimisation of the design.

The channel depth in this report has been selected as 15% of the maximum vessel draught. With a design vessel draught of 16 m for loaded cape size bulk carriers, this resulted in a channel depth of (-) 18.4 m CD. For this type of study (selection of the preferred location for the port facilities) this design method is considered to be acceptable.

However, for the port facilities at Positra, the required channel depth should be further optimised in the detailed design phase of the project and should take into account the following aspects :

- wave conditions along the whole channel
- acceptable risk levels (number of bottom touches)
- entry of high tides for deep drafted vessels
- acceptable downtime for the port

(i) It has been commented that the turning circle diameter should be 650 m and not 350 m as indicated. Moreover, consultant should consider the effect of currents during turning manoeuvres as they might necessitate a somewhat larger turning circle diameter.

There has been a regrettable typographical error in the turning circle diameter which should be 650 m.

The turning area is located in the shelter of the Boria reef and currents in this location are expected to be small (as also indicated in the Admiralty Chart). Hence the turning area would not have to be enlarged to allow for current conditions.

(j) It has been commented that the "consultant is not clear as far as downtime during manoeuvring to and from the port site is concerned. It is unclear where pilots will board the vessels and where tugs will make fast."

The pilot boarding area is located in the offshore approaches to the port. Pilot boarding operations can be carried out in the waves upto H_S = 2.5 m.

Tugs fastening is carried out in the final approaches to the port facilities, ie. in the lee of Paga and Boria reefs and this area is protected from significant offshore wave impacts.

Tugs can make fast to the ships when the sailing speed is 6 knots or less. The required channel width of 250 m has been based on low to moderate sailing speeds and is therefore considered to be sufficient for tug fastening operations.

(k) It has been commented that " it is also unclear how consultant proposes the vessels to traverse the area with cross currents of upto 5 knots.... As a consequence, the vessels should traverse the area at slack tide. This restriction limits the effective operation of the port to a large extent."

It is true that the final approach to the port facilities is passing an area where strong cross currents may be expected. The maximum current velocities at spring tides are reported to be some 5 kn. Safe entry into the port in such extreme current conditions is not considered possible. At those times, port entry and exit will have to be restricted to slack tides only.

However, the average number of vessels to be handled per day in the final development phase of the port is estimated at 6 vessels (both in and out). This estimate has been based on the following aspects:

- number of berths : 3 for oil, 4 for coal , and 5 for containers
- average service time of one day for oil tankers and container vessels and three days for coal ships
- a berth occupancy factor of 65%

It has to be noted that oil and coal are import cargo and hence the ships will leave the port lightened and with ballast. Hence these vessels can leave at slack tide during ebb also. This means with four slack periods per day and with the duration of these slack periods being 2 or 3 hours, it should be possible to manage the projected movement of ships.

Moreover, departure of ballasted vessels during daytime could be possible via a route westerly of Paga reef in view of available water depths along this route.

(l) It is commented that the navigational procedures should be based on better understanding of the current pattern within the different bays.

There is no doubt that a better understanding of the current pattern in the different bays would be useful to further optimise the navigational procedures for the port. In this respect, it is to be considered to install one or more current meters in the final approaches to the port to provide the pilots with on-line current information while passing the cross currents area in front of the port entrance.

(m) This again refers to the possible restriction due to slack tide manoeuvring.

This has been clarified under point (k) above.

3. *Coastal Engineering Aspects*

(a) It is strongly recommended to set up a wave survey before any further steps will be taken

(b) The current survey provided results that can be taken as a starting point for preliminary design purposes. For detailed design of channel and manoeuvring areas more extensive surveys are required.

(d) To find the optimal design, as well for operations as for influence on the investments it is necessary to have more accurate wave data at the specific location.

These comments once again reiterate the necessity of site specific studies which the consultants have already recommended in the final report. Nevertheless, the following response is made as regards the wave climate.

Four classes of wind speed have been observed :

W1	62 kmph	(7 - 8 Bft)
W2	20 -61 kmph	(3-4 Bft to 7-8 Bft)
W3	1 -20 kmph	(1 Bft to 3-4 Bft)
W4	no wind	

Even though some irregularities have been pointed out, in itself, part of the method of IIT is correct. By adopting a wave period, the problem of selecting a proper fetch length or storm duration is avoided. But as regards the effect of different wave periods, using the Shore Protection Manual 1984 wind wave growth graph (for deep water), the following explanation is given :

- Class W4 does not generate waves.
- Class W3 does not generate significant waves higher than 0.70 m with wave periods upto 5 seconds (fully arisen sea).
- Class W2 (may) generate the following wave heights assuming the indicated wave periods.

WAVE PERIOD (S)	WAVE HEIGHT (M)	STORM DURATION (hrs)
5 -6	0.90 -2.00	3.5 - 11
6 -8	1.25 - 3.00	5 - 15
8 -10	2.30 - 4.25	9 - 19
10 - 12	3.50 - 5.50	14 - 24

This corresponds well with the graphs in Annexe A to Appendix C. In the non-monsoon period (where 5-6 seconds wave period prevail), the significant wave height hardly exceeds 2.0 m. During the SW monsoon (where wave periods of 8 seconds prevail and wave periods upto 12 seconds occur) significant wave heights of 3 m prevail and wave heights of 3.5 m and 4.0 m occur. During the NE monsoon (where again waves of 5 and 6 seconds prevail) waves hardly become higher than 1.5 to 2.0 m.

- Class W1 may generate even higher waves depending on the actual wind speed, but this occurs infrequently.

When the critical wave height for pilot boarding is set at 2.5 m H_S, the W3 and W4 wind conditions do not pose any problem. Of the W2 class only waves with periods higher than 7 - 8 seconds may pose a problem.

Especially, during the SW monsoon these wave periods occur. Annexe A to Appendix C indicates an occurrence of about 55 % during the SW monsoon. Adopting an occurrence of class W2 during SW monsoon at 65% to 85% [Figure 3(a) and 3(b) of Appendix C], waves larger than 7 seconds would occur some 35% to 45% of time (approximately). This will be an upper limit since not at all times will waves with periods larger than 7 seconds be higher than 2.5 m H_S.

The above assessed wave heights are wind generated waves in ***deep water***, not including for any wave energy dissipating effects. However, towards the coast, wave energy dissipation by bottom friction and wave breaking occurs. Further, wave refraction may have a reducing effect on the wave heights. Importantly, especially for longer wave periods, the reducing effects of bottom friction and wave refraction increase.

It is beyond this assessment to go into all the details of these reduction mechanism, but Figure 11a of Appendix C indicates that offshore waves of 3m H_S would reduce to 1.80 m H_S in the pilot boarding area. Hence, although waves with periods larger than 7 seconds and larger than 2.5 m H_S occur at open sea during 35% to 45% of the time, in the pilot boarding area these wave heights will be significantly reduced. In fact, the above would indicate that, even during this 35% to 45% time of risen seas offshore, there would be no restriction to pilot boarding due to waves exceeding H_S= 2.5 m in the pilot boarding area.

Although, the actual situation will probably not be so propitious, it may be concluded that downtime resulting from pilots not being able to board the vessels will not be significant.

--ooOoo--

Frederic R. Harris, Inc.
Engineers, Planners, Economists & Consultants

HARRIS

41, Zamrudpur Community Centre
Kailash Colony, New Delhi - 110048. India
Tel. : 91-11-646 0186, 622 2246, 623 4959,
Fax : 91-11-646 0186

10th February, 1998

Mr. K. Kailashnathan I.A. S
Vice Chairman & Chief Executive Officer,
Gujarat Maritime Board
Ahmedabad

Sub : **DPR for development of port facilities at Positra**

Dear Sir,

This refers to the Task 3 Report submitted to GMB in December '97.

At the instance of GMB, this report was discussed with Mr. K.P. Vohra of GPPL on 17th January at Ahmedabad . Subsequently we received comments from Mr. Vohra vide his letter dated 7th February. This was later followed up by personal discussions with him, during his visit to our office in Delhi on 9th & 10th February '98.

The following final requirements emerged out of the discussion, which will be covered in the final report :

1. Locations of jetties in terms of geo-graphical co-ordinates to be marked on the drawings.
2. The basis of sizes of vessels, specially loaded draft to be specified.
3. The availability of third generation container ships to be confirmed again.
4. Dredging aspects to be discussed in more detail, specially the rate of dredging, type of dredger, time required for dredging, etc.
5. The likely impact, if any, of the proposed Transhipment Terminal at Cochin on the proposed Container Terminal at Positra to be discussed.
6. Reasons for terminating MB-2 at 5.2 m below seabed to be made clear.
7. Since the rock is of weathered type with low core recovery, the sufficiency of its bearing capacity to be discussed in more detail.
8. To confirm that the onshore investigations have been carried out covering the planned area for the port activities.
9. The details of hinterland connections, both road and rail, along with the order of magnitude costs are to be indicated, even though these might not have been considered as the project costs for financial analysis.
10. Advice on additional investigations, studies, to be included in the final report.
11. More drawings to be given elaborating details of marine fixtures, (such as fenders, bollards, cat ladders) connection between POL approach jetty with the land.
12. Capacity of the grab unloader at coal terminal to be mentioned in cubic metre also.

Frederic R. Harris, Inc.
Engineers, Planners, Economists & Consultants

HARRIS

41, Zamrudpur Community Centre
Kailash Colony, New Delhi-110048. India
Tel. : 91-11-646 0186, 622 2246, 623 4959,
Fax : 91-11-646 0186

February 28, 1998

Mr. K. Kailashnathan, IAS
Vice Chairman & Chief Executive Officer
Gujarat Maritime Board
Ahmedabad-380 016

Sub : DPR for development of port facilities at Positra

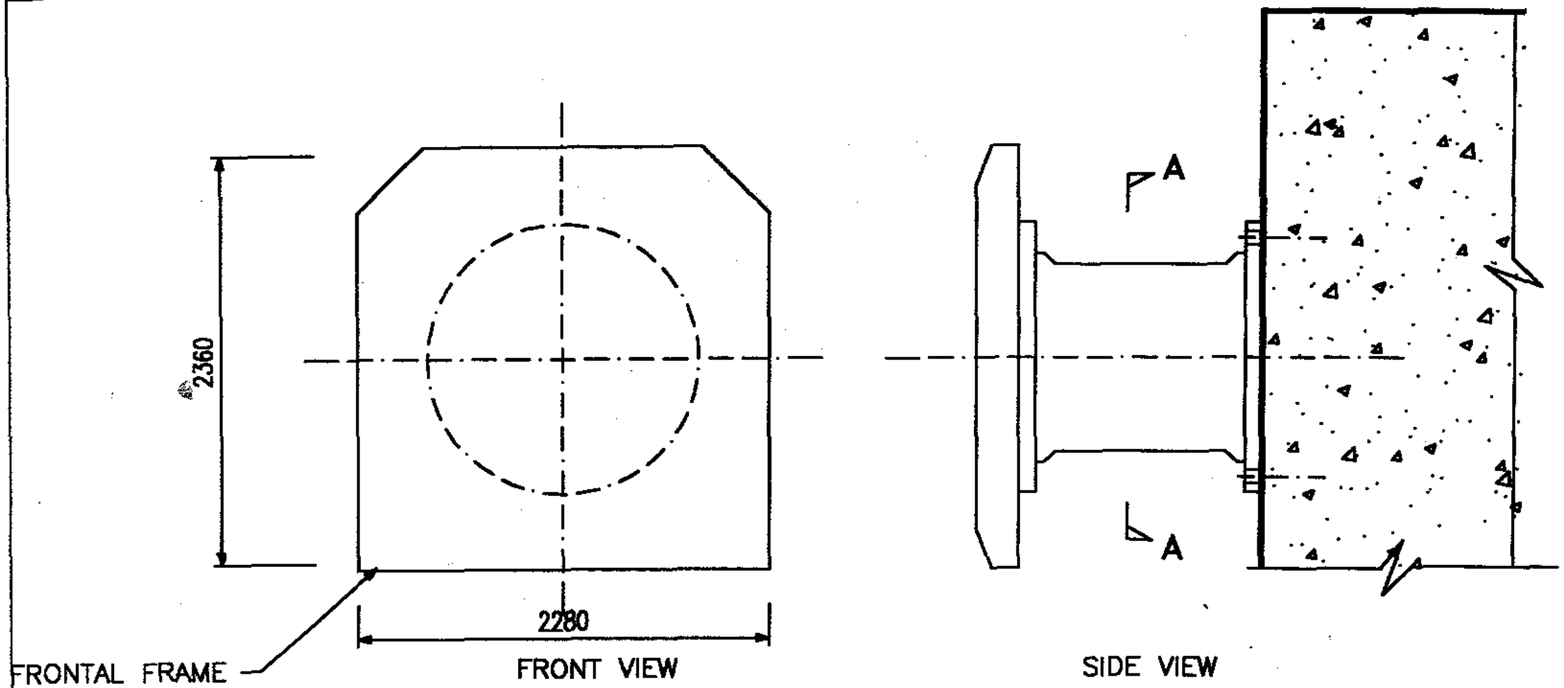
Dear Sir,

This has reference to our letter dated 10th February '98.

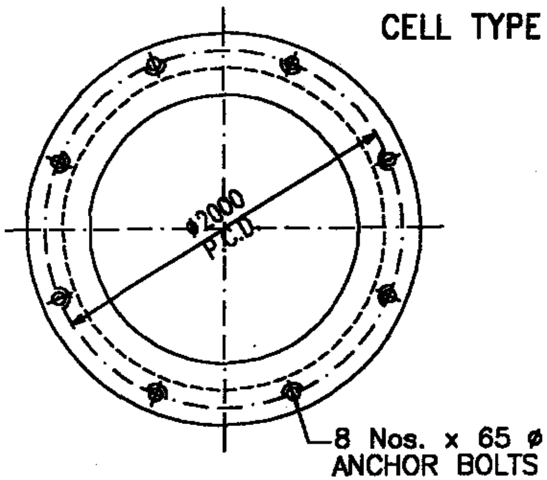
We are pleased to submit herewith the final report incorporating all the comments given by GPPL on behalf of GMB.

The comments are covered as under :

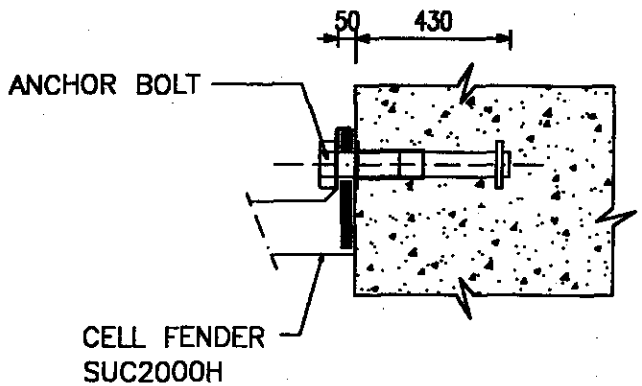
1. Locations of jetties are marked on drawing no.GMB/DPR/01.
2. The sizes of design vessels as recommended in our DPR are based on the current available fleet in the Indian & world market. Due consideration is also given to the emerging shipping trends (based on the "ships on order").
3. On the Far East/Indian Sub Continent/Europe route , vessels of third generation (2000-3600 TEUs) are deployed. The round-the-world route is serviced by vessels of post-Panamax size (4000-6000 TEUs). On the feeder route , the trend is towards deployment of first / second generation (800-1500 TEUs) vessels.
4. Dredging aspects have been discussed in details in Volume I, Section 7, Chapter 1.
5. The purpose of marine boreholes (MB1 & MB2) is to find out the dredgeability of seabed material in the approach channel. The final dredged depth in the approach channel is 18.4 m below CD. Existing bed level at the location of MB2 is (-)14.5 m w.r.t. CD. As such the termination of the borehole at 5.2 m below bed level (i.e. at -19.7 m w.r.t. CD) is sufficient.
6. The limestone rock though of weathered type is relatively medium strong from UCS characteristics. The founding levels of piles have been calculated considering a conservative SPT (N) value of 100 at a level of 3.0 m below the weathered rock surface. Based on DIN 4014 ultimate end bearing resistance of bored cast-in-situ piles can be taken as 600 T/sqm for the lime stone even under partly weathered condition with good mineral binding. With a factor of safety of 2.0 , the safe end bearing capacity works out as 300 T/sqm. In addition the safe frictional resistance is estimated



CELL TYPE FENDER SUC2000H



VIEW A-A



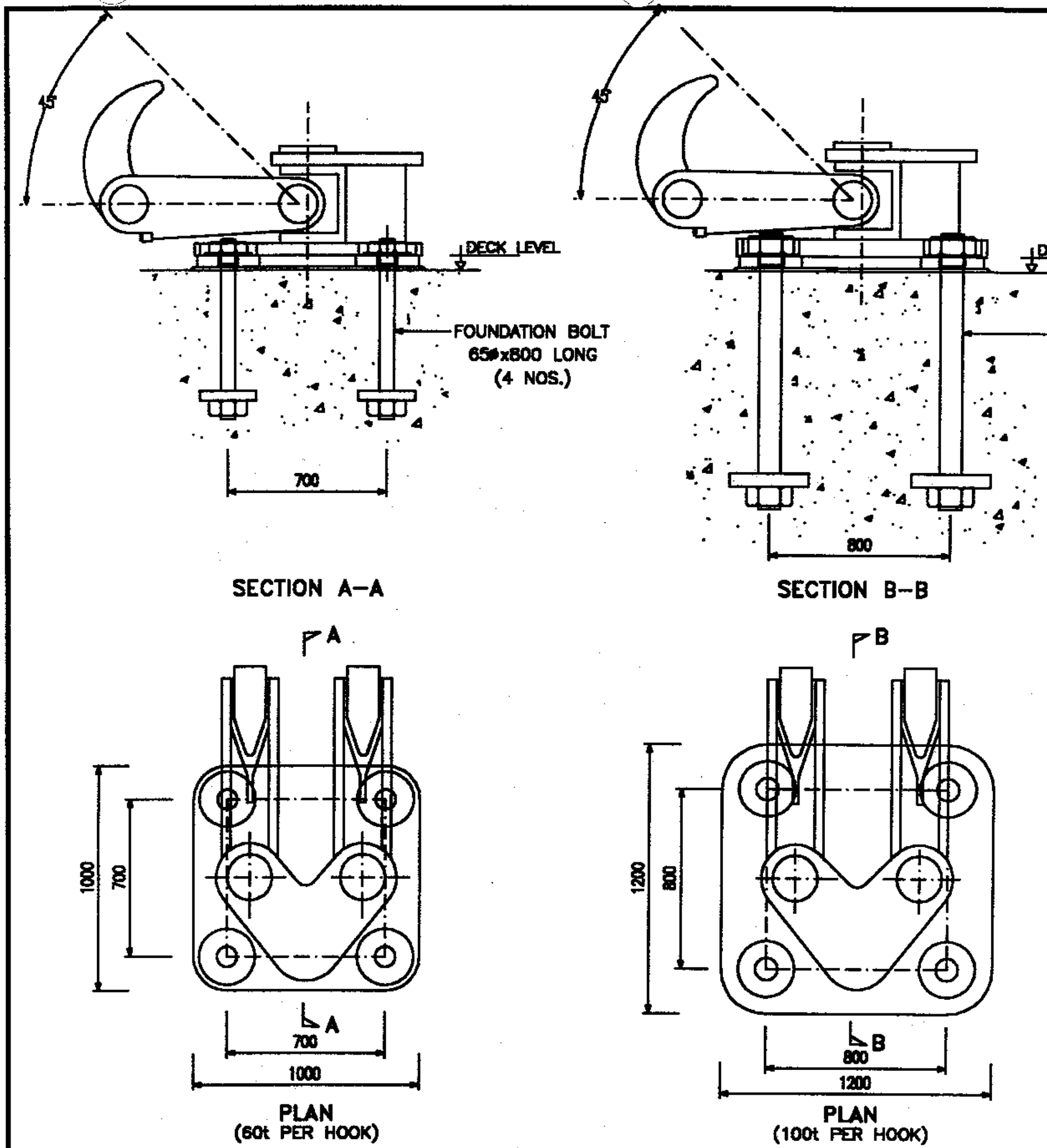
DETAILS OF ANCHOR BOLT

NOTE :

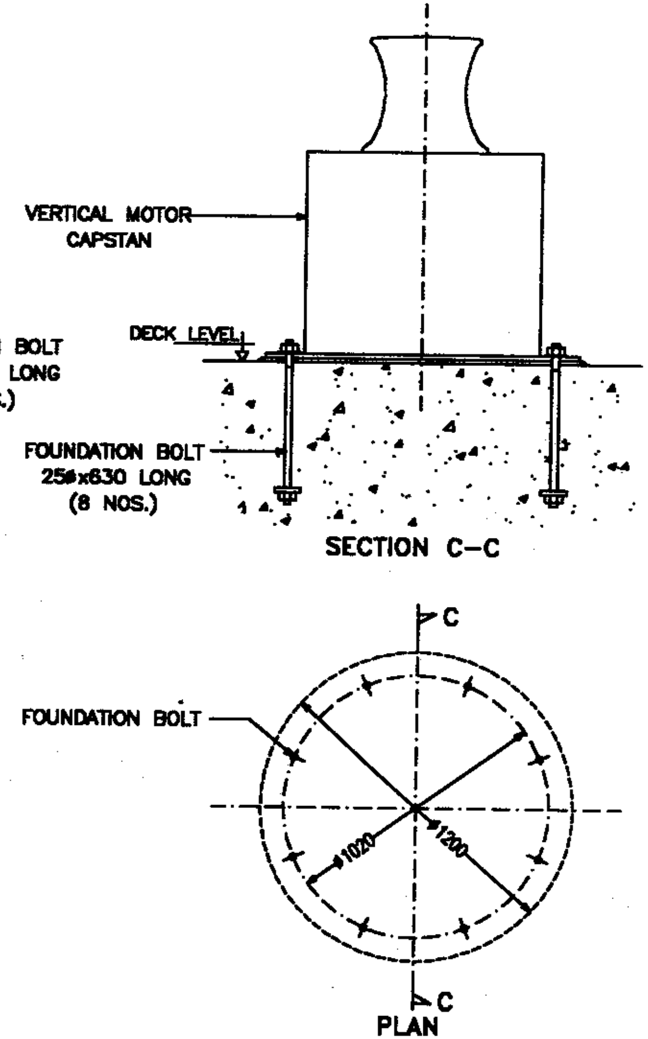
1. ALL DIMENSIONS ARE IN mm.

TYPICAL FIXING DETAILS OF CELL TYPE FENDER

FREDERIC R. HARRIS, INC			
GUJARAT MARITIME BOARD			
DETAILED PROJECT REPORT FOR DEVELOPMENT OF PORT FACILITIES AT POSITRA			
FIXING DETAILS OF CELL TYPE FENDER			
SCALE	DATE	DWG. No.	REV
-	[illegible]	GMB-DPR-02 (Sheet 1 of 4)	0



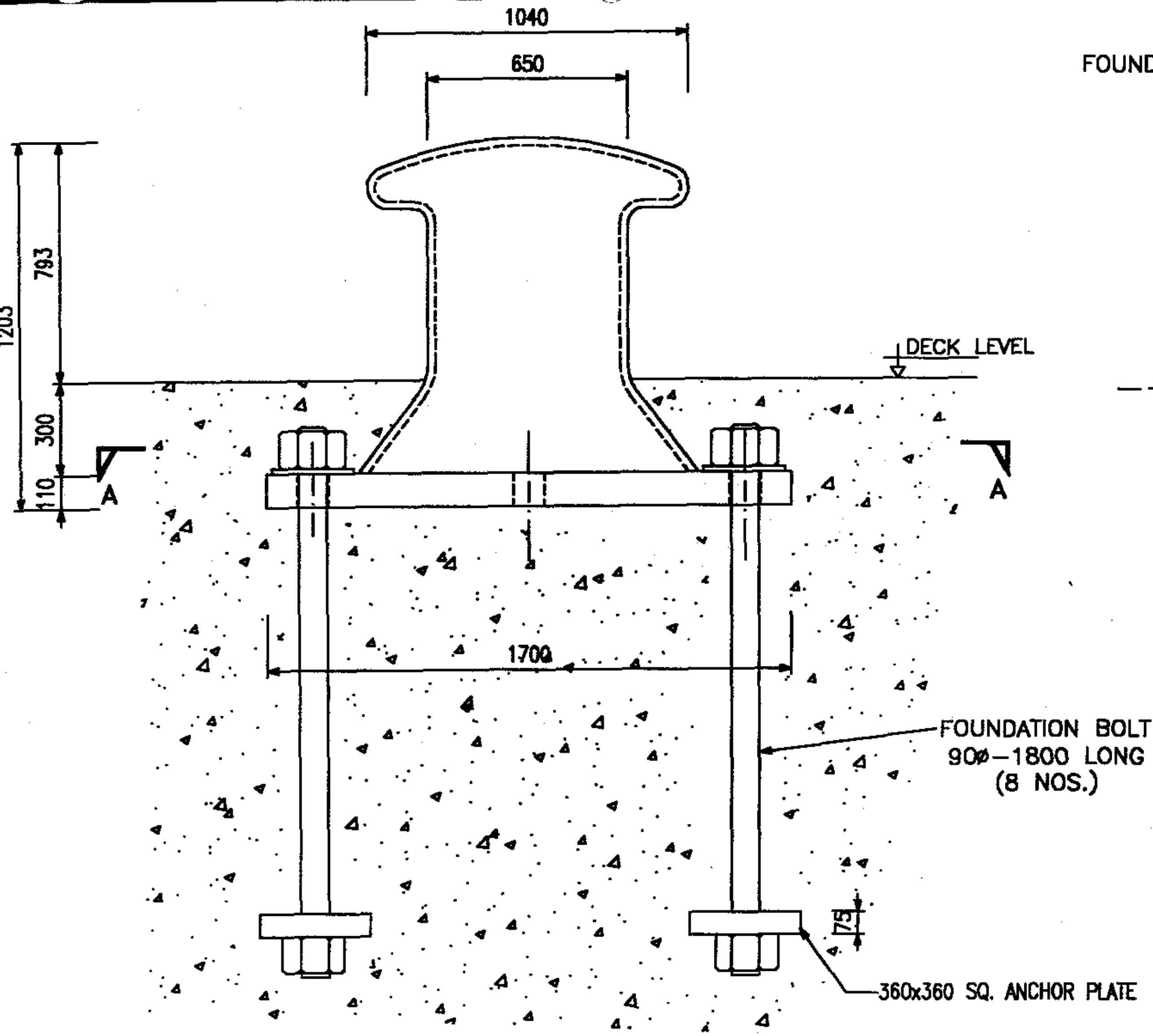
DETAILS OF DOUBLE QUICK RELEASE HOOK



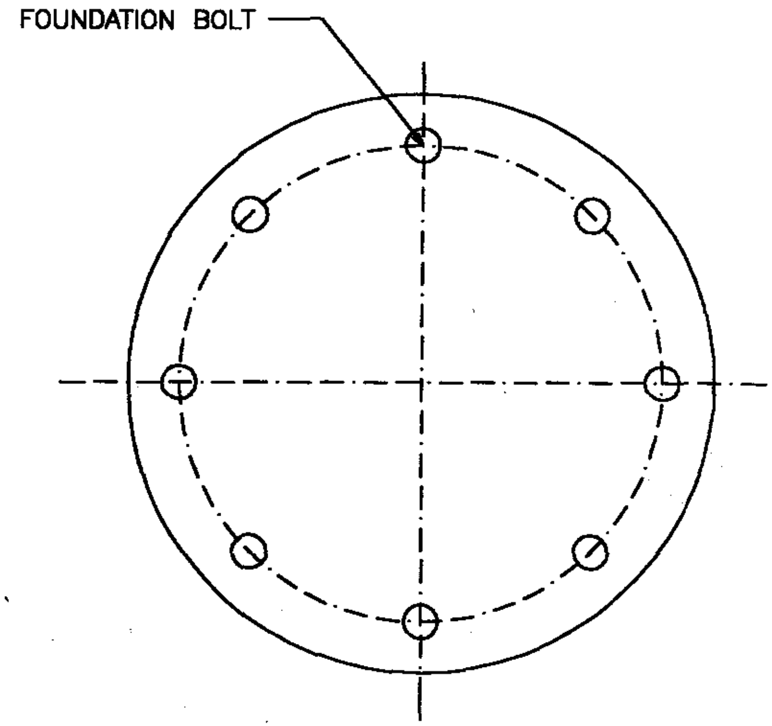
DETAILS OF CAPSTAN

(1500kgx30m/min)

FREDERIC R. HARRIS, INC			
GUJARAT MARITIME BOARD			
DETAILED PROJECT REPORT FOR DEVELOPMENT OF PORT FACILITIES AT POSITRA			
DETAILS OF QUICK RELEASE HOOK AND CAPSTAN			
SCALE	DATE	DWG. No.	REV
-	[illegible]	GMB-DPR-02 (Sheet 2 of 4)	[illegible]



ELEVATION



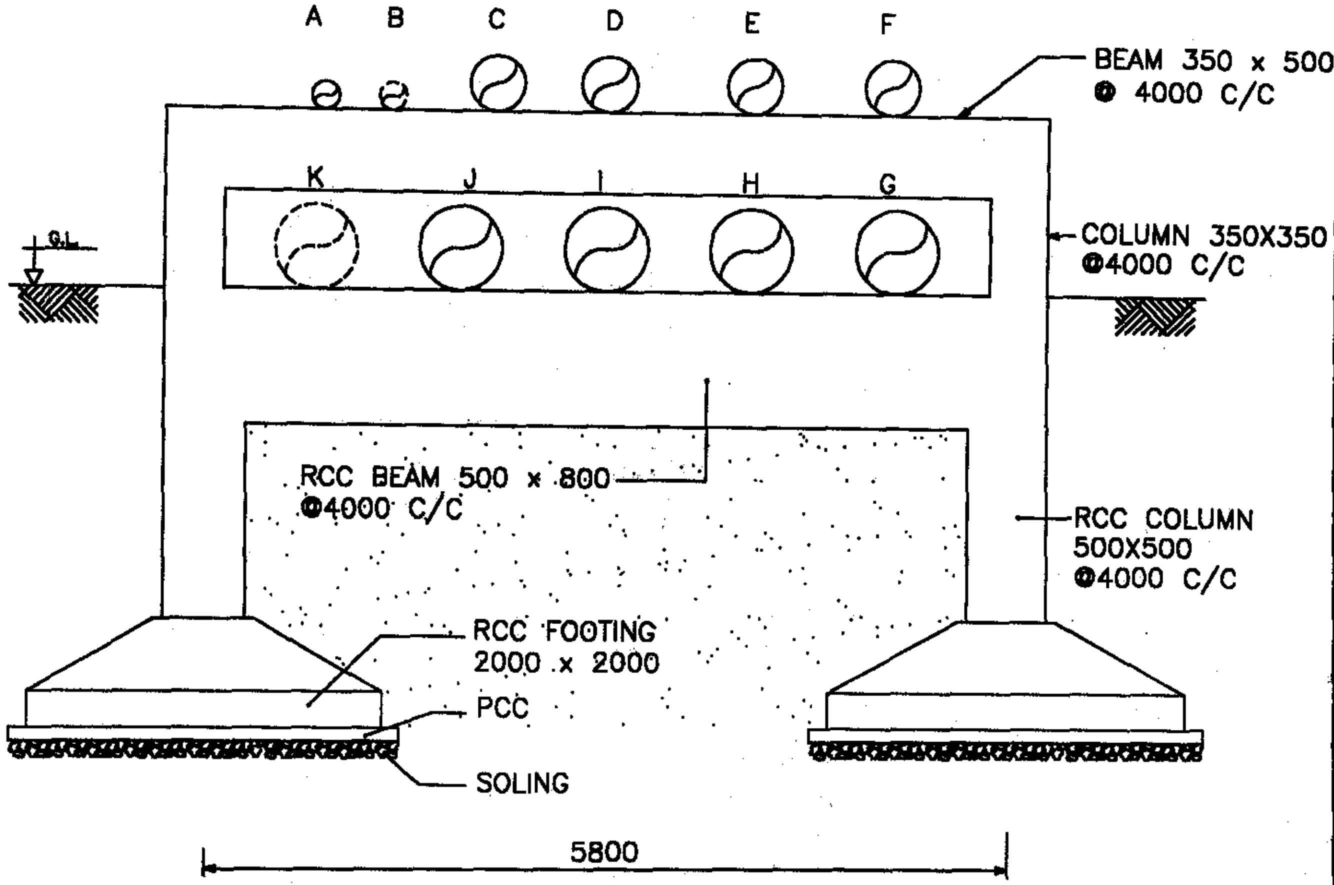
VIEW A–A

NOTE :

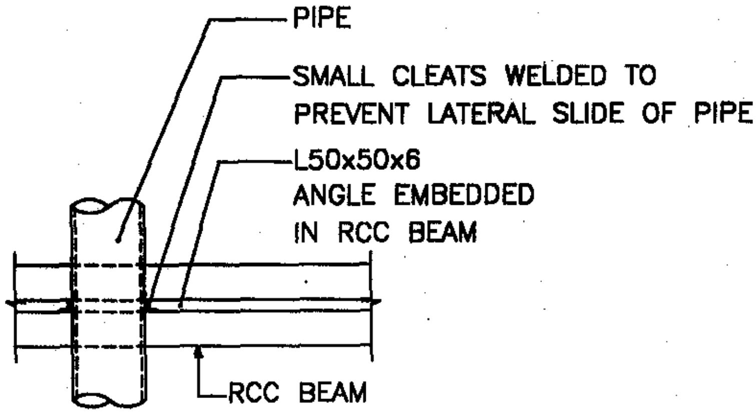
1 ALL DIMENSIONS ARE IN mm.

DETAIL OF 200t BOLLARD

FREDERIC R. HARRIS, INC			
GUJARAT MARITIME BOARD			
DETAILED PROJECT REPORT FOR DEVELOPMENT OF PORT FACILITIES AT POSITRA			
TYPICAL FIXING DETAILS OF 200t BOLLARD			
SCALE	DATE	DRG. No.	REV
-	[illegible]	GMB–DPR–02 (Sheet 3 of 4)	0



DETAILS OF ONSHORE PIPE SUPPORTS AT POL TERMINAL



TOP VIEW OF BEAM

NOTE:
1. ALL DIMENSIONS ARE IN mm
2. GRADE OF REINFORCED CEMENT CONCRETE (RCC) SHALL BE M–25 UNLESS OTHERWISE STATED

FREDERIC R. HARRIS, INC

GUJARAT MARITIME BOARD

DETAILED PROJECT REPORT FOR DEVELOPMENT OF PORT FACILITIES AT POSITRA

DETAILS OF ONSHORE PIPELINES AT POL (LIQUID BULK) TERMINAL

SCALE	DATE	DWG. No.	REV
-	[illegible]	GMB–DPR–02 (Sheet 4 of 4)	0