2. Natural Conditions

2-1 Geography

The surveyed area is situated at the mouth of the River Balsas on the Pacific coast in the southwestern part of Mexico and 220 km to the southwest of the capital city of Morelia of the State of Michoacan. The projected site of the repair dockyard is indicated in Fig. III-2-1, Fig. III-2-2. The projected site is on a part of the Cayacal Island in the delta area at the mouth of the River Balsas and located at the innermost of the canal made by dredging the Lazaro Cardenas river bed which is one of the branch streams of the Balsas. It is at $17^{\circ}57'$ of north longitude and $102^{\circ}10'$ of west latitude. The surveyed area is in the heavy and chemical industrial zone of the Lazaro Cardenas industrial port and the city of Lazaro Cardenas lies behind it.

2-2 Topography

2-2-1 Topography of land

The topography of this Lazaro Cardenas area is flat with gentle slope to the south and hill to the north which stretches to the mountaineous areas of the South Madre mountains. The topography of the Cayacal Island where the projected site is situated is a delta area at the mouth of the River Balsas and is rather monotonous with gentle ups and downs up to an altitude of 2m - 8m.

This configuration can be clearly understood from the topographical map drawn on a scale of 1 : 50,000 issued by SPP (Secretaria de Programacion y Presupuesto) and the topographical map in a scale of 1 : 3,000 of this area (Fig. III-2-3) prepared in 1985 by FONDEPORT of Lazaro Cardenas (Fondo Nacional para los Desarrolos Portuarios).

In the upper stream of the River Balsas, there exists the Jose Maria Morelos dam having a hydraulic power station, and no damage due to flood seems to have been recorded after the construction of the dam. The difference of level of the stream of the River Balsas is approximately 2.0 to 5.0m and the stream is calm near the mouth of the river although it is partly due to the adjustment made by the dam. The projected site of construction is located at the innermost of the canal and is hardly subject to the influence of the river stream.

2-2-2 Topography of seabed

The topography of the bottom of the canal in front of the projected site of repair dockyard can be grasped from the depth survey map (1982, see Supporting Report) prepared by the port authorities. The base of depth and altitude of those surveys of depth is the Datum level DL = N.B.M.I. (Nivel de Bajamar Media Inferior) namely 0.277m under the mean sea level (MSL = Nivel Medio del Mar).

The bottom of the canal seems to consist, according to the port authorities, of sand or clay mixed with gravel without large stones, etc. nor accumulated sand carried by the stream of the River Balsas and is comparatively stable. It retains the topography of the time of dredging in 1982 and no dredging has been made since that time. The water depth around the mouth of the river toward the Ocean can be understood by Fig. III-2-4 and Fig. III-2-5.

The Fig. III-2-5 shows the depth from the Lazaro Cadenas Canal to the mouth of the River Balsas. Moreover, it shows the depth from the mouth of the river to the Pacific Ocean. A sufficient depth is maintained up to the mouth of the river and a stable seabed topography is formed without drift sand even near the mouth of the river.

The dredging operations of the canal are being performed based on the development program of the port of Lazaro Cardenas established by the port authorities, but there are some differences between the project plan and the results of the actual dredging works as indicated in Table III-2-1. In the present feasibility study, we carry out all works on the supposition that the dredging operations are performed in conformity with the project plan of the port.

2-3 Geological Conditions

2-3-1 Outline

In implementing the present feasibility sutdy, the data necessary for the construction of the repair dockyard have been investigated based on the results of the geological survey made by AUSA.

The geological structure of this area can be explained briefly as follows:

The structures of the rocks seen in the branches of the South Madre mountains or at the bottom of the Jose Maria Morelos dam show that they are andesite, granular diorite and lots of limestone.

The adhesive soil lying under a large quantity of deposits may probably be classified as the shale produced during the Pleistocene era or toward the end of the Tertiary formation seen from its age and resistance value.

Non coagulate conglomerate (formed probably during the Pliocene era or the Pleistocene era) found in the Plain along the coast and on the rock of the hilly country among the South Madre mountains is exposed in such towns as Lazaro Cardenas, La Horilla, La Mira, etc. Such conglomerate can be classified as aragillaceous gravel consisting of clay in 20% to 30% of its volume, seen from the nature of the ground.

The alluvial soil in the delta area consists of somewhat plastic clay, mud, coarse sand of medium size, gravel and round stones. Those deposits form the greater part of the plain along the coast. There are also deposits of lakes and marshes formed by organic substances which accumulated in river beds or in marshy districts.

Those soils constitute migratory strata in which sand, gravel, gravel with sand and clay are mixed alternately.

On the surface, there are plastic clay, slightly plastic clay and clay containing even peat in its composition. The islands of Cayacal and Palma are composed mostly by such deposits.

Recent deposits by littoral current are found only on the south side of the iron mill and in the Enmedio Island where there is now a factory of FERTIMEX. It indicates that even Cayacal Island may be subject to erosion on the seashore and that there is also a possibility of accumulation of deposits.

Those deposits contain fine sand and coarse sand and their density gets higher with the increase of their depth.

2-3-2 Constitution of soil strata

The constitution of soil strata of the planned site of the repair dockyard is indicated in Fig. III-2-6 - III-2-8. The soil strata of this point are those constituted geologically by the sedimentary soil of the alluvial period. This is the delta area deriving from the Balsas. This area is also an extensive sedimentary land of sand on the seashore. The topography of the planned site is generally flat with little difference of level. There was not much difference in the height of the ground when the boring was performed by AUSA (1981) but a change appeared at the time of issuance (1985) of the topographical map (see Fig. III-2-3 mentioned earlier) prepared by

FONDEPORT. The height of the ground in 1981 (Fig. III-2-9) was approximately 2 to 4m from DL while it is shown as approximately 5 to 12m from DL in the map prepared by FONDEPORT. This difference comes from the fact that the dredged material of the dredging works executed around 1982 was piled up in the projected site of the repair dockyard. The main components of the dredged material are gravel and sand soil (GW - GM according by the classification symbol of unified geological classification and sandy soil (SP - SM by the said classification symbol) which existed in the depth from DL +/-0 to DL -10m. This soil is piled up by approximately 3 to 8m on the surface of the project site of construction and forms a very fragile stratum.

As of 1987, gravel of a diameter of 10 to 20 cm are exposed on the surface of the ground as a result of dispersion of fine grains. Under this surface stratum, there is an accumulated layer of clay and sandy clay (classification symbol CL - CH) having a plasticity of medium degree with a depth of 1 to 4m. This stratum contains lots of granules and is dark gray in tone of colour. This soil is comparatively soft with the N values distributed under 10. Its liquid limit (LW) is approximately 40% and the plasticity index (IP) is 20 to 40%. This soil stratum is not very suitable as the supporting layer of a structure, but the graveland sand soil found beneath this layer is believed to have a sufficient bearing capacity. The variation of depth for the bearing layer is shown in Fig. III-2-10. This stratum of graveland sand soil exists not higher than DL +/-0 and has a depth of 10m to over 20m. The tone of colour of the soil is greeny gray and its water content is approximately 15%. It constitutes a comparatively dense layer of N values ranging from 20 to 50 and has a sufficient bearing capacity as the supporting layer of various structures. This stratum contains lots of gravel (boulders) mentioned before and, for that reason, a special attention must be paid in the selection of the type of piles and the method of execution when pile foundations are used for structures. Generally speaking, the cast-in-place method is applicable for a soil stratum of those characteristics.

Still under the above-mentioned gravel and sand layer cohesive soil is found. This cohesive soil is not seen all over the projected site of repair dockyard but exists only in certain parts of it. The distribution and the thickness of layer of the cohesive soil are indicated in Fig. III-2-11 - III-2-12. Those strata of cohesive soil play an important role in the construction of a graving dock. Namely, the uplift pressure shut-off method is a method which consists, in a case where a stratum of cohesive soil (impermeable layer) exists at a proper depth of the dock area, in shutting off the uplift pressure to the dock slab by providing a cut-off wall which reaches the layer of cohesive soil. As it is seen from Fig. III-2-11, graving dock type cannot be regarded advantageous because the stratum of cohesive soil having a proper thickness is found only partially in the construction site. According to the geological survey performed by AUSA, the characteristic values of this stratum of cohesive soil are as follows: water content 40 - 50%, liquid limit 40 -70%, plasticity index 20 -40%. The soil is expressed as CL or CH according to the unified geological classification system. The N value varies a great deal between 10 and 40. This dispersion of N values comes from the fact that the soil is formed by a mixture of layers of silt, sand and clay, and even the clay stratum contains gravel and sand of various qualities and forms.

2-3-3 Geological characteristics

Part of the geological characteristics obained from the results of soil survey performed by AUSA are indicated in Table III-2-2. The projected site of repair dockyard in the present feasibility study is the western part of the site provided by FONDEPORT (the utilization plan of the site will be described in detail in 3-1). It is necessary to make a detailed soil survey of the part according to the characteristics of the civil engineering and building structures to be constructed. In the actual designing, it is necessary to study in detail the questions of settlement due to and liquefaction based on those data.

2-4 Oceanographic Phenomena

2-4-1 Tide

As of 1987, there is no automatic tide gauge station in the port of Lazaro Cardenas. There was one formerly in the site of the current SICARTSA steel mill, but it was closed with the construction of the steel mill and since then no new station has been established in this port. It is, therefore, impossible to get accurate data on tide level. Fig. III-2-13 shows the characteristics of tide in the port of Lazaro Cardenas.

According to those data, the maximum tide level (HHWL) is the average seawater level +0.922m, while FONDEPORT stipulates the maximum tide level (by tidal wave) as +4.00m in the port of Lazaro Cardenas for a period of reappearance of 100 years and specifies the minimum height of the quay as 4.00m above the average seawater level. According to the estimated table of tide levels issued every year by the University of Mexico (UNAM), the difference of tide level in a day is no larger than 1.5m, so the fluctuation is comparatively small. Although the projected site of repair dockyard faces the mouth of the Balsas, the influence of the river current is almost negligible thanks to the adjustment made by the dam located in the upper stream of the river.

2-4-2 Tidal current

The projected site of repair dockyard faces a canal, and the only influence of the tidal current on it is that of ups and downs of the tide. The tidal current due to the range of tide is not much influential because of the small difference of tide level as mentioned earlier.

2-4-3 Waves

According to the port authorities of Lazaro Cardenas, no observation of waves is made in this area and therefore no data is available at present. When SICARTSA steel mill was constructed, grand level (MSL +4.0 m) seems to have been decided by considering some wave height in addition to maximum tide level MSL +2.88 m (above mean sea level) at the time of cyclone for a period of reappearance of 100 years.

SICARTSA steel mill directly faces the ocean and, therefore, it seems reasonable to adopt this value for grand level. However, considering the fact that the planned site of dockyard does not face the ocean but is situated at the innermost of a canal, adopted grand level DL +4.3 m (i.e. MSL +4.0 m) for the dockyard has some margin in height against wave and is safty decision.

2-5 Meteorology

2-5-1 Wind

The climate of the surveyed area is roughly divided into the rainy season from June to October and the dry season in other months when it is always dry except occasional rainfalls. The constant wind throughout the year is the sea wind which may be characteristic in the coastal zone. It is a breeze of an average velocity of 1.1 m/s from the sea caused by the convection on the ground. This sea wind is very conspicuous during the dry season. The constant winds and the velocities observed in Lazaro Cardenas of the State of Michoacan during the period from 1981 to 1986 are shown in Table III-2-3 together with Beaufort scale.

Data on strong wind necessary for the design of buildings, etc. are unavailable at present, so it is necessary to set the maximum design wind velocity considering the "Technical Recommendations for Planning of Structures in the Lower Stream Area of the River Balsas" and the past records on strong wind.

On the Pacific coast of Mexico including Lazaro Caradenas, tropical rainstorms or hurrycanes (huracan) have been often produced especially during the period from June to September. The number of the tropical rainstorms which influenced on Lazaro Cardenas during the period from 1941 to 1968 was approximately 40, and their rate of occurrence by month is as shown in Table III-2-4. Fig. III-2-14 shows the main route of tropical rainstorms. Those data should also be taken into consideration in determining the maximum wind velocity for design.

2-5-2 Rainfall

Table III-2-5 indicates the monthly volume of rainfall during the period from 1965 to 1986. As it is seen from this table, the rainfalls concentrate in the period from June to October. The monthly volume of rainfall during the rainy season is approximately from 100 mm to 300 mm, but it sometimes exceeds 500 mm. Other months are the dry season with very little rain. Table III-2-6 shows the maximum 24-hour volume of rainfall during the period from 1981 to 1986. There is a record of maximum 200 mm.

2-5-3 Atmospheric temperature

During the period from 1981 to 1986, the mean annual atmospheric temperature was about 27°C with little fluctuation between the seasons. May, June, July, August and September are the hottest months when the mean maximum temperature was 32°C to 34°C. The recorded mean minimum temperature during the refreshing season (from October to April) was approximately 20°C.

The highest temperature during the said period was 42.5°C recorded in April, 1985, and the lowest temperature was 11.0°C of January, 1986. Table III-2-7 -III-2-11 indicates the mean temperature by month during the period from 1981 to 1986, the minimum temperature during that month, the mean monthly minimum temperature, the maximum temperature during that month and the monthly mean maximum temperature.

2-5-4 Number of clear days

Tables III-2-12 - III-2-13 indicate the number of clear days by month and the number of rainy days by month during the period from 1981 to 1986, respectively. As it is seen from the data of rainfall, there is a remarkable difference between the rainy season and the dry season. This data should be sufficiently taken into account in the planning of schedule at the time of construction as well as in the establishment of operating plan, etc.

2-6 Earthquake

Lazaro Cardenas situated at the mouth of the River Balsas belongs to the most strongly shaked area of Mexico. Indeed, a strong earthquake having its seismic center in this area occurred in September, 1985 (Mexican earthquake of 1985). The epicenter was near Caleta de Campos (18.1 N, 102.7 W), the depth of the center 33 km, magnitude 8.1, and the length and the width of the estimated fault plane were approximately 200 km and 70 km respectively, as reported (Report on results of studies made by the general study team on the science of natural disasters, February, 1986). As to the results of observation of strong earthquakes, a maximum acceleration of approximately 125 gals was observed in the La villita observatory 14 km to the north of Lazaro Cardenas and approximately 160 gals in Zihuatanejo. The record of acceleration in the neighborhood of the seismic center area was comparatively small with 150 gals approximately and little damags were caused to the civil and building structures. On the contrary, the damages suffered by Mexico City were very serious. Since Mexico City is located on a soft ground formed by filling up a lake, the prevailing the synchronization of the ground is rather long with 2 seconds approximately and this ground responded to the components of long periodicity of the Mexican earthquake. Moreover, the long continuous time of vibrations on the soft ground of 300 seconds also contributed to increase the damages of Mexico City.

One of the problems in the sandy ground at the time of an earthquake is liquefaction of the ground. It is reported that a phenomenon of liquefaction was produced in a certain part of Lazaro Cardenas during the Mexican earthquake in 1985. As a factor influencing the resistance to liquefaction of sand, the importance of stress-strain history has come to be generally recognized. To examine those points in detail, it is necessary to check the results of undrained shear tests, etc. in addition to those of the soil tests performed in the past. An advantage of the N value has been recognized as the index that reflect the efficiency resulted from the test. The design standards of port and harbour structures of Japan indicate a method to judge the state of liquefaction by using the distribution of grain size and the N value. Fig. III-2-15 shows the distribution of grain size of a ground liable to liquefaction. The degree of liquefaction can be estimated by applying the grain size accumulation curve of the specified ground to this chart. Since no grain size accumulation curve was obtained in the present survey, we will attempt to study the matter of liquefaction will be studied by the method indicated in the Japanese design standards of architectural foundations and their commentary. According to the said standards, the ground requiring a study of liquefaction phenomenon is a purely sandy stratum consisting of medium-sized sand uniform in grain size which is saturated with water of a level no higher than the level of underground water and which exists within the depth of 15 to 20m from the surface of the ground, and has the range of danger as indicated in Fig. III-2-16. Here, we plotted the N value of the cores No. 30MC-E13 and No. 34MC-K14 of boring conducted by AUSA. Both samples show little risk of liquefaction. The soil survey was conducted in 1981 and, after that, the dredged soil was piled up in the planned site of the repair dockyard. This outer stratum of this soil contains loosely-piled sand and this layer has the risk of liquefaction. The current height of the ground is DL +5 to 12m but the height of ground of the repair dockyard is planned to be DL +4.3m. Therefore, this loose layer will be removed and the possibility of liquefaction will be smaller. consequently, it is believed that there is little possibility of liquefaction in the projected site of repair dockyard. In the actual construction, however, it is necessary to make a more detailed soil survey since the current data are not quite sufficient for making an accurate judgement.

Table III-2-1 DEVELOPMENT PLAN OF CANALS AT LAZARO CARDENAS PORT

Unit : meter

Location	Data of canals			
	Width of canal bottom		Depth of canals	
	Actual	Project	Actual	Project
Canal of access	150	350	- 14.0	- 16.0
Canal (FTE. T. GRANOS)	205	360	- 14.0	- 14.0
Eastern canal	120	300	- 14.0	- 14.0
Northern canal	170	300	- 12.5	- 14.0
Southern canal (FTE. CIKARTSA)	300	300	- 12.0 to - 14.0	- 16.0
Canal of ARMADA	60 to 123	300	- 7.0	- 10.0

Sourse : Port Authority (OBRAS MARITIMAS) in Mexico
June 7 , 1985

Table III-2-2 SOIL PROPERTIES

No. of Bore Hole	29MC-G13	30MC-E13	30MC-E13	32MC-H14	24MC-S13
Depth	DL+2.0 - 1.5	DL-19.0 - 29.5	DL-24.5 -25.0	DL+2.0 -1.5	DL-19.5 -20.0
Stratum (Soil Layer)	Clay	Clay	Clay	Clay	Sandy Clay
Unified Classification	CL	CL	CL	CL	SC
Grandwater Level	DL - 0.2	DL - 0.9	DL - 0.9	DL - 0.2	DL + 0.2
Unit Weight (T/m3)	2.0	1.8	1.7	1.9	2.0
Cohesion 60 (kg/cm2)	0.6	0.6	0.8	0.2	0.4
Natural Moisture Content (%)	21	35	47	32	27

Table III-2-3 PREDOMINANT WIND AND VELOCITY BY BEAUFORT'S WIND FORCE SCALE (1981-1986)

Unit: m / s

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1981	2 SE	2 SE	2 SE	2 SE	2 SE	3 SE	2 SE	2 SE	2 SE	2 SE	1 SE	2 SE	
1982	2 SE	2 SE	2 SE	1 S	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	
1983	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	2 SE	2 SW	2 SE	2 SW	
1984	2 SW	2 SE	2 SW	2 SW	2 SE	2 SE	2 NE	2 SE	2 SW	1 SW	2 SE	1 SE	
1985	1 S	1 S	1 S	1 S	1 S	1 N	1 N	1 N	1 N	1 S	1 S	1 SE	
1986	1 S	1 S	1 S	1 S	1 S	1 SE	2 S	1 SW	----	1 S	1 S	1 S	
Average													
Extreme (Year)													

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 15-227 CARD : 14
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-4 INCIDENCE OF CYCLONES MONTHLY (1960-1980)

Unit : %

Incidence of Cyclone (Monthly)	May	June	July	August	September	October	November	Remarks
Cyclones affected at Lazaro Cardenas	4.8	33.3	14.3	7.1	26.2	11.9	2.4	
Cyclones occurred at the side of Pcific Ocean	2.1	20.6	9.3	11.3	34.0	19.6	3.1	
Cyclones occurred near Mexico	1.5	16.7	8.7	12.3	37.7	19.6	3.6	

Table III-2-5 MONTHLY RAINFALLS (1981-1986)

Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Amount
1981	76.6	0.0	0.0	0.0	0.0	99.7	222.5	524.6	336.4	158.5	0.0	----	1418.3
1982	0.0	0.0	----	0.0	57.9	169.3	172.3	90.1	183.8	97.0	52.0	3.6	826.0
1983	13.4	2.6	2.6	0.0	146.0	46.2	315.0	273.3	423.5	164.3	33.0	45.3	1465.2
1984	5.5	----	0.0	0.0	18.5	214.8	293.2	203.8	789.5	64.0	37.3	----	1626.6
1985	1.0	0.0	12.2	0.0	22.0	302.1	234.9	190.4	207.9	7.2	17.2	0.0	994.9
1986	0.0	0.0	0.0	14.2	43.5	140.1	43.9	179.5	----	141.7	3.5	10.4	-----
Average	16.1	0.4	2.5	2.4	48.0	162.0	213.6	243.6	----	105.5	23.8	9.9	1266.2 ('81-85)
Extreme (Year)	76.6	2.6	12.2	14.2	146.0	302.1	315.0	524.6	789.5	164.3	52.0	45.3	

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 07
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-6 MAXIMUM RAINFALL OF 24 HOURS (1981-1986)

Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1981	37.0	0.0	0.0	0.0	0.0	41.2	86.7	204.0	76.4	37.3	0.0	----	204.0 (Aug.)
1982	0.0	0.0	----	0.0	24.2	107.5	39.5	35.5	52.5	73.5	30.0	3.5	107.5 (Jun.)
1983	6.8	2.6	2.0	0.0	100.0	16.0	49.6	144.3	95.4	62.0	12.5	45.0	144.3 (Aug.)
1984	2.2	----	0.0	0.0	18.5	57.0	76.8	45.4	219.0	44.0	29.7	----	219.0 (Sep.)
1985	1.0	0.0	12.2	0.0	16.0	40.0	50.3	40.3	33.6	2.1	10.8	0.0	50.3 (Jul.)
1986	0.0	0.0	0.0	11.0	20.6	40.3	20.2	42.5	----	30.8	3.5	10.3	42.5 (Aug.)
Average													
Extreme (Year)	37.0 ('81)	2.6 ('83)	12.2 ('85)	11.0 ('86)	100.0 ('83)	107.5 ('82)	86.7 ('881)	204.0 ('81)	219.0 ('84)	73.5 ('82)	30.0 ('82)	45.0 ('83)	

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 08
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-7 MONTHLY MEAN TEMPERATURE (1981-1986)

Unit: Centigrade

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
1981	24.7	25.8	25.4	26.8	26.3	27.0	26.8	26.8	26.9	27.2	26.6	26.3	26.4
1982	24.2	26.7	26.4	27.8	28.1	28.4	28.3	29.4	27.9	27.8	27.6	26.1	27.4
1983	26.1	25.0	24.7	26.3	27.5	29.1	28.3	28.7	27.3	27.8	27.2	26.2	27.0
1984	26.0	26.0	26.9	27.2	28.4	28.4	27.3	27.7	26.2	28.2	26.8	26.8	27.2
1985	25.9	26.9	26.8	27.2	27.3	27.4	26.6	26.8	27.5	27.2	26.4	25.6	26.8
1986	23.7	26.0	25.9	30.0	27.9	25.5	26.7	27.1	----	27.8	26.4	24.6	26.5
Average	25.1	26.1	26.0	27.6	27.6	27.6	27.3	27.8	22.6	27.7	26.8	25.9	26.9
Extreme (Year)													

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 01
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-8 EXTREME MINIMUM TEMPERATURE (1981-1986)

Unit: Centigrade

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Extreme
1981	16.5	17.0	17.0	18.0	17.0	20.0	20.0	20.0	21.0	21.5	18.5	19.0	16.5 (Jan.)
1982	17.5	18.5	19.5	20.0	21.0	22.0	21.0	22.0	21.0	22.0	17.0	17.5	17.0 (Nov.)
1983	17.0	17.5	18.0	17.0	20.5	22.5	22.0	23.0	22.5	22.5	20.5	18.5	17.0 (Jan.)
1984	19.0	18.5	18.5	19.0	19.5	21.5	22.0	21.5	21.5	23.0	18.0	18.0	18.0 (Dec.)
1985	15.0	15.0	15.0	15.0	15.0	15.5	18.0	18.0	19.0	17.5	17.0	15.5	15.0 (Jan.)
1986	11.0	13.5	15.0	17.5	16.0	14.5	17.0	17.5	----	18.0	18.0	14.5	11.0 (Jan.)
Average													
Extreme (Year)	11.0 ('86)	13.5 ('86)	15.0 ('85)	15.0 ('85)	15.0 ('85)	14.5 ('86)	17.0 ('86)	17.5 ('86)	19.0 ('85)	17.5 ('85)	17.0 ('82)	14.5 ('86)	11.0 ('86)

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 03
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-9 MEAN MINIMUM TEMPERATURE (1981-1986)

Unit: Centigrade

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
1981	19.1	20.0	19.7	21.0	21.1	22.7	22.1	22.4	22.5	22.9	21.4	20.2	21.2
1982	19.7	20.8	20.7	22.5	23.2	24.5	23.9	24.4	23.7	23.7	22.6	20.5	22.5
1983	20.9	19.3	19.3	20.8	22.6	25.1	24.3	24.5	23.5	23.7	22.5	21.1	22.3
1984	20.6	20.2	20.7	21.5	23.1	23.9	23.3	23.3	22.8	23.7	21.0	20.5	22.1
1985	17.9	17.9	17.2	17.1	17.3	18.0	19.8	20.1	20.3	19.7	18.6	17.4	18.4
1986	13.0	16.3	17.6	20.4	18.7	16.4	18.9	19.8	----	20.0	19.5	17.3	18.0
Average	18.5	19.0	19.2	20.5	21.0	21.7	22.0	22.4	18.8	22.2	20.9	19.5	20.6
Extreme (Year)													

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 06
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-10 EXTREME MAXIMUM TEMPERATURE (1981-1986)

Unit: Centigrade

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Extreme
1981	33.5	35.0	34.0	36.0	35.0	34.0	35.0	33.0	33.0	34.0	33.5	36.0	36.0 (Dec.)
1982	34.5	35.0	35.5	35.0	35.5	35.0	36.0	36.5	34.5	33.5	34.5	34.5	36.5 (Aug.)
1983	34.5	34.5	32.5	34.0	35.0	34.5	34.5	34.5	34.0	34.5	33.0	33.0	35.0 (May)
1984	34.0	33.5	33.5	34.0	36.5	34.0	34.0	33.5	32.5	33.5	34.0	35.5	36.5 (May)
1985	38.5	38.0	40.0	42.5	41.0	41.0	34.5	34.5	36.0	36.0	35.5	35.5	42.5 (Apr.)
1986	36.5	38.0	37.0	42.0	41.5	36.5	35.5	36.5	----	39.5	37.0	34.5	41.5 (May)
Average													
Extreme (Year)	38.5 ('85)	38.0 ('86)	40.0 ('85)	42.5 ('85)	41.5 ('86)	41.0 ('85)	36.0 ('82)	36.5 ('82)	36.0 ('85)	39.5 ('86)	37.0 ('86)	36.0 ('81)	42.5 ('85)

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 02
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-11 MEAN MAXIMUM TEMPERATURE (1981-1986)

Unit: Centigrade

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
1981	30.3	31.6	31.1	32.5	31.5	31.3	31.5	31.1	31.2	31.4	31.6	32.4	31.5
1982	28.6	32.5	32.1	33.1	32.9	32.3	32.7	34.3	32.1	31.9	32.5	31.6	32.2
1983	31.3	30.6	30.1	31.7	32.3	33.0	32.3	32.8	31.0	31.9	31.8	31.3	31.7
1984	31.4	31.8	32.1	32.8	33.7	32.8	31.2	32.0	29.7	32.7	32.6	33.1	32.2
1985	33.9	35.9	36.3	37.2	37.2	36.7	33.4	33.5	34.6	34.7	34.2	33.7	35.1
1986	34.3	35.6	34.2	39.5	37.0	34.5	34.4	34.3	----	35.6	33.3	31.8	35.0
Average	31.6	33.0	32.6	34.4	34.1	33.4	32.5	33.0	31.7	33.0	32.6	32.3	32.9
Extreme (Year)													

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 15
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-12 NUMBER OF RAINY DAYS (1981-1986)

Unit: Number

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Amount
1981	3	0	0	0	0	9	19	20	18	11	0	0	80
1982	0	0	0	0	8	7	8	7	17	8	3	2	60
1983	4	1	2	0	2	7	17	12	18	8	4	2	77
1984	4	0	0	0	1	18	16	17	22	3	2	0	83
1985	1	0	1	0	2	18	17	12	20	8	3	0	82
1986	0	0	0	4	7	18	13	16	-----	10	1	2	------
Average	2	0	1	1	3	13	15	14	-----	8	2	1	
Extreme (Year)													

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 09
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

Table III-2-13 NUMBER OF CLEAR DAYS (1981-1986)

Unit: Number

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Amount
1981	15	19	21	17	10	13	9	5	2	10	18	13	152
1982	13	12	13	10	7	8	1	12	4	7	7	12	106
1983	7	16	15	17	10	14	5	11	9	11	9	14	138
1984	9	18	16	18	9	9	4	13	2	14	20	21	153
1985	26	26	29	30	24	11	14	17	10	19	25	26	257
1986	27	28	31	26	21	12	12	15	----	17	25	29	243
Average	16	20	21	20	14	11	8	12	5	13	17	19	
Extreme (Year)													

Source : SARH DIR. GRAL. SERVICIO METEOROLOGICO NACIONAL.
LAZARO CARDENAS, MICHOACAN. ORG. D.G.E. CODE : 16-227 CARD : 11
COORD : LAT : 18 - 01 LONG : 102 - 12 ALT :

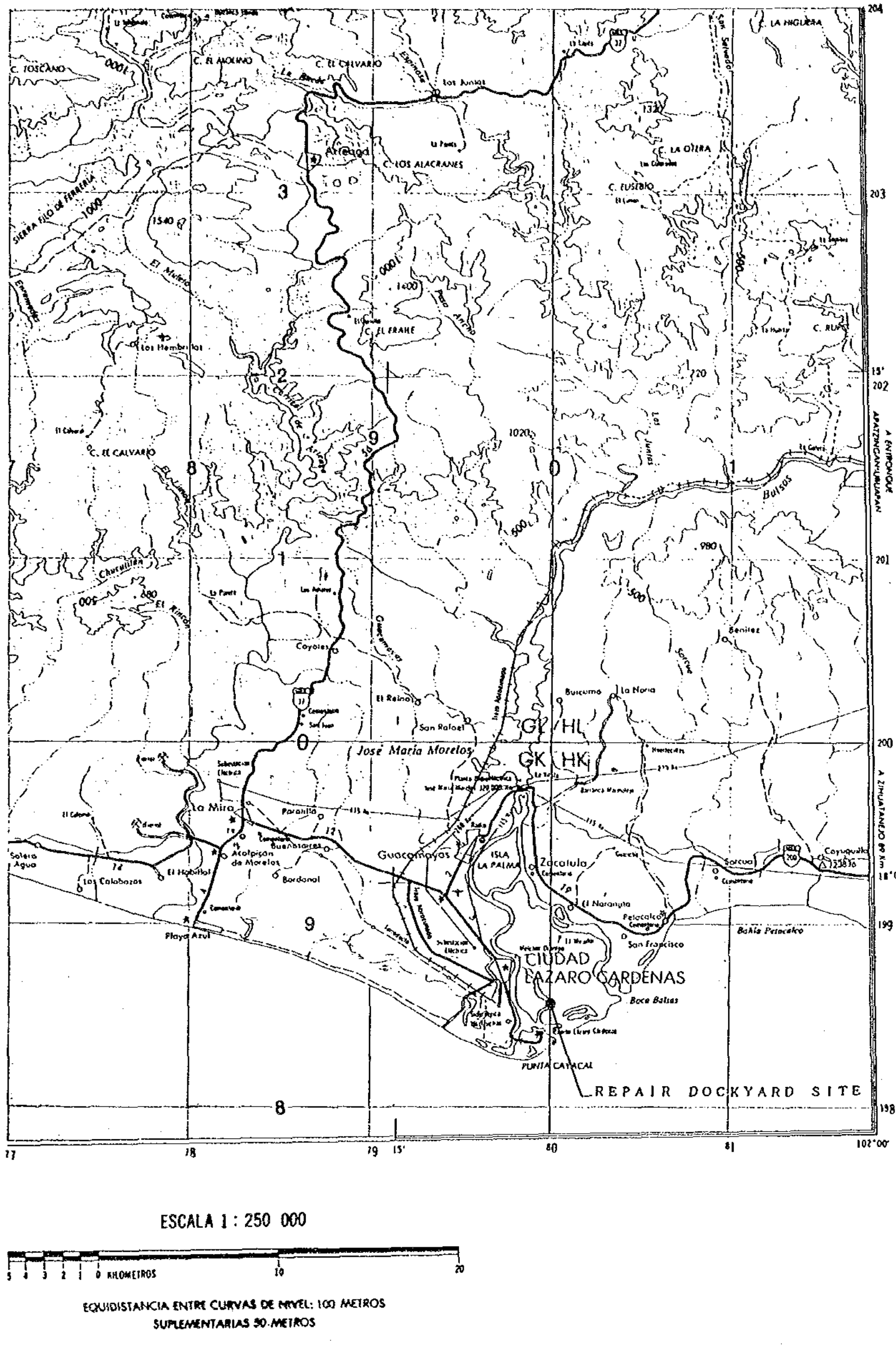


Fig. III-2-1 LOCATION OF SITE

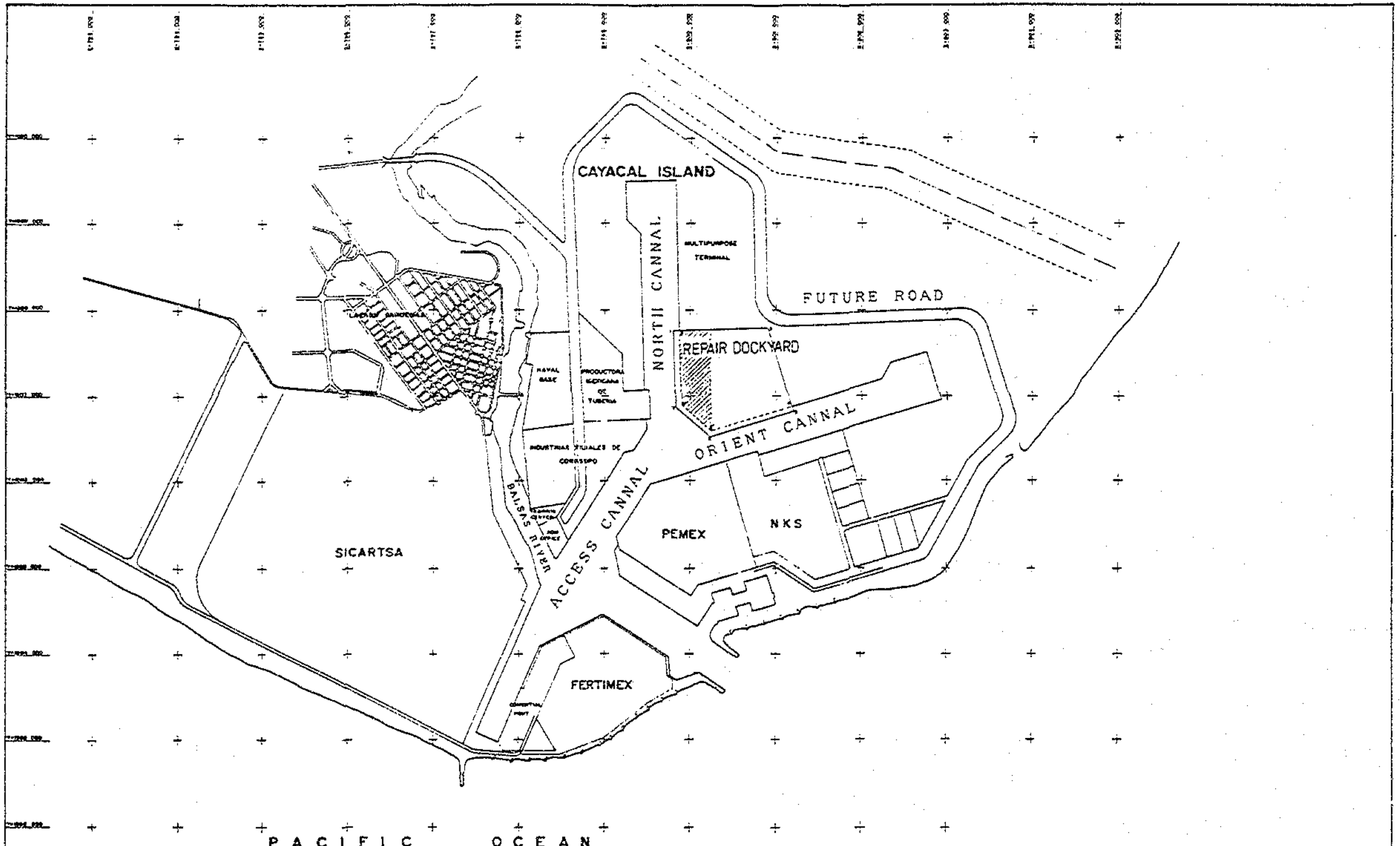
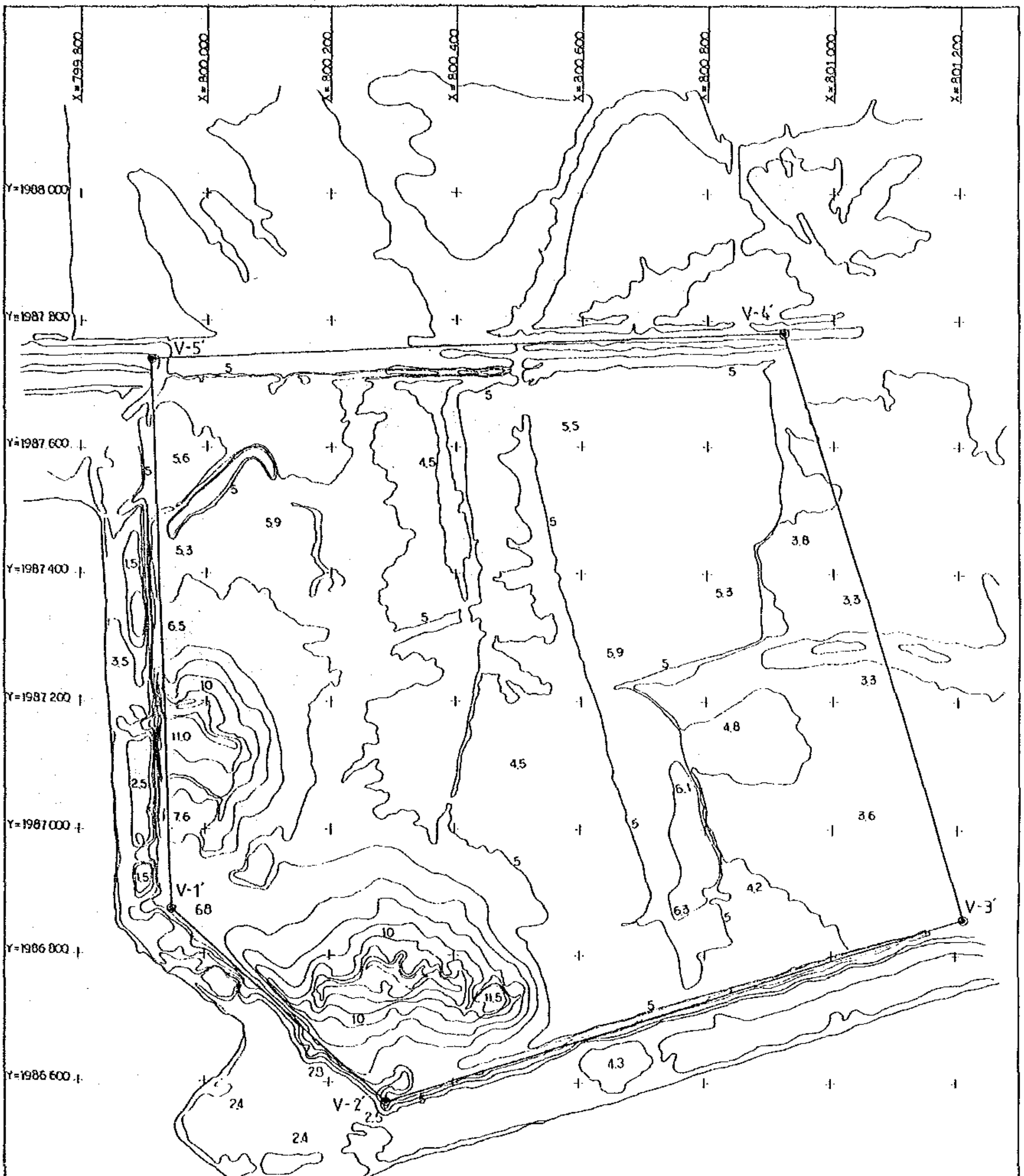
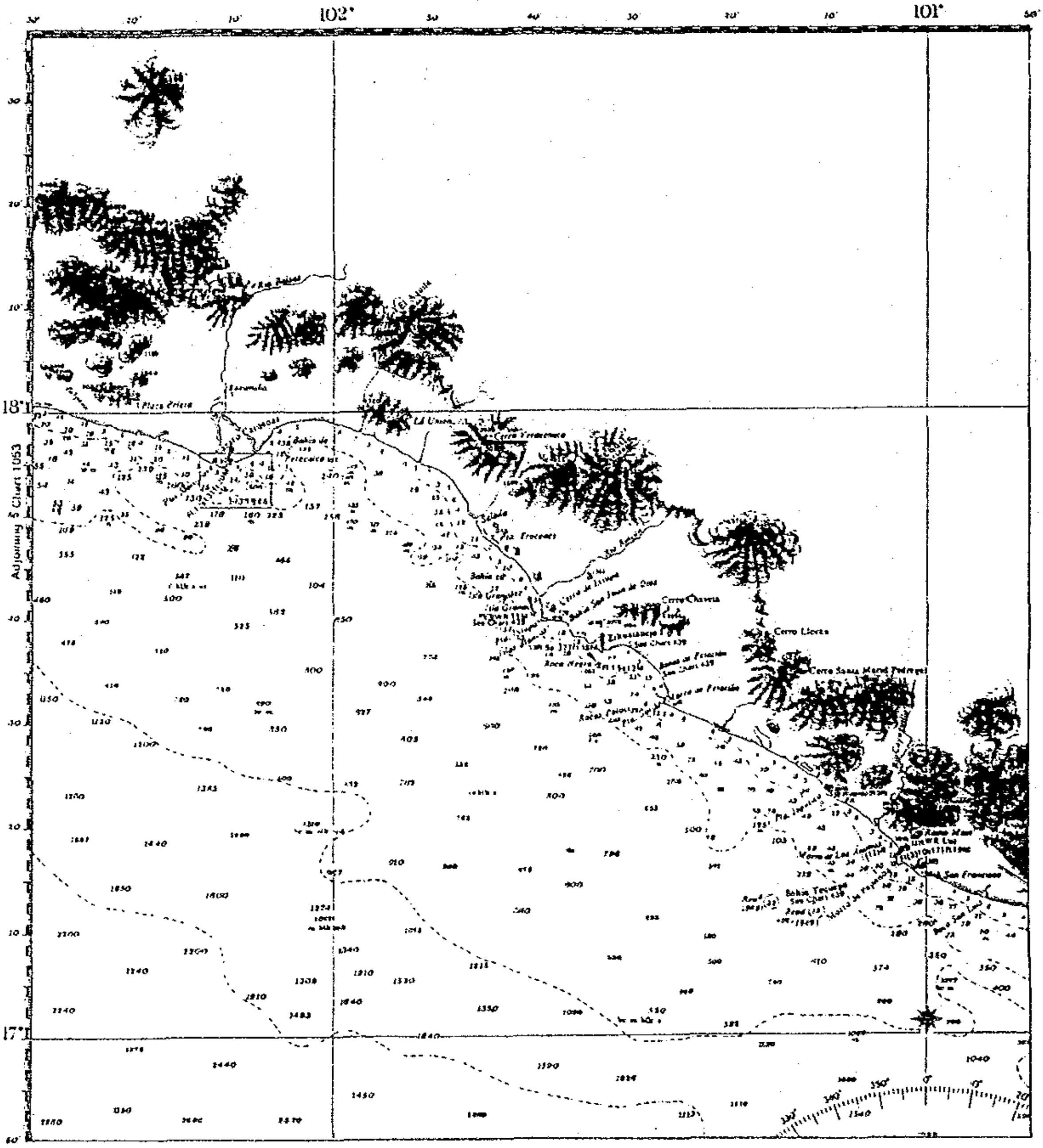


Fig. III-2-2
LOCATION OF REPAIR
DOCKYARD AT LAZARO
CARDENAS (FOR FUTURE)



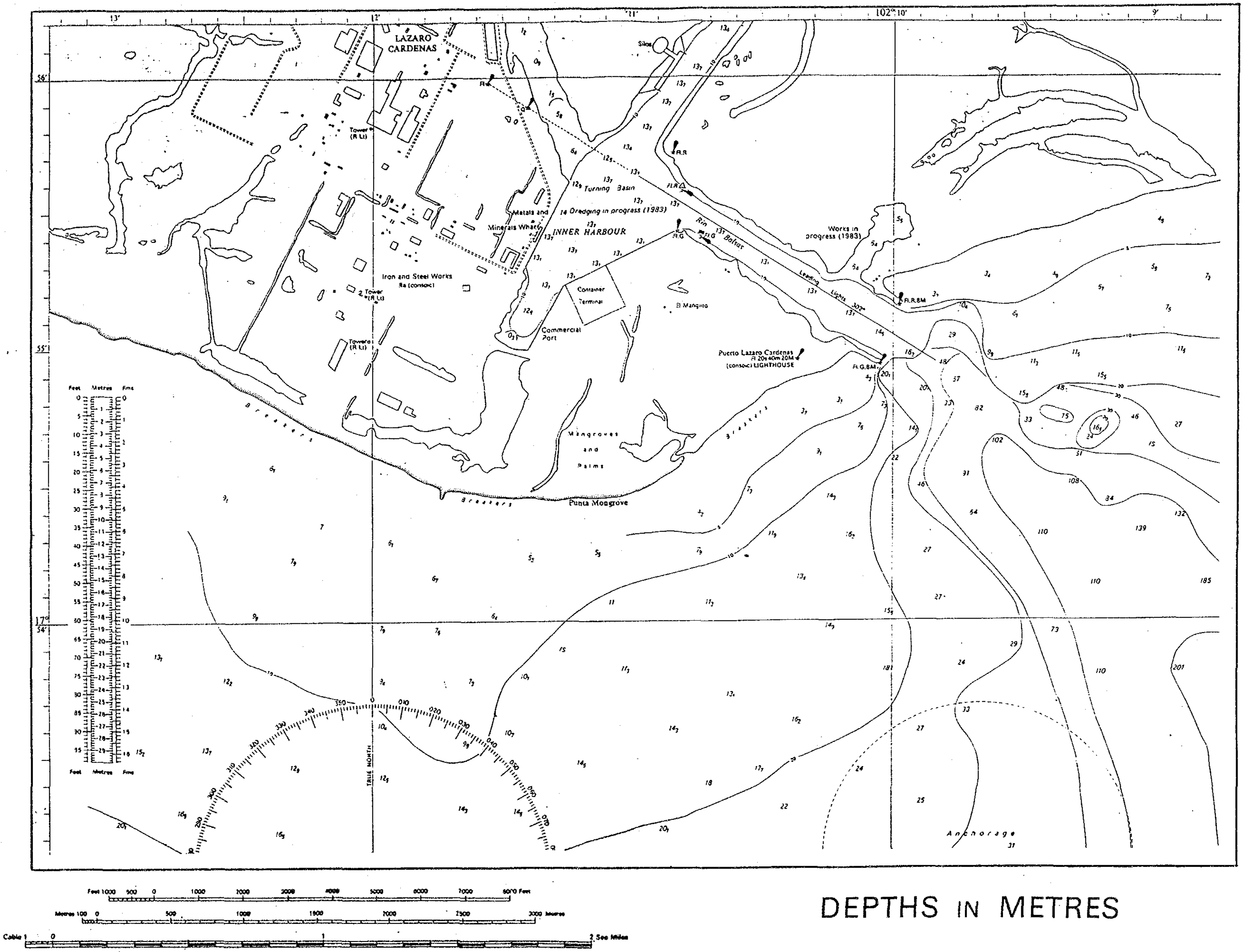
NOTE: 1). THE HEIGHT IN METRES.
2). THE HEIGHT IS MEASURED FROM MSL (=DL+0.3)

Fig. III-2-3
TOPOGRAPHICAL MAP FOR REPAIR DOCKYARD SITE AT 1985 (BY FONDEPORT)



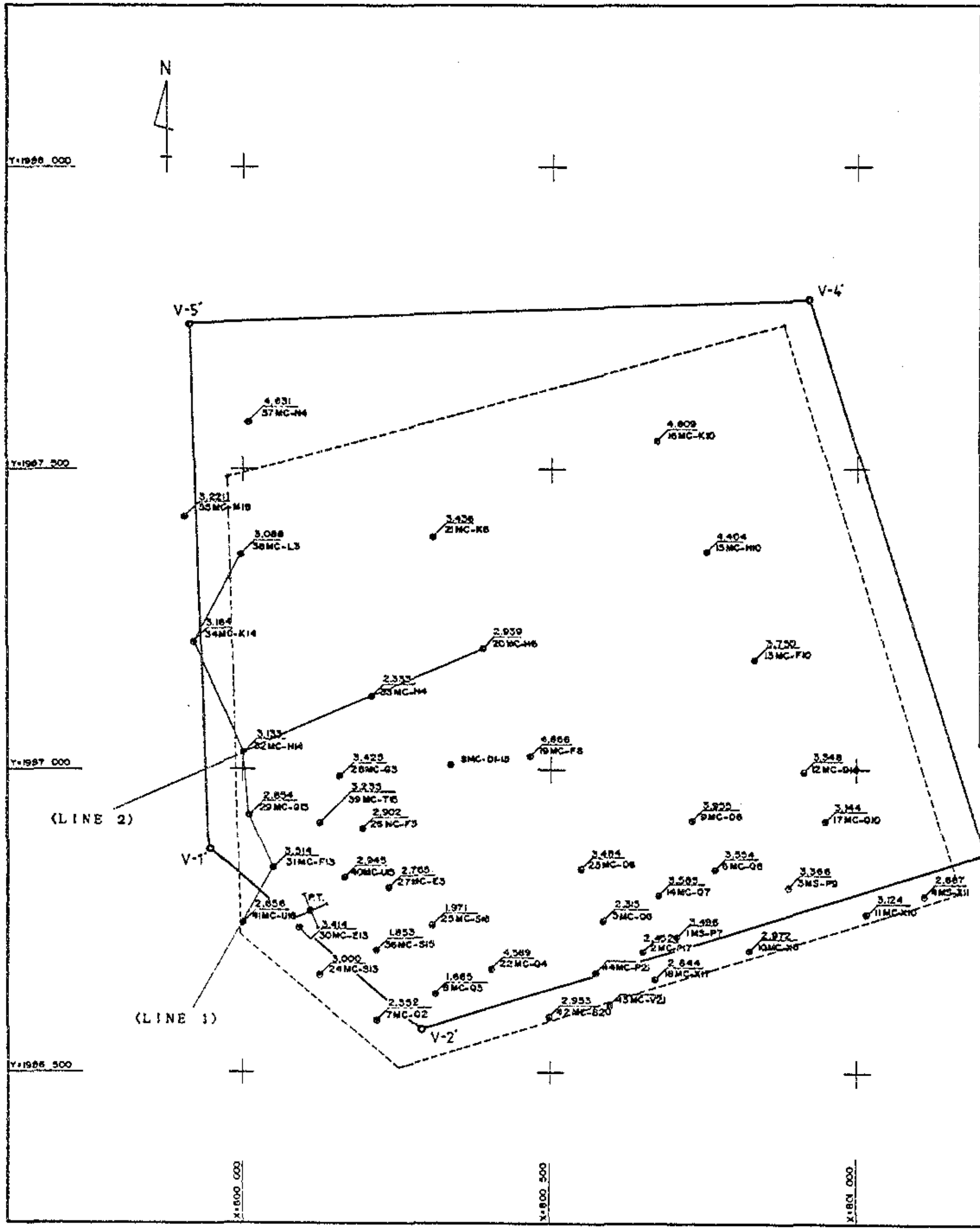
SOUNDINGS IN FATHOMS

Fig. III−2−4
CHART OF PACIFIC OCEAN
NEAR LAZARO CARDENAS

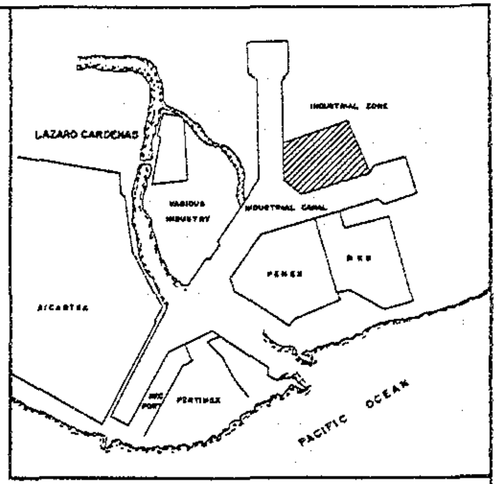


DEPTHS IN METRES

Fig. III-2-5
CHART OF LAZARO CARDENAS PORT



BORING No. & TYPE.	COORDINATES X	COORDINATES Y	FINAL DEPTH m.
1MS-P7	800,714.52	1,986,743.26	30.00
2MC-P17	800,660.24	1,986,717.67	30.00
3MS-P9	800,695.44	1,986,828.51	30.00
4MS-X11	801,129.46	1,986,801.06	30.00
5MC-O6	800,594.22	1,986,783.94	30.00
6MS-O8	800,755.14	1,986,849.20	49.65
7MC-O2	800,684.66	1,986,606.57	30.25
8MC-Q3	800,322.84	1,986,626.06	29.95
9MC-D8	800,736.77	1,986,930.61	30.35
10MC-X8	800,848.40	1,986,710.71	30.00
11MC-X10	801,036.10	1,986,770.96	30.00
12MC-D10	800,917.69	1,987,015.87	30.15
13MC-F10	800,832.44	1,987,196.75	30.05
14MC-Q7	800,684.68	1,986,806.57	30.10
15MC-H10	800,747.18	1,987,377.71	30.25
16MC-K10	800,661.93	1,987,558.62	30.05
17MC-O10	800,965.06	1,986,934.46	29.95
18MC-X17	800,666.24	1,986,682.52	30.00
19MC-F6	800,470.60	1,987,026.28	30.15
20MC-N6	800,565.34	1,987,207.19	30.10
21MC-K6	800,300.08	1,987,566.11	30.00
22MC-O4	800,413.30	1,986,678.69	30.00
23MC-D6	800,567.35	1,986,850.06	30.60
24MC-S13	800,131.22	1,986,667.36	30.60
25MC-S16	800,246.62	1,986,722.76	30.05
26MC-F3	800,199.22	1,986,890.39	30.25
27MC-E3	800,241.60	1,986,807.95	30.25
28MC-G3	800,156.59	1,986,966.86	30.00
29MC-G13	800,011.86	1,986,920.65	30.10
30MC-E13	800,087.12	1,986,739.73	30.05
31MC-F13	800,054.49	1,986,850.19	30.05
32MC-H14	800,006.42	1,987,028.16	29.95
33MC-H4	800,214.43	1,987,121.94	30.10
34MC-K14	779,920.16	1,987,209.07	30.15
35MC-M15	779,669.16	1,987,415.57	29.85
36MC-S15	800,221.66	1,986,708.99	29.90
37MC-N4	799,991.29	1,987,574.23	30.05
38MC-L3	799,966.06	1,987,330.67	30.35
39MC-T15	800,136.03	1,986,904.46	30.15
40MC-O15	800,166.26	1,986,827.58	30.40
41MC-O18	800,006.44	1,986,750.65	30.20
42MC-B20	800,514.47	1,986,604.76	30.05
43MC-V21	800,622.24	1,987,622.36	30.00
44MC-P21	800,592.40	1,986,665.70	30.25
PERMEABILITY TEST	800,115.73	1,986,770.61	27.00



SIMBOL

⊙ BORING POINT

Elevation / No. of boring

PERMEABILITY TEST

NOTE: —— BOUNDARY LINES OF LAND FOR REPAIR DOCKYARD (PREPARED BY FONDEPORT)

---- OLD BOUNDARY LINES (AT 1982 BY AUSA)

GRAPHICAL SCALE

0 50 125 250 500

Fig. III-2-6
LOCATION OF BORE HOLE
EXECUTED BY AUSA

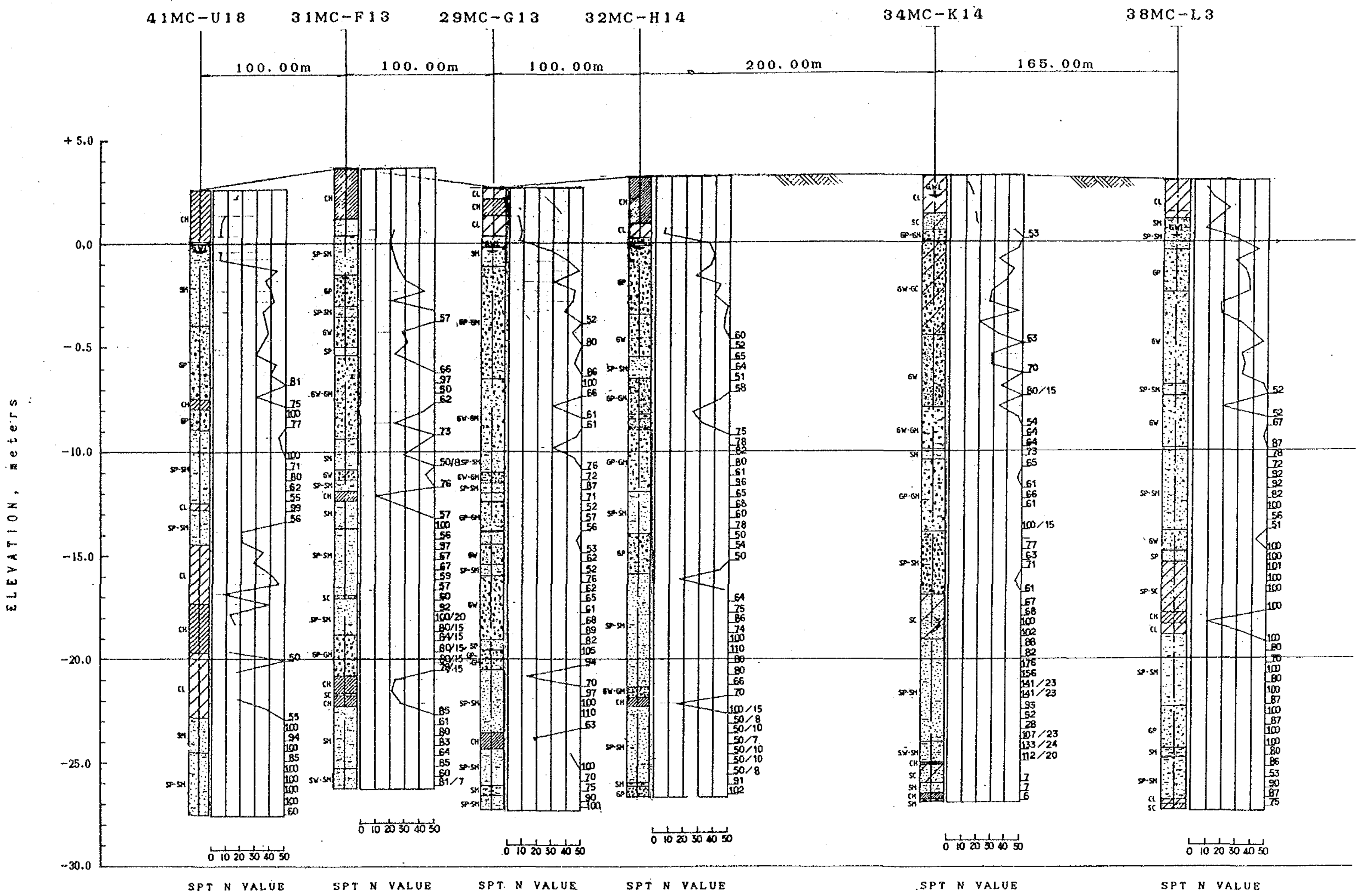


Fig. Ⅲ-2-7

SOIL PROFILE (LINE 1)

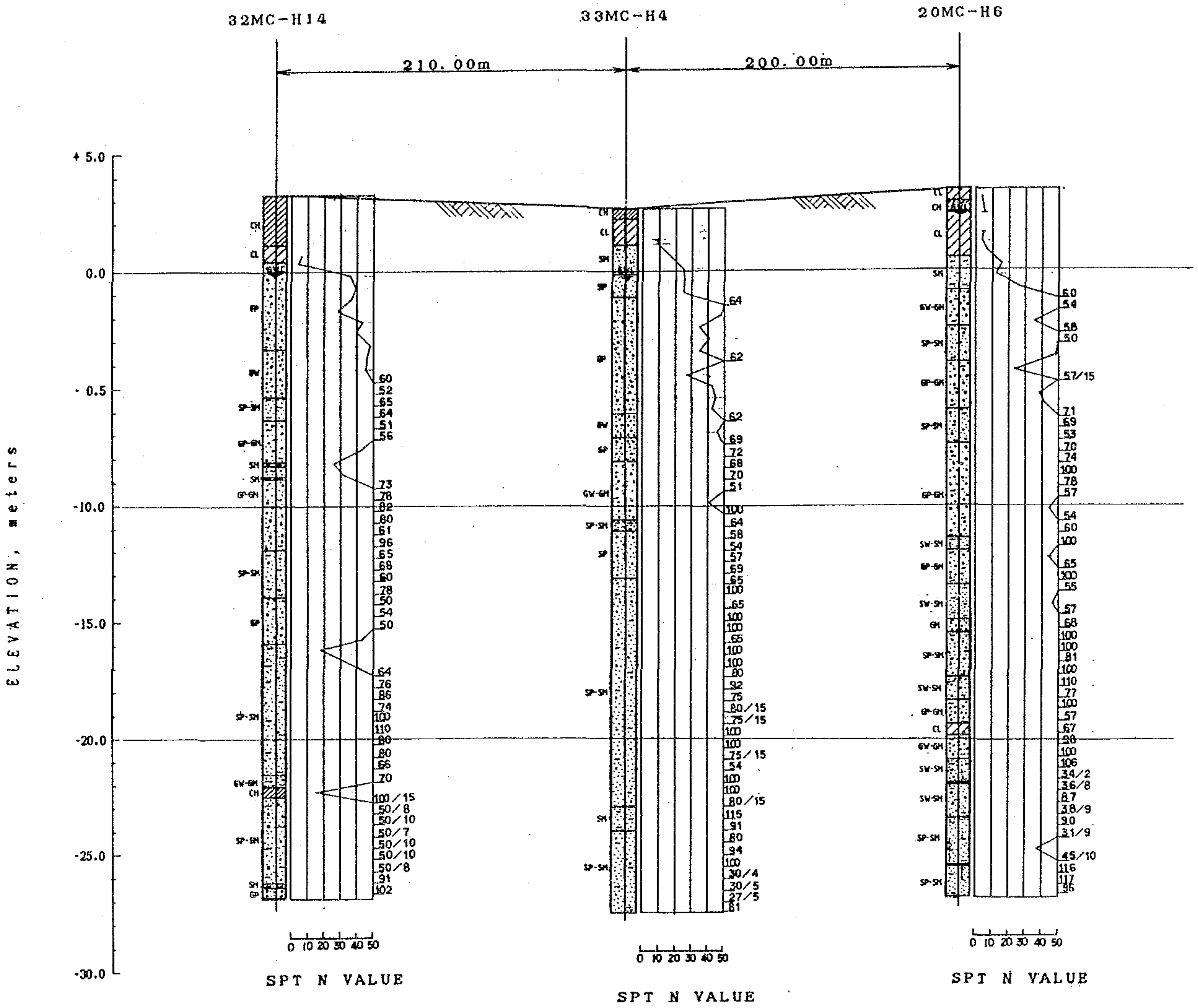
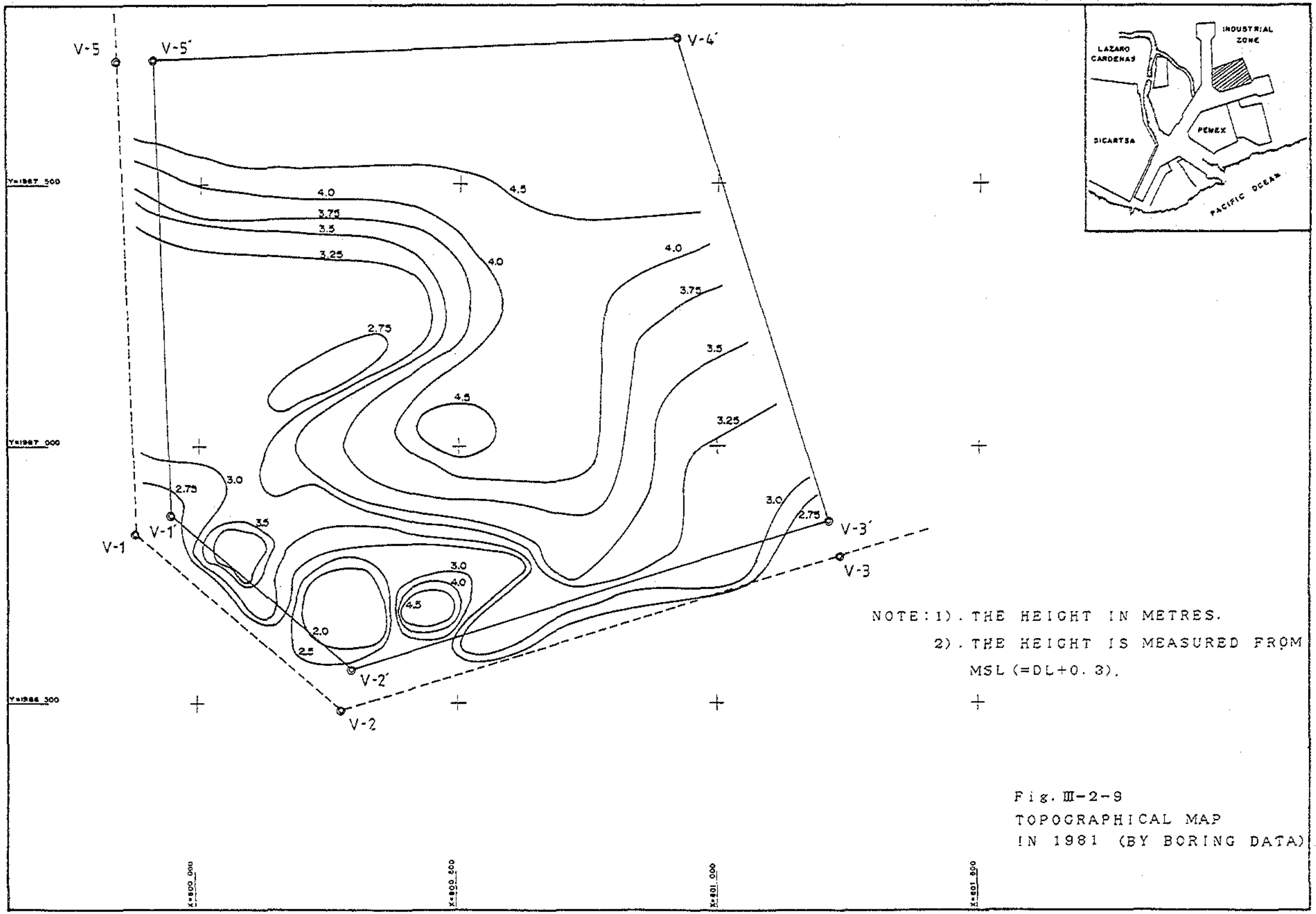


Fig. Ⅲ-2-8
SOIL PROFILE (LINE 2)



NOTE: 1). THE HEIGHT IN METRES.
2). THE HEIGHT IS MEASURED FROM MSL (=DL+0. 3).

Fig. III-2-9
TOPOGRAPHICAL MAP
IN 1981 (BY BORING DATA)

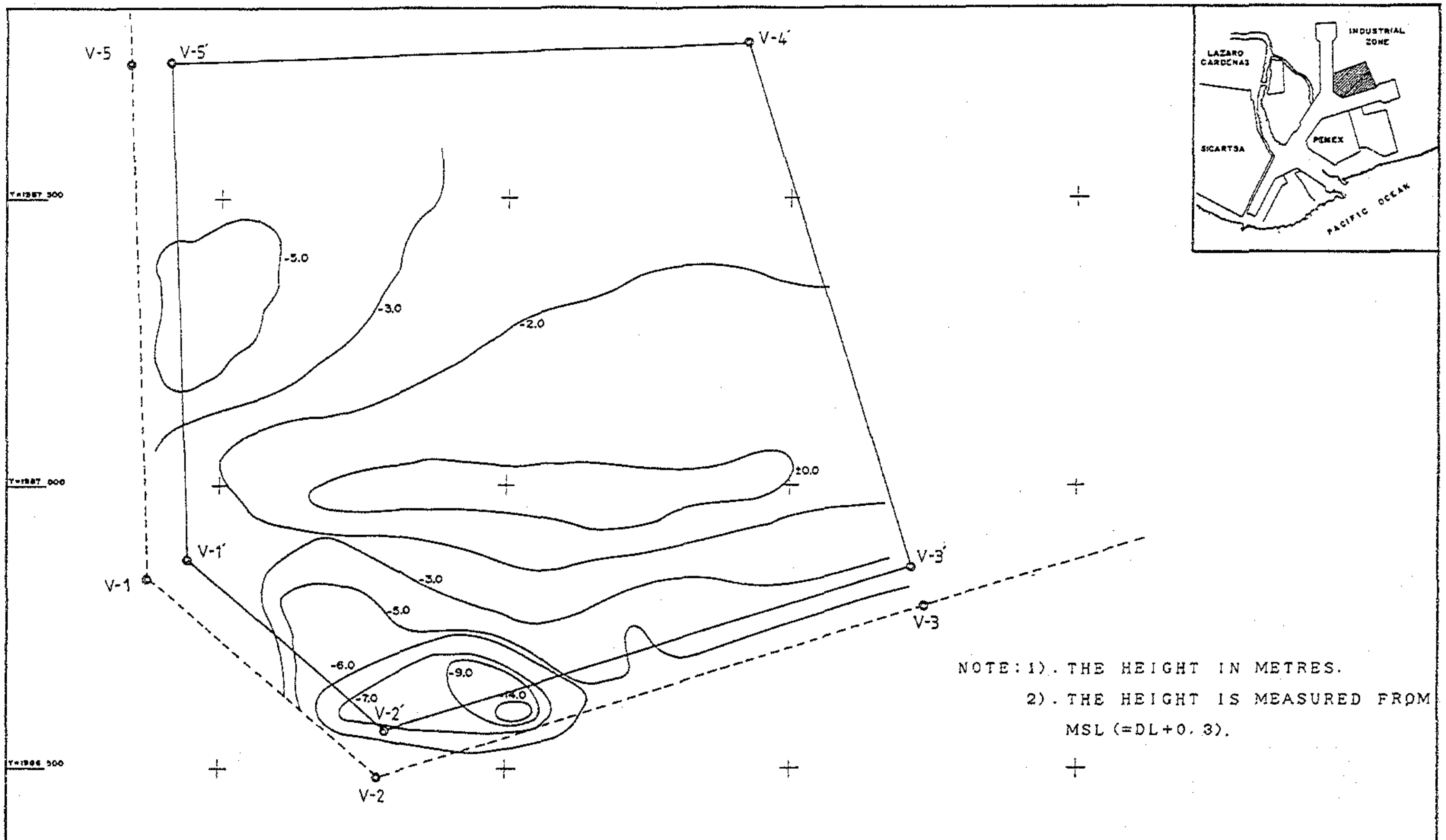


Fig. III-2-10
TOP LEVEL OF BEARING LAYER

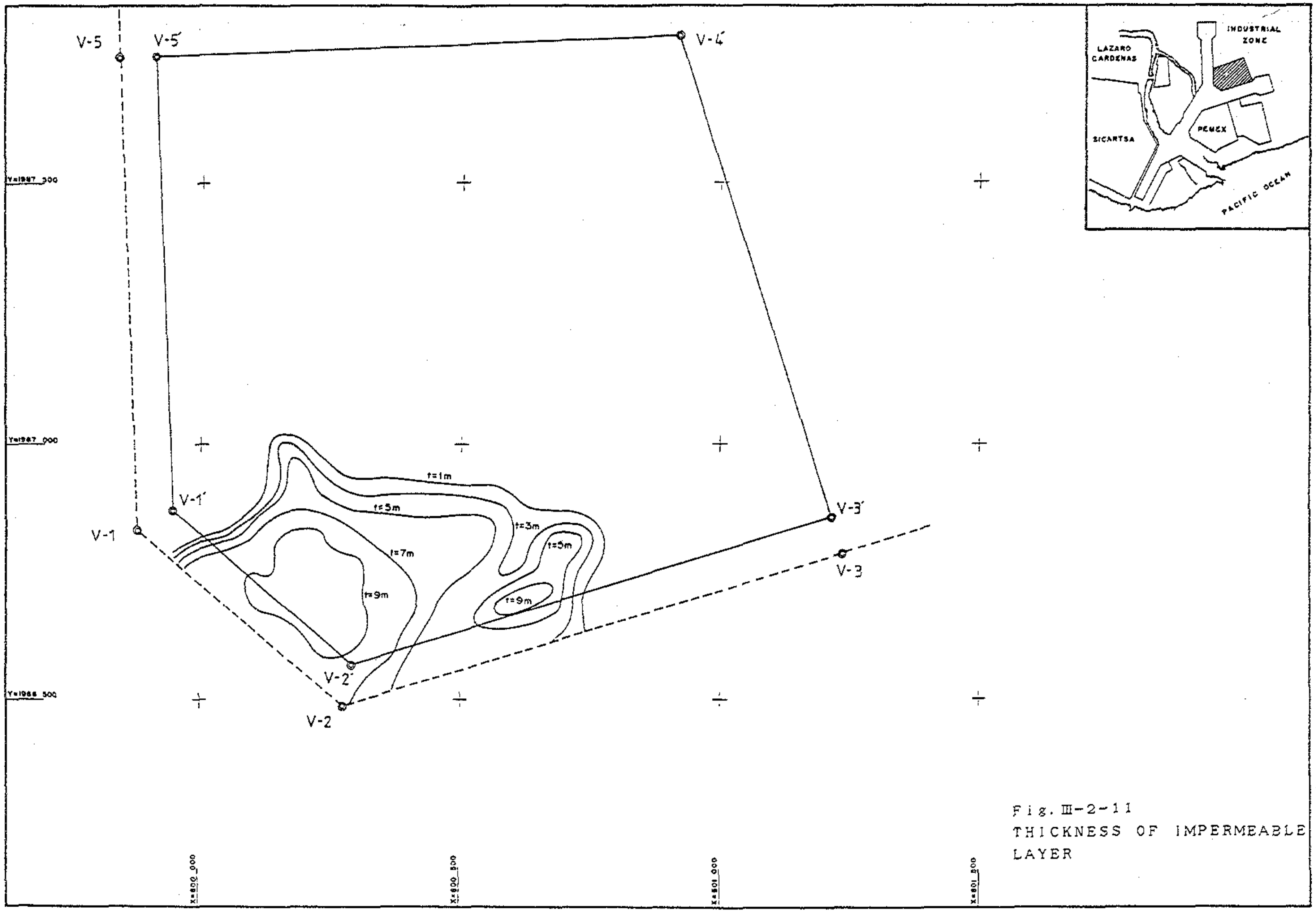
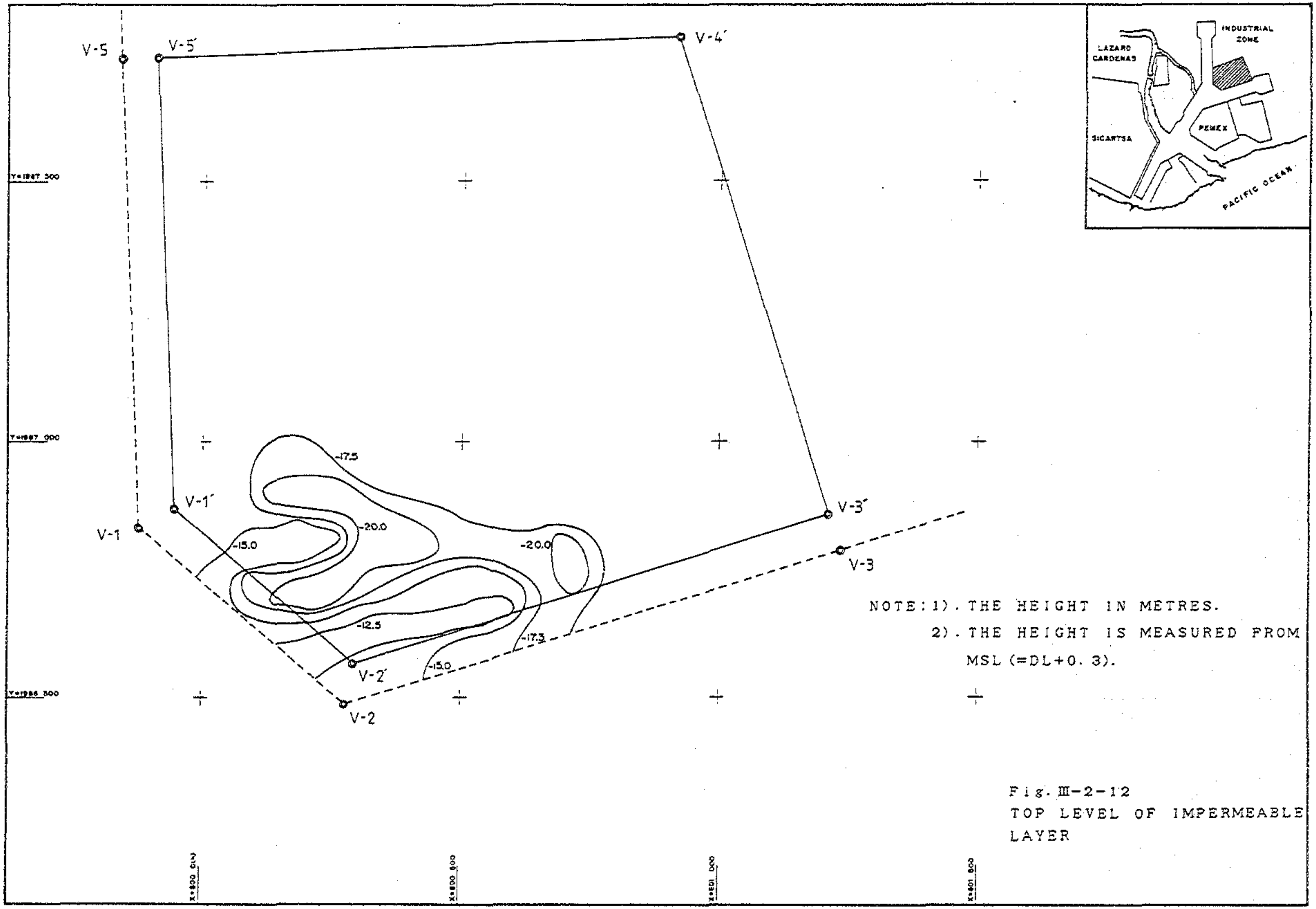


Fig. III-2-11
THICKNESS OF IMPERMEABLE LAYER



NOTE: 1). THE HEIGHT IN METRES.
2). THE HEIGHT IS MEASURED FROM MSL (=DL+0.3).

Fig. III-2-12
TOP LEVEL OF IMPERMEABLE LAYER

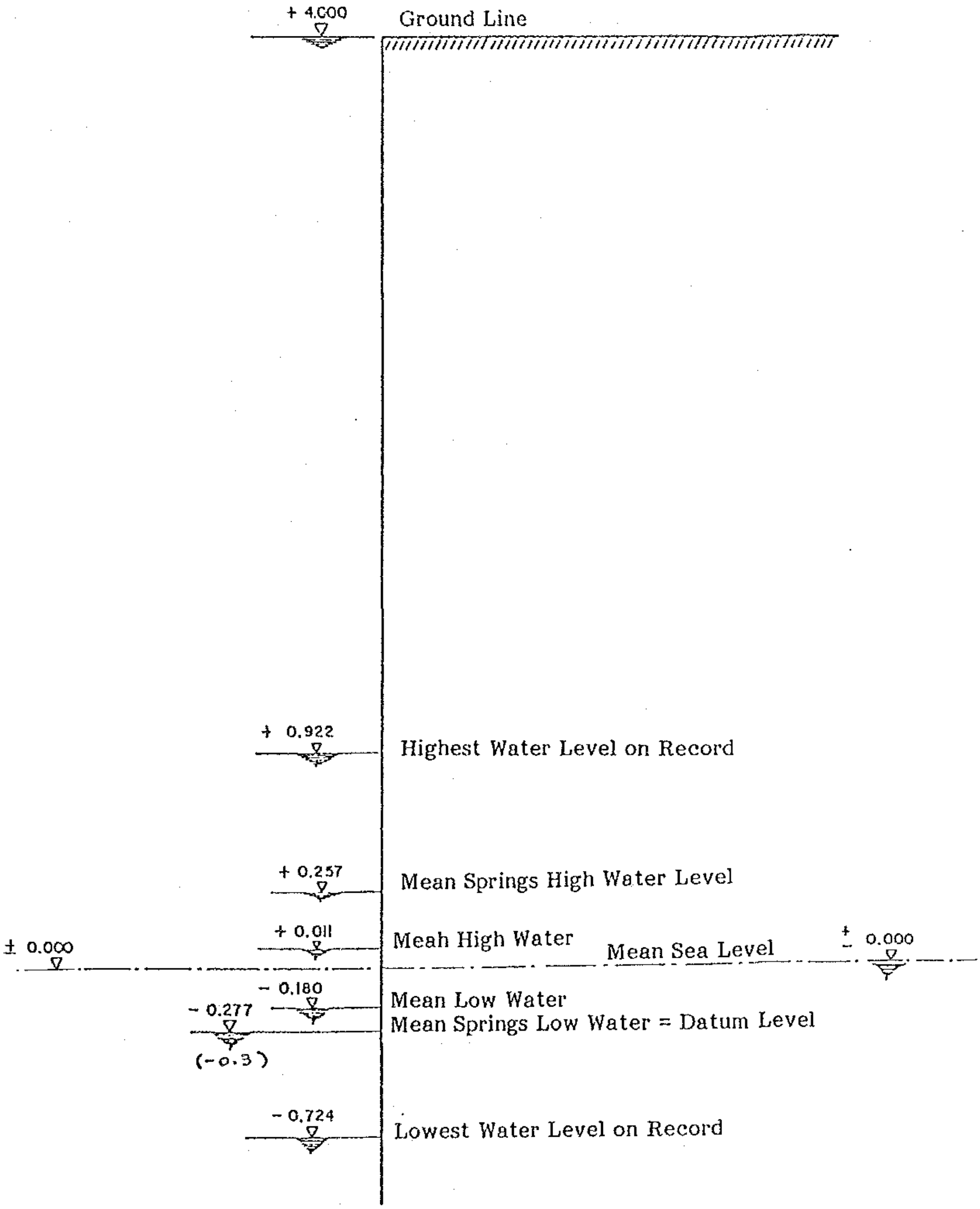
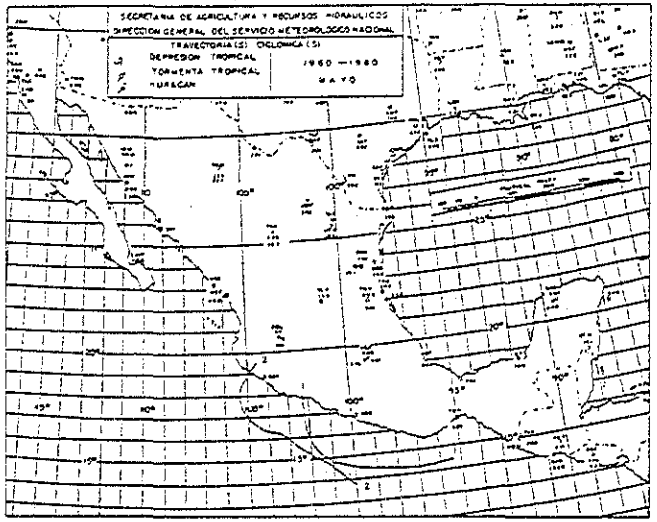
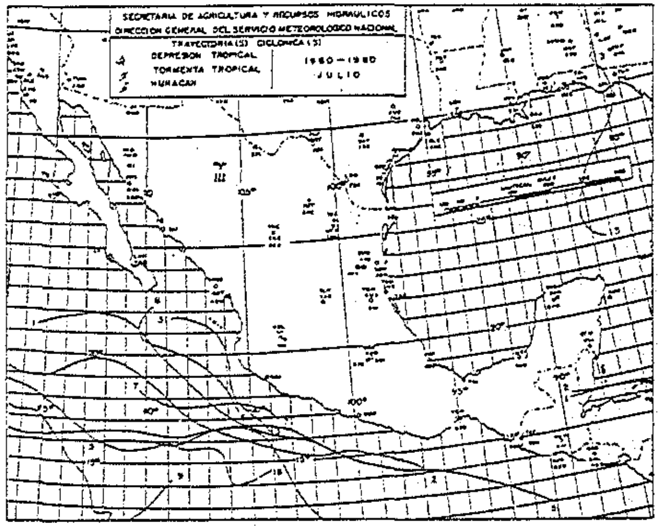


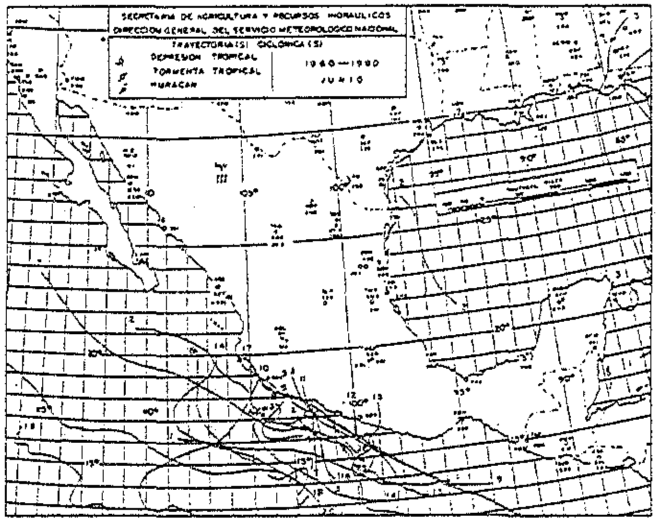
Fig. III-2-13 CHARACTERISTICS OF TIDES AT LAZARO CARDENAS PORT



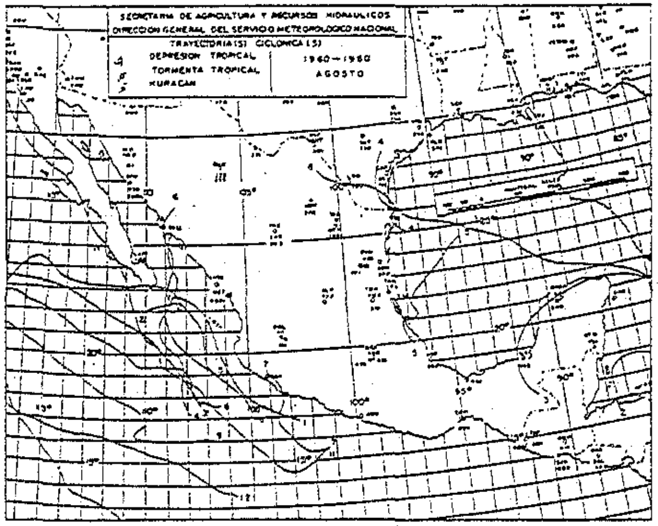
MAY



JULY

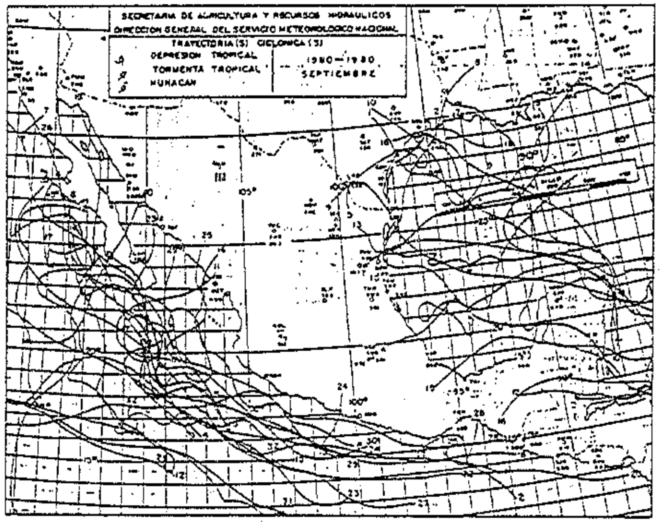


JUNE

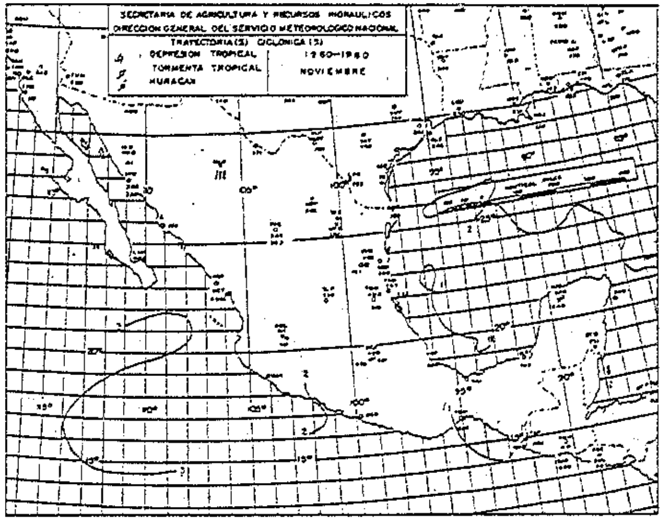


AUGUST

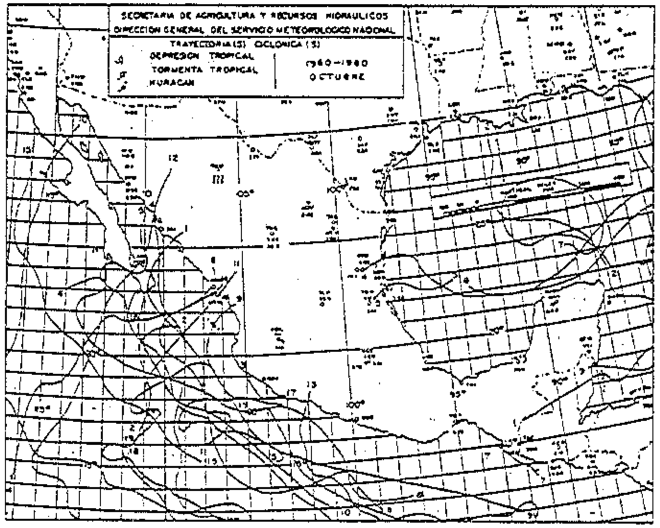
Fig. III-2-14 (A)
MAJOR CYCLONE ROUTE
IN EACH MONTH (1960~1980)



SEPTEMBER



NOVEMBER



OCTOBER

Fig. III-2-14 (B)
MAJOR CYCRONE ROUTE
IN EACH MONTH (1960~1980)

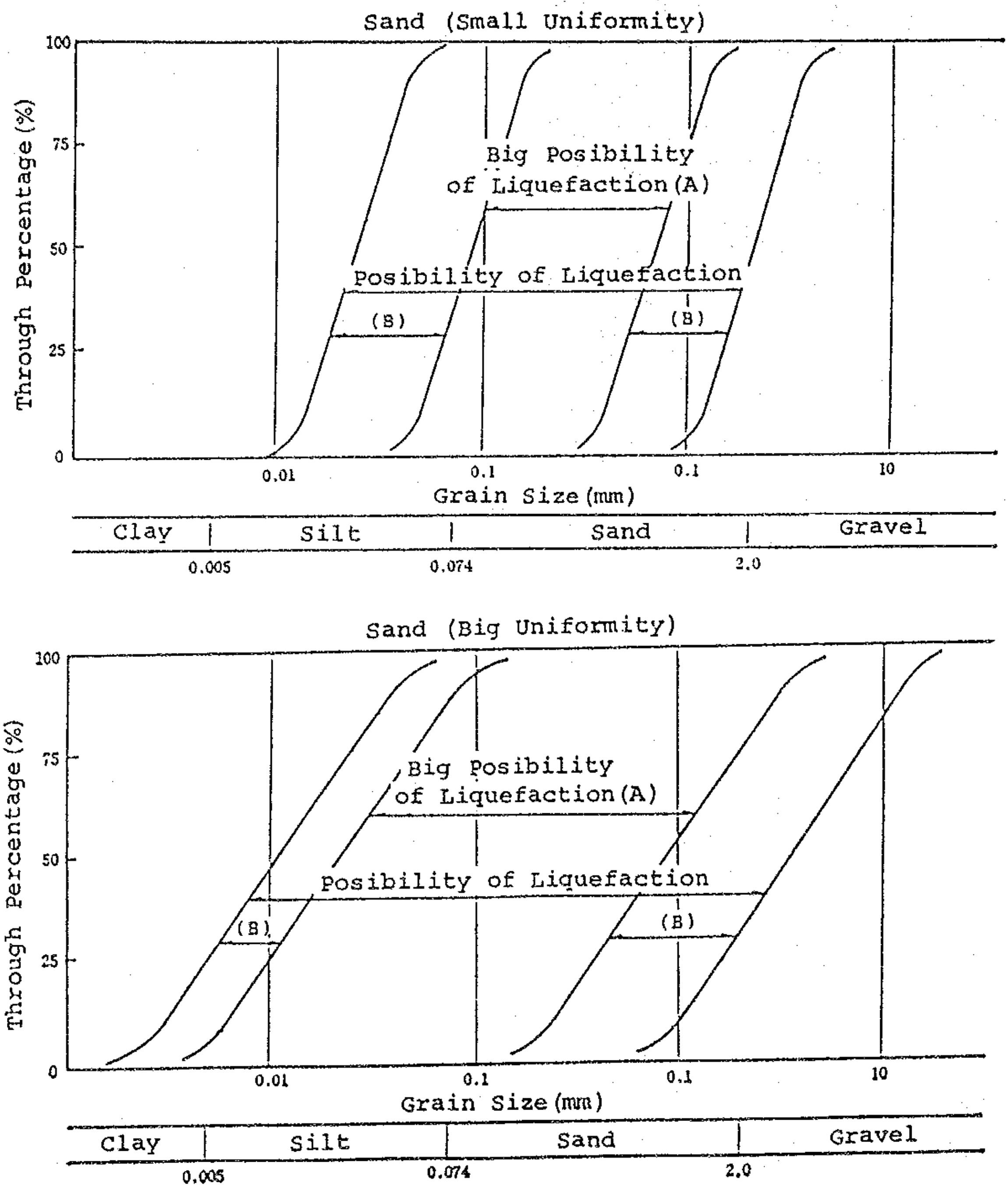


Fig. III-2-15 GRADING RANGE AGAINST LIQUEFACTION

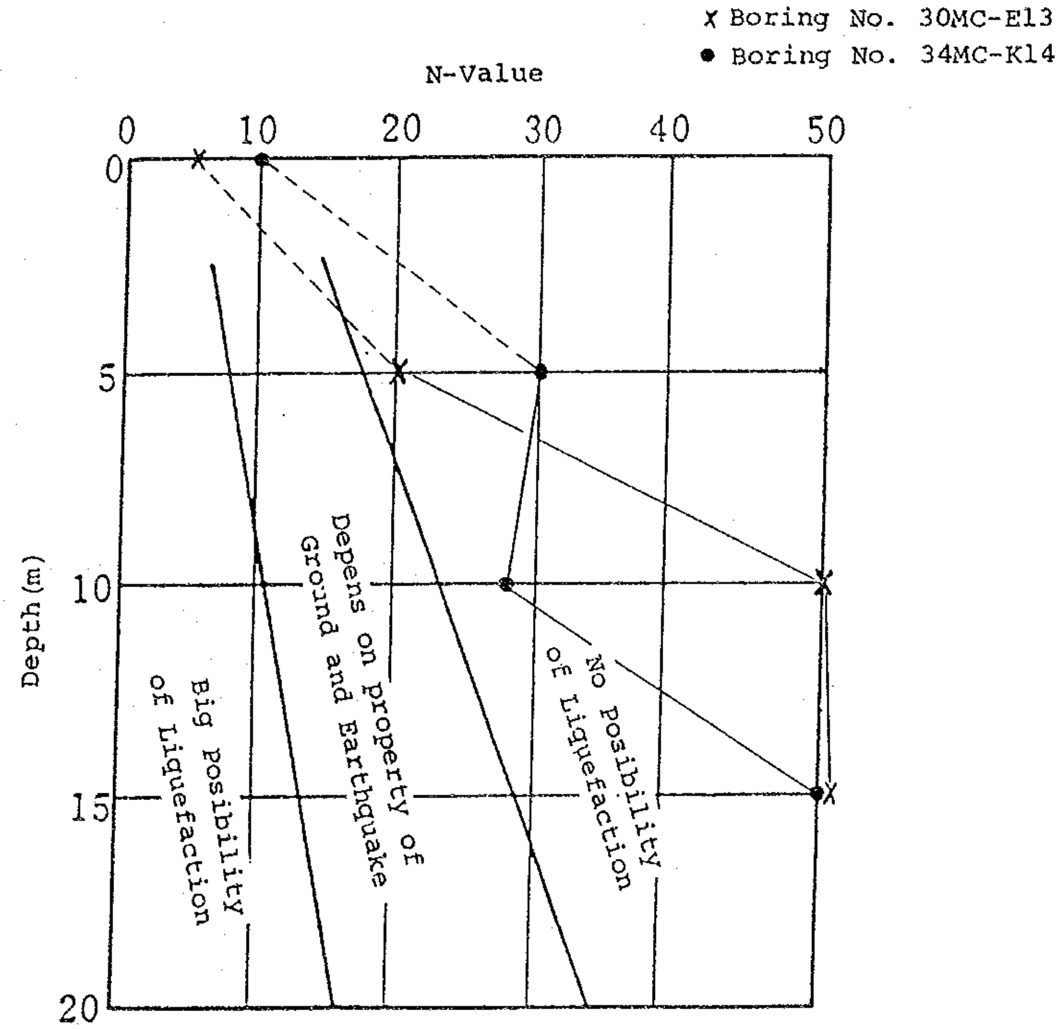


Fig. III-2-16 POSIBILITY OF LIQUEFACTION - N-VALUE

3. Environmental Conditions

3-1 Characteristic Features of Envisaged Shipyard Location

As part of the industrialization policy pursued by the Mexican Government in the National Plan of Development 1984-88, the industrial ports of Salina Cruz and Lazaro Cardenas have been accorded the position of key economic and industrial centers on the Pacific coast. Of the two ports, Salina Cruz --situated at the southern extremity of the Mexican Pacific coastline-- is already serving as the pipeline terminal and main transfer point for oil shipments to Asia and the Far East, as well as to domestic ports on the Pacific coast.

Lazaro Cardenas --the site of the envisaged new Repair Dockyard-- embraces the largest industrial zone on the Mexican Pacific coast, and is currently being further developed as a key industrial port. In its hinterland are mines furnishing 1/5 of the national production of iron ore, which is utilized by the integrated steelworks established at Lazaro Cardenas. Other heavy chemical plants are also already in operation in the industrial zone, to be further expanded in projects planned for the future. Lazaro Cardenas, however, still only ranks 10th among the 15 sea ports on the Mexican Pacific coast, in terms of aggregated domestic and foreign freight handled during 1985. A port presenting particular interest is La Paz, constituting a terminal for ferries serving tourist resorts located in its vicinity.

In respect of facilities for repairing of bigger ships on the Mexican Pacific coast, currently the only exisiting installation is one located at Salina Cruz, but which is of narrow width and has only a nominal capacity of 25,000 DWT maximum --far too small for accommodating the modern and wider merchant vessels. Not a single full-size repair dockyard is found along almost 5,500 km of coastline extending from San Diego, CA., to Panama.

In view of the expanding industrial activity promised for Salina Cruz, Lazaro Cardenas and other Mexican Ports, an adequately-equipped repair dockyard established at Lazaro Cardenas --located roughly midway along the Mexican Pacific coast of about 3,000 km-- should fulfil a manifestly needed economic and social mission, and for this reason, the envisaged Repair Dockayrd is promised lasting prosperity in the long run.

3-2 Site

The area which is to be placed under the control of FONDEPORT within the framework of the development program of the industrial port of Lazaro Cardenas is 4,200 ha. of which 2,730 ha. is reserved for industrial zone, 980 ha. for residential zone and the rest is reserved for a buffer green zone. Of the industrial zone, 640 ha. is currently used while 140 ha. has been levelled and is under preparation for use as plant site. Those are centered on Cayacal Island but, when the development is further promoted, they will be extended to the State of Guerrero (2,500 ha.). The projected site of repair dockyard is not yet levelled, and the area has non negligible differences of level as mentioned earlier (see Fig. III-2-3) and is not provided with utilities such as electricity, industrial water, etc. Those facilities are to be provided by FONDEPORT at the request of the user of the industrial site.

FONDEPORT provides an area of 120 ha. for the repair dockyard (Fig. III-3-1). This lot is to be used by lease from FONDEPORT with the payment of a certain amount of rent. (The amount of rent is not yet fixed for the projected site of repair dockyard.) FONDEPORT made it clear that the area planned for the repair dockyard will be delivered after the height of ground is adjusted at DL +4.3 m. This height of ground of DL +4.3 corresponds to the minimum necessary height of the tide embankment of the port of Lazaro Cardenas. The canal in front of the repair dockyard is to be controlled by the port authorities. The canal is currently not completed as it was planned in the development program of the port of Lazaro Cardenas, and the section of the canal is smaller than it was originally planned and part of the dredging works are still left to be executed. The facilities planning mentioned hereunder shall be carried out on the basis of presupposition that the remaining part of the dredging works will be executed by the port authorities of Mexico.

The present feasibility study supposes the area indicated in Fig. III-3-1 as the site of repair dockyard. This lot has an area of approximately 36.2 ha. and is planned with sufficient consideration for future expansion. The access to this site is currently provided with the provisional road leadinng to PEMEX or NKS and there is no railway installed. The access is expected to be provided by FONDEPORT when the repair dockyard is constructed.

3-3 Utilities

3-3-1 Water

Water of good quality of a flow rate of 3 m^3 per second or 260,000 tons per day is supplied to each enterprise as industrial water either directly or through a dam from the River Balsas. Since the installation works of water supply and drainage facilities are currently under way, each enterprise is retreating this water internally to obtain potable water.

The supply route of industrial water to the repair dockykard is going to be installed by FONDEPORT up to the boundary. There is nothing to worry about the supply volume since the maximum volume of water used in the yard is approximately 1,000 m^3/day.

3-3-2 Electricity

The current supply of electric energy is assured by hydraulic power generation using a dam located in the upper stream of the Balsas and by a supply from other districts, but a thermal power station of a capacity of 1,400 MW is also under construction in the adjoining area aiming at completion in 1994. At present, the power supply to each enterprise in the industrial port is made through the substation of this thermal power plant. According to a program of the Electric Power Agency, they expect the maximum power supply of 16,000 KW to the yard and are planning to establish a substation near the repair dockyard.

The power supply to the yard will be made at 13.8 KV and this will be reduced to 6.6 KV, 440V, 110V respectively in the yard. Since the maximum power used is estimated at about 5,000 KW, there is nothing to worry about the power supply capacity.

3-3-3 Gases

Currently, gases such as oxygen, ethylene, propane, argon and carbon dioxyde are easily available in this area. When the repair dockyard is in operation in the future, liquefied gases will be purchased by tank lorry except argon and carbon dioxide. The volume of daily consumption is approximately 500 m^3 for oxygen and 150 m^3 for acetylene, so there is no problem about the supply capacity of the gas company.

3-3-4 Communications

It is necessary for the repair dockyard to directly promote sales or grasp the situation of ships to be repaired at every moment with shipping companies in the country and abroad by using communication means such as telephone, telex, facsimile, etc.

The public communications facilities supporting such activities are currently not sufficient. However, the construction works of new facilities are now under way and, therefore, it is expected that latest multi-channel facilities of telephone and telex allowing direct communication will be available when the repair dockyard is completed.

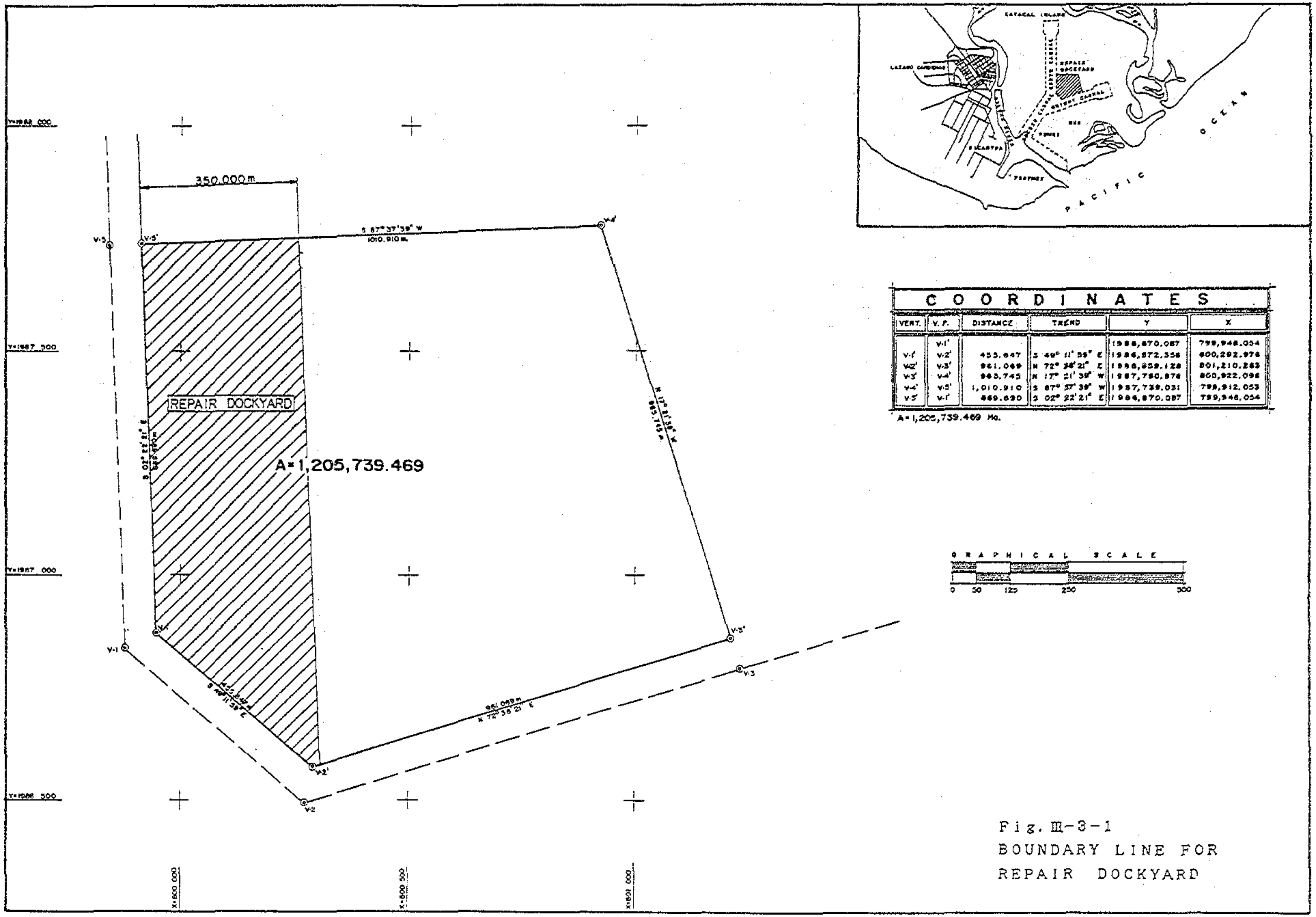
3-4 Labor Force

The human resources are rather abundant in Lazaro Cardenas area. There is a school of industry of medium level in the city. There is also a technical training center (CONALEP) in the industrial port and it provides professional trainings according to the request by the enterprises. Therefore, recruitment of technicians and general workers is easy and it is also possible to reeducate them after recruitment.

On the other hand, as to engineers and managers, it is necessary to recruit experienced people or new university graduates on the nationwide scale to find suitable persons. Residences for such people coming from other districts may be found among those constructed by the public housing corporation.

3-5 Miscellaneous

Tugboat, mobile crane, etc. are available by lease, so there is no need for the repair dockyard to prepare the quipment of their own.



COORDINATES					
VERT.	V. F.	DISTANCE	TREND	Y	X
	V-1'			1986,870.087	799,948.054
V-1'	V-2'	455.647	S 49° 11' 59" E	1986,572.356	800,292.978
V-2'	V-3'	961.069	N 72° 38' 21" E	1986,859.128	801,210.283
V-3'	V-4'	983.745	N 17° 21' 39" W	1987,780.878	800,922.096
V-4'	V-5'	1,010.910	S 87° 37' 39" W	1987,739.031	799,912.053
V-5'	V-1'	469.690	S 02° 22' 21" E	1986,870.087	799,948.054

A = 1,205,739.469 Mo.

Fig. III-3-1
BOUNDARY LINE FOR
REPAIR DOCKYARD

4. Facilities Plan

4-1 Basic Policy

4-1-1 Guideline for planning

This dockyard will be constructed as a specialized ship repairing plant and its facilities will be planned with special attention to the following points so that the plant may be managed most economically and efficiently:

(1) The investment in plant and equipment shall be kept at the minimum level to the extent that there will be no serious obstacles to the production activities. Therefore, any work and services which can be carried out by subcontractors shall be performed as much as possible by subcontractor or by lease without providing facilities for such work and services.

(2) The timing of installation of the facilities shall be decided in accordance with the increase of work as much as possible to make the investment efficient.

(3) The layout of the plant shall be designed in such a way as to allow future expansion to cope with probable increase of repair business.

(4) Equipment and tools necessary for prevention of pollution shall be provided.

(5) Regarding the docking system, detailed studies shall be made only on the combination system based on the conclusion of the discussion made on the progress report (II).

4-1-2 Planning procedure of main facilities

(1) Determination of dock size (capacity)

According to the demand forecast at the time of this writing, the repair work being carried out in Lazaro

Cardenas is limited, for the time being, to the ships which can pass through the Panama Canal. Therefore, it will be justifiable at this moment to decide the dock capacity which can accommodate typical Panamax ships (total length approx. 220m x breadth 32.2m) from an economic point of view. However, when the steel mill and other industries of Lazaro Cardenas become more prosperous or when the Pacific Rim Trade becomes thriring, ships with more economical, wider and larger than Panamax, will be used for transportation.

It is not impossible to expand the dock size at the time when the demand of repair for larger ships becomes certain, but it will be more difficult technically and incur a lot of excess costs. Therefore, if docking of wide-body ships is expected in the future, it is better to construct the dock which has sufficient breadth for wider ships from the beginning and extend the length later when the demand becomes certain. (An extension in the longitudinal direction is technically easy and its cost will be maintained within a tolerable level.)

Consequently, planned dock is 46.0 m wide, supposing the ships larger than Panamax, namely ships of approximately 80,000 DWT (approx. 50,000 GT) and considering the recent wide economical type ships among others.

In addition to the question on ship size, it will be also necessary to take container ships into consideration for the repair work in Lazaro Cardenas. It is expected that the number of container ships and regular cargo vessels carrying containers to and from Lazaro Cardenas will gradually increase. When repairing those ships, it will be often necessary to allow the ships in the dock with part of the containerized cargoes on board because of the schedule of regular service and the condition of cargoes. Consequently, it is necessary to have sufficient load conditions and lifting capacities of the dock as well as a sufficient docking draft to satisfy the said request, and in the present study the lifting capacity is set at 33,000 tons and the maximum docking draft at -8.5m under the datum level.

(2) Depth of water at quay

The maximum depth of water at the quay is planned to be 9.0m since docking of container ships with cargoes on board is expected as mentioned hereabove.

4-1-3 Number of docks, work bays and quays

Based on the demand forecast, the waiting conditions of the dock and the quay about the repair ships entering into the dockyard in 1995, 2005 and 2015 have been checked respectively by simulation using exponential distribution. The results are given in Table III-4-1. The following table indicates the main parts of the results obtained :

Table III-4-2 REQUIRED NUMBER OF DOCK AND QUAY

Item \ Year	1995	2005	2015
No. of dock required	1	2	2
Dock operation rate	94%	54%	61%
No. of quays required	2	2	2
Quay operation rate	88%	72%	86%
No. of ships to be repaired	68	94	131

Therefore, in the combination system, one floating dock, one work bay and two quays will be required . Room for future expansion of work bays and quays shall be left in preparation for eventual increase of demands in the future.

Table III-4-1 SIMULATION RESULT OF OPERATION RATE

No. of quay	No. of dock / Year / Month / Items	1 Dock				1 Dock				2 Docks				2 Docks			
		1995				2005				2005				2015			
		1-3	1-6	1-9	1-12	1-3	1-6	1-9	1-12	1-3	1-6	1-9	1-12	1-3	1-6	1-9	1-12
1	dock operation rate %	76.8	81.5	85.1	84.0												
	dock wait. days	2.3	2.8	2.9	2.8												
	quay operation rate %	88.6	94.3	96.2	97.1												
	quay wait. days	6.7	10.3	16.9	23.2												
	No. of ship	12	29	45	62												
2	dock operation rate %	76.8	88.3	92.2	94.1	88.0	94.0	96.0	96.1	49.9	54.5	54.9	54.0	57.6	64.1	59.9	61.4
	dock wait. days	2.7	5.3	6.2	6.6	4.0	5.2	5.4	5.8	0.3	0.4	0.4	0.5	0.4	0.5	0.5	0.4
	quay operation rate %	59.6	78.3	84.4	88.0	79.5	89.7	93.1	94.8	66.8	68.2	69.0	71.6	74.4	78.7	81.2	85.8
	quay wait. days	0.7	2.7	4.7	5.9	1.7	7.3	12.1	16.8	0.4	1.1	1.3	1.4	1.4	2.0	2.4	3.3
	No. of ship	12	31	49	68	18	42	66	87	20	48	74	96	31	69	99	133
3	dock operation rate %	76.8	88.3	92.2	94.1	88.0	94.0	96.0	97.0	49.9	54.5	54.9	54.0	57.6	64.8	62.7	62.6
	dock wait. days	3.2	7.0	8.7	9.3	5.3	7.9	8.9	9.4	0.3	0.8	0.8	0.8	0.4	0.8	0.8	0.7
	quay operation rate %	42.4	62.3	70.1	74.6	63.5	80.7	87.1	90.3	46.5	50.3	52.1	54.7	55.5	61.7	64.3	69.0
	quay wait. days	0.0	0.8	2.3	3.3	0.2	4.6	8.9	13.1	0.0	0.4	0.5	0.5	0.4	0.8	0.7	0.9
	No. of ship	12	32	50	68	18	42	66	88	20	48	74	98	31	70	102	135

Note: 1) Premise of work process at quay and dock.

A — B — C

Arrival — Delivery

A: Preparation/work at quay (Fixed 2 days)
B: Work in dock
C: Work at quay

2) As for the work period B and C of Above, see Table III-5-4

4-2 Selection of Docking System

In September, 1987, consultations were held in Mexico City between the parties concerned of Japan and Mexico based on the progress report (II) prepared by the study team. On that occasion, of the different systems, that is, graving dock, floating dock, synchro-lift and combination systems, the combination system was adopted as the most appropriate to the new repair yard of Lazaro Cardenas. The reason for the adoption of this system will be explained here again. See Supporting Report Group 1 for the related data of the progress report (II).

4-2-1 Basic idea for selection

The performance of the docking system have a great on the productivity of the repair work and its cost of construction represents approximately 30 to 50% of the total construction costs of the repair yard. Therefore, its selection must be made very carefully. The construction costs vary depending on various factors such as type of ships to be repaired, kind of works planned (product mix), natural conditions such as nature of soil, earthquake, etc. and such factors also impose some restrictions on the selection of the docking system in the aspect of purpose of use (suspension of container ship, for example).

4-2-2 General premises for comparison

(1) Size and kind of ships to be docked

It should be capable of docking ships of approximately 40,000 GT (approx. 60,000 DWT) and container ships partly loaded with cargo which call at Lazaro Cardenas.

(2) Docking system and number of quays

Supposing the number of repaired ships in 2015 is 131, the state of waiting queue by using Poison's distribution was checked. As a result, the number of nécessary docks and quays are planned as 2 and 2 respectively.

(3) Natural conditions

Since the planned site of repaired dockyard is already fixed, due attention must be paid to the natural conditions of the site such as geological conditions, earthquake, etc.

(4) Estimation of sales amount and cost

1) Sales amount of repairs

The average sales amount is estimated at 17.80$/GT tentatively by studying the data obtained at field survey and the data at hand. Naturally, since the volume of works in each year after start of operation will be on the same level for each system (docking system) from the results of the demand estimation, the sales amount is the same for each of the different systems compared.

2) Yard facilities, etc.

The costs of various machines in the repair shops and facilities are same for all systems compared.

3) Cost of work

The efficiency of work may vary according to the type of system, but the cost of work has been set as identical to all systems. Therefore, the wages, materials costs, etc. have also been set at the same level in all systems.

4-2-3 Particular comparison of different systems

(1) General layout

As shown in Fig. III-4-1, the south part of the projected site is planned to be used in the case of graving dock and ship lift systems and the west part in the case of other systems.

In the case of graving dock, the layout of the dock has been made as shown in the drawing considering the geological conditions namely for the safety of civil engineering works and the reduction of construction costs. Moreover, the space between docks has been widened because of the dock structure and this led to the supplement of one set of crane to the dock side. This system is a little better in work efficiency than the other systems. In the case of ship lift system, because of a larger dead space in comparison with other systems, namely the space for moving the ship in the traverse direction, the south part having a longer coastal line is used. In the case of floating dock and combination systems, the west side is used since the required area is comparatively small. In the case of combination system, the number of floating dock is one and the dock is disposed in the administrative waters of the repair dockyard beyond the quay line because it is possible to move the floating dock within the quay line with the provided mooring equipment when necessary. On the contrary, in the case of floating dock system, two floating docks are used and the mooring method consists in fixing the floating docks to both sides of the pier.

(2) Comparison from technical viewpoint

1) Repair of container ship

It is very dangerous and therefore to be avoided in the ship lift system to transfer a container ship loaded with part of the cargoes.

2) Work efficiency

It must be kept in mind in the first place that the ships to be repaired in the new repair dockyard in Lazaro Cardenas are medium-and large-sized ships.

In the case of ship lift system, the ship must be moved to the work bay before starting the repair work. If it is a large ship, the distance of movement comes to almost 600m including the transverse movement. Supposing that the movement is made at the average speed of 1.5 m/min, it takes 400 minutes for the movement. Since this movement is necessary in two ways, the time lost for this operation is 800 minutes, or 13.3 hours. In the actual work, it may take more time, considering the time eventually required for retightening blocks or the direction of wind, etc. The repair work must be performed speedily, counting time by the minute and it is quite unbearable for a repair dockyard to suspend the work for more than 10 minute except during the rest time.

Moreover, painting of the bottom and of the side shell plating is usually an important purpose for docking of a ship. To perform the painting, it is necessary to remove marine growths attached to the side shell plating, wash with clean water, remove the rust and apply the paint 4 to 6 times. Since painting absolutely requires drying time, it is not allowed to reduce the number of coats or shorten the drying time for reason of shortage of time.

Therefore, to reduce the time of the ship's stay in the dock, it is necessary to start the work as early as possible.

In the systems except the ship lift system, it is possible to provide a special machine and make such works as removing seaweeds, shell-fish and floating rust on the side of the ship by splashing high-pressure cleaning water against the shell plating immediately after the docking of the ship before the evacuation of the water. It may not be impossible from technical viewpoint to provide this machine on the work bay of the ship lift but it is difficult from economical point of view. Moreover, by doing so, the merits of the work bay such as access to ship side, easiness of carrying in materials are lost. Use of a special vehicle for work at high place is impossible in a high place because of a strong reaction of the high-pressure nozzle.

3) Convenience at drydocking

When docking a ship and installing it on the blocks, the tolerance of ship's posture (trim and heel) is larger with a small ship than with a large ship. However, the ship's posture at the time of docking is severely restricted with a large ship especially with a ship of fine type. This restriction is particularly severe in the ship lift system and it is required to lift the ship horizontally. This restriction about the ship's posture (docking condition such as trim, heel, etc.) is not so severe in the case of floating dock. It is because the posture of the floating dock can be adjusted to some extent to the posture of the ship. This means that less preparatory work is required for the control of the ship's posture at the time of docking.

Moreover, the systems other than that of ship lift are provided with a device for guiding a large ship into and out of the dock safely and efficiently. In the ship lift system, such device is not currently used and it is necessary to modify the design of the elevator and its surrounding to adopt this device and therefore it further increases the construction cost.

4) Adaptability to a long period of work

There may be no problem if there is sufficient margin in the number of docking systems, but generally speaking it lowers the profitability of the enterprise to have margin in the number of such system. In the case of ship lift and combination systems, however, since the work bay on the ground can be constructed with comparatively small costs and the facilities used to lift the ship onto the ground are common to all kinds of jobs, it will be easier to cope with the works requiring a long period, for example, replacement of bottom shell plating amounting to hundreds of tons, if the yard is equipped with additional work bays.

5) Comparison between ship lift and combination systems

Both in the ship lift system and the combination system, the ship is moved to the work bay on the ground or launched from the work bay into the water. The biggest difference between the two systems lies in the function of the device used to lift the ship. The ship lift simply lifts the ship, while in the combination system the lifting device not only lifts the ship but also serves as the most important and efficient device for the repair work. Moreover, the ship lift requires a transvers movement and therefore the distance of movement gets more than double in comparison with the case of combination system. The transvers movement in the case of combination system consists only in moving the floating dock on the sea, but the movement on the ground consists of a movement in the longitudinal direction only.

6) Comparison in the field of production control

Most of repairs to a ship can be done on the ground or in the drydock; some of them can be done while a ship is moored alongside the quay. It is essential to make the best use of the costly facilities and improve economic efficiency so that a period of repair work may be minimized. And it is far move effective and economical to continue repairs from the beginning till completion while a ship is drydocked, because of better working environment, if there is no other ship requiring drydocking at the same time. Changing working places, for instance, from the quay to the drydock, involves change-over of power sources and other additional preparatory jobs, thus leading to less efficiency in work.

In the case of ship lift and the combination system, all the repair work ot a ship will be done on the work bay without dividing the repair jobs between places, that is, at the quay, in the drydock and on the work bay. Production and man-hours may be easily controlled, but convenience will sometimes cause unexpected delay unless work schedule is carefully worked out and work progress is closely watched day by day.

Under the combination system, a ship lift is the most vital equipment in the repair facilities. It should be operated according to a overall repair or production schedule for all the ships under repair at the dockyard and new arrivals, instead of being utilized for lifting and lowering a particular ship out of immediate necessity. In addition, workload will be suddenly increased in the event that, as a result of bottom survey of ship, extra repairs to the findings are ordered.

More experienced managers and more skilled engineers must be deployed in this combination system to take care of production control including work period of each repair ship and lifting/lowering rotation.

(3) Comparison regarding construction costs

The construction costs are estimated as follows under the conditions described in paragraph 4-2-2 :

Table III-4-3 CONSTRUCTION EXPENSES OF FOUR DOCKING SYSTEMS

Docking system	Construction costs (US$)
Graving dock	119,940,000
Floating dock	120,800,000
Ship lift	159,380,000
Combination	101,640,000

(4) Comparison of other characteristics

Table III-4-4 indicates comparison of general characteristic of four different docking systems.

4-2-4 Docking system most suitable to Lazaro Cardenas

In the preceding paragraph, different systems were compared in various aspects such as engineering (including the aspect of control), construction costs, period of works, etc. From this comparison, the combination system shall be recommended as the most appropriate to perform repair work of ships in the area of Lazaro Cardenas.

This system involves some difficulties in the area of production control. However, if constant efforts are made to maintain the planned period of works, this difficulty may be changed into a kind of advantage in the sense that such efforts greatly contribute to the improvement of the technical and managerial capabilities of this repair dockyard.

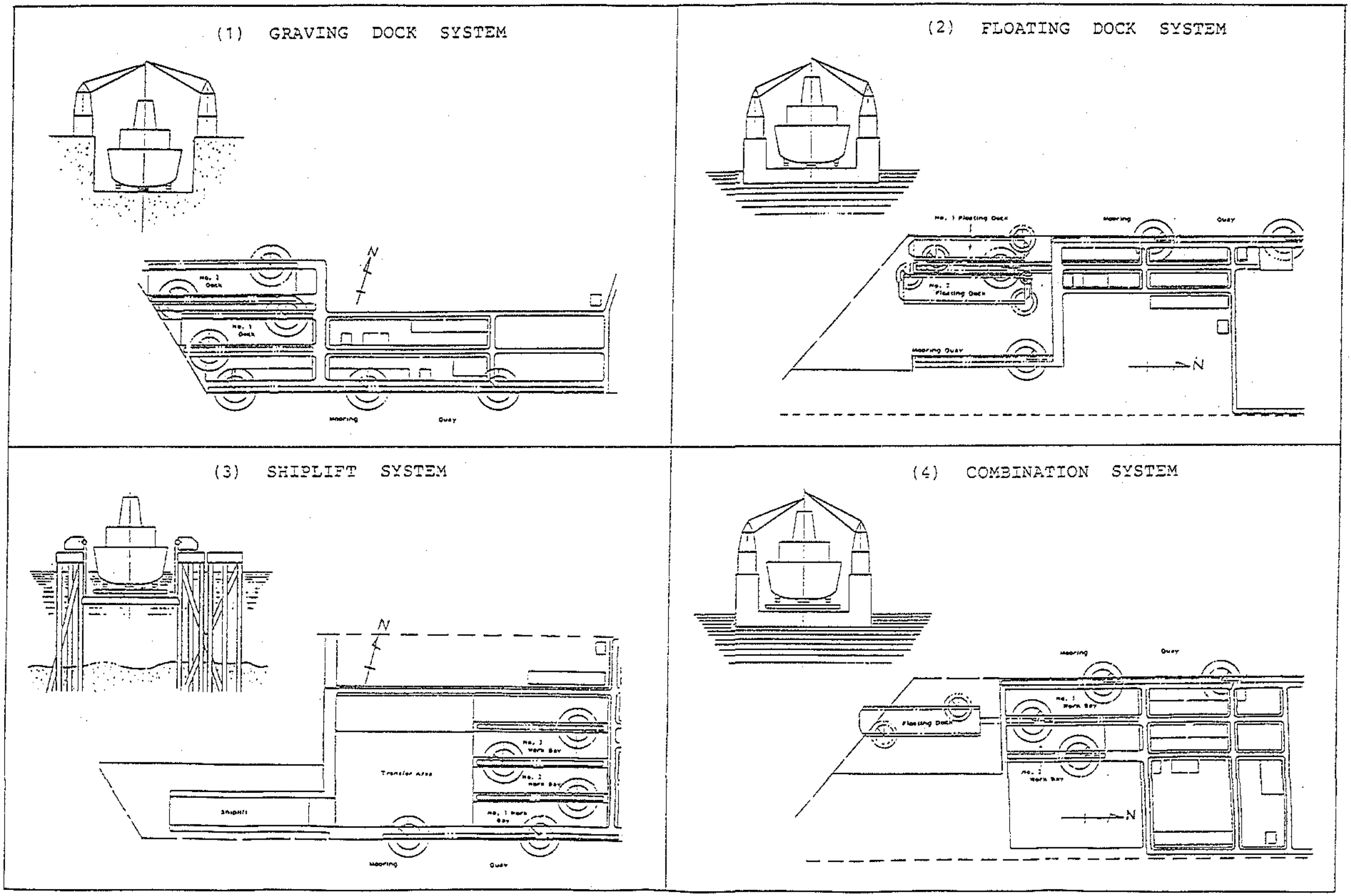


Fig. III-4-1 OUTLINE OF FOUR DOCKING SYSTEMS

Table III-4-4 CHARACTERISTICS OF DOCKING SYSTEMS FOR CASE OF LAZARO CARDENAS

	Graving dock	Floating dock	Shiplift	Combination
Installation cost	medium	medium	high	low
Period of construction	very long	short	long	very short
Civil engineering problem	big	a little	big	little
Effect by earthquake	big	little	big	none (dock) + big (work bay)
Mech/Shipbuilding engineering prob.	little	medium	big	big
Possibility of resale (dock)	none	big	little	big
Existing facilities for big capacity	many	many	none	many (dock) + some (transfer)
Cost for additional system (expansiveness)	big	big	small	small
Applicability of new shipbuilding	little	little	yes	yes
Maintenance cost	low	medium	high	medium
Convenience of docking operation	not so good	very good	not so good (esp. for transfer)	very good (dock) + not so good (transfer)
Possibility of bigger ship docking (overhang)	uncommon	yes	a little	yes
Possibility for early start of repair work	big	big	little	big
Working condition (crane service, etc.)	good	good	bad (elevator) + good (work bay)	good
Flexibility of production control	small	small	big	big

4-3 Outline of Facilities

4-3-1 General layout of the dockyard

Following the consultation on the progress report (II), detailed studies were made on operating conditions, etc. and some modifications have been made to the conditions put forward in the progress report (II), as mentioned in chapters III-4-1 and III-5. Those modifications are of the nature of increasing or decreasing the comparative investment amount, etc. for all systems and, therefore, do not change priority among the four different docking systems.

(1) Floating dock, work bay, quay and repair shop were arranged as collectively as possible to assure easy supply of power source such as electricity, gas, etc. and a smooth flow ot workers, repair parts, materials, etc.

(2) Special attention was paid to the flow of materials and products so that a block (or module) method may be adopted when there should be a large volume of hull work for casualty repairs.

(3) One (1) work bay is believed to be enough for some time (until around 2015), but the layout leaves room for additional one(s) to be arranged in the future.

(4) Two (2) quays are believed to be enough for some time (until around 2015), each capable of mooring two ships at a time.

4-3-2 Outline of main plant facilities

(1) Handling of shafting and rudder

The floating dock shall be provided with the facilities so that the repair of shafting and rudder of largest possible ship which can be docked, while the working bay shall be equipped with lifting and transportation system so that the repair of shafting and rudder of Panamax type ships can be done.

The repair shop shall be provided with various facilities and equipment so that the handling of the above-mentioned items may be possible.

(2) Handling of large shell block

At repair work shop, facilities and means of transportation will be provided to make it possible to assemble hull blocks of 30 tons each and transport them either to the dock or to the work bay.

4-3-3 Main specifications and characteristics of floating dock

(1) The internal width of the side wall of the dock is to be 46m.

(2) The length of the dock is to be 230m at the beginning and so designed that it may be extended up to 270m in future.

(3) The maximum draft of the ships to be docked is to be 8.5m and the lifting capacity of the dock is to be 33,000 tons considering the possibility that container ships may be docked partially loaded.

(4) It is to be so designed that the ships of displacement of up to 17,000 tons may be carried to the work bay.

(5) Electricity, water, compressed air and gases are to be supplied from the shore.

(6) The dock is to be moored by chain & anchor system to facilitate the grounding of the repair ships into the work bay.

(7) A computer-controlled ballast operating system is to be applied so as to assure a safe and quick transfer of repair ships from the dock to the work bay.

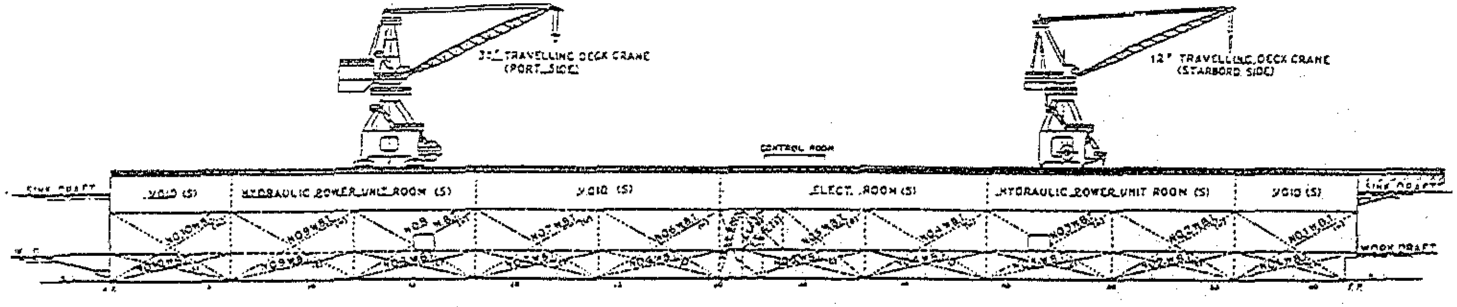
(8) Cranes are to be provided on the wing walls so that overhaul and landing of large equipment such as shafting, propeller, rudder, hatch cover, etc. of the largest ships docked is carried out efficiently.

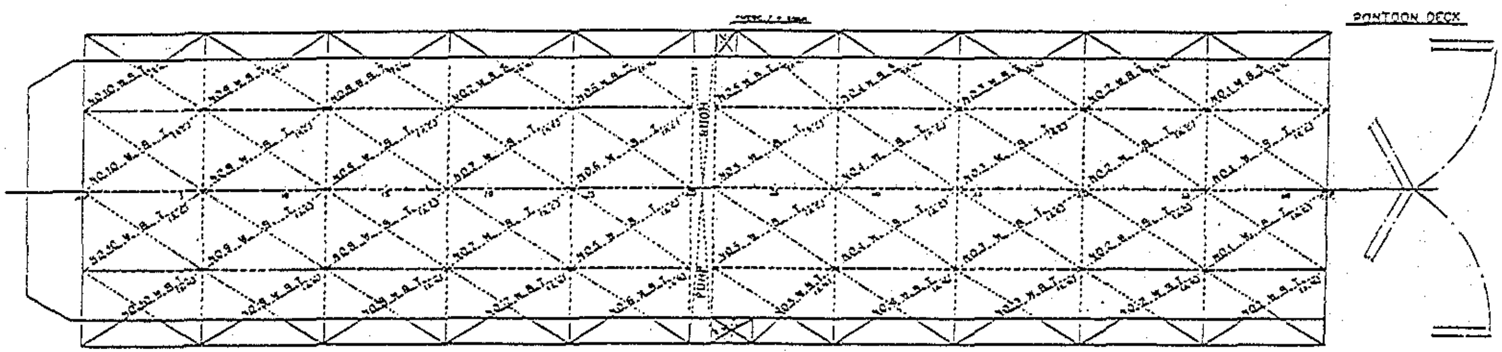
(9) A travelling stage is to be provided on the inside face of the wing wall.

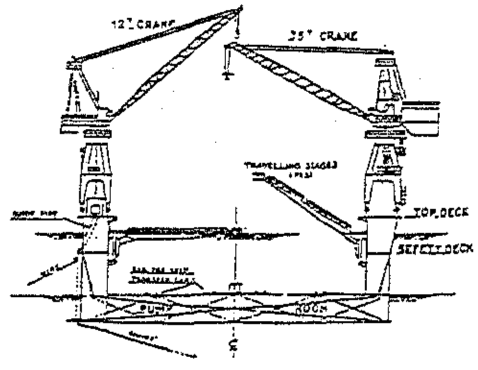
(10) A hydro-jet water washing system is to be provided.

(11) Anti-corrosive provision shall be applied to the outside plating so that it may be durable for no less than 30 years.

The general layout and the outline of specifications of the floating dock are indicated in Fig. III-4-2 and Table III-4-5 respectively.







SECTION

PRINCIPAL PARTICULARS

LENGTH OVERALL		230M00
LENGTH OVER PONTOON	(MLD)	220M00
BREADTH BETWEEN OUTER WING WALLS	(MLD)	55M00
BREADTH BETWEEN INNER WING WALLS	(MLD)	46M00
DEPTH TO TOP DECK	(MLD)	18M70
DRAFT AT WORKING	(MLD)	4M60
DRAFT AT SINKING	(MLD)	15M70
LIFTING CAPACITY		33000MT
BALLAST PUMP		2 SETS
TRAVELLING DECK CRANE	(35T, 25M RADIUS)	1 SET
DO	(12T, 25M RADIUS)	1 SET
TRAVELLING STAGE		2 SETS
HYDRO-JET PUMP	(300 [illegible])	2 SETS

Fig. III-4-2

GENERAL ARRANGEMENT OF
LIFTING CAPACITY 33000 MT FLOATING DOCK

Table III-4-5 OUTLINE SPECIFICATION OF LIFTING CAPACITY 33,000 MT FLOATING DOCK

1. Type of Dock : Steel Caisson (1-piece) type with a steel platform on aft end.

2. Classification : NK or LRS or ABS

3. Lifting capacity : 33,000 metric tons at freeboard of 300 mm from pontoon deck.

4. Transfer capacity : 17,000 metric tons

5. Principal dimensions :

Length, overall	230.00 m
Length, over pontoon	220.00 m
Breadth, between outer wing walls	55.00 m
Breadth, between inner wing walls	46.00 m
Depth to top deck above base line	18.70 m
Designed working draft	4.60 m
Designed sinking draft	15.70 m
Water depth above keel blocks at sinking	9.00 m
Height of keel blocks	1.60 m

6. Electric power, fresh water, fire-fighting water compressed air and gases shall be supplied from on-shore facilities.

7. Mooring System : Chain, anchor and wire rope mooring system. Mooring windlasses and winches shall be equipped for dock translation.

8. Dockyard furnished equipment :
All connecting devices such as accesses, cables and hoses between shore and Dock.

9. Ballast piping system :

Ballasting & deballasting time :	within 3 hours
Ballast pump in a pump room :	2 sets
Ballast control :	Remote-control in control room

10. Computerized ballast operation system

1) Lifting and sinking mode

Dock shall be operated by instruction of computerized ballast operation using of it's datas such as draft, trim, hull, diflection, ballast level.

2) Transfer mode

Dock shall be operated by instruction of computerized ballast operation using the sill load and ship position in addition to above data. As a result Dock can maintain flat level same as Work bay.

11. Major docking equipment :

Winches	Electro-Hydraulic type		
	15 t x 15 m/min, 2-drum	4 sets	
	8 t x 15 m/min, 1-drum	4 sets	
	Hyd. pump unit		4 sets

12. Corrosion protection :

Appopriate method for corrosion protection shall be taken for Dock to maintain good in use more than thirty years. Impossed current system shall be applied to outer surface below working draft.

13. Duty room etc. :

1-control room (air-conditioned)

2-toilets

14. Repair work equipment :

Travelling cranes 35 ton x 1, 12 ton x 1)	2 sets
Travelling stages	2 sets
High pressure water cleaning system with multi-nozzle and pump (300 kg/cm^2 x 160 l/min.)	2 sets
Flying gangway at fore end.	

Note:

1) Design, construction and tests should be in accordance with Builder's standards and practices.

2) All materials and equipment should be generally of Japanese make and in accordance with the Japanese Industrial Standard (JIS), the Builder's Engineering standards and/or the current Japanese manuafactures' standards.

4-4 General Layout of Dockyard and Shops

The general layout of the dockyard is shown in Fig. III-4-3.

4-4-1 Floating dock

The dock shall be moored usually to a position at approximately 10m from the quay as indicated in the drawing, and a gangway bridge is to be provided between the dock and the quay. When the ship comes into or goes out of the dock, the dock shall be moved by about 30m offshore and submitted to rise and submerge at a point of a depth of 17m. When transferring the ship from dock to work bay, the dock shall be moved in such a way that it may be adjusted to the center of the work bay to come straight at the end of work bay. Those parallel shifts in the longitudinal direction shall be made by operating mooring winches provided on the dock. When transferring the ship in dock to the work bay, the dock is to be kept horizontally by adjusting the ballast according to the command of the ballast control system by computer.

At the time of a hurricane (wind velocity no less than 25 m/sec), the dock shall be submerged and the docking ship shall be evacuated to the mooring quay.

4-4-2 Work bay

A level luffing crane of 40Tx20m/15Tx40m, is to be installed on the starboard side of work bay, and one 20Tx32m/10Tx50m and one 40Tx20m/15Tx20m on the port side, which are used for serving the repair quay in common, so that the lifting and replacing of the rudder, propeller shaft and large shell blocks, etc. can be carried out easily and efficiently. Since the bottom of the work bay is lower than the ground line of the quay, factory, etc. by 2.7m, both the fore and the aft are provided with ramps for the convenience of passage of various vehicles and personnel.

One unit of work bay will be enough for the time to cope with the demands for repair, but if the number of ships to be repaired or other demands increase in the future, it will be possible from the point of view of layout to supplement one or two units of work bay.

4-4-3 Repair quay

A quay to which 2 large ships to be repaired can be directly moored alongside at the same time is to be constructed on the north side of the floating dock. Since the coast line on the west side has a length of 700m, it is possible to construct a repair quay on the entire length of this coast according to the repairing demand in the future. However, the quay shall be constructed in such a way that for the time being a second ship may be moored on the external side of the repair ship which is directly alongside the quay, to cope with specially busy periods.

For that purpose, we have planned to have, as the quay cranes, a combination of one unit of level luffing jib crane of a large working radius of 20Tx32m/10Tx50m and one unit of crane of a large lifting capaity of 40Tx20m/15Tx40m.

On the quay, mooring devices which can moor the ships up to approximately 100,000DWT (approx. 60,000GT) are to be provided and the depth of the water is to be set at DL -9.0m partially over a length of 230m of the quay to make it possible for a large container vessel loaded with its cargoes to come alongside the quay, although the depth of the water is generally DL -6.5m on other parts.

4-4-4 Steel shop

Fig. III-4-4 shows the general layout of the steel shop.

The steel shop is a factory of a total length of 150m and of a width of 25m consisting of a stockyard of steel material and workshops for steel processing, assembly and sheet metal work. The factory is to be provided with a fixed roof over 50m in the central part. A steel stockyard slabs for marking and cutting, shearing machine, roller, press, are to be arranged in sequence of material processing flow. On the part extending over 60m on the south side, 3 units of motorized moving roofs of a width of 25m and of a length of 15m are to be provided so that the roof may be opened as required. This portion should be used for assembly of hull block or equipment or for repair of large materials. The design of the factory makes it possible to introduce or take out hull blocks of a weight up to 30 ton directly with the quay crane by moving the roof.

On both sides of the safety passage in the center, one unit each of 2 ton semi-gantry crane should be provided for the purpose of improving the efficiency of mounting work of small members. 2 units of overhead travelling crane of 10 ton each should be put into service over the entire length of 150m.

4-4-5 Repair shop

Fig. III-4-5 shows the general layout of the repair shop.

It is a factory of width of 25m and a length of 150m provided with a fixed roof, and the cranes assigned to different workshops can cover the entire length of the respective workshops.

(1) Pipe shop

A stockyard of tube materials and work areas for pipe cutting, bending, assembly, finishing, etc. are provided. The slabs plate for moulded pipe are to be arranged amply taking the fluctuation of repair job volume into consideration. The hydraulic test area is designed in such a way that not only pipes but also valves may be submitted to hydrostatic test in the same place. The pipe shop should be provided with 2 units of 0.5T wall hanging crane for exclusive use and one unit of overhead travelling crane of 10 ton for common use. As pipe bender, a ram type hydraulic bender of a nominal size up to 80 mm should be used for the time being.

(2) Machining shop

The shop is designed to be provided with ordinary lathe, shaper, slotting machine, universal milling machine, etc. for general machining work to take care of almost general kinds of machining work. In case there is any need for machining of large components such as shaft, propeller, rudder stock, etc., the work should be entrusted to established machining shop such as NKS and no large lathe, horizontal boring machine, etc. should be provided in the machine shop.

The machining shop should also be provided with a dynamic balancing machine (of a capacity of approximately 800 kg) indispensable for the verification of balance and adjustment after repair of rotary components such as supercharger, motor, etc.

As to overhead travelling crane, 2 units of 25T type and 1 unit of 10T type are to be commonly used. One unit each of large and small transportable boring machine should be provided in preparation for boring works in the ship, etc.

(3) Finishing shop

A high-pressure cleaning system (2000 kg·cm^2 x 5.6 lit/min) and a chemical cleaning system are to be installed for the cleaning of mechanical parts. A special grinding machine is to be arranged to carry out efficient fitting job of valve and valve seat. The hydraulic test area should be commonly used with the pipe shop. The overhead travelling cranes should be commonly used with the machining shop and the electric shop.

(4) Electric shop

A coil winding machine, a drying furnace, a varnish treating tank, are to be arranged to repair electric motors. The overhead travelling cranes are to be commonly used with other shops but mainly the 3 ton type is to be used in common with the carpenter shop.

(5) Carpenter shop

This shop is used for manufacturing, repair, temporary storage and receiving of small-sized wooden equipment. Any work requiring particularly large woodwork machine should be subcontracted to external processor. One overhead travelling crane is to be commonly used with the electric factory.

4-4-6 Galvanizing shop

Small-scale hot-dip galvanizing facilities are to be installed for galvanizing pipes and small-sized equipment. Since this kind of galvanizing facilities is not found in the Lazaro Cardenas region, the layout of equipment has been planned in such a way as to allow it to introduce full-scale galvanizing facilities in the future depending on the trend of demands.

4-4-7 Warehouse

Fig. III-4-6 shows the general layout of the warehouse. The warehouse is to be arranged at its entrance with a corner intended for receiving and acceptance of goods. The storing area of goods is to be roughly divided into three sections or an area provided with shelves for the running stock articles such as bolts & nuts, flanges, factory consumables, and others, an area for storing equipment and parts purchased for specific works and an area reserved for the storage of articles supplied by the ship owner.

One unit of 10 ton overhead travelling crane should be installed for handling heavy articles.

4-4-8 Painting shop and store

Fig. III-4-6 shows an outline of general layout of the paint warehouse. This warehouse is to be arranged in such a way as to have a space for small painting works in addition to the storing area of paints. One unit of 2 ton overhead travelling hoist of explosion-proof type is to be installed for storage and painting works.

4-4-9 Service facilities

Fig. III-4-7 shows an outline of general layout of the service facilities.

(1) Electricity

Electric power supplied at 13.8 kV 60 Hz from the Agency of Electricity is to be stepped down to 6600V at the central substation located in the service facilities area of the dockyard. The dockyard site is divided into the following 7 blocks and the substation and the transmission cubicles in each block should be fed at 6600V

1) Floating dock (2000 KVA)
2) Repair quay and steel shop (1500 KVA)
3) Repair shop,
4) Work bay facilities

5) Offices
6) Service
7) Galvanizing shop

The power should be stepped down in the substation of each block to 3-phase 440V, 220V 60 Hz and single phase 110V 60 Hz respectively and supplied to factories, repair ship, and others. The repair quay and the floating dock is to be provided with facilities capable of supplying 3-phase 380V 50 Hz to the ship.

(2) Oxygen, gases

Oxygen and cutting gas are to be purchased in the form of liquid. Evaporators of oxygen and gas are to be installed in the service facilities area and the oxygen and the gas are to be supplied to each section of the dockyard directly by pipeline. The evaporator of gases are to be provided by lease from the gas supplier. No special facilities are to be provided for argon gas, nitrogen gas, carbon dioxide, etc. since such gases are to be purchased in bottles as required.

(3) Water

The industrial water is to be used for the works and as fire fighting water. It is also to be used as potable water by passing through a purifier. A 500T industrial water storage tank is to be installed in the service facilities area and then the water is to be supplied by pump to different parts of the dockyard. Drinking water will be stored in the storage tank after passing through a purifier and distributed to different parts by using pumps. 2 sets of pump for industrial water and 2 sets for potable water are to be used as transfer pumps.

(4) Compressed air

2 sets of air compressor of 44 m^3/min x 7 kg/cm^2 are to be installed in the service facilities area and one of them is to be put in automatic operation (start/stop) for normal operation while the other one is to be kept as a spare unit. The compressed air is to be supplied to different parts of the dockyard through pipeline.

In case a large quantity of compressed air is required temporarily as for sandblasting, portable air compressor are to be used by lease from an external source.

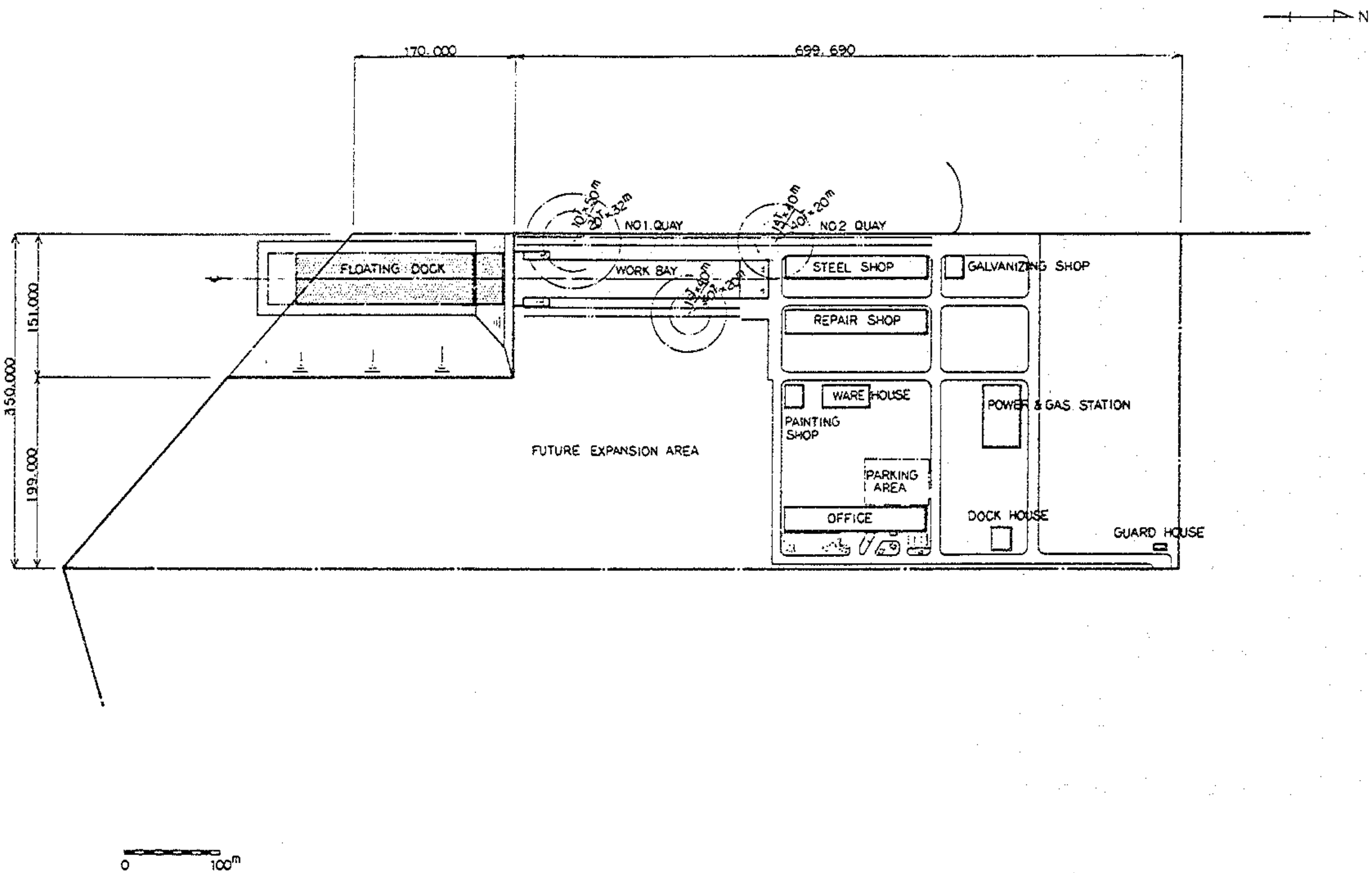
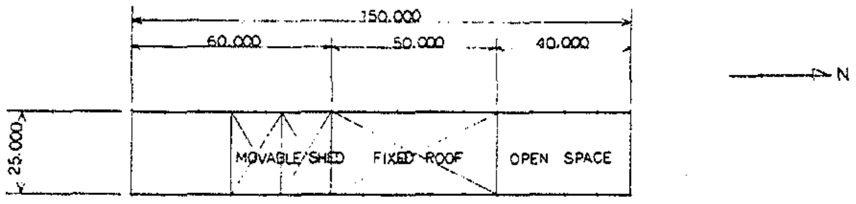


Fig. Ⅲ-4-3 GENERAL ARRANGEMENT OF REPAIR DOCKYARD



KEY PLAN

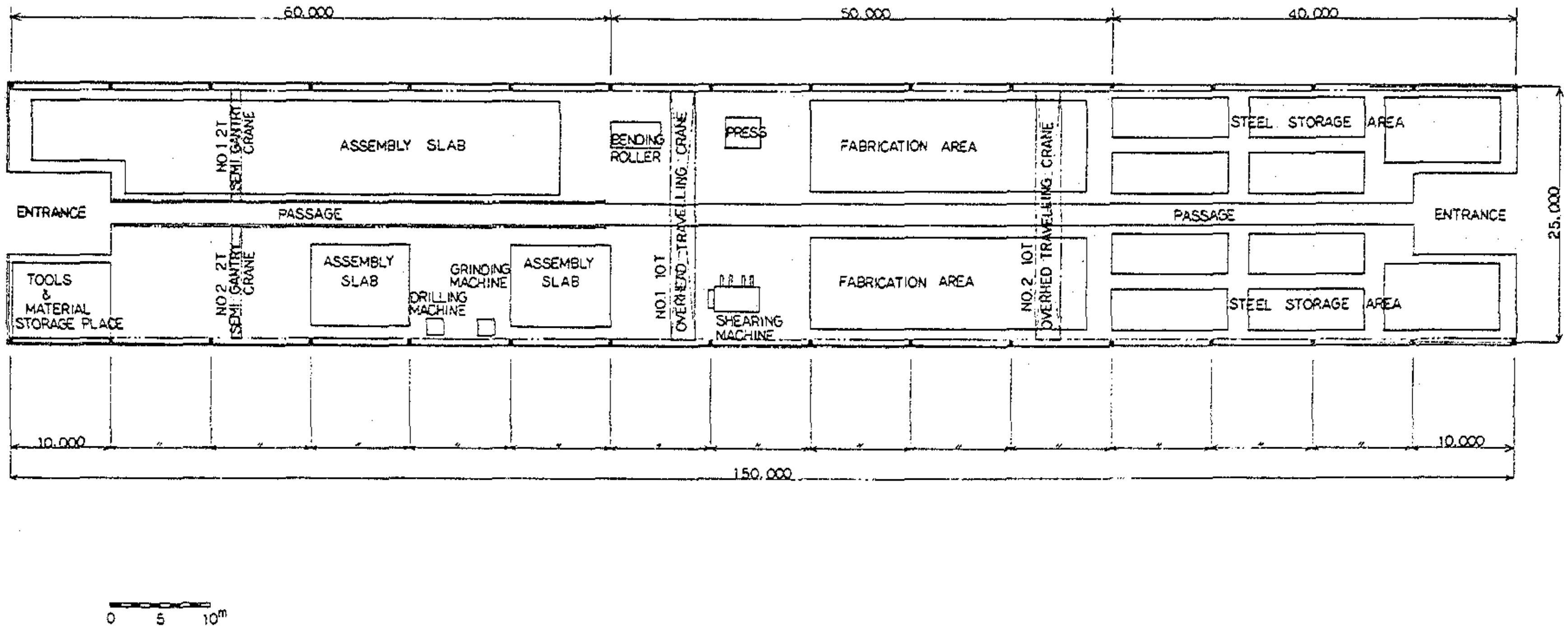


Fig. Ⅱ-4-4 GENERAL ARRANGEMENT OF STEEL SHOP

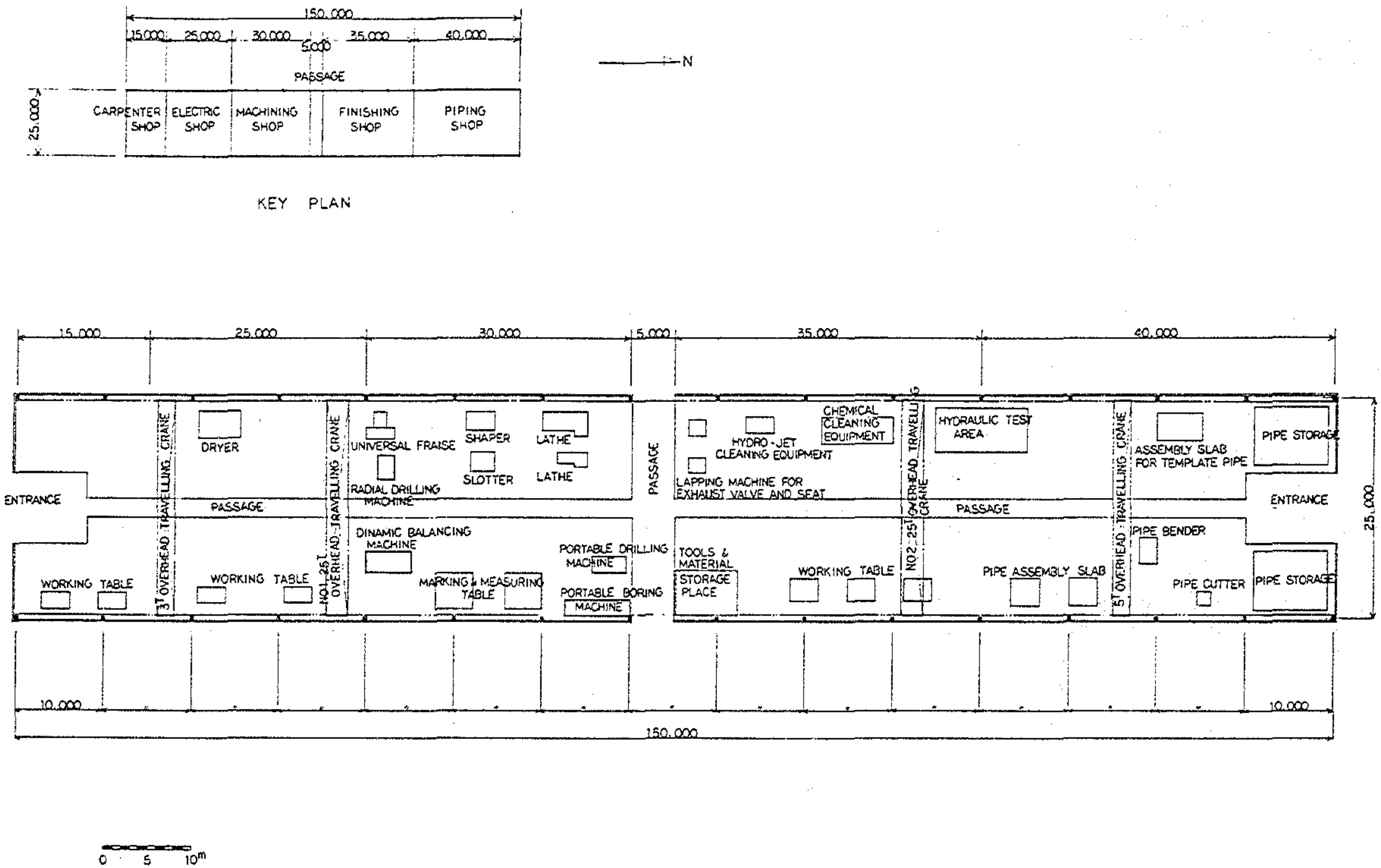
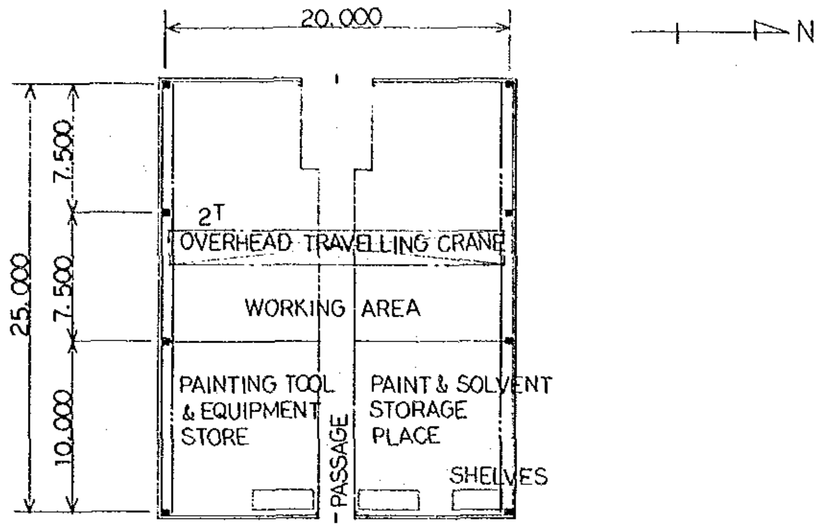
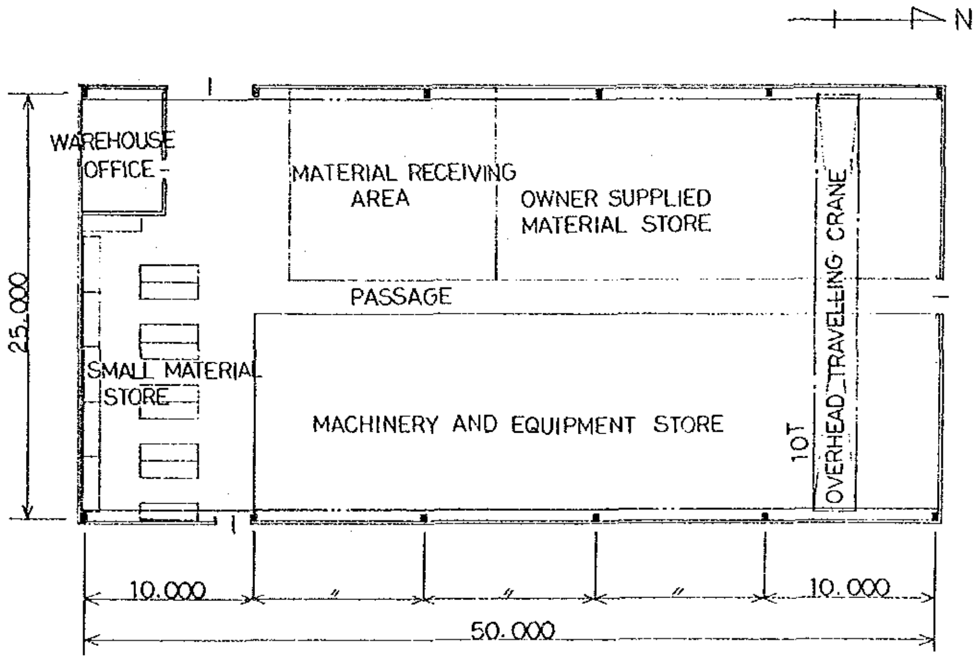


Fig. Ⅱ-4-5 GENERAL ARRANGEMENT OF REPAIR SHOP



PAINTING SHOP AND STORE



WAREHOUSE

Fig. Ⅲ-4-6 PAINTING SHOP AND STORE . WAREHOUSE

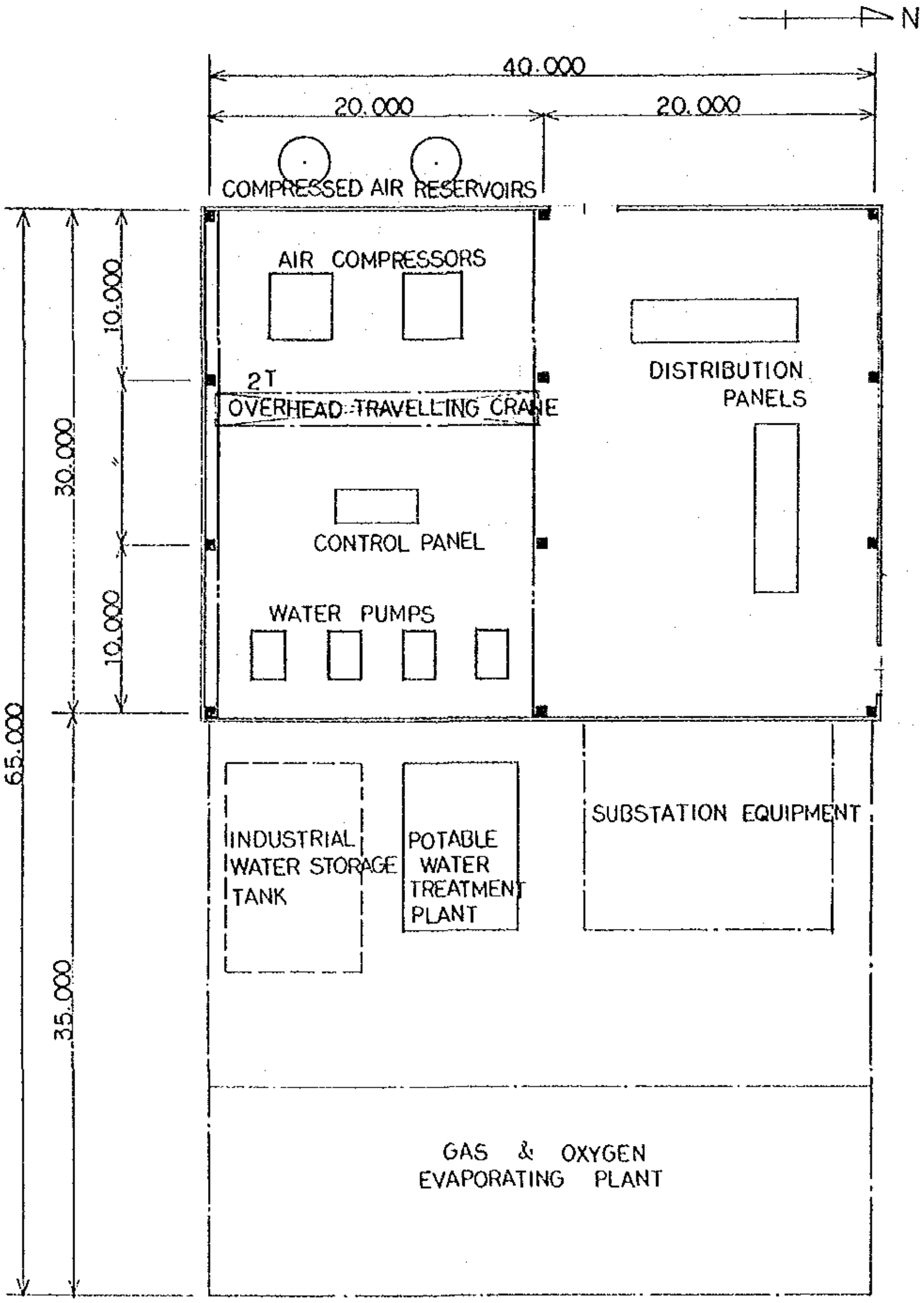


Fig. Ⅲ-4-7 POWER AND GAS STATION

4-5 Other Equipment

4-5-1 Heavy cargo vehicles

A 15 ton trailer and a 40 ton platform car are to be provided for transportation of large articles such as shafting, rudder, hatch cover, inside and outside the site.

4-5-2 Boats

A small work boat shall be owned by the dockyard for use for such purposes as rope fastening at the time of docking of the ship. In addition, one each of 200 ton waste oil barge and rubber boat are to be owned for temporary storage of waste oil and in-ship work respectively.

4-6 Specifications of Facilities

Table III-4-6 indicates the specifications of the facilities to be installed.

Table III-4-6 OUTLINE SPECIFICATION OF FACILITIES

No.	Item	No.	Main Particulars
1.	Yard Area	1	362409 m^2
2.	Floating Dock	1	230m x 55m
			Lifting Capacity 33,000 MT
	Access Ladder	1	4m x 10m
3.	Transfer System	1	Transfer Capacity 17,000 MT
4.	Shiprepair Quay	1	460m
			Depth 9m & 6.5m
	Level Luffing Crane	1	40T x 20m/15T x 40m
		1	20T x 32m/10T x 50m
	Access Tower	2	3m x 4m x 10m
	Shore Ladder	2	
	Mooring Winch	2	10T x 20m
	Rubber Fender	20	V type
	Bitt	8	100T Bitt
	Welding Machine	60	500 Amp, 300 Amp
5.	Work Bay	1	230m x 40m
	Level Luffing Crane	1	40T x 20m/15T x 40m
	Welding Machine	60	500 Amp, 300 Amp
	Dogshore and Block for ship	250	
	Towing Tractor	2	
6.	Steel Shop	1	150m x 25m
	Steel Storage Area	1	40m x 25m
	Fabrication Area	2	28m x 9m
	Hull Assembly Slab	1	43m x 9m
	Hull Outfitting Assembly Slab	2	10m x 9m
	Tools, Material Storage Place	1	10m x 7.5m
	Overhead Travelling Crane	2	10T x 25m x 9m
	Semi Gantry Crane	2	2T x 10m x 6m
	Hydraulic Press	1	500T
	Shearing Machine	1	6mm x 1.8m

No.	Item	No.	Main Particulars
	Bending Roller	1	20mm x 2.4m
	Bench Grinder	1	300ø SGE-T
	Bench Drilling Machine	1	19ø ASD-410
	Abrasive Cut off Machine	1	455ø HCW-18M
	Welding Machine	35	500 Amp. 300 Amp
	Semi Automatic Gas Cutter	8	
	Welding Rod Oven	1	
	Movable Shed	2	15m x 25m
7.	Repair Shop	1	150m x 25m
7-1.	Piping Shop	1	40m x 25m
	Pipe Storage Area	2	7m x 6.5m
	Assembly Slab for Template Pipe	1	5m x 3m
	Assembly Slab	2	3m x 3m
	Hydraulic Test Space	1	10m x 5m (Common Use)
	Overhead Travelling Crane	1	5T x 25m x 9m
	Abrasive Cut off Machine	1	455ø HCW-18M
	Pipe Bender	1	3" Ram Type
	Hydraulic Water Pump	1	500 kg/cm^2 x 19ℓ/min
	Threading Machine	1	1/4" - 2"
	Bench Grinder	1	300ø SGE-T
	Welding Machine	20	300 Amp
	Welding Rod Oven	1	
	Finishing Table with Vise	2	2m x 2m
	Wall Crane (Hoist)	2	0.5T x 8m
7-2.	Finishing Shop	1	35m x 25m
	Overhead Travelling Crane	1	25T x 25m x 9m
	Chemical Cleaning Equipment	1	4 Tank with Heating Equipment
	Hydraulic Jet Cleaning Equipment	1	2000 kg/cm^2 x 5.6ℓ/min
	Lapping Machine for Suction Valve	1	for Valve HK-150G
	Lapping Machine for Exhaust Valve	1	for Valve Seat EC-160
	Bench Drilling Machine	1	1/2 H

No.	Item	No.	Main Particulars
	Working Table with Vise	3	3m x 2m
	Tools, Material Storage Place	1	7.5m x 5m
7-3.	Machining Shop	1	30m x 25m
	Overhead Travelling Crane	1	25T x 25m x 9m
	Lathe	1	1m x 2m
	Lathe	1	0.6m x 3m
	Shaper	1	Stroke 600mm
	Slotter	1	Stroke 300mm
	Universal Fraise	1	350mm x 1.5m
	Radial Drilling Machine	1	
	Portable Drilling Machine	1	
	Portable Boring Machine	1	250ø x 9m
		1	150ø x 2m
	Dynamic Balancing Machine	1	800 kg
	Marking and Measuring Table	2	4m x 3m
	Machining Tools		
	Measuring Tools		
7-4.	Electirc Shop	1	25m x 25m
	Dryer	1	
	Coil Winding Machine	1	
	Working Table	2	3m x 2m
8.	Galvanizing Shop	1	25m x 20m
	Caustic Soda Bath	1	3m x 1m x 1.2m
	Sulfuric Acid Bath	1	3m x 1m x 1.2m
	Washing Water Bath	2	3m x 1m x 1.2m
	Flux Bath	1	3m x 1m x 1.2m
	Galvanizing Bath	1	3m x 1m x 1.2m
	Quenching Water Bath	1	3m x 1m x 1.2m
	Overhead Travelling Crane	2	2T x 2 Hoist x 20m
	Control Room	1	
	Heating Equipment	1	

No.	Item	No.	Main Particulars
9.	Power and Gas Station	1	65m x 40m
	Electric Substation (Main)	1	2 sets of 13.8KV/6.6KV x 3,000KVA
	Aux Substation	1	6.6KV/440V/110V x 1,500KVA
			for Quay, Work Bay, Steel Shop
	Transmission Cubicle	7	for Repair Shop, office, Warehouse, etc.
	Invertor	1	380V x 50Hz x 100KVA for Ship's Supply
	Switch, Panels	1 set	
	Air Compressor	2	460KW, 7 kg/cm^2 x $44m^3/min$
	Compressed Air Reservoir	2	7 kg/cm^2 x $14m^3$
	Control Panel for Air Compressor	1	
	Industrial Water Pump	2	$80m^3/h$ x 3.5 kg/cm^2
	Potable Water Pump	2	80 m^3/h x 3.5 kg/cm^2
	Overhead Travelling Crane (Hoist)	1	2T x 16m x 6m
	Industrial Water Storage Tank	1	$500m^3$
	Potable Water Treatment Plant	1	$300m^3/day$
	Gas Evaporator	1	(Rental)
	Oxygen Evaporator	1	(Rental)
10.	Warehouse	1	50m x 25m
	Overhead Travelling Crane	1	10T x 25m x 9m
	Shelf	15	1m x 3m x 4m
11.	Painting Shop and Store	1	25m x 20m
	Overhead Travelling Crane (Hoist)	1	2T x 20m x 6m
	Shelf	3	1m x 3m x 4m
12.	Vehicles		
	Truck	2	10T, 5T
	Fork Lift	2	3T, 2T
	Motor Truck	2	1T

No.	Item	No.	Main Particulars
	Trailer	1	40T x 12m x 3m
		1	15T x 10m x 2.6m
		2	5T
		2	2T
	Ambulance Car	1	
	Business Car	2	
13.	Stages		
	Stage Tower for Stern and Stem	2	2m x 4m x 8m
	Painting Stage	2	2m x 4m x 10m
	Stage Blank	1,000	50mm x 300mm x 4m, 2m
	Convertible Steel Pipe	200 set	
14.	Pollution Preventive Equipment		
	Waste Water Treatment	1	For Finishing Shop
	Equipment	1	For Galvanizing Shop
	Sewage Treatment Plant	1	
	Oily water Separating Tank	1	
	Oil Fence	1	1,200m
	Incinerator	1	2T/day
15.	Vessels		
	Work Boat	1	50HP
	Rubber Boat	1	
	Oil Barge	1	200T
16.	Piping		
	Industrial Water Line		150A x 4350m
	Fire Line		150A x 4350m
	Potable Water Line		100A x 3600m
	Compressed Water Line		150A x 3700m
	Oxygen Line		50A x 3600m
	Gas Line		50A x 3600mm

No.	Item	No.	Main Particulars
17.	Electric Wiring		
	Shiprepair Quay		
	Floating Dock		Total about 13,000m
	Work Bay		
	Work Shop		
	Power and Gas Station		Total about 7,500m
	Office		
18.	General		
	Welding Machine	150	500 Amp, 300 Amp
	Ventilating Fan	20	500ø
		40	Small Type 2KW
		10	Anti Explosion Type 7.5KW
	Chain Block	9	Air Chain Block, 10T, 5T, 2T
		6	Electric Chain Block, 20T, 5T, 2T
		12	Chain Block, 5T, 1T, 0.5T
	Hydraulic Water Test Pump	1	200 kg/cm^2
	Hydraulic Oil Test Pump	1	200 kg/cm^2
	Sea Water Ballast Pump	1	$120m^3/h$ x 3.5 kg/cm^2
	Bilge Pump	6	
	Paint Spray Equipment	8	
	Vacuum Cleaner	5	
	Gas Header	50	
	Gas Hose	5,000	25m x 100 sets x 2 pcs
	Air Header	50	
	Air Hose	2,500	25m x 100 pcs
	Cabtire	10,000	20m x 500 pcs
	Temporary Light	200	Anti Explosion Type
		400	Ordinary Type
	Pallet	10	For Fitting 1.2m x 3m x 0.7m
		10	For Fitting 1.5m x 4m x 0.8m
		10	For Parts 1m x 1m x 0.7m
	Oil Jack	40	50T, 30T, 20T, 10T, 5T

No.	Item	No.	Main Particulars
19.	Others		
	Tools, Jigs, Measuring Equipment, etc.	1 set	
20.	Office Supplies		
	Copy Machine	1	
	Electro Copy Machine	1	
	Telefax Equipment	1	
	Telephone & Exchanger	1 set	
	Computor and Soft	1 set	
	Office's Furniture	1 set	

4-7 Planning of Civil Construction and Building

4-7-1 Outline

The projected site of this repair dockyard is situated at the mouth of the Balsas and is a flat ground of a height of DL + 3 - 5m (DL : Mean low water level = Nivel de bajamar media inferior). According to the results of the boring (Performed around 1981) obtained from AUSA, the height of the ground was changed after the boring. This is because the material produced as a result of the dredging made in the nearby canal around 1982 was piled on this site up to the height of approximately DL + 12m maximum. (See Fig. III-2-3)

The soil conditions on which to establish the civil engineering and building plan were taken from the boring data obtained from AUSA. Those data did not include the test data relating to land subsidence such as those of consolidation test, etc. However, the plan is prepared on the assumption that the consolidation of the cohesive soil of heigher than DL +/-0 has been completed under the influence of the embankment and therefore there will be no subsidence in the future. When establishing the execution design for the construction of the plant, it is necessary to evaluate the embankment of the dredged soil and make supplementary borings corresponding to the planning and layout of the plant to obtain required test data. Judging from the available data, the soil is in major part a sandy ground up to the depth of -10m - -15m including the dredged soil and contains a thicken layer of gravel. Under the level, there are some points where there is a layer of adhesive soil.

Therefore, in the planing of the foundation of various structures, cast-in-place piles and concrete diaphragm wall are to be used because of difficulty of driving piles and sheet piles due to the presence of stones in the gravel and sand layer.

4-7-2 Work bay

(1) Planned characteristics of work bay

1) Target ship : approx. 60,000 DWT (Approx. 40,000 GT)
2) Dimensions of work bay : Length 230m / Width 40m / Height of slab DL +1.6m (Depth of 2.7m against grand level DL +4.3m)

(2) Type of structure of work bay

According to the boring data obtained, a gravel and sand layer exists from DL +/-0 to around DL -15m in the area of work bay and the N-values of standard penetration test are generally 30 or more. (Of the boring points, the point of 34MCK-14 is the closest to the work bay.) Therefore, the structures are so designed that areas subjected to rail load and block load of the slab are supported directly by the ground without pile. The general part of the slab is also designed in direct foundation structure since its working load is rather small. (Ref. Fig. III-4-8 - III-4-10)

(1) Slab

The height of the slab is DL + 1.6m which is higher than + 1.3m of the highest tide of the past. Therefore, instead of a gradient to drain rain water in long direction drain ditches are to be provided. Rails for transfer (8 lines) are to be installed on the slab.

The slab is designed to safely support the rail load and the block load with the repair ship placed in the direction of incoming ship (stern on the entrance side).

(2) Wall

The wall of the work bay is designed in L type retaining wall structure in reinforced concrete which is highly reliable as a structure and economical, since it is small in height and can be executed by open excavation.

(3) Entrance

The transfer of the ship from the floating dock to the work bay is to be carried out by moving trucks on the rails. At this time, the edge of the floating dock is to be placed on the supporting structure provided at the entrance of the work bay in order to maintain the continuity of the junction of rails. The entrance is therefore constituted by the supporting structure and the quay.
The quay is planned to have a depth of water of DL -6.0 in front of the entrance so that floating barges may approach it in the highest floating state.
The quay shall be constructed with a concrete diaphragm wall as front wall and tie rods are to be used for anchor.
Moreover, the supporting structure of the floating dock is to be installed at the top of the front wall of the quay so that the load at the time of rolling off may be supported by the front wall of the quay.

4-7-3 Quays for equipment

(1) Planned characteristics of quay

1)	Target ships	Max. approx. 100,000 DWT (Approx. 60,000 GT)
2)	Depth of water	-6.5m and -9.0m
3)	Length	230m each

4) Load: Normal time $1.0\ t/m^2$
At the time of earthquake $0.5\ t/m^2$

5) Facilities Crane foundation/Mooring bitt / Pit for utilities

(2) Structure and type of quays

The front wall is to be a concrete diaphragm wall in concrete and the anchor wall is to be a concrete wall and they are connected to each other by tie rods. The crane foundation is to be constructed in such a way that the beams in reinforced concrete are supported by piles. The beam of the crane foundation is to be connected by connecting beam. (Ref. Fig. III-4-11)

4-7-4 Floating dock sinking area

The area where the floating dock is submerged to be loaded with the repair ship requires a water depth of DL -17m. However, since the construction of quays of such a large depth of water is very costly, we tried to reduce the construction costs by making slope as indicated in Fig. III-4-10, having a water depth of DL -6m for the quay of the work bay side, and for the east side ground forming the slope of 1 : 3 also and protecting shore line with riprap.

4-7-5 Office building

The office building has been designed to reduce the number of columns to the minimum and to have a largest possible freedom in the change of partitions between rooms in order to enhance the functions of offices by coping with variety of needs of the office space. (See Fig. III-4-12)

(1)	Structure	One-story house in reinforced concrete with steel truss roof
(2)	Total area	3,750 m^2
(3)	External finish :	External wall -- Concrete block Roof -- Corrugated iron sheet
(4)	Internal finish :	
	Floor	Vinyl tile/mortar finish
	Wall	Mortar/paint finish
	Ceiling	Sound absorbing gypsum board

4-7-6 Shops

The shops have been planned with special attention to the functions responding to the needs of the production line of each factory and to the comfort of the factory workers. (See Fig. III-4-13 - III-4-16)

(1)	Structure :	Steel structure
(2)	External finish	
	External wall	Corrugated iron sheet
	Roof	Corrugated iron sheet
(3)	Internal finish	
	Floor	Concrete floor with trowel finish
	Wall	Exposed steel structure
	Ceiling	No ceiling. Pasting of insulation material under the roof.

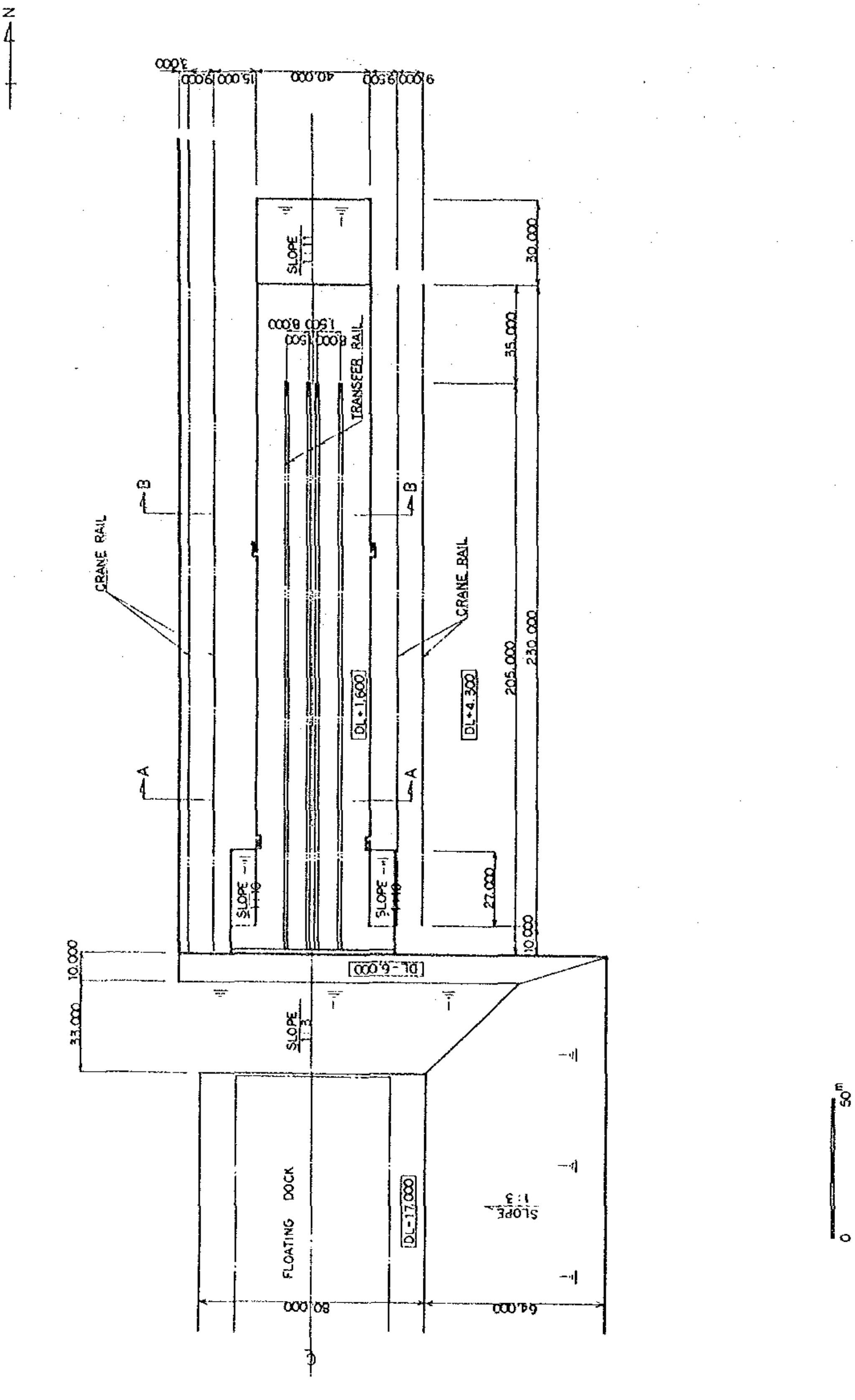


Fig. II-4-8 WORK BAY PLAN

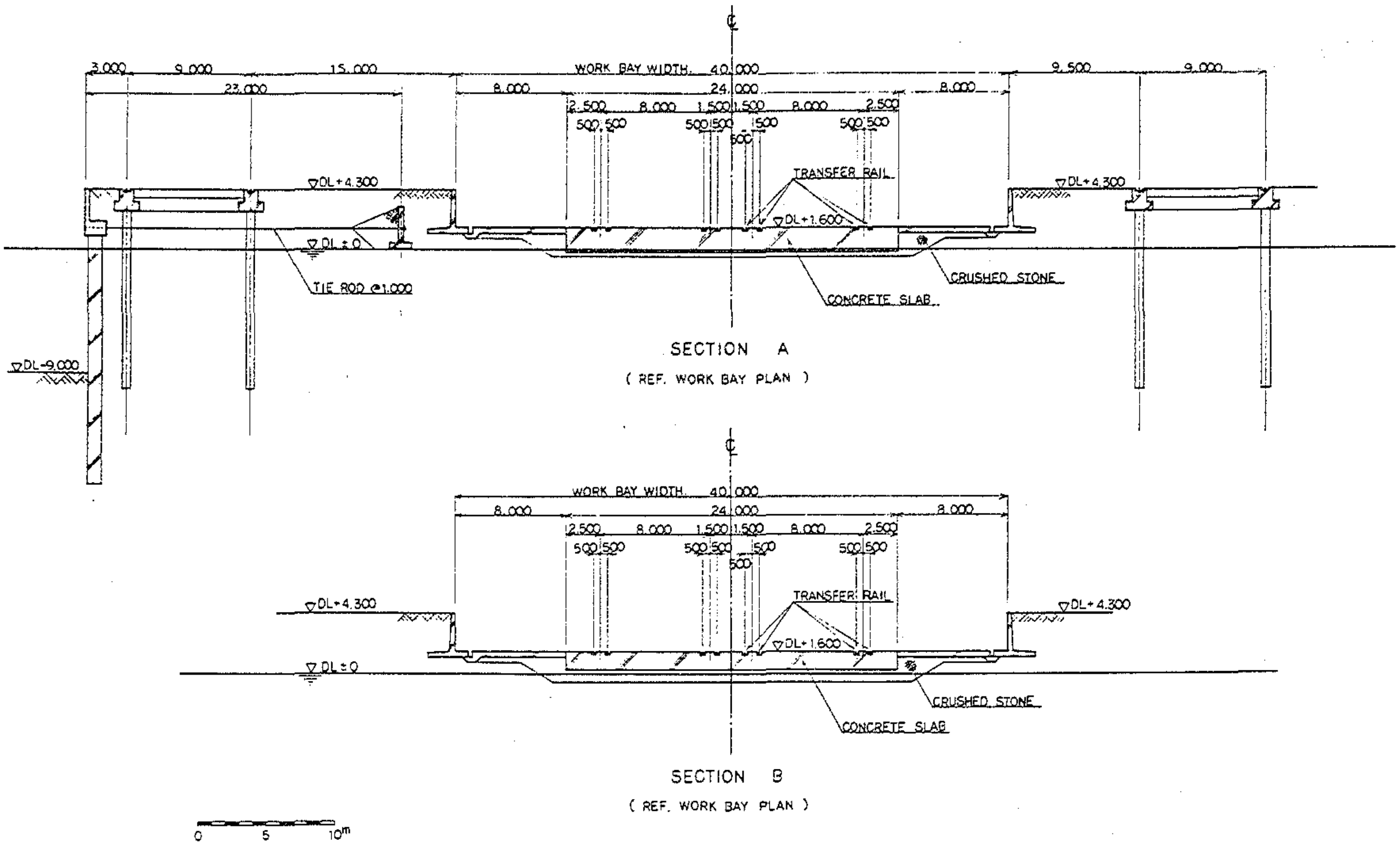


Fig. Ⅲ-4-9 WORK BAY SECTION

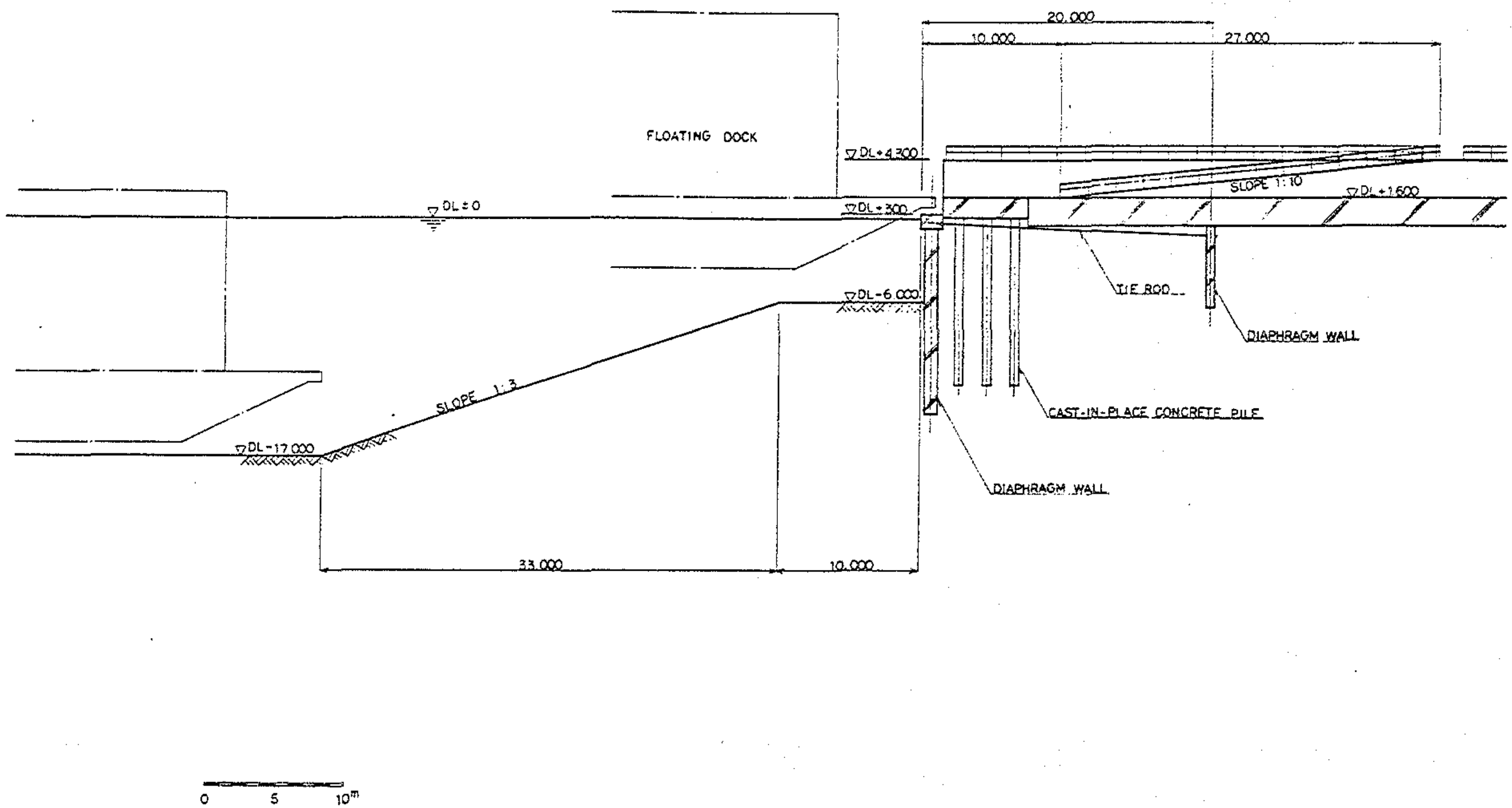
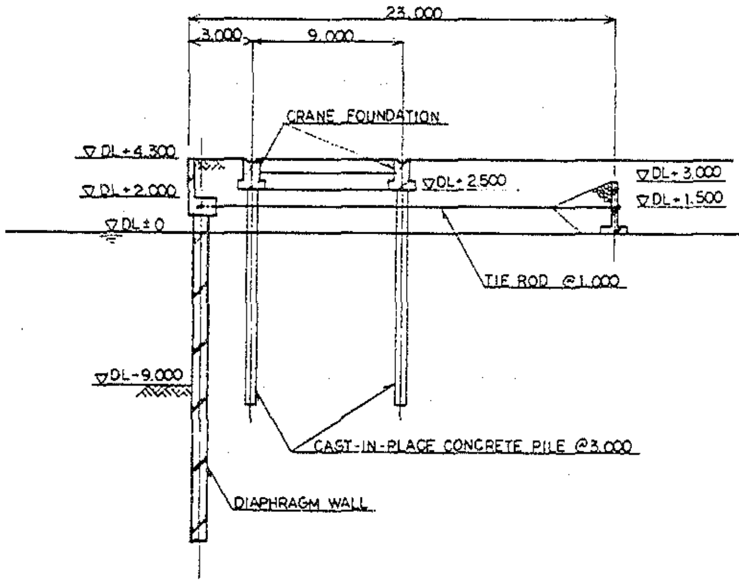
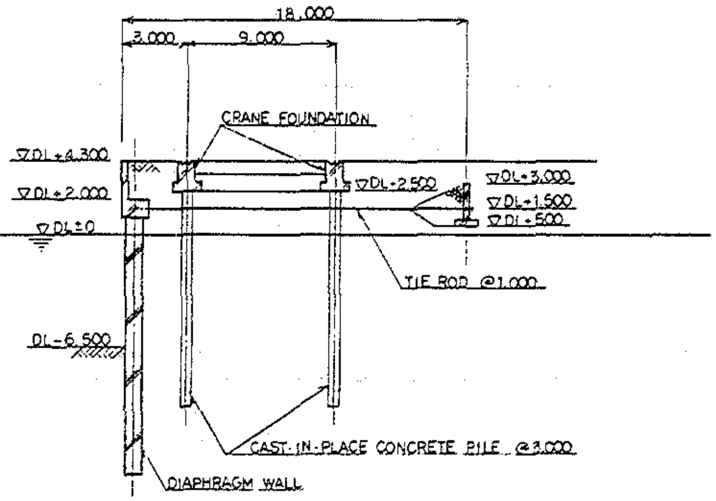


Fig. Ⅲ-4-10
WORK BAY ENTRANCE SECTION



NO.1 QUAYWALL



NO.2 QUAYWALL

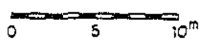


Fig. II-4-11 QUAYWALL TYPICAL SECTION

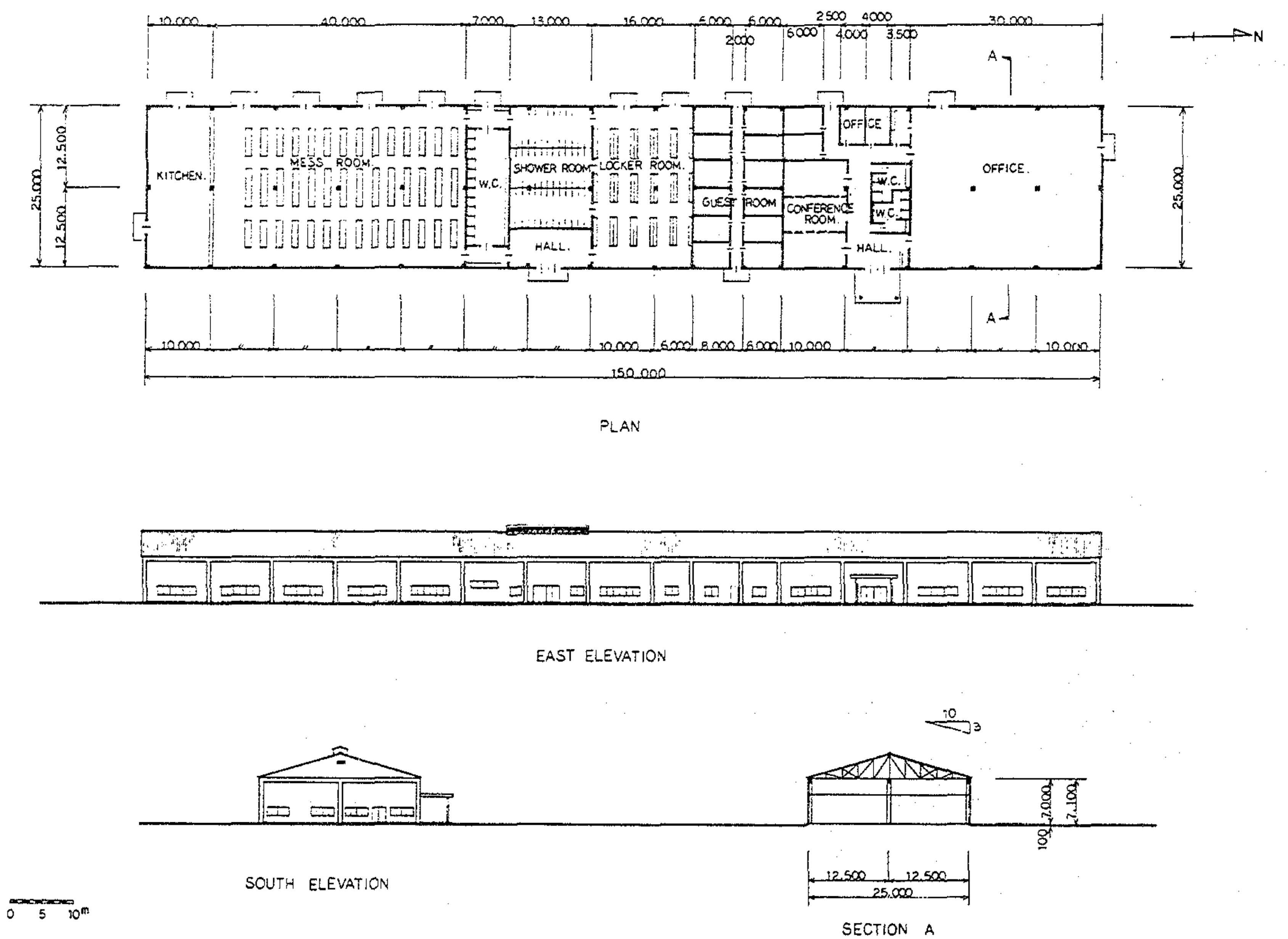


Fig. III-4-12 OFFICE BUILDING

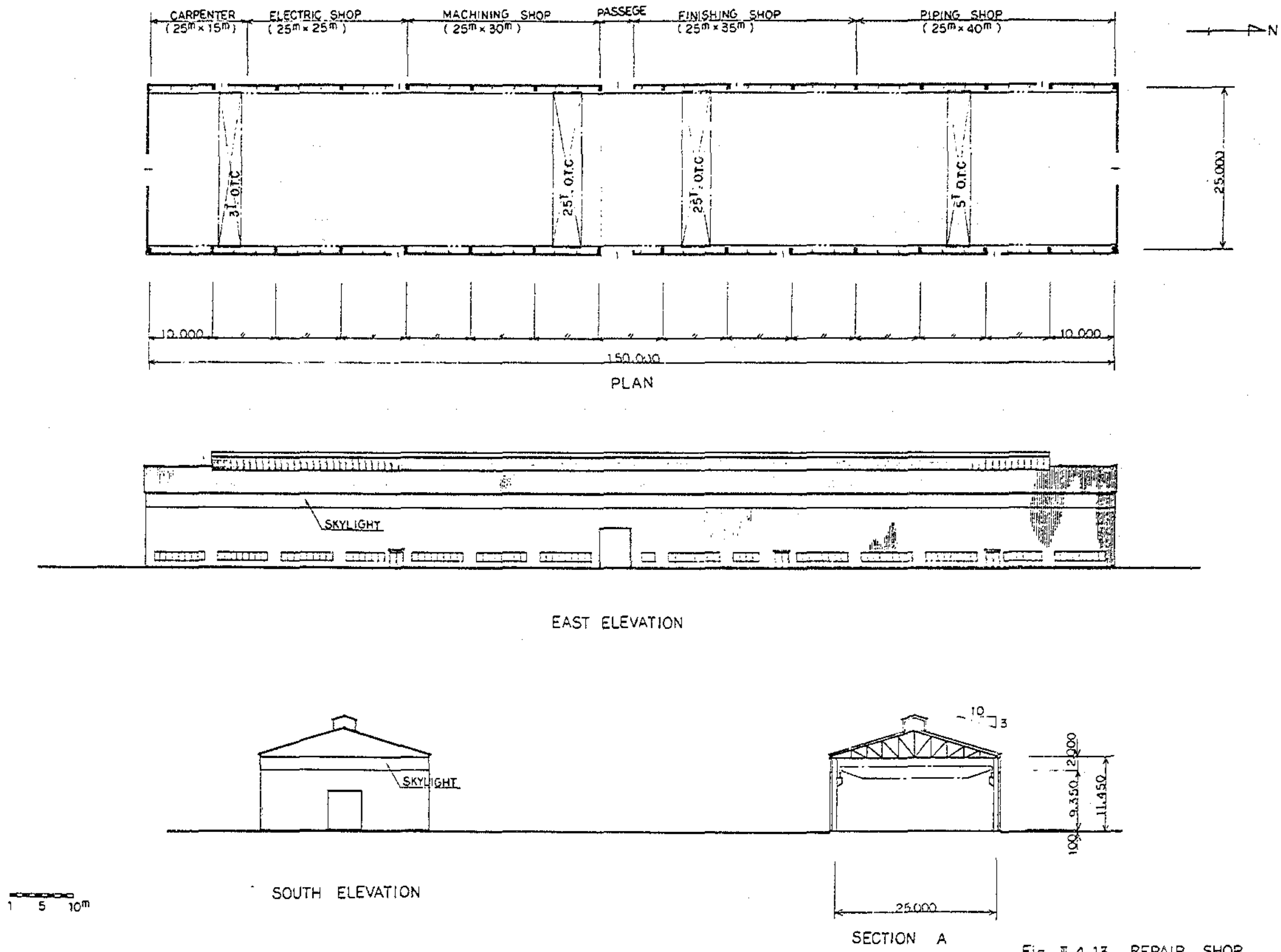


Fig. II-4-13 REPAIR SHOP

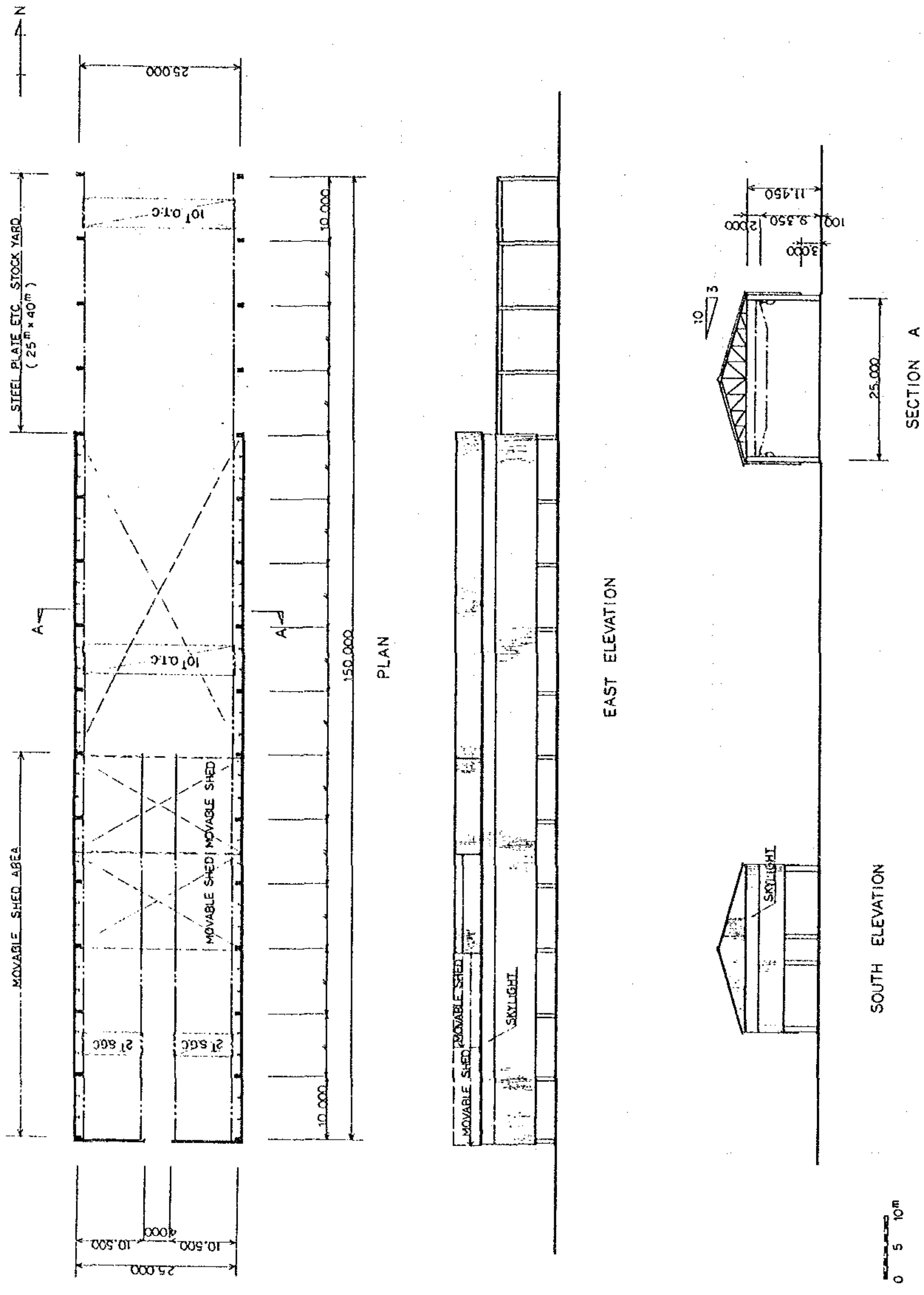


Fig. Ⅲ-4-14 STEEL SHOP

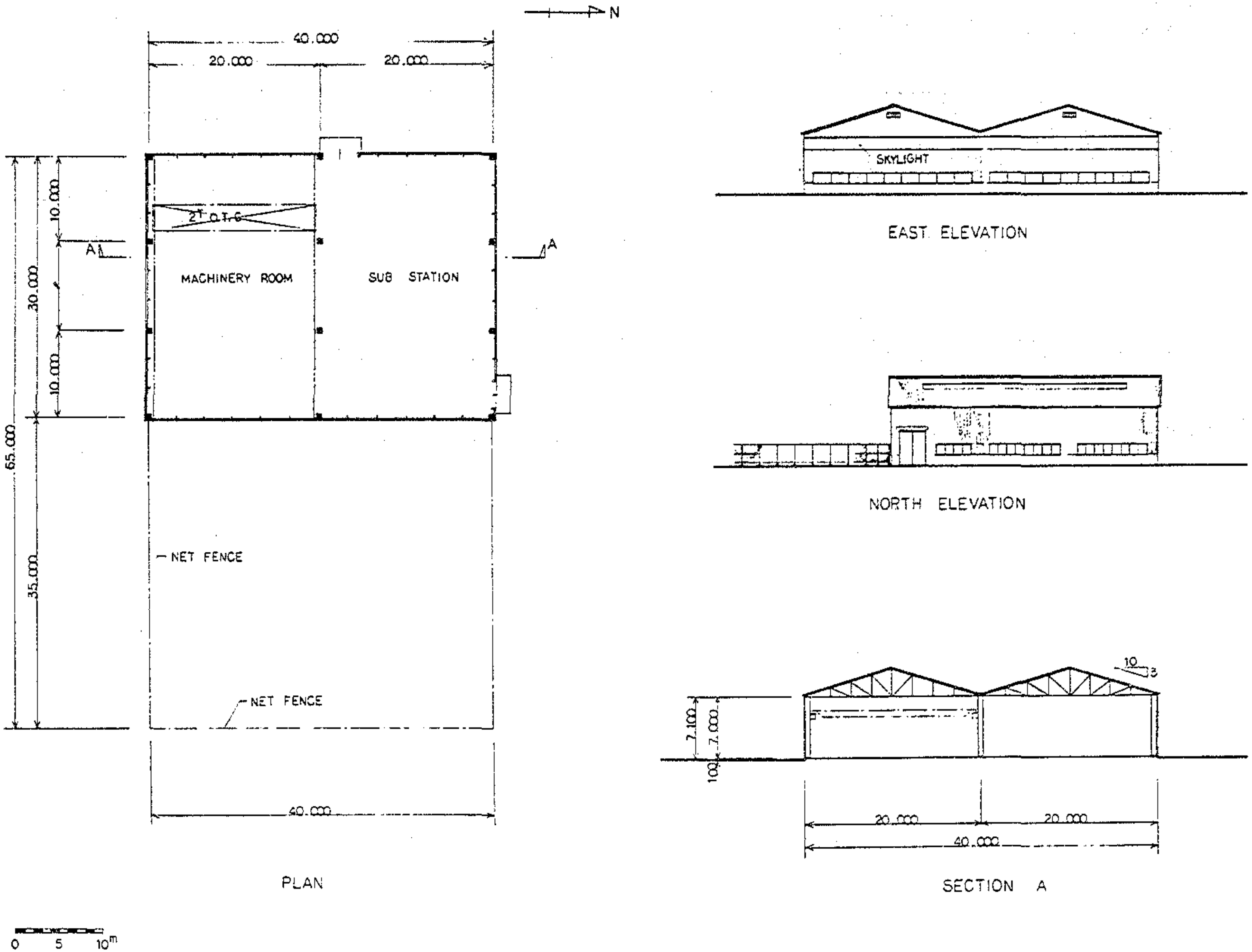


Fig. III-4-15 POWER & GAS STATION

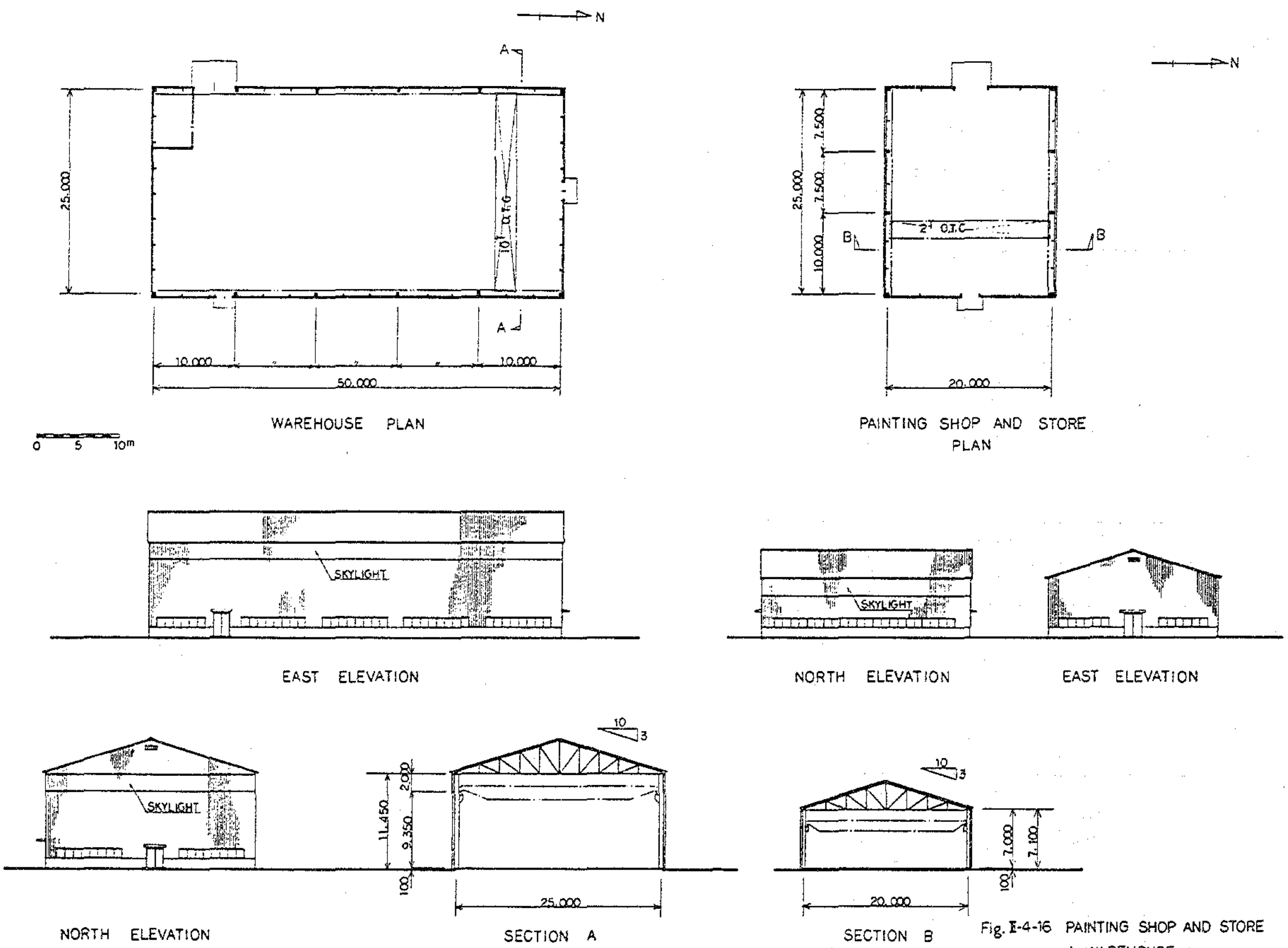


Fig. II-4-16 PAINTING SHOP AND STORE & WAREHOUSE

4-8 Construction Implementation Plan

4-8-1 Time Schedule

1)	Start of preparation for construction	Jan. 1990
2)	Start of 1st stage construction	July 1990
3)	Start of dockyard operation	Jan. 1992
4)	Completion of 1st stage construction	Dec. 1992
5)	Start of 2nd stage construction	Jan. 1995
6)	Completion of 2nd stage construction	Dec. 1996

Fig. III-4-17 shows construction schedule of the principal facilities.

4-8-2 Project Cost

The estimated costs for yard construction are given in Table III-4-7 and 8, which represent the amounts evaluated at the price level of June, 1987.

Table III-4-9 shows construction material procurement program.

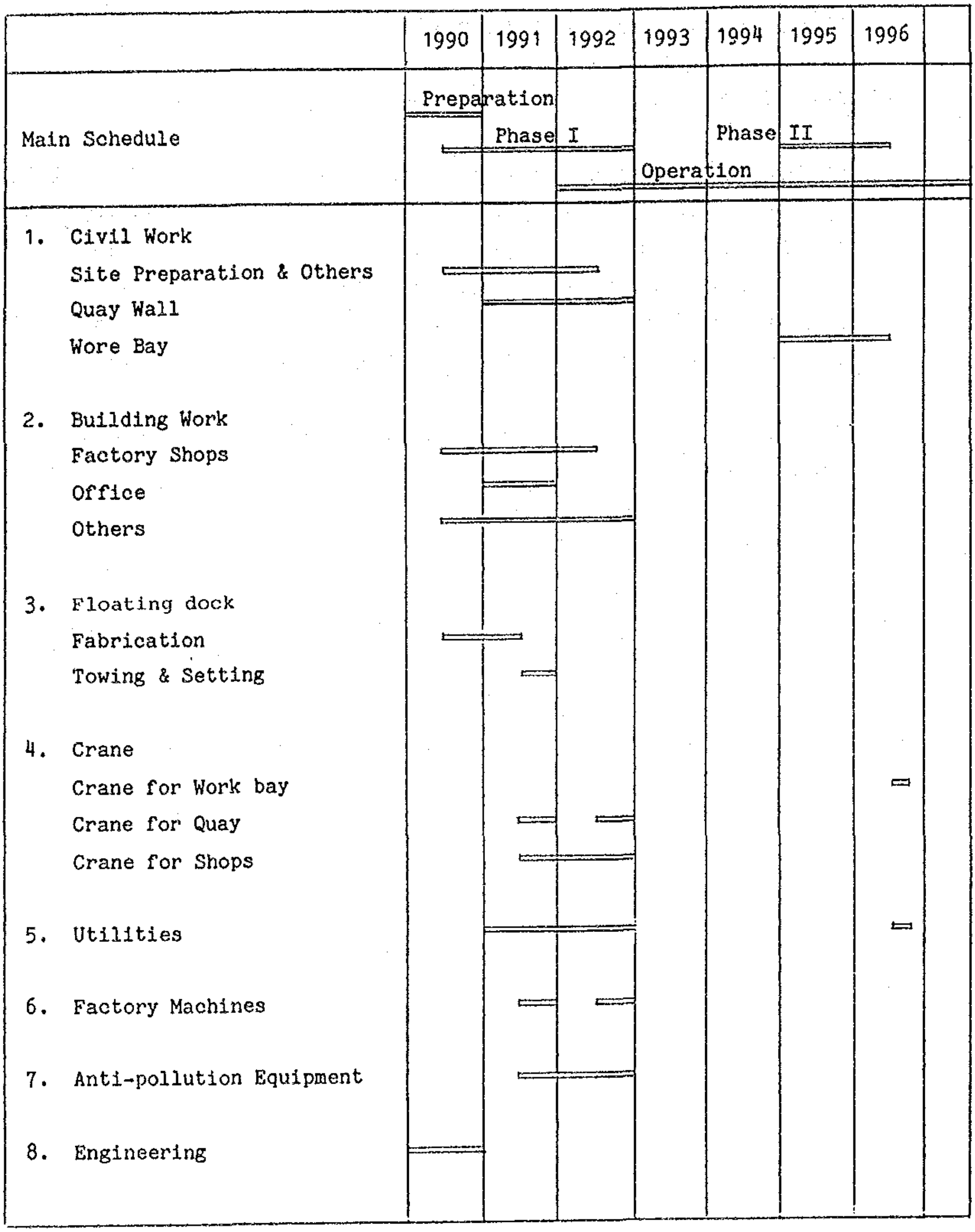


Fig. III-4-17 CONSTRUCTION SCHEDULE

Table III-4-7 INVESTMENT PLAN

(Unit: 1,000 US$)

No.	Description	Total	Domestic currency portion	Foreign currecy portion
1	Civil work	25,823	25,080	743
2	Building work	14,056	13,395	661
	Sub total (1) and (2)	39,879	38,475	1,404
3	Floating dock and transfer equipment	37,320	420	36,900
4	Cranes	4,498	1,442	3,056
5	Utilities equipment and pipe lines	1,365	772	593
6	Electric equipment	2,281	471	1,810
7	Vehicles and vessels	1,653	307	1,346
8	Factory machines	4,649	694	3,955
9	Anti-pollution equipment	421	209	212
10	Office supplies	1,689	336	1,353
	Sub total (3) - (10)	53,876	4,651	49,225
11	Engineering fee	1,500		1,500
12	Initial expenses and working capital	3,592	2,111	1,481
13	Contingency	2,849	2,231	618
	Total (1) - (13)	101,696	47,468	54,228

Table III-4-8 CONSTRUCTION INVESTMENT (DETAIL)

Unit: 1,000 US$

No.	Description	Estimated Cost	Funds	
			Domestic Portion	Foreign Portion
1.	Civil Work	25,823	25,080	743
	Site Preparation & Dredging	5,225	5,225	
	Quaywall & Crane Foundation	10,355	10,355	
	Work Bay & Crane Foundation	5,225	5,225	
	Road, Fence, Drainage, etc.	4,275	4,275	
	Supervisor	743		743
2.	Building Work	14,056	13,395	661
	Factory Shops	7,790	7,790	
	Office	3,990	3,990	
	Others	1,615	1,615	
	Supervisor	661		661
3.	Floating Dock and Transfer Equipment	37,320	420	36,900
	Floating Dock, Others	35,270	70	35,200
	Transfer Equipment	2,050	350	1,700
4.	Repair Quay-related Equipment	166	38	128
	Mooring Winch	57		57
	Welding Machine	71		71
	Access Tower, Others	38	38	
5.	Work Bay-related Equipment	142		142
	Welding Machine	71		71
	Shipsupporting Pillar, Others	71		71
6.	Cranes	4,498	1,442	3,056
	Level Luffing Crane	3,285	315	2,970
	Overhead Travelling Crane	1,060	1,060	
	Gantry Crane	153	67	86

Unit: 1,000 US$

No.	Description	Estimated Cost	Funds	
			Domestic Portion	Foreign Portion
7.	Utilities Equipment and Pipe Lines	1,365	772	593
	Compressor and Air Reservoir	445	29	416
	Water Pump and Treament Plant	129		129
	Gas Equipment Others	77	29	48
	Compressed Air Pipe Lines	152	152	
	Water Pipe Lines	448	448	
	Gas and Oxygen Pipe Lines	76	76	
	Others	38	38	
8.	Electric Equipment	2,281	471	1,810
	Transformer, Distribution Panel, and Switch Board	1,924	114	1,810
	Electric Cables, wiring Lighting Apparatus	357	357	
9.	Vehicles and Vessels	1,653	307	1,346
	Towing Tructor	1,248		1,248
	Other Vehicles	325	236	89
	Boat and Barge	80	71	9
10.	Factory Machines	4,341	656	3,685
	Steel Shop	945	130	815
	Piping Shop	146	56	90
	Machining Shop	906	133	773
	Finishing Shop	238	48	190
	Electric and Carpenter Shop	213	19	194
	Galvanizing Shop	300	143	157
	Warehouse and Paint Store	29	29	
	Stage Equipment	181	48	133
	Other Tools and Equipment	1,383	50	1,333

Unit: 1,000 US$

No.	Description	Estimated Cost	Funds	
			Domestic Portion	Foreign Portion
11.	Anti-Pollution Equipment	421	209	212
	Waste Water Treatment Equipment	314	152	162
	Oily Water Separating Tank, Oiltence, Incinerator, Otheers	107	57	50
12.	Office Supplies	1,689	336	1,353
	Computor and Soft	1,238		1,238
	Telephone and Exchanger	67		67
	Telex, Telefax, Copy Machine and Others	96	48	48
	Furniture for Office and so on	288	288	
13.	Engineering Fee	1,500		1,500
14.	Initial Expenses	3,362	2,065	1,297
15.	Working Capital	230	46	184
16.	Contingency	2,849	2,231	618
	Total	101,696	47,468	54,228

Table III-4-9 CONSTRUCTION MATERIAL PROCUREMENT PROGRAM

No.	Item	Description	Procurement	
			Domesitcs	Imports
1.	Civil Engineering Work			
	(1) Design			o
	(2) Material		o	
	(3) Construction Machine		o	
	(4) Labour force	Labour force for Construction	o	
2.	Machinery and Electric Facilities			
	(1) Design			o
	(2) Manufacturing		o	o
	(3) Labour force	Labour force for Installation	o	
3.	Wiring, Piping			
	(1) Design			o
	(2) Manufacturing		o	o
	(3) Labour force	Labour force for Installation	o	
4.	Vehicles and Oil barge			
	(1) Design		o	o
	(2) Material		o	o
	(3) Labour force	Labour force for Construction	o	
5.	Anti-pollution Facilities			
	(1) Design			o
	(2) Material		o	o
	(3) Labour force		o	

4-8-3 Implementation of construction works

In the planning of construction works of this dockyard, considerations have been made to use materials, construction equipment and labour force available in Mexico as much as possible.

Moreover, since the depth of excavation for the work bay is small (4 - 5m), the construction of quay, crane foundation, etc. have been planned in a way not using temporary cofferdam so that the construction work may be made reliably and speedily. For the casting piles and diaphragm wall, it is necessary to select construction machinery which are capable for excavating stones of the gravel and sand layer.

(1) Work bay

The excavation shall be made to the specified depth by the open excavation method. As the draining method required for that purpose, well-point method and draining with pump shall be used.

After excavating down to the specified depth, the concrete diaphragm wall for front wall of the quay at the entrance shall be executed, followed by the execution of anchor wall and tie-rod works

The side and end walls and the slab shall be executed following the above-mentioned works.

As to the slab works, the boring data indicate that there exists, at about DL +/-0m, a layer of gravel which may probably has certain bearing capacity, but if that layer is somewhat deep, it is necessary to replace soft soil by crushed stone.

After the execution of the side and end walls, the back of wall shall be filled up with sandy soil with compaction up to the specified height compaction, and then the piles for the crane foundation shall be executed.

(2) Quay

Since the construction of the quay can be performed on the ground, excavations should be made at necessary part and the concrete diaphragm wall for the front wall of the quay and the piles for the crane foundation should be built first.

Next, the anchor wall and the coping part of the front wall should be built and tie rods should be set. After that, the work of crane foundation beams, mooring bitt, etc. are to be carried out while performing backfilling.

When the quay work are completed, the front should be dredged at the specified depth.

5. Business Management and Operation Scheme

5-1 Basic Principle of Operation

5-1-1 Aim of this project

This project is to be implemented, managed and operated for the purpose of contributing to the United Mexican States and the local society at Lazaro Cardenas; more specifically, an increase in employment opportunities, an acquisition of foreign currencies, improvement of ship repairing technologies and development of associated industries, by providing ship repair services not only to Mexican flag ships but foreign ships which are trading or passing along the Pacific coast of Mexico.

5-1-2 Market share on the Pacific in Mexico

As seen in the preceding paragraph on demand forecast, the relation of supply and demand is, in principle, predicted to turn out favorably to the repair dockyard when it starts to operate, and it should aim at securing a percentage of several tens of the market share on which to base its operation in stead of trying to monopolize or get extraordinary control over the market.

The repair dockyard would otherwise affect existing repair yards of smaller size and suffer seriously from market recession.

5-1-3 Managerial and operational strategies

In order to realize the said aim, following strategies are to be established:

(1) To provide ship repair service of first quality and international competitiveness

(2) To be prepared to undertake ship repairs of any kind and extent required by customers

(3) To operate the business with minimum number of indirect personnel

(4) To exclude small size ships and fishing boats from the range of targets at Lazaro Cardenas so that competition with existing small or medium-scale repair yards can be avoided as far as possible.

For the details, refer to respective Chapters.

5-2 Shiprepair Business Scheme

5-2-1 Object ships to be repaired and details of repairs

Target ships for repair work shall be merchant ships and working ships but exclude warships. Their gross tonnages will be mainly more than 1,000 GT.

Repairs of container ships should be done strictly in time as promised and require high repairing technology. It is more difficult to dock and undock container ships than those of other types. Since there is a container yard in Lazaro Cardenas Port, and, the chances to repair container ships can be expected to surely increase in the future, the dockyard should secure such orders positively.

Though such repair should also be received as large modification work including main engine conversion and jumboizing, they should be excluded from object work for the time being in view of the presnet situations of this dockyard (design capacity, material procurement ability and schedule control ability).

5-2-2 Definition of words relating to repair work

The work relating to repairs and being used in the following chapters are defined as follows:

(1) General repair

To include those of periodical survey and those of lightly damaged ships in sea casualty, but exclude those to be done alongside pier.

(2) Afloat repair

To mean repair work to be done on an afloat condition the quay of dockyard without docking ships.

(3) Offshore repair work

To means repair work to be done, for example, on a container wharf, by workers to be sent out of the repairing dockyard.

5-2-3 Price for ship repair work

Ship repair work cover various objects including hull, machinery, accommodation spaces for traveller and crew, etc., and the extent of repair varies. Even in case of similar types of repair work, expenses depend on type of ship, tonnage, age of ship and work site.

Prices for repair work are also fluctuated greatly by the situations in shipping markets and repaired ship markets.

Since, as mentioned above, there are many mobile factors, it is quite difficult to predict prices for repair work at this new repairing dockyard. The best way to estimate the price is to use the statistics of repair work prices of Mexican shipyards at the present time.

The data obtained from the first and the second field investigations are only those of Veracruz Shipyard in 1983 and 1984, of Ensenada Shipyard on fishing boats and those on ferryboats, and the numbers of data are limited. But it would be possible to presume present selling prices by analyzing these data.

(1) General repair

Referring to data on general repair work of Veracruz shipyard except data on repair work assumed to be particular cases and those for less than 1,000 GT of ships, the correlations between ships' gross tonnages and their selling prices will be assumed as follows (see Fig. III-5-1):

Regression equation:

Selling price (US$/GT) = 4490 x $(GT)^{-0.547}$

Regression coefficient: -0.482

Though it cannot be decided directly from the Veracruz Shipyard's data that there are correlations between their selling prices and ships' gross tonnages, Japanese work data on repaired ship show considerably high correlations between them. Ships repaired at Veracruz Shipyard are mainly those of Mexico and of Latin America, their ages are high and the percentage of ships repaired as marine casualty is comparatively high. Therefore, their selling prices vary widely from Japanese ones. If they come to receive orders for repair of industrialized countries' ships in addition to high aged ships as the new repair dockyard at Lazaro Cardenas Port intends to, it is considered that their data will show high correlations between ships' tonnages and their selling prices as Japanese data do. On the other hand, however, this means that their new selling unit prices will lower below Veracruz Shipyard's actual prices in the past.

When the Veracruz Shipyard's data are applied to the average target ship of the gross tonnage of 16,000 to 17,000 tons of the new dockyard, the selling price comes to US$22,20/GT.

In Japan the general repair cost of 16,000 to 17,000 GT class ship is supposed to be US$16.50/GT. This figure was obtained by the regression analysis of repair costs of ships of 105 companies joining in the Japan Shipowners' Association (See Fig. III-5-2).

Also, according to Japanese statistics, the repair cost amount of foreign ships is about 35% larger than that of Japanese flag ships. This means that more repairs due to high ship age and other reasons are included in the foreign ship repair costs. This is also confirmed by studying the man-hour data of Veracruz Shipyard together with the factor of efficiency.

On the other hand, the average selling price per direct hour ranges US$23.00 to $25.00 and is much higher than US$14.3/H, the selling price of a fishing boat of Ensenada Shipyard in 1987. The data quantity of Ensenada Shipyard is very limited, and, if this price is a special example in the highly competitive market of fishing boat, the figure of Ensenada Shipyard cannot be used as it is. (See Table III-5-1)

Anyway, the price of Veracruz Shipyard is considered to be very profitable because many repair for marine casualties are included in their general repair work.

Besides, these data are under a bias toward smaller boats relatively. The price per direct manhour for gross tonnage in Fig. III-5-3 shows that the price per manhour for 15,000 GT or 16,000 GT is not so high as US$23, though the correlation coefficient of regression analysis is lower.

Therefore, it is considered reasonable to deduct the safety factor of 20% as the average selling price.

The selling price can be estimated as follows:

Average selling unit price (US$/GT) = 22.2 x 0.8 = 17.8

The annual sales estimated by using this unit price are shown in Table III-5-2.

It is possible to receive orders for repair of marine casualties relatively large at the rate of less than several percents of total repair work, and they often bring about large profits. But these orders are not counted in the initial orders in this feasibility study and are only considered in a safety factor.

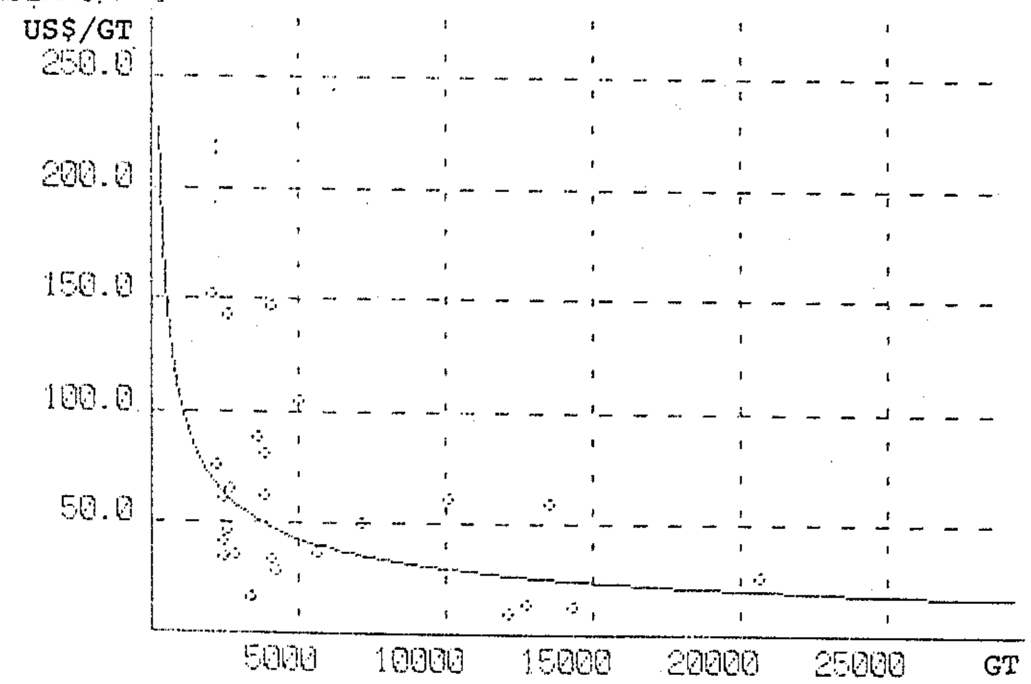
(2) *Repair at quay*

As for repair work at quay, the regression analysis cannot be made satisfactorily due to large dispersions in few data. But, since the overall average is around US$2.00/GT, the cost of repair work at quay is considered to be one eight of that of general repair work. It seems that ferry boats are repaired at quay for long periods along the Pacific coast of Mexico. These situations are considered to have occurred due to the shortage of docking facilities and some work management problem, and these are not included in the category of repair work at quay. Considerably, high repair cost can be pressumed, and these were not taken into account when calculating the pressumed cost.

PROJECT : LAZARO CARDEMAS F/S

VERACRUZ SHIPYARD

REPAIR RECORD



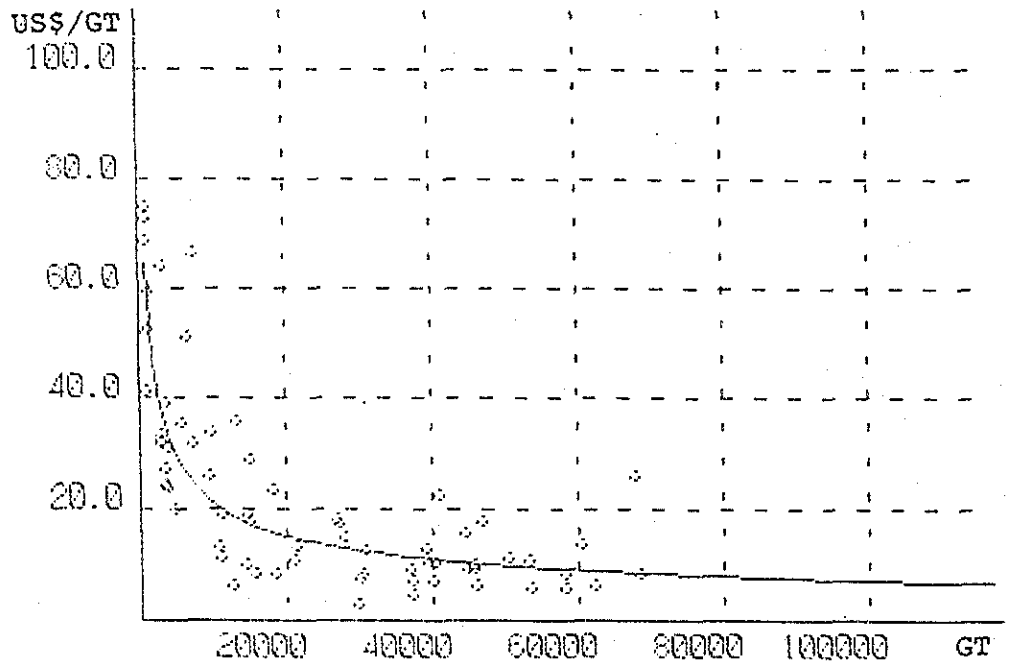
(1) Y= A + BX	A:	B:	C:	CORR:
(2) 2ND CURVE	A:	B:	C:	CORR:
(3) Y = B*X^C	A: 0	B: 4494.72	C: -.546876	CORR: -.48191

Fig. III-5-1 SALES PRICE PER GROSS TON OF VERACRUZ SHIPYARD

PROJECT : LAZARO CARDENAS F/S

ALL KINDS' SHIP

RECORD OF JAPAN



(1)Y= A + BX A: B: C: CORR:
(2)2ND CURVE A: B: C: CORR:
(3)Y = B*X^C A: 0 B: 1682.93 C: -.476109 CORR: -.864867

Fig. III-5-2 COST OF GENERAL REPAIR (RECORD OF JAPAN SHIP OWNERS' ASSOCIATION)

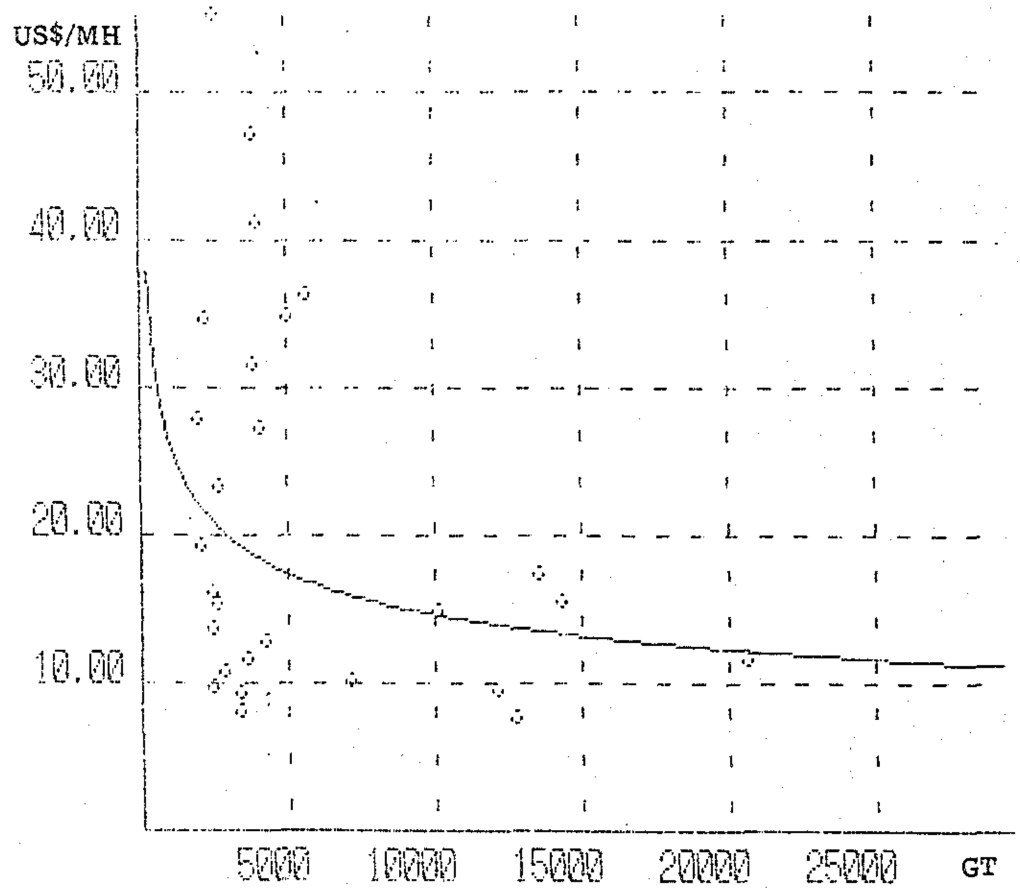
Table III-5-1 REPAIR PRICE OF "1200 TON" FISHING BOAT (APPROX. 1000GT) AT ENSENADA

Date	Name of ship	Price	Ex.rate	US$	Manhour	Means
		x1000P				
85/1	CUAHTEMOC	6,442	198P/$	32,535		
	BUCANERO	4,021	"	20,308		
	KUKULKAN	4,494	"	22,697		
	BEATRIZ	11,426	"	57,707		
2	ALETA AZUL	9,838	203	48,463		
	AZTECA III	293	"	-		
	LUPE DEL MAR	12,762	"	62,867		
3	MARIA VERONICA	5,244	209	25,091		
4	BRUJA DEL MAR	4,818	215	22,409		
5	MARIA FERNANDA	5,162	222	23,252		
6	CABO SAN LUCAS	6,096	228	26,737		
	VENTUROUS	7,850	"	34,430		
11	MARIA AMALIA II	897	341	-		
12	AZTECA I	10,513	372	28,261		
	CONVEMAR	6,675	"	-		
	Total 12 boats			404,757		33,730 $/boat
86/1	CHAC-MOOL	9,470	402 P/$	23,557		
	OLGA DEL PACIFICO	20,470	"	50,920		
	CONVEMAR	8,364	"	-		
2	ALETA AMARILLA	22,616	440	51,400		
3	MARIA ROSSANA	16,617	474	35,057		
4	NICOLE K	15,457	505	30,608		
	CONVEMAR	7,398	"	-		
10	SALINA CRUZ	14,484	807	17,948		
	Total 6 boats			209,490		34,915 $/boat
87/1	TEACAPAN	27,752	949 P/$	29,243		
	CAP. ISIDORO DUARTE	40,220	"	42,381		
2	MARINER	20,381	1,015	20,080		
3	CAP. ISIDORO DUARTE	3,516	-	-		
5	CONVEMAR	58,937	1,268	46,480	3,500H	13.28 $/H
	COPEATUN II	96,621	"	76,200	5,300	14.38 $/H
6	TRAMONTANA	47,714	1,317	36,229	2,300	15.75 $/H
	CANCUN	44,532	"	33,813		
	Total 7 boats			284,426		40,632 $/boat
	Grand Total 25 boats					35,947 $/boat

PROJECT : LAZARO CARDENAS F/S

VERACRUZ SHIPYARD

GT vs US$/MH



(1)Y= A + BX	A:	B:	C:	CORR:
(2)2ND CURVE	A:	B:	C:	CORR:
(3)Y = B*X^C	A: 0	B: 151.075	C: -.253304	CORR: -.299366

Fig. III-5-3 SALES PRICE PER MANHOUR OF VERACRUZ SHIPYARD

Table III-5-2 SALES AMOUNT

Project life	Year	General repair		Afloat repair		Total	
		(x 1,000 GT)	(x 1,000 US$)	(x 1,000 GT)	(x 1,000 US$)	(x 1,000 GT)	(x 1,000 US$)
1	1990						
2	1991						
3	1992	383	6,817	67	149	450	6,966
4	1993	553	9,843	97	216	650	10,059
5	1994	723	12,869	127	283	850	13,152
6	1995	951	16,928	168	375	1,119	17,303
7	1996	989	17,604	175	390	1,164	17,994
8	1997	1,028	18,298	181	404	1,209	18,702
9	1998	1,066	18,975	188	419	1,254	19,394
10	1999	1,105	19,669	195	435	1,300	20,104
11	2000	1,144	20,363	202	450	1,346	20,813
12	2001	1,183	21,057	209	466	1,392	21,523
13	2002	1,222	21,752	216	482	1,438	22,234
14	2003	1,261	22,446	223	497	1,484	22,943
15	2004	1,301	23,158	229	511	1,530	23,669
16	2005	1,340	23,852	236	526	1,576	24,378
17	2006	1,398	24,884	247	551	1,645	25,435
18	2007	1,457	25,935	257	573	1,714	26,508
19	2008	1,516	26,985	267	595	1,783	27,580
20	2009	1,574	28,017	278	620	1,852	28,637
21	2010	1,633	29,067	288	642	1,921	29,709
22	2011	1,692	30,118	298	665	1,990	30,783
23	2012	1,750	31,150	309	689	2,059	31,839
24	2013	1,809	32,200	319	711	2,128	32,911
25	2014	1,868	33,250	330	736	2,198	33,986
26	2015	1,928	34,318	340	758	2,268	35,076
27	2016	1,928	34,318	340	758	2,268	35,076
28	2017	1,928	34,318	340	758	2,268	35,076
29	2018	1,928	34,318	340	758	2,268	35,076
30	2019	1,928	34,318	340	758	2,268	35,076

Note: General repair includes periodical survey, annual survey, marine casualties.