BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF
THE OKAT PORT
IN
THE FEDERATED STATES OF MICRONESIA

FEBRUARY, 1999

JAPAN INTERNATIONAL COOPERATION AGENCY
TETRA CO., LTD.

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PREFACE

In response to a request from the Government of the Federated States of Micronesia the Government of Japan decided to conduct a basic design study on the Project for Improvement of the Okat Port and entrusted the study to the Japan International Cooperation Agency (JICA).

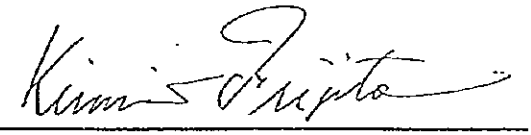
JICA sent to Micronesia a study team from September 15 to October 19, 1998.

The team held discussions with the officials concerned of the Government of Micronesia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Micronesia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Federated States of Micronesia for their close cooperation extended to the teams.

February, 1999



Kimio Fujita
President
Japan International Cooperation Agency

February, 1999

Letter of Transmittal

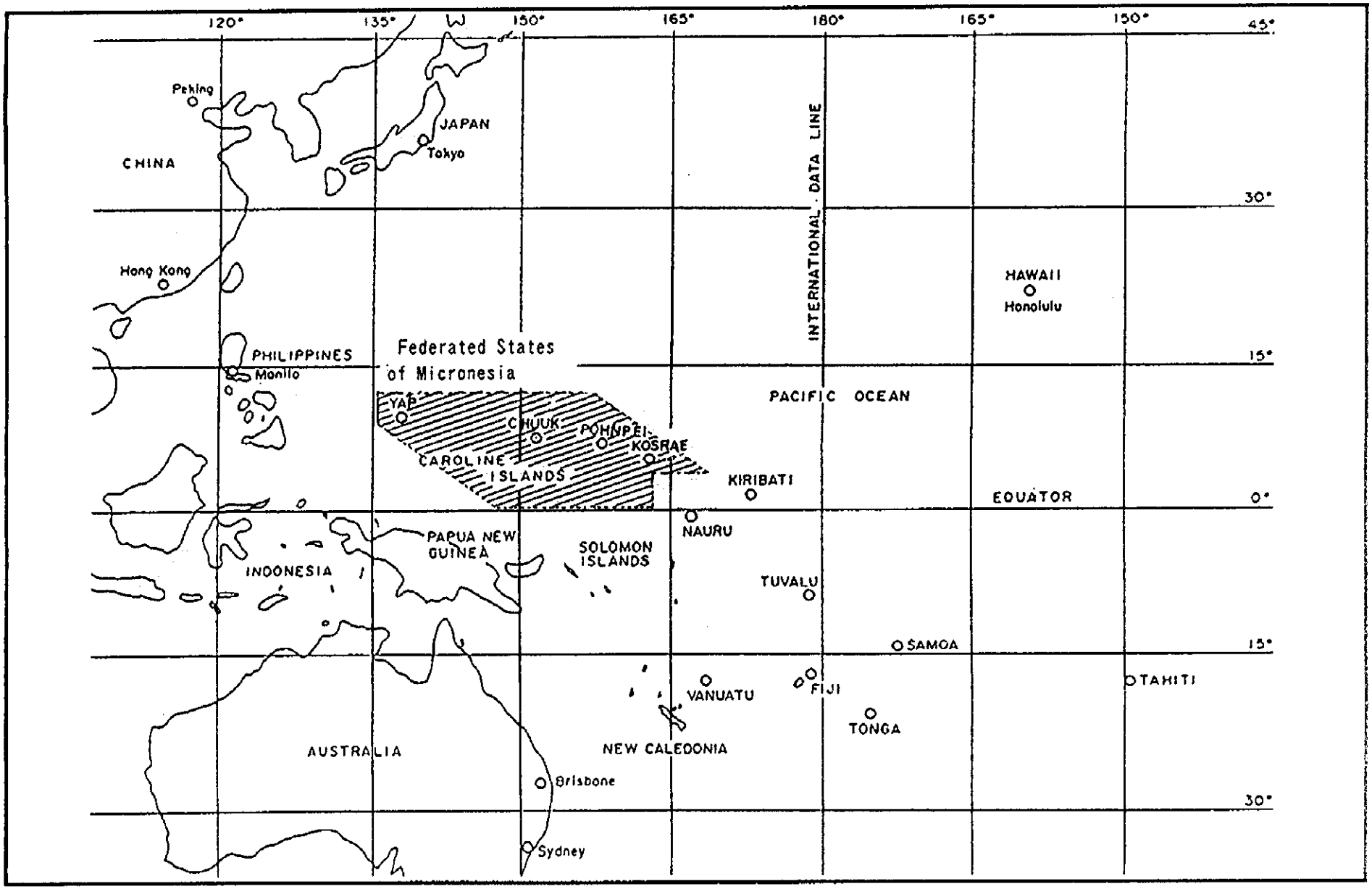
We are pleased to submit to you the basic design study report on the Project for Improvement of the Okat Port in the Federated States of Micronesia.

This study was conducted by TETRA Co., Ltd., under a contract to JICA, during the period from September 4, 1998 to March 11,1999. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Micronesia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

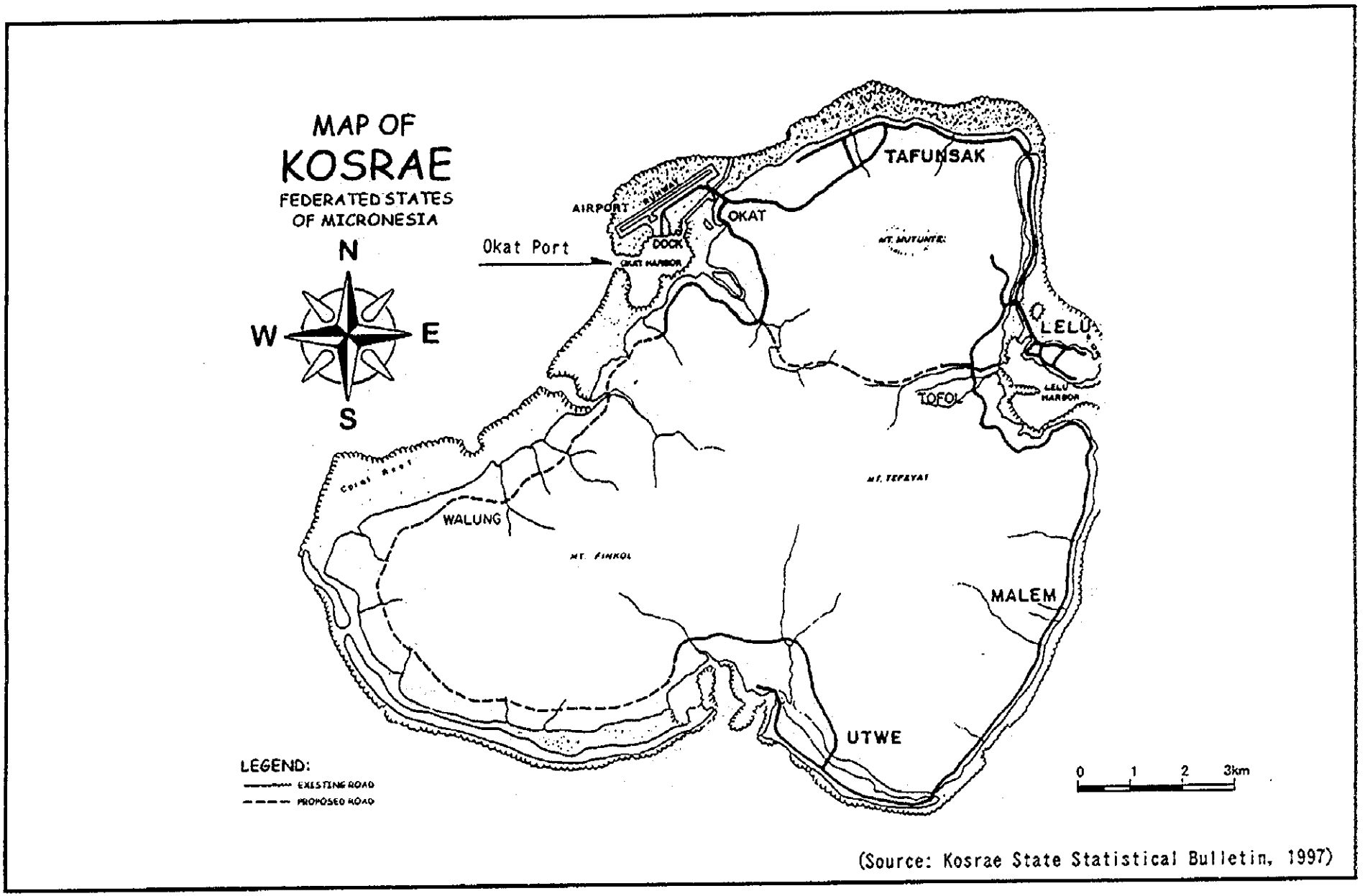
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Yutaka Ochi
Project Manager,
Basic Design Study Team on
the Project for Improvement of the Okat Port
TETRA Co., Ltd.

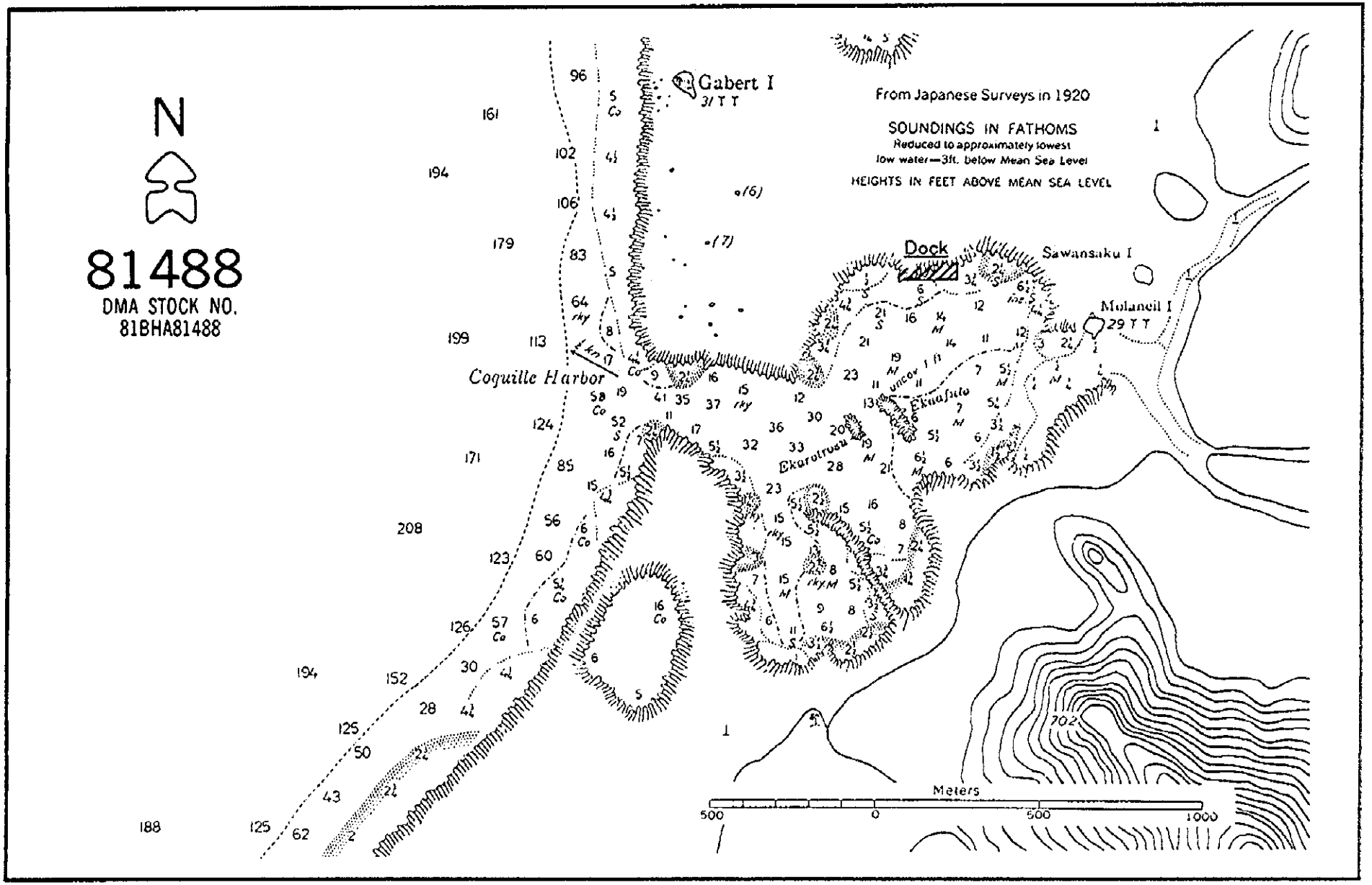


Location Map of Micronesia

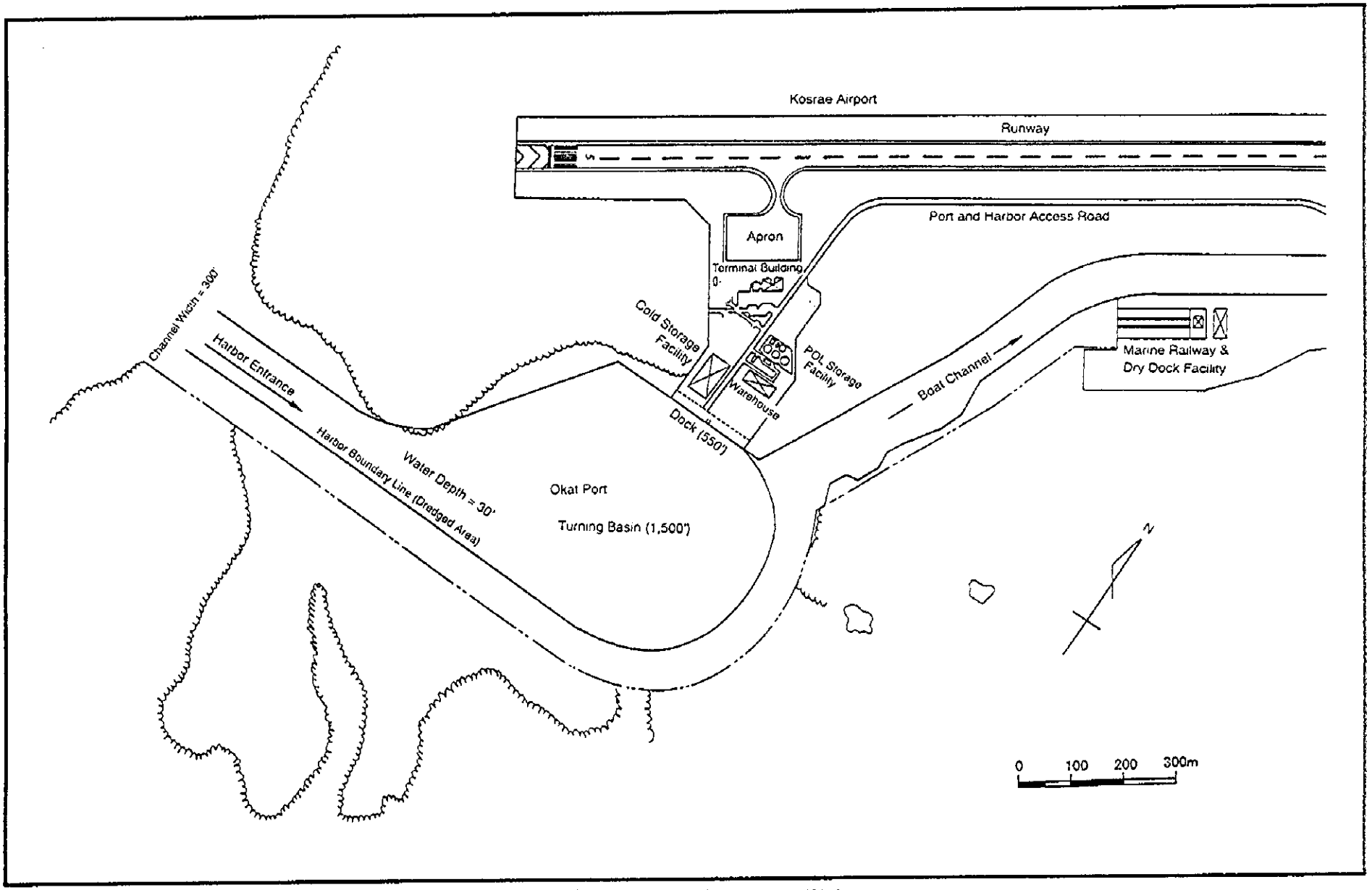


(Source: Kosrae State Statistical Bulletin, 1997)

Location Map of Okat Port



Marine Chart of Okat Port (1920)



Location Map of Port Facilities

Abbreviations

DL	Datum Level
DT&U	Department of Transportation & Utilities
DWT	Dead Weight Tonnage
FSM	The Federated States of Micronesia
GRT	Gross Registered Tonnage
HWL	High Water Level
$H_{1/3}$	Significant Wave Height
IALA	International Association of Lighthouse Authorities
KT&ST	Kusaie Terminal & Stevedoring Company
LED	Light Emitting Diode
LOA	Length Overall
LWL	Low Water Level
MPC	Micronesia Petroleum Company
MSL	Mean Sea level
NFC	National Fisheries Corporation
ODA	Official Development Assistance
PTI	Pacific Tuna Industries, Inc.
$T_{1/3}$	Significant Wave Period

Basic Design Study Report on
the Project for Improvement of the Okat Port

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CHAPTER 1

BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

1.1 Background of the Project

The Federated States of Micronesia is an island country, which consists of four states called Pohnpei, Kosrae, Chuuk and Yap. The maritime transportation plays an important role of transporting daily commodities as well as imports and exports of products, thus contributing to the national economy and people's livelihood. Improvement of the port facilities is in particular of great importance in social infrastructure development.

The government, at both central and state level, greatly relies on the Compact Fund provided by the United States on the basis of the Compact Agreement for Free Association, which aims at achieving economic independence by the year 2001 when the agreement expires. For this reason, each state has made great efforts to promote fishery industries to achieve regional development and to revitalize economic conditions by promoting the export of fishery products.

Okat Port of the only port for international trade in Kosrae State has been planned by the State Government as the port of exclusive use for fisheries. The Government therefore requested a grant aid of the Japanese Government with regard to the comprehensive development of the port facilities including quays and container yards. However, the preliminary surveys revealed that the large scaled expansion of the port including the quay extension, dredging of waterways and basins were considered premature. Because the present conditions of the port utilization, that is, the size of calling ships and the ship call frequency is not appropriate to proceed the project at current stage. However, installation of navigation aids, replacement of fenders and so on was considered important to secure the navigation safety of calling ships.

The following requests are stated on the Minutes of Meeting of the preliminary mission.

(1) Establishment of navigation aids,
(2) Fielding consultant(s) for safety advice,
(3) Replacement of fenders.

1.2 Situation of the Project Site

1.2.1 Natural Conditions

(1) Climatic Conditions

The climate of Kosrae State is typically tropical, characterized by high temperature and high humidity. There are no significant differences in temperature throughout the year. The average temperature is 27 ℃, the average humidity is 80% and the precipitation is about 4,100mm. The country is not heavily affected by typhoons or tropical depressions. The easterly wind prevails throughout the year.

The data observed at the Kosrae Meteorological Station located adjacent to Okat Port are used for the analysis of climatic conditions.

1) Temperature

The highest, lowest and average temperature for the past 4 years are shown in Table 1.2.1.1 and Figure 1.2.1.1. The highest temperature is about 31℃ and the lowest is 22℃. There are small differences in temperature throughout the year.

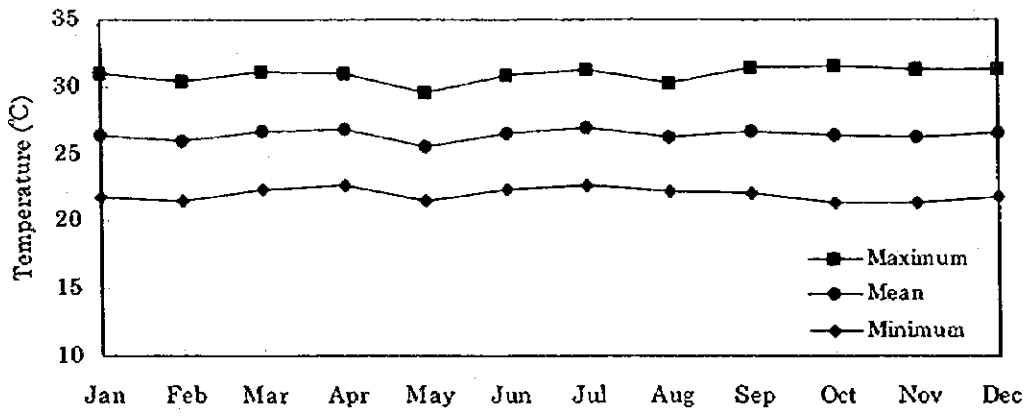


Figure 1.2.1.1 Highest, Lowest and Average Annual Temperature

Table 1.2.1.1 Highest, Lowest and Average Annual Temperature

(℃: 1995-1998)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
Highest	31.0	30.5	31.1	30.9	29.5	30.8	31.2	30.3	31.4	31.5	31.2	31.3	31.1
Lowest	21.8	21.5	22.3	22.6	21.6	22.4	22.7	22.1	22.0	21.3	21.3	21.7	22.1
Average	26.4	26.0	26.7	26.8	25.5	26.6	27.0	26.2	26.7	26.4	26.3	26.5	26.6

2) Precipitation

The monthly changes in the average precipitation during the last 4 years is shown in Table 1.2.1.2 and Figure 1.2.1.2. The annual precipitation is about 4,100mm, while the precipitation is higher during April to June.

The highest daily rainfall in past 10 years from 1988 to 1997 is shown in Table 1.2.1.3.

Table 1.2.1.2 Average Monthly Rainfall

(mm/day: 1995-1997)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rain fall	361	317	212	492	438	405	341	337	292	301	280	329	4,106

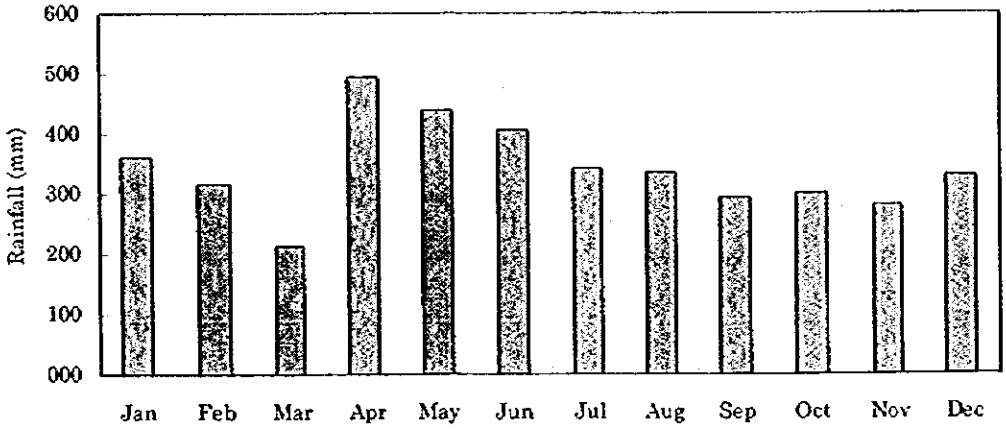


Figure 1.2.1.2 Average Monthly Rainfall (1995-1997)

Table 1.2.1.3 Maximum Daily Rainfall (1988-1997)

Year	Month/Day	Max. Rainfall
1988	Dec. 13	97 mm/day
1989	Mar. 7	177 mm/day
1990	Nov. 12	78 mm/day
1991	May 4	137 mm/day
1992	Jan. 3	155 mm/day
1993	Dec. 2	196 mm/day
1994	Sep. 11	104 mm/day
1995	Apr 14	111 mm/day
1996	Jun. 26	144 mm/day
1997	Sep. 10	159 mm/day

3) Wind Directions and Speed

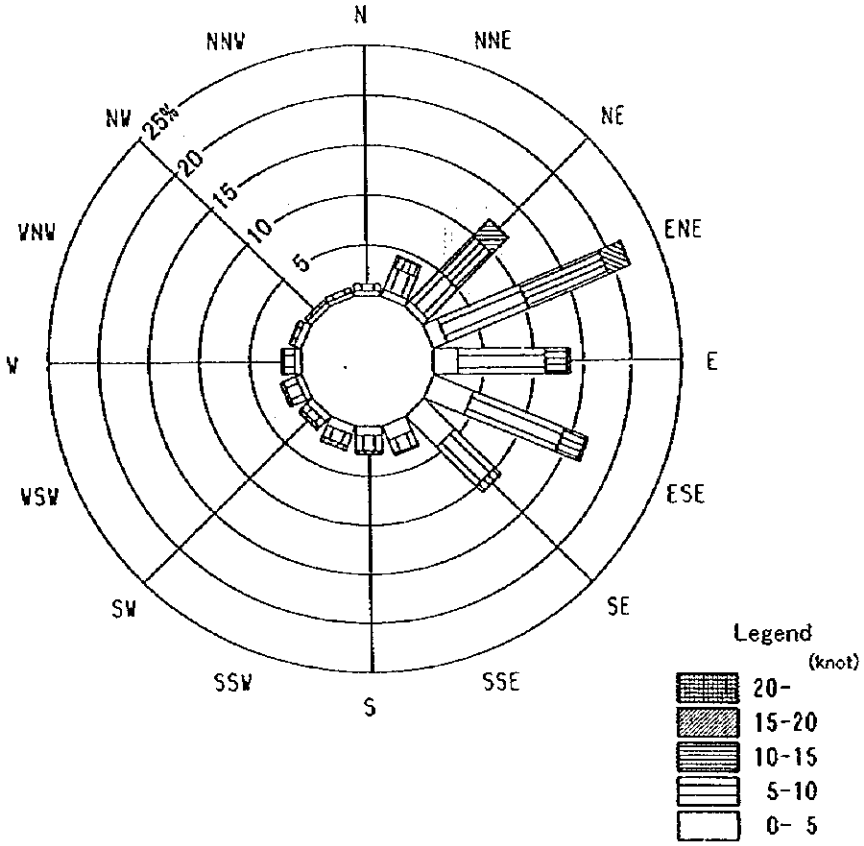
The monthly distribution of wind direction and speed during the past 3 years, i.e. 1995-1996, is shown in Figures 1.2.1.3 and 1.2.1.4, respectively. The easterly wind prevails throughout the year and the maximum speed is about 25 knots.

4) Typhoons

Table 1.2.1.4 shows typhoons observed in Kosrae from 1988 to 1997. The typhoon, which gave a damage to Kosrae was only the typhoon "Axel" which appeared in June, 1997. Its maximum wind speed was recorded at 55 knots, but she did not directly hit Kosrae and passed by the island.

Table 1.2.1.4 Typhoon Records of Kosrae (1988-1997)

Name	Day/Month/Year	Max Wind speed
Owen	20/12/1990	12 knots
Yuri	24/11/1991	25 knots
Russ	16/12/1991	15 knots
Axel	09/01/1992	55 knots
Paka	13/12/1997	23 knots



Unit : %

Speed (knot)	Wind Direction																Total
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
1- 5	0.56	0.75	0.75	1.64	2.59	4.46	4.42	1.62	0.99	0.95	0.78	0.58	0.60	0.73	0.50	0.43	22.36
5-10	0.67	2.46	4.33	8.84	8.69	9.87	5.61	1.42	1.55	1.25	0.80	1.40	1.12	0.47	0.34	0.54	49.37
10-15	0.02	1.06	4.92	8.90	2.31	2.31	0.86	0.17	0.37	0.47	0.32	0.28	0.17	0.06	0.02	0.02	22.27
15-20	-	0.19	2.24	2.29	0.22	0.26	0.06	0.06	-	0.02	0.06	0.04	0.09	0.02	-	-	5.56
20-25	-	-	0.13	0.15	0.02	0.04	-	-	-	-	-	-	-	-	-	-	0.34
25-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00
Total	1.25	4.46	12.38	21.82	13.82	16.95	10.95	3.28	2.91	2.70	1.96	2.31	1.98	1.29	0.86	0.99	99.91

Calm 0.09

Figure 1.2.1.3 Annual Wind Characteristics (1995-1996)

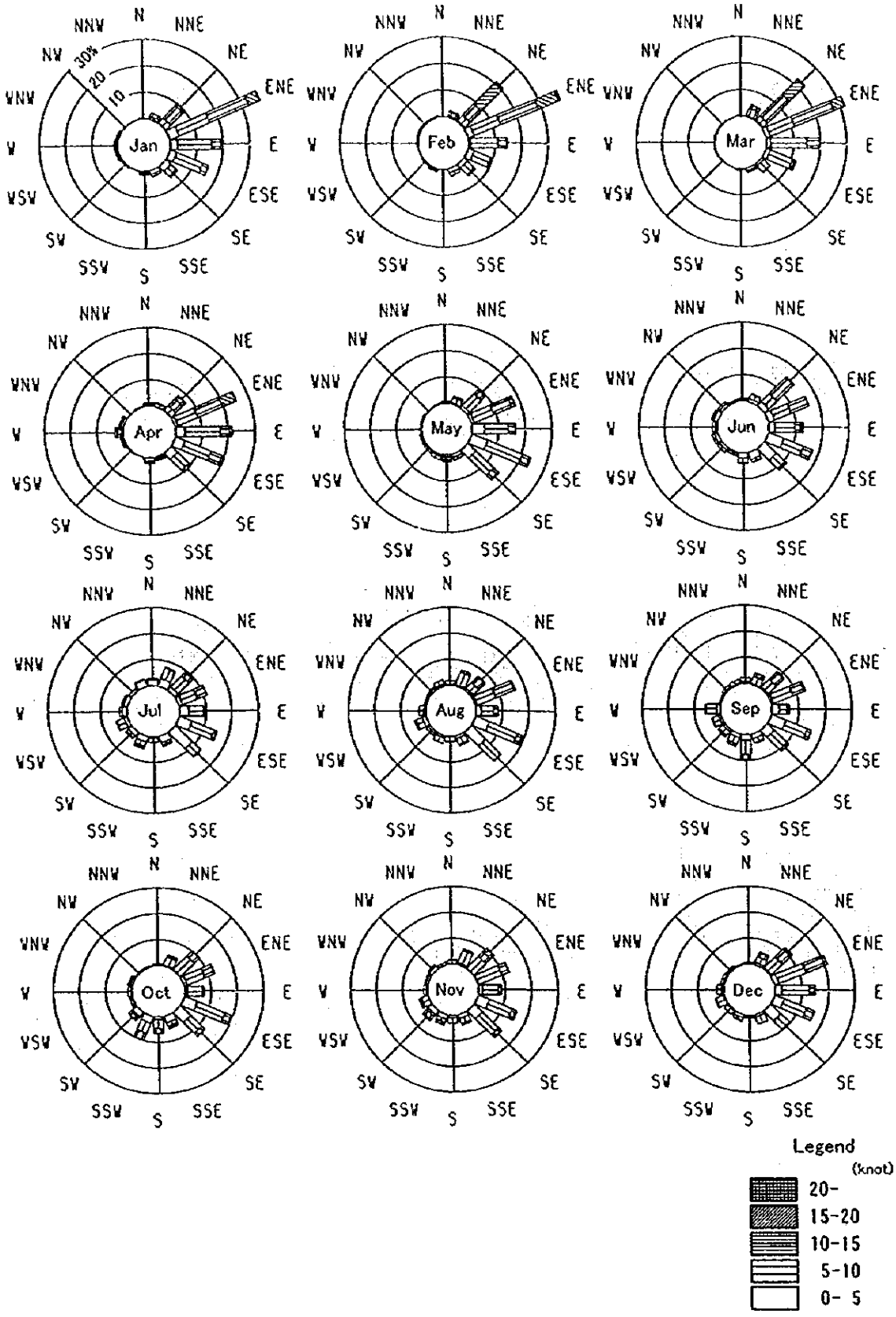
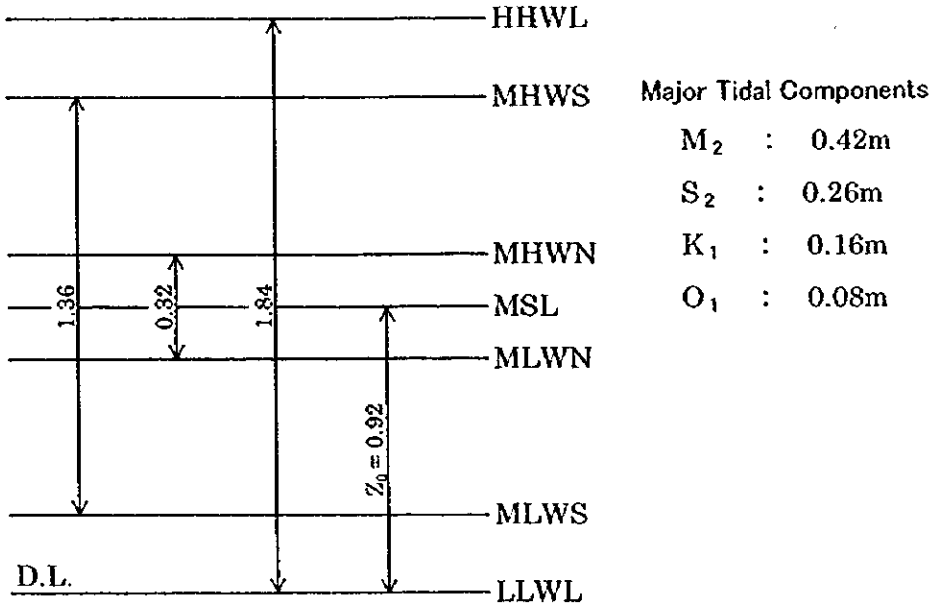


Figure 1.2.1.4 Monthly Wind Characteristics (1995-1996)

(2) Sea Conditions

1) Tide

The datum sea level, the mean highest and lowest sea level during spring and neap tides are shown in Figure 1.2.1.5 according to "Admiralty Tide Table Vol. 2", the UK Hydrographic Office. These data can be considered appropriate by referring the tide observation survey undertaken by the mission.



(Resource: Admiralty Tide Table Vol.2)

Figure 1.2.1.5 Tide Condition in Okat Port

2) Waves

There are no observation facilities to measure the waves adjacent to Okat Port and thus no data are available in this respect. Presuming from the data on wind observation records at the site, it seems that there are not so severe waves attacking on Kosrae Island. According to the interview of the staff of the Kosrae Meteorological Station, the biggest waves experienced recently are generated by typhoon "Axel" which attacked the island in January, 1992. The lighted buoys installed at the port entrance were drifted away by severe waves.

Based on the wind data recorded at the Kosrae Meteorological Station, the wind growth and decay pattern is modeled in order to estimate the waves by the SMB Method. Consequently, the biggest waves generated by typhoon "Axel" is hindcasted as following features.

Wave Height ($H_{1/3}$) : 3.8m
Wave Period ($T_{1/3}$) : 7.2 s

The wave agitation analysis in the port basin was also carried out with respect of the above-mentioned wave. The simulation results of the wave height distribution by the wave induced from NE direction are shown in Figure 1.2.1.6. On this basis, it was found that the calmness of water surface within the port as well as the quay front are not very high even when the waves induced from the NE of severe wave direction for Okat Port. This indicates that Okat Port is a naturally good port, particularly well protected by coral reefs from intruding waves.

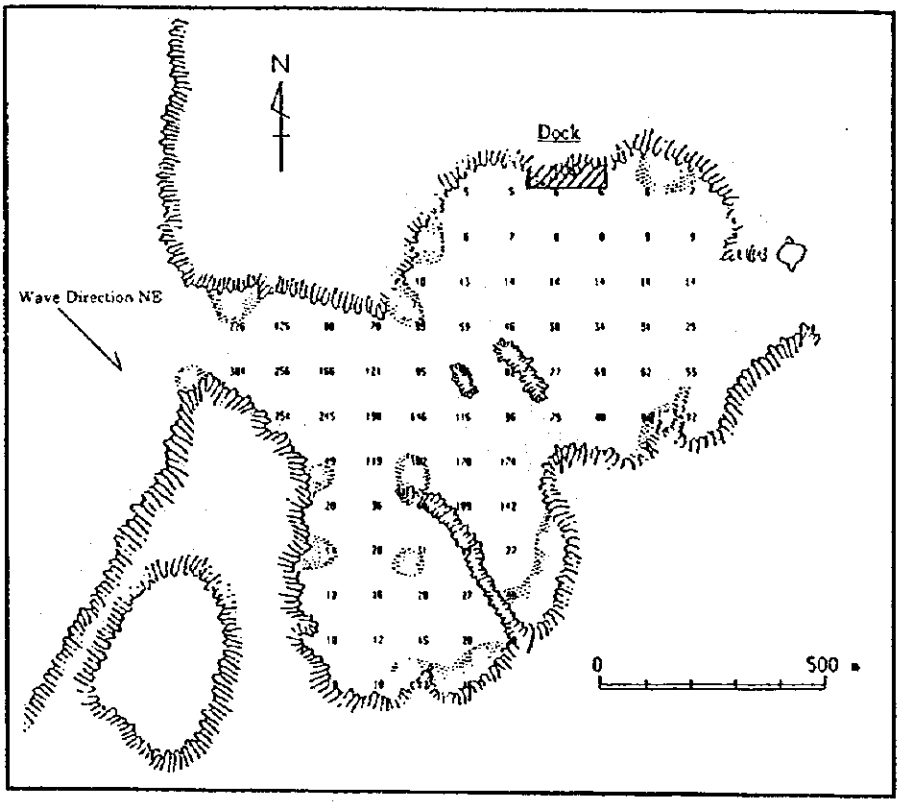


Figure 1.2.1.6 Results of the Wave Agitation in Okat Port

3) Tidal Current

Tidal current observation surveys were carried out at 6 points during the spring tide when the maximum current velocity appears. The survey results are shown in Table 1.2.1.5 and Figure 1.2.1.7. The current directions in Okat Port between the ebb and flood tide periods do not vary so much. It can be said that currents outgoing to open sea are prevailing. The current velocity is very low, being 0.07 m/s at maximum.

Table 1.2.1.5 Tidal Current Observation Results

	Flood Tide		Ebb Tide	
Point	Velocity (m/s)	Direction	Velocity (m/s)	Direction
①	0.05 m/s	W	0.05 m/s	NNE
②	0.06 m/s	WSW	0.04 m/s	W
③	0.07 m/s	SNS	0.03 m/s	WSW
④	0.04 m/s	WSW	0.03 m/s	W
⑤	0.07 m/s	NW	0.02 m/s	WNW
⑥	0.02 m/s	WSW	0.03 m/s	SW

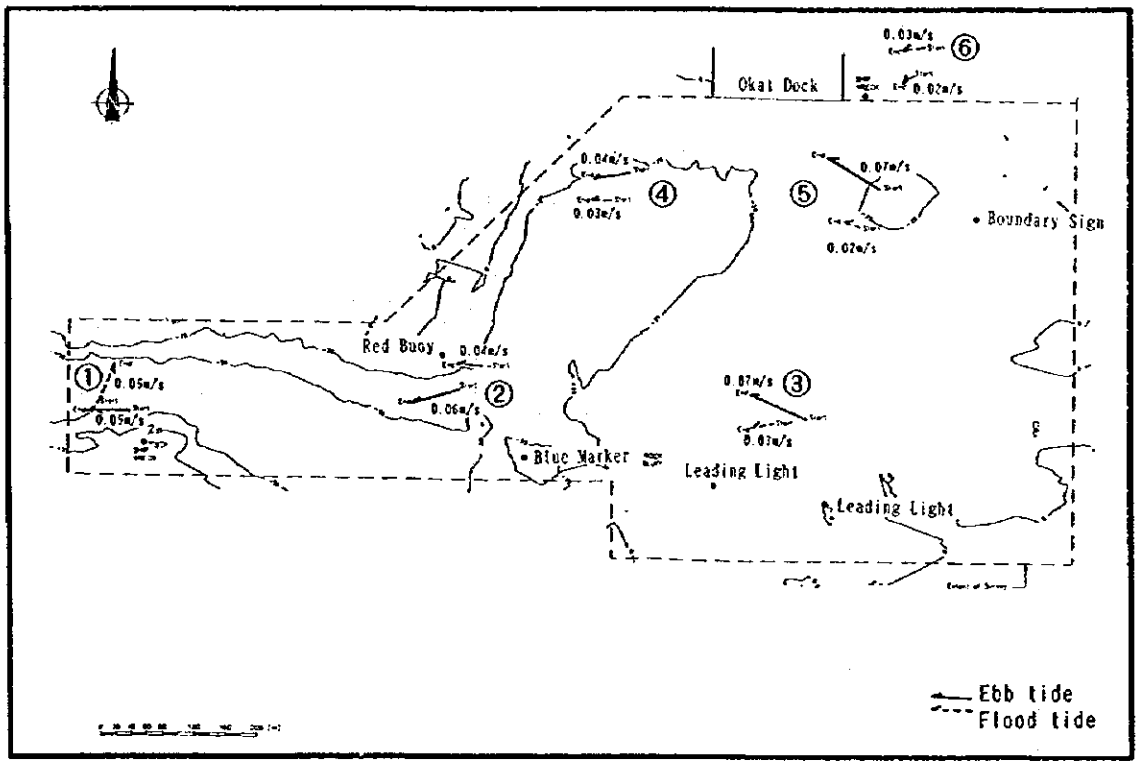


Figure 1.2.1.7 Tidal Current Observation Results

(3) Bathymetric Condition

The existing sounding map and marine chart regarding the bathymetry in the port is very limited, only the marine chart published by the Government of Japan in 1920. In order to secure the navigation safety and also to determine the spots to set navigation aids such as lighted beacon buoys, sounding surveys were carried out for the turning basin as well as the access channel. In addition, the sea bed condition survey was carried out to grasp the local topographic change of the coral sea bed and the habitats and species of corals.

1) Sounding Survey

Figure 1.2.1.8 shows the bathymetry of the port area. In the vicinity of the port entrance and the access channel, the waterway is restricted by reef edge with a very steep slope and the water depth along the centerline measures over 50m. Because of a narrow width of the access channel and coral reef obstacles, careful ship manuevering is required to enter or leave the port.

2) Sea Bed Condition Survey

The sea bed materils in the area of the port entrance, access channel, turning basin and its vicinity consist of coral reefs. The bottom of the north area of the turning basin is covered by fine sand.

Table 1.2.1.6. shows the species of corals observed within the port. These corals were the ordinary species which can be widely observed in Kosrae and rare corals which require preservation were not detected.

Table 1.2.1.6 Coral Species Observed in Okat Port

Name	Water Depth
Milleporide	3 m
Heliopora	2 m
Carijoa	3 m
Pocillopora	4 m
Acropora	6 m
Montipora	6 m
Porites	3 m
Pavona	5 m
Lobophyllia	10 m

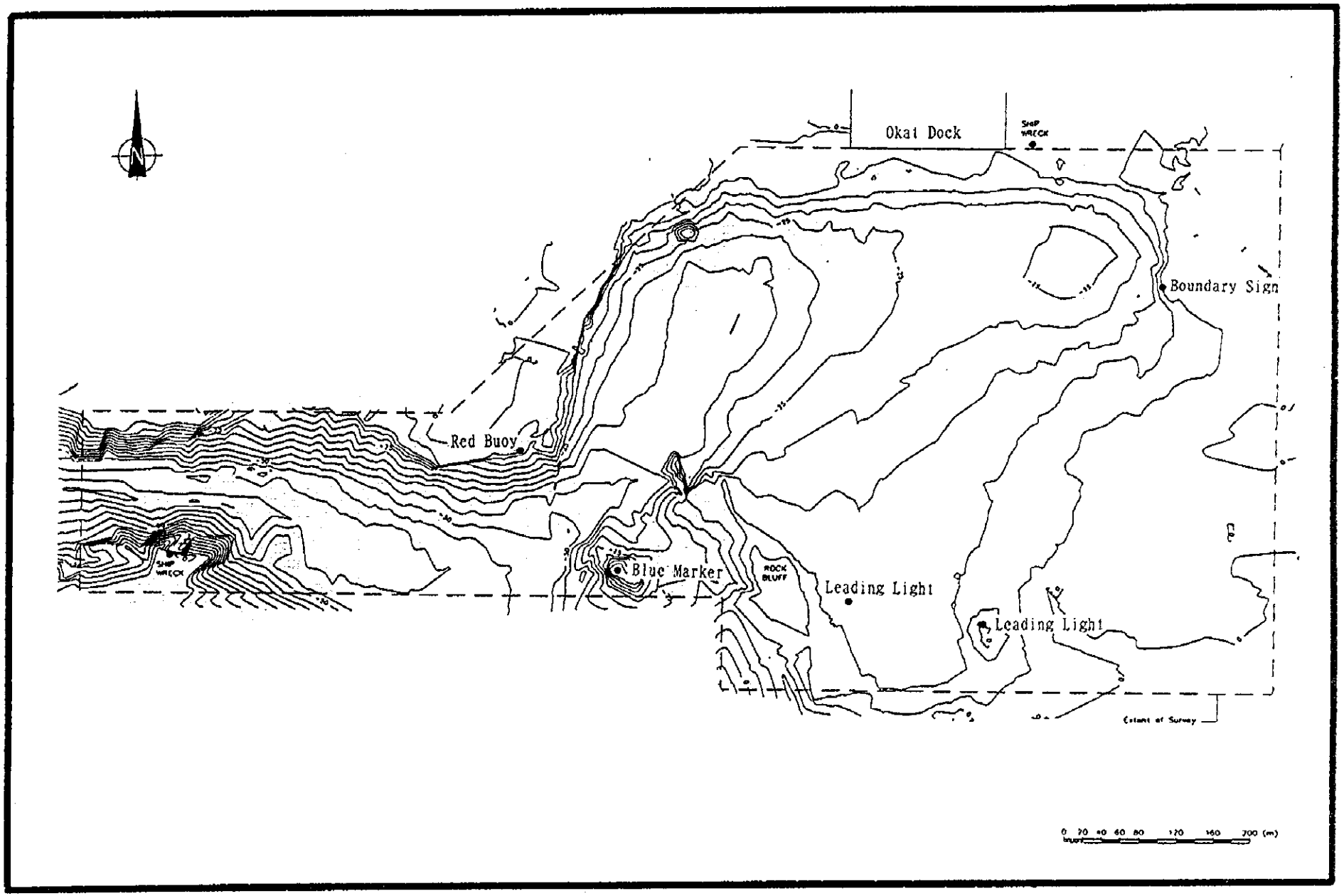


Figure 1.2.1.8 Bathymetry of Port Area

1.2.2 Existing Facilities and Equipment

(1) Port Facilities

Okat Port is equipped with the following facilities and equipment. The port area is surrounded by coral reefs, while it does not have protective facilities such as a breakwater. The layout of the port facilities is shown in Figures 1.2.2.1 and 1.2.2.2.

1) Waterway and Basin

The waterway and basin of Okat Port consist of the access channel of 91.4m (300ft.) width and of about 500m in length, and the turning basin of 457.2m (1500ft.) in diameter. Since coral reef obstacles exist between the access channel and the turning basin, entering ships can not go straight toward the turning basin. Incoming ship must change her direction at the point of the coral reef obstacles by 45 degrees to reach the quay.

The lighted buoy and marker which are presently existent are shown in Figure 1.2.2.3 and Table 1.2.2.1, consisting of a pair of leading lights, a blue light marker, a red temporary buoy and a boundery marker.

Table 1.2.2.1 Coordinates of Navigation Aids

	Coordinates		
Type	South-North	East-West	Water Depth
Red Buoy	591,383.4 N	273,106.5 E	DL – 5.1 m
Blue Marker	591,250.8 N	273,212.7 E	DL + 0.4 m
Fore Leading Light	591,216.7 N	273,465.5 E	DL -10.8 m
Aft. Leading Light	591,192.2 N	273,608.5 E	DL + 2.0 m
Boundary Marker	591,563.4 N	273,806.0 E	DL – 0.3 m

Coordinates System : World Geodetic System 1972 (W.G.S 72)

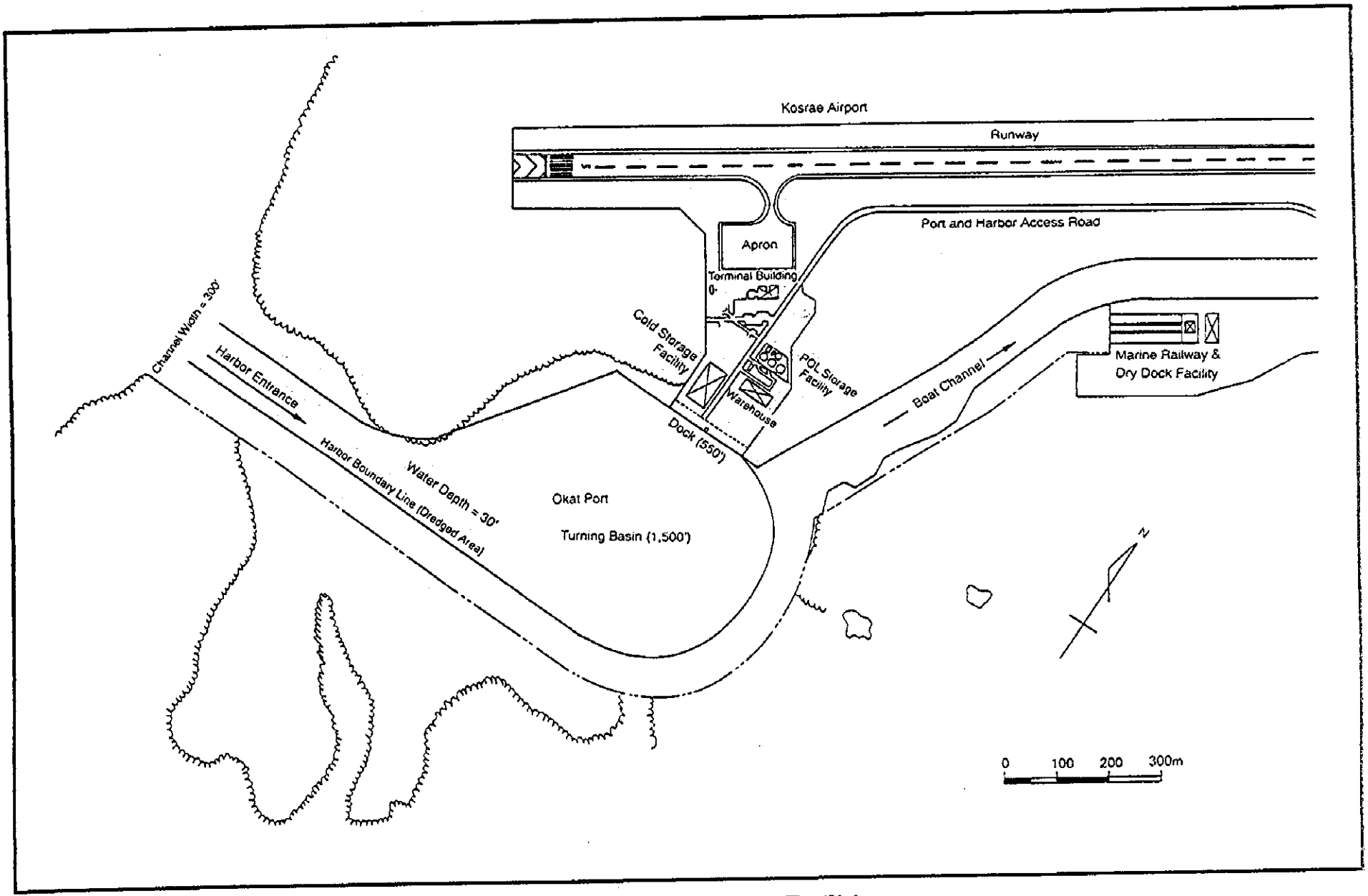


Figure 1.2.2.1 Layout of Port Facilities

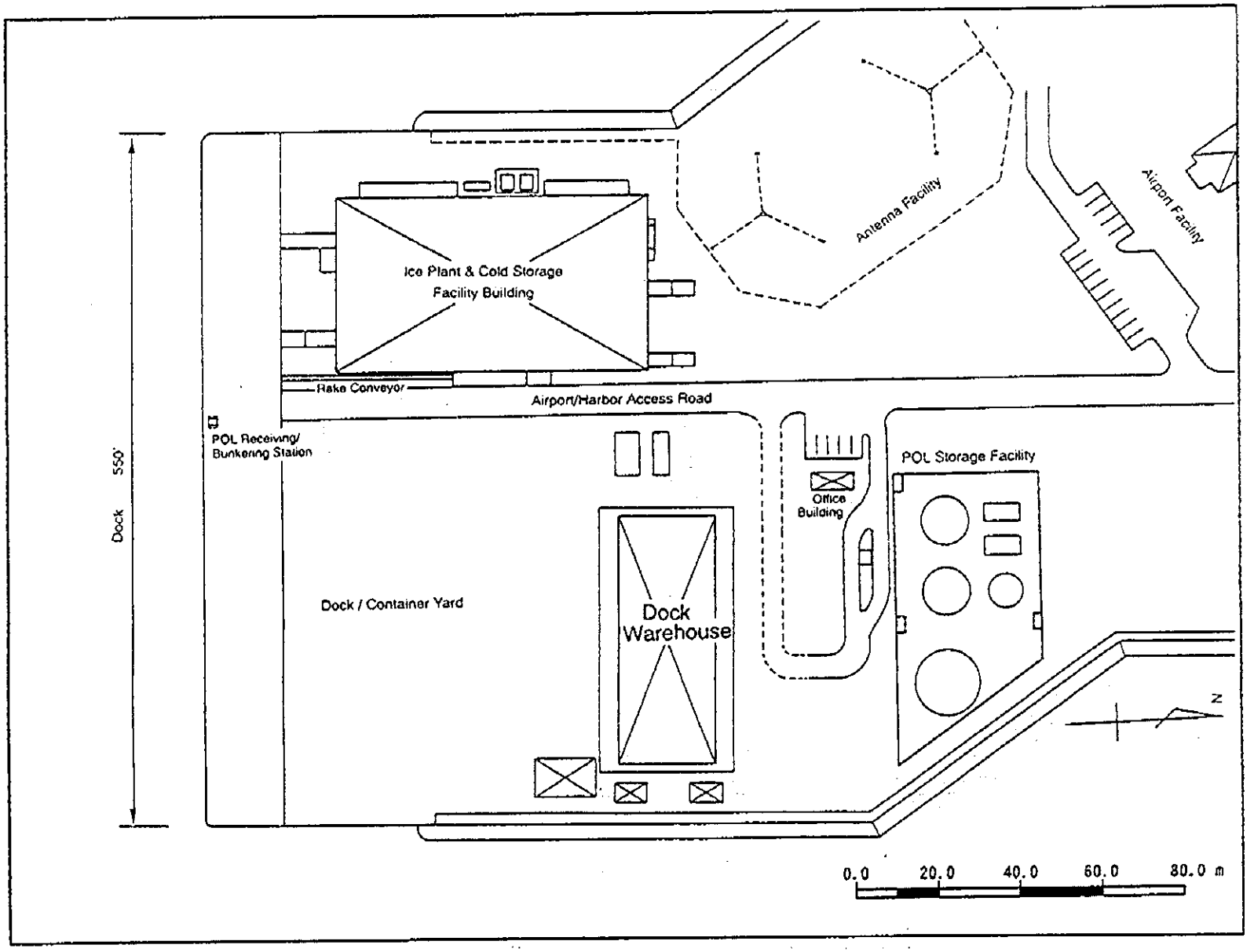


Figure 1.2.2.2 Layout of On-land Facilities

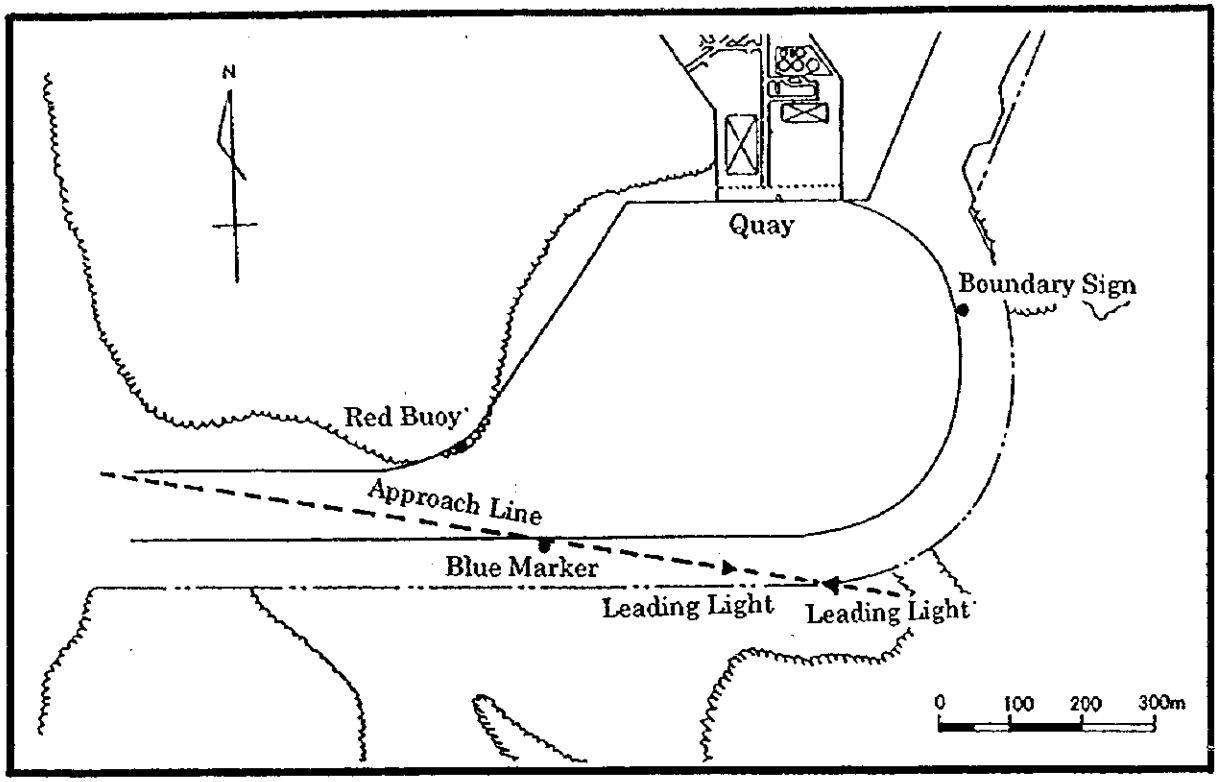


Figure 1.2.2.3 Location of Navigation Aids

2) Mooring Facilities

The mooring facilities were constructed by U.S. Navy in March, 1984 together with Kosrae Airport located in the north of the port. The structure of the quay is of steel sheet pile type with the specifications of 167.64m (550 ft.) in length and 9.14m (30 ft.) below MSL in water depth. Figure 1.2.2.4 shows the cross sectional view of the quay as well as the wooden fenders installed along the face line.

Quay Dimensions	: Length 167.64m (550ft)
	: Water Depth - 9.14m (30ft) below MSL
Type of Structure	: Steel Sheet Pile Type

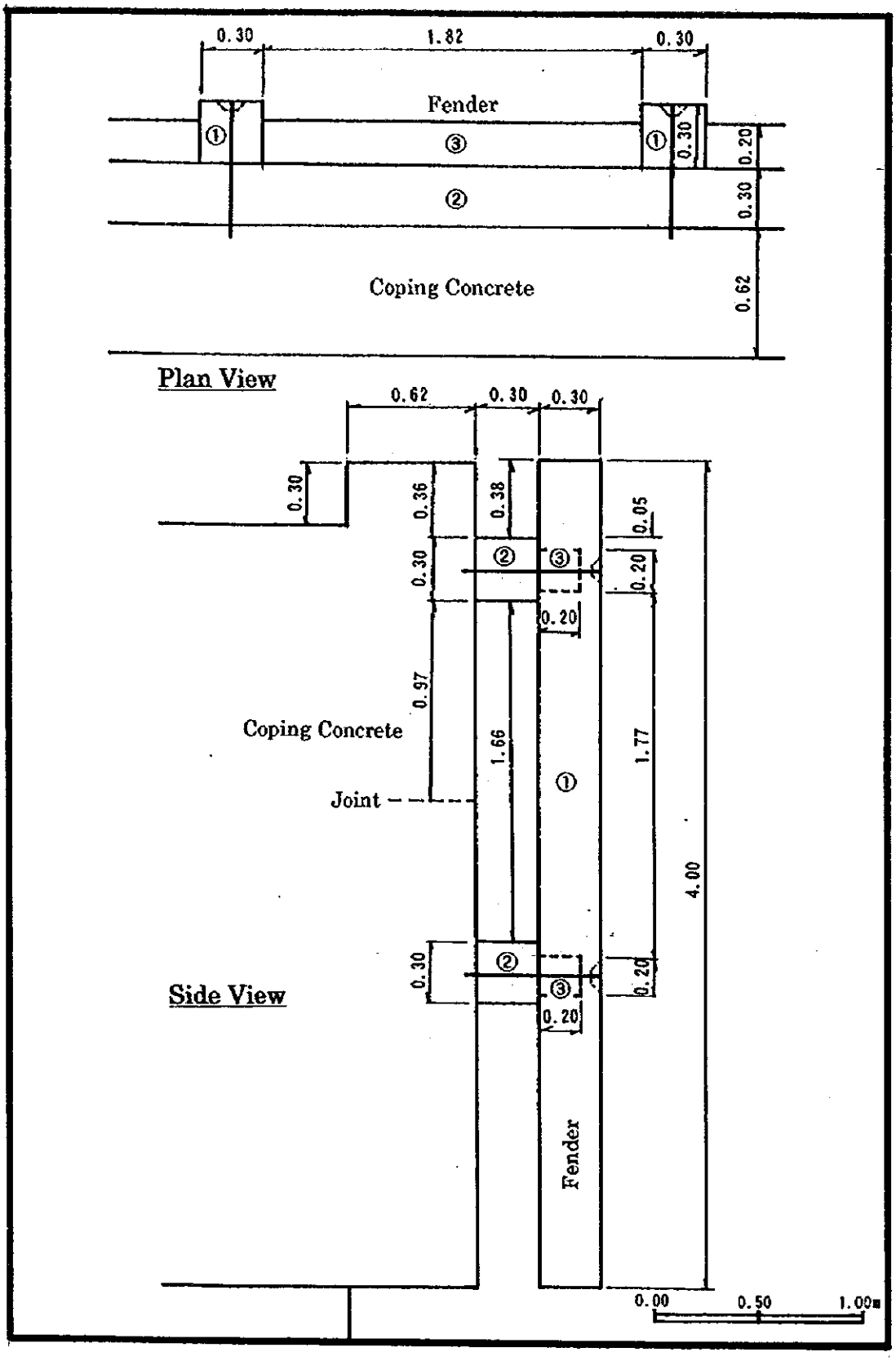


Figure 1.2.2.4 Cross Section of Existing Quay Wall

3) On-land Facilities

The on-land facilities include the shed, the container yard and the quay apron, which were constructed at the same time. Afterwards, the cold storage facility for marine products and the copra storage were built.

The container yard is outlined below.

- Total Area	: 13,800 m^2
- Quay Apron	: 18.8 m wide x 167.64 m long = 3,152 m^2
- Container Yards	: 77 m wide x 100 m long = 7,700 m^2
- Shed	: 46.1 m wide x 22.78 m long = 1049.7 m^2
- Copra Storage	: 9.0 m wide x 12.5 m long = 112.5 m^2
- Cargo Handling Equipment	: 26t, 3.5t and 2.5t forklifts

(2) Existing Condition of Fenders

The fenders installed along the quay are heavily damaged as they are made of wood. As shown in Figure 1.2.2.5, the fenders installed on the front face of the quay are completely destroyed. The fenders need to be replaced as soon as possible, since the steel bolts used to fix the fenders are exposed and tend to hurt the hull of the berthing ships.

(3) Existing Condition of Quay Concrete

The quay concrete can still be considered durable since no severe cracks were visually recognized. The strength of the quay concrete was measured to be more than 300kg/ m^2 according to the Schmidt Hammer Test, indicating that the quay concrete has the sufficient strength at present.

Existing Condition of Fenders

No.	Condition	No.	Condition	No.	Condition	No.	Condition	No.	Condition	No.	Condition
1	N	22	H	43	H	64	H&C	85	S	106	C&B
2	N	23	H	44	C	65	S	86	H	107	C&B
3	N	24	H	45	B	66	H&S	87	H	108	B&C
4	N	25	S	46	C	67	B	88	B	109	S&H
5	N	26	H	47	S	68	S&H	89	H	110	H
6	N	27	S	48	C	69	H	90	H	111	H
7	N	28	S	49	C	70	B	91	B&S	112	N
8	N	29	S	50	C	71	S	92	H	113	N
9	N	30	B	51	S	72	B	93	H	114	N
10	N	31	T	52	S	73	C	94	S&T	115	N
11	N	32	C	53	B	74	C	95	H	116	N
12	N	33	B	54	S	75	H	96	B	117	N
13	N	34	T	55	B	76	H&C	97	C&S	118	N
14	N	35	H	56	B	77	H	98	H	119	N
15	N	36	H	57	H&S	78	S&C	99	H	120	N
16	N	37	H	58	B	79	S&H	100	H&S	121	N
17	H	38	B	59	H&C	80	H&C	101	H	122	N
18	H	39	H	60	S	81	S&H	102	S	123	N
19	H	40	B	61	B	82	S&H&B	103	H	124	N
20	H	41	C	62	B&C	83	S	104	H	125	N
21	H	42	H	63	C	84	H	105	H		

Romarks: C: Complotely Damaged, T: Top Half Damaged, B: Bottom Half Damaged,
H: Head Damaged, S: Surface Abrasion, N: Functioned Low

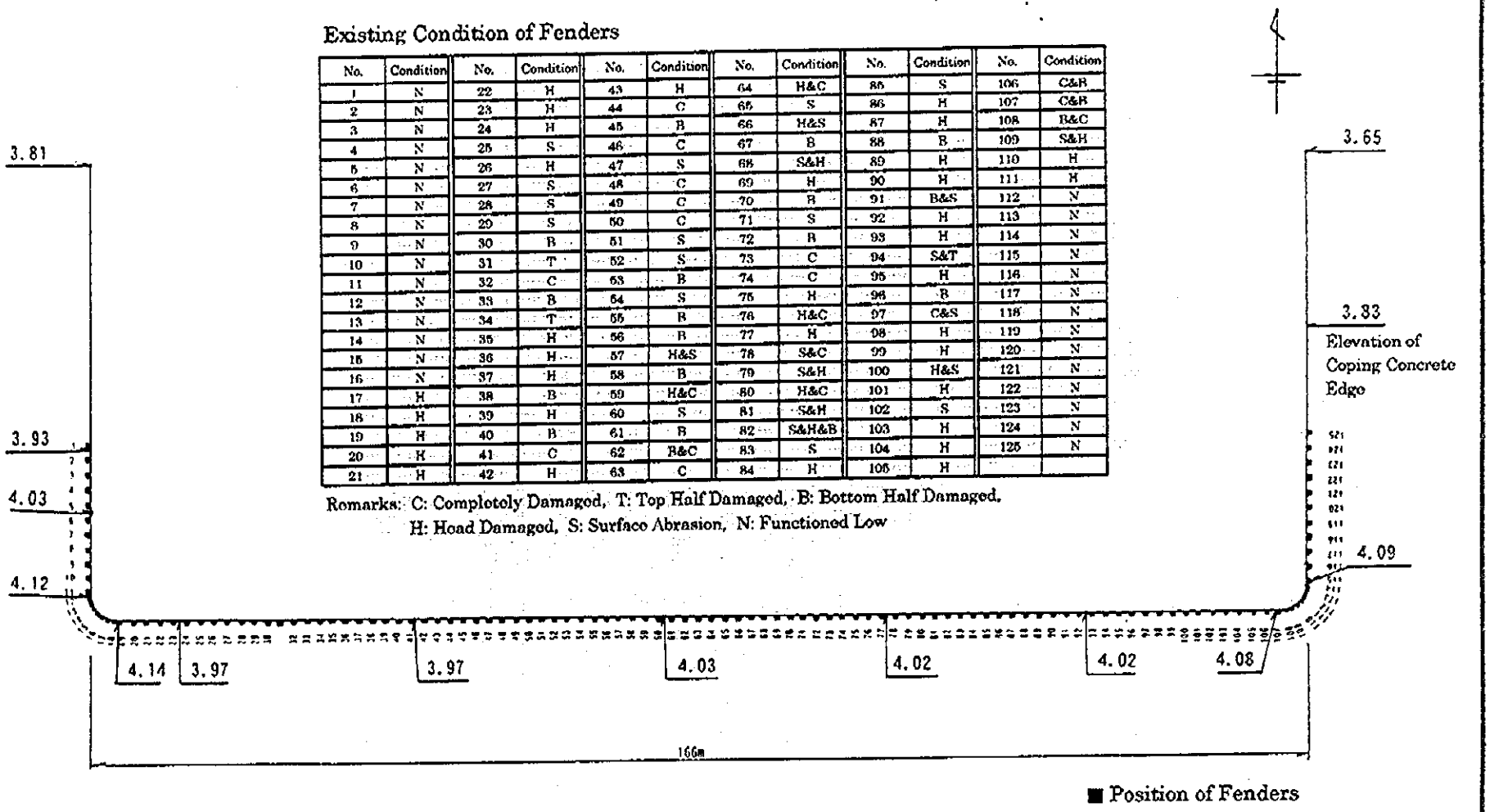


Figure 1.2.2.5 Existing Condition of Fenders

1.2.3 Port Activities

(1) Ships' Call

The annual ship calls to Okato Port are shown in Table 1.2.3.1, indicating that on an average call of large ships is twice a month. At present, PM&O Lines and Kyowa Shipping Co. operate a regular cruise to Okat Port. PM&O Lines operates the ocean liners which connects the West Coast of the US, the South Pacific and the Far East Asia. Three container ships with the capacity of 9,000 GRT operated by PM&O Lines visit Okat Port once every three weeks. Kyowa Shipping Co. operates two cargo ships of each 7,000 GRT, a Ro-Ro type, between the Far East Asia and the South Pacific and visit Okat Port once every two months.

- RM&O Lines

Ship Name:	Micronesian Nations
	Micronesian Navigator
	Micronesian Heritage
Frequency:	Every three weeks

- Kyowa Shipping Co.

Ship Name:	Asian Hibiscus
	Kyowa Violet
Frequency:	Every two months

During January to August in 1998 apart from these ocean liners, a variety of ships such as small cargo boats of 1,000 to 4,000 DWT, small tankers and patrol boats called at the port. In addition, 18 Chinese fishing boats of approx. 100 GRT use the port as fishing base and Japanese purse seiners of 1,000 GRT called at the port to change crew and to acquire supplies.

Table 1.2.3.1 Numbers of Ships Coming into Okat Port

Year	1993	1994	1995	1996	1997	Monthly Ave.
Cargo ship	28	27	17	25	23	2.0
Tanker	17	27	12	18	4	1.2
Fishing boat	112	737	912	223	235	37.0
Yacht	22	25	29	15	18	1.8
Total	179	808	970	281	280	42.0

Table 1.2.3.2 Voyage Route of Kyowa Shipping and PM&O line

Kyowa Shipping Co.

	Port	Transit Time
1	Busan	
2	Kobe	1 day
3	Nagoya	1 day
4	Yokohama	1 day
5	Saipan	5 days
6	Guam	1 day
7	Chuuk	3 days
8	Pohnpei	1 day
9	Kosrae	2 days
10	Busan	13 days

PM&O line

	Port	Transit Time
1	Portland	
2	Oakland	2 day
3	Los Angeles	1 day
4	Majuro	12 days
5	Ebeye	0 day
6	Kosrae	1 day
7	Pohnpei	1 day
8	Chuuk	1 day
9	Tinian	2 days
10	Saipan	0 day
11	Yap	2 days
12	Koror	1 day
13	Manila	3 days
14	Hong Kong	2 days
15	Keflun	1 day
16	Koror	3 days
17	Yap	1 day
18	Guam	1 day
19	Saipan	0 day
20	Pohnpei	3 days
21	Majuro	2 days
22	Tarawa	1 day
23	Honolulu	5 days
24	Portland	6 days

Table 1.2.3.3 Dimensions of Calling Ships

(January to October, 1998)

Type	Ship Name	GRT	DWT	LOA(m)	Depth(m)	Breadth(m)	Draft(m)
Liner Ship	PM&O lines						
	Micronesian Heritage	9,048	12,742	129.10	11.00	24.20	8.19
	Micronesian Nations	9,048	12,713	129.10	11.00	24.20	8.20
	Micronesian Navigator	9,048	12,742	129.10	11.00	24.20	8.20
	Kyowa Shipping Co., Ltd.						
	Asian Bridge	6,788	8,015	109.42	13.30	18.50	7.54
	Asian Hybiscus	7,170	8,004	117.92	7.35	18.80	8.19
	Kyowa Violet	7,337	8,038	117.97	13.10	19.20	7.35
Tanker	Micronesia Petroleum Company						
	Essberger Pioneer	1,616	----	----	----	----	----
	Micronesian Sunrise	1,063	----	70.10	4.60	11.60	4.17
	Pacific Star	3,795	6,015	107.90	8.20	16.00	7.01
	Golden Craig	4,409	----	----	----	----	6.89
Others							
	Olympus	12,413	9,360	152.94	13.60	22.20	8.00
	Caroline Voyager	1,335	401	53.00	7.00	11.00	----
	US Army MG Charles P. Gross	2,861	858	76.28	4.80	18.31	----
Fishing Boat	Long Liner						
	Hong Shnen Tsai	48	----	20.10	2.30	4.26	----
	YUE Yue Yuan Yu 195	125	----	31.50	2.98	6.00	----
	YUE Yue Yuan Yu 196	125	----	30.60	2.98	6.00	----
	YUE Yue Yuan Yu 197	114	----	31.50	2.98	6.00	----
	YUE Yue Yuan Yu 198	114	----	31.80	2.98	6.00	----
	YUE Yue Yuan Yu 603	101	----	23.89	2.65	5.92	----
	YUE Yue Yuan Yu 604	101	----	26.50	2.65	5.92	----
	YUE Yue Yuan Yu 607	119	----	32.00	2.90	5.90	----
	YUE Yue Yuan Yu 608	119	----	32.30	2.90	5.90	----
	YUE Yue Yuan Yu 621	98	----	31.40	2.90	5.74	----
	YUE Yue Yuan Yu 622	98	----	34.50	2.90	5.74	----
	YUE Yue Yuan Yu 625	99	----	31.50	2.90	5.90	----
	YUE Yue Yuan Yu 626	99	----	27.38	2.90	5.90	----
	YUE Yue Yuan Yu 627	99	----	30.20	2.90	5.90	----
	YUE Yue Yuan Yu 628	99	----	31.20	2.90	5.90	----
	YUE Yue Yuan Yu 660	116	----	26.00	3.30	6.50	----
	YUE Yue Yuan Yu 665	111	----	29.30	2.90	5.80	----
	YUE Yue Yuan Yu 666	111	----	28.50	2.90	5.90	----
	Purse Seiner						
	Eikyu Maru No.2	1,096	----	63.24	7.26	12.00	4.46
	Fukuichi Maru No.85	1,094	----	62.96	----	12.00	7.23
	M/V Chance No. 2	1,001	----	59.84	4.98	12.19	8.00
	Otoshiro Maru No.31	1,093	----	58.53	7.28	12.00	----
	Queen Mary	509	----	46.02	----	10.46	5.10
	Showa Maru No.85	349	----	----	----	----	----
	Taikei Maru No.1	349	----	----	----	----	----
	Ten Oh Maru No. 7	1,093	----	----	----	----	----
	Tokiwa Maru No.18	1,096	----	57.80	7.24	12.00	7.27
	Wakaba Maru No.2	1,096	----	----	----	----	----
	Wakaba Maru No.3	1,096	----	57.80	7.24	12.00	----
	Wakaba Maru No.6	1,096	----	----	----	----	----
	Wakaba Maru No.8	1,096	----	----	----	----	----
Yacht	Epicurus	8	----	----	13.60	22.20	8.00
	M/Y Desiance	9	----	----	----	----	----
	Qthmani	39	----	----	----	----	----

(2) Cargoe Handled

The amount of cargoes handled at Okat Port is shown in Table 1.2.3.4. It should be noted that most of the cargoes are imported and there were few cargoes exported. In recent years, the total amounts of bulk cargoes and container cargoes have ranged in the neighborhood of 10,000 tons per year.

Table 1.2.3.4 Imported Cargo Amount at Okat Port

(Revenue Tons)

Year	1993	1994	1995	1996	1997
Bulk cargo	3,011	1,087,324	5,172	4,958	5,563
Container cargo	19,808	412,353	9,035	9,231	10,308
Subtotal	22,819	1,499,682	14,207	248	482
Catches	Unknown	2,0630	1,947	248	482
Total	Unknown	1,501,745	16,154	14,437	16,353
Oil products	1,707,041	2,418,933	3,144,026	946,944	1,627,109

Unit of Oil: US gallon

(3) Related Enterprises at Okat Port

Port related firms are located in Okat Port, such as stevedoring company, petroleum company and fisheries companies. Besides, there is a dockyard situated in the vicinity of the port. The present status of these companies is described below.

1) Stevedoring Company : Kusaie Terminal & Stevedoring Co. (KT&SC)

This is the sole stevedoring company at Okat Port, which is responsible for stevedoring since the present port facilities were established. They are also engaged in the security service of the port area.

The company has only two small forklifts. And a large forklift for container handling is leased from the State Government. Likewise, the company uses the shed as well as the container yard under a lease from the State Government.

2) Petroleum Company: Micronesia Petroleum Company (MPC)

The company was established in November, 1997 and is based in Kosrae State. The company owns the oil storage facilities in the back of the port and provides calling ships with fuel and oil. The company has been active in commencing business in other states of Micronesia and the neighboring countries. The storage capacities are as follows:

- Diesel Oil :600,000 US Gallon,
- Jet Fuel :310,000 US Gallon,
- Gasoline :250,000 US Gallon.

2) Fishery Companies

One of the important functions of Okat Port concerns the landing of fresh tuna for export to Japan by air. The fresh tunas landed are sorted and packaged, and then transport to Guam by air for further shipment to Narita, Nagoya, Osaka and Fukuoka in Japan.

Fishery companies based at Okat Port are as follows:

- Pacific Tuna Industries, Inc. (PTI)

The PTI was established as the public corporation of Kosrae State and is leased the state government's cold storage facilities for fisheries products. They give a service in sorting and packaging the fresh tunas landed at Okat Port and transporting tunas to the airport. They provide fishing boats with ice and water as well. Fuel supply is consigned to MPC. Table 1.2.3.5 shows the amount of tunas dealt with by PTI during 1994 to 1998.

- Luen Thai Fishing Venture

The company based in Guam belongs to the Luen Thai Group which replaced Ting Hong Company in June 1997 to deal with the trade of fresh tunas at Okat Port. Luen Thai Fishing Venture operates Micronesia Fishing Venture, Inc. in Phonpei State and Belau Fishing Venture, Inc. in Palau in addition to Kosrae State.

The company undertakes providing fishing gears and baits for fishing boats based at Okat port as well as the shipment of fresh tuna by air to Japan including its marketing in the Japanese market.

- Pacific Fishing Venture, Inc.

This company was established under Luen Thai Fishing Venture in Kosrae State and is engaged in Chinese tuna long liners operating within 100 nautical miles from Kosrae Island.

- National Fisheries Corporation (NFC)

The company is based in Phonpei and deals with the shipment of fresh tuna landed at Okat Port to Guam.

4) Dockyard : Semo-Micronesia, Inc.

This is the ship repairing joint venture established by Kosrae State and the Semo Company of Korea. The company is now building a ship repair workshop with two slipways for 1,000 tons and 200 tons, respectively on the eastern part of Okat Port. The major part of the workshop has been completed and the inauguration ceremony was held on September 24, 1998. It is expected that the company will expand its activities to cover not only Kosrae State, but also other states and neighboring countries. Navigation buoys and mooring buoys included in the Project will be repaired by the workshop, when damaged or for maintenance.

Table 1.2.3.5 Fresh Tuna Handled at Okat Port

Month	1994				1995				1996				1997				1998			
		Port	Net Weight, Kgs			Port	Net Weight, Kgs			Port	Net Weight, Kgs			Port	Net Weight, Kgs			Port	Net Weight, Kgs	
	Flight	Calls	Export	Rejected	Flight	Calls	Export	Rejected	Flight	Calls	Export	Rejected	Flight	Calls	Export	Rejected	Flight	Calls	Export	Rejected
January	5	16	41,400	18,257	14	78	130,125	71,056	6	51	66,203	12,510	-	-	-	-	7	36	101,873	12,466
February	7	38	73,295	32,323	11	58	122,647	63,014	4	44	41,548	15,247	-	-	-	-	6	70	89,394	11,475
March	9	49	98,651	43,505	5	33	49,054	27,118	2	42	15,786	3,358	-	-	-	-	4	36	43,202	6,390
April	9	48	98,748	43,548	8	57	70,302	6,464	1	16	4,400	1,225	-	-	-	-	1	30	18,946	2,573
May	10	54	115,285	50,841	8	60	89,929	52,349	3	25	24,781	5,040	-	-	-	-	3	49	31,873	2,851
June	9	52	93,844	44,882	14	97	171,663	121,004	2	22	22,515	9,324	3	14	35,020	4,755	4	35	42,022	1,641
July	18	81	201,928	141,415	18	115	216,718	114,205	2	23	21,660	4,089	9	55	124,841	16,972	3	34	31,759	884
August	15	101	176,136	69,076	10	105	112,621	57,839	-	-	-	-	6	46	71,021	5,485	2	18	28,878	7,151
September	13	89	155,449	44,294	13	111	146,105	103,969	-	-	-	-	3	31	36,677	1,566	2	20	28,511	4,979
October	13	68	135,973	47,128	6	80	75,240	31,304	-	-	-	-	3	32	46,634	5,228	-	-	-	-
November	16	60	151,722	61,326	4	49	39,792	15,240	-	-	-	-	5	32	71,911	8,057	-	-	-	-
December	8	81	89,502	34,439	5	49	49,254	10,081	-	-	-	-	4	27	48,013	6,295	-	-	-	-
Total	132	737	1,431,933	631,034	116	892	1,273,450	673,643	20	223	196,893	50,793	33	237	434,117	48,358	32	328	416,458	50,410

(4) Traffic Condition Survey

1) Ship Traffic Survey

The survey was carried out for traffic conditions within Okat Port for 29 days from September 19 to October 17 in 1998. The number of incoming and outgoing ships are summarized in Table 2.4.6.6. The daily movements of mooring cargo ships and fishing boats are shown in Appendix 6.

As for large ships, the container ship of PM&O Lines and the Ro-Ro ship of Kyowa Shipping Co. visited the port during the survey period. The former has frequently called the port and the captain and crew are well experienced in maneuvering within Okat Port. Thus, the captain can enter and leave the port in his discretion, while those of the Ro-Ro ship observed during field survey are not able to do so due to no experience to enter the port. In this case, they have to enter or leave the port with a pilotage service. Figures 1.2.3.1, 1.2.3.2 illustrate the change of positions of fishing boats when a large ship enters the port. The port was busy with landing tunas on the previous day when Ro-Ro vessel berthed the quay. The Figure shows that the quay is kept clear, in spite of the busy movement of fishing boats before the entry of large cargo ship.

Table 1.2.3.6 Ship Arrival and Departure Records (1998)

Month	Day		Number of Ships														
			Cargo Ship			Fishing Boat			Patrol Boat			Others			Total		
			In	Out	Stay	In	Out	Stay	In	Out	Stay	In	Out	Stay	In	Out	Stay
Sept.	19	Sat						12							0	0	12
	20	Sun				2	3	11							2	3	11
	21	Mon				2	2	11	1		1				3	2	12
	22	Tue				2	1	10			1				2	1	11
	23	Wed					6	4		1					0	7	4
	24	Thu				1	2	3							1	2	3
	25	Fri						3	2		2				2	0	5
	26	Sat				2	2	3			2				2	2	5
	27	Sun				2	3	2			2				2	3	4
	28	Mon						2		2					0	2	2
	29	Tue				4	1	5							4	1	5
	30	Wed						5							0	0	5
Oct.	1	Thu				1	1	5							1	1	5
	2	Fri	1	1		1	1	5							2	2	5
	3	Sat				4	1	8							4	1	8
	4	Sun				0	0	8							0	0	8
	5	Mon				4	2	10							4	2	10
	6	Tue				0	0	10							0	0	10
	7	Wed				0	4	6							0	4	6
	8	Thu				0	4	2							0	4	2
	9	Fri				0	0	2							0	0	2
	10	Sat				0	0	2							0	0	2
	11	Sun				0	0	2							0	0	2
	12	Mon				0	0	2							0	0	2
	13	Tue				1	0	3							1	0	3
	14	Wed				4	0	7							4	0	7
	15	Thu				2	0	9							2	0	9
	16	Fri	1	1		5	0	4							6	1	4
	17	Sat				0	1	3							0	1	3

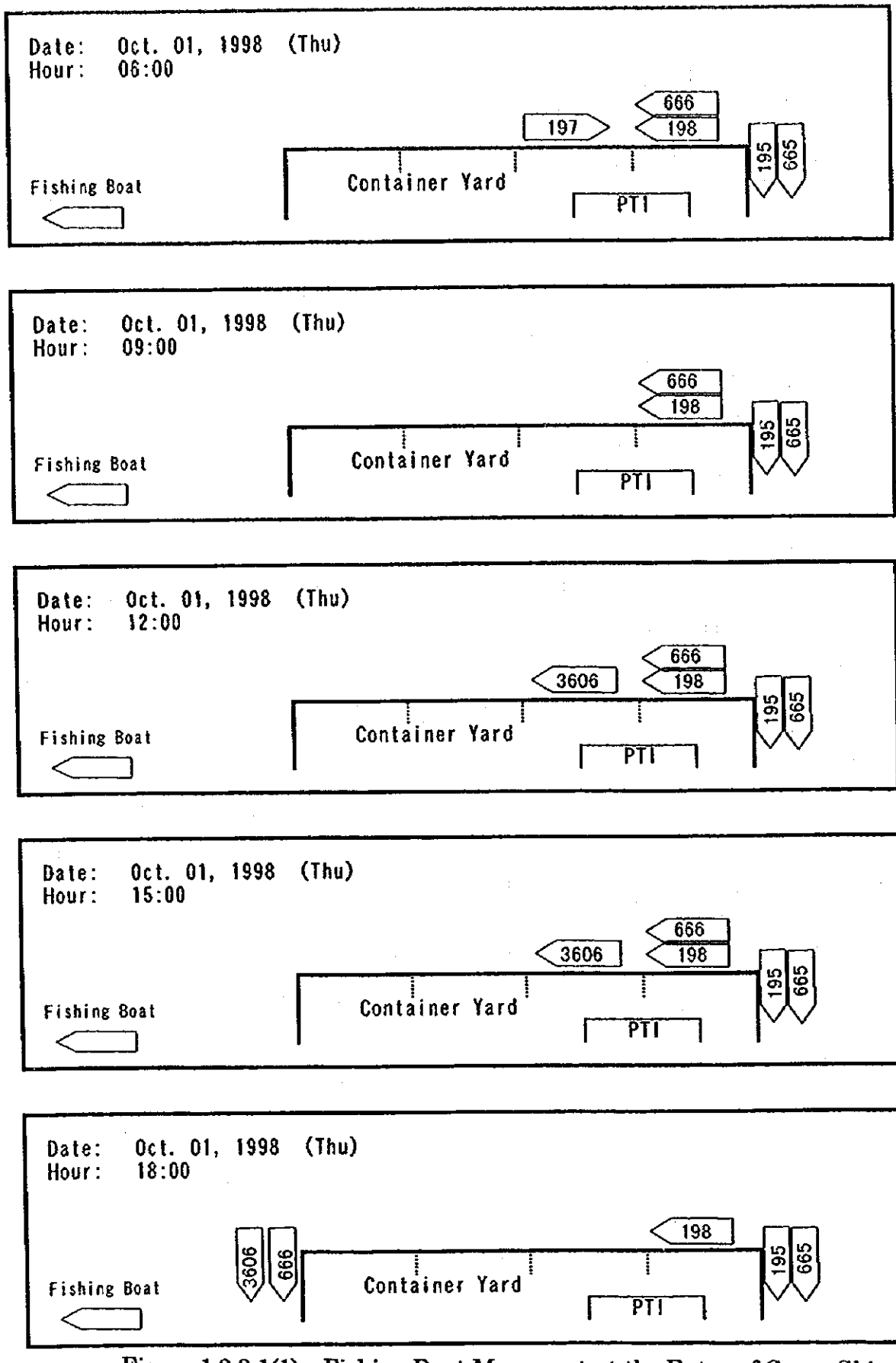


Figure 1.2.3.1(1) Fishing Boat Movement at the Entry of Cargo Ship

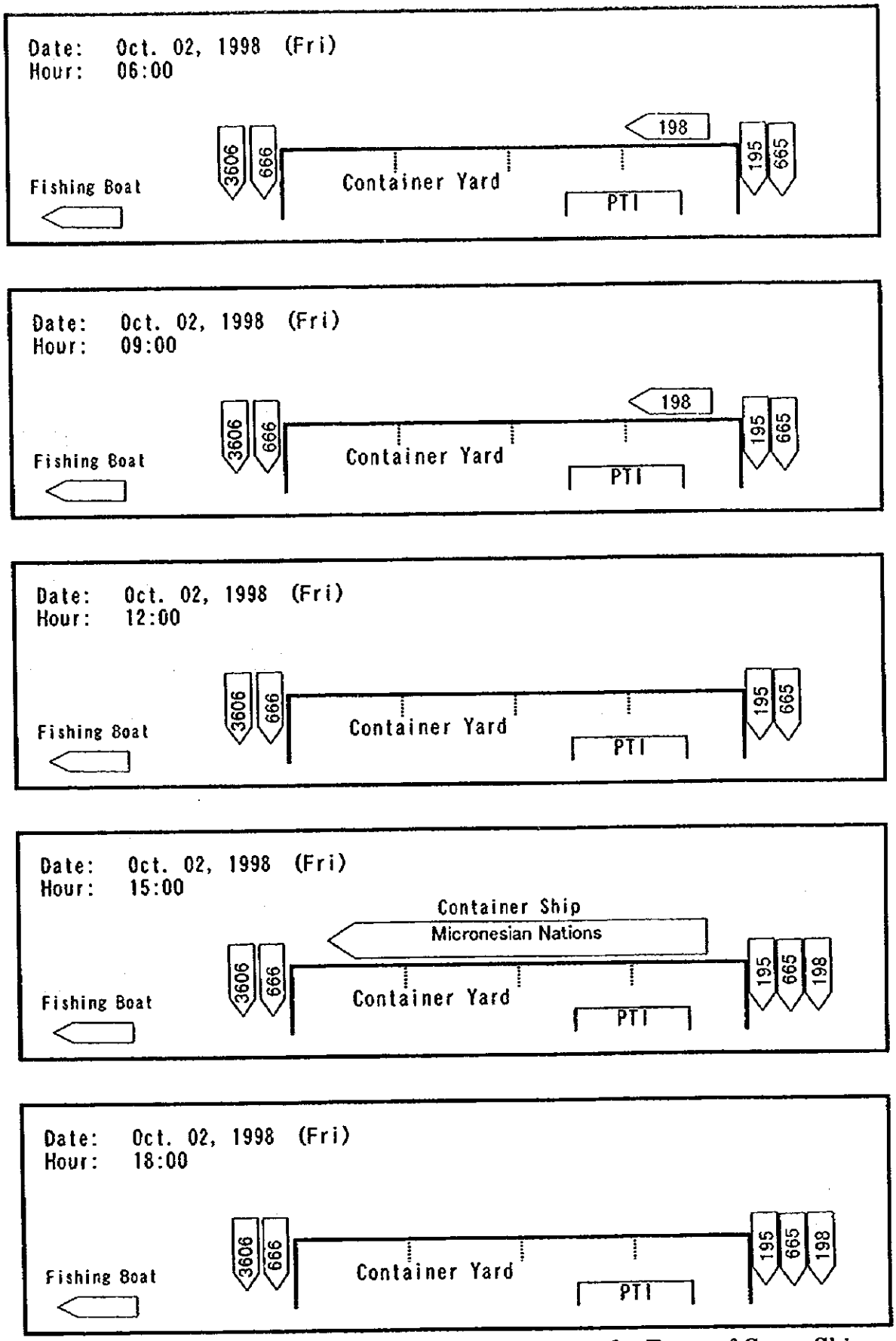


Figure 1.2.3.1(2) Fishing Boat Movement at the Entry of Cargo Ship

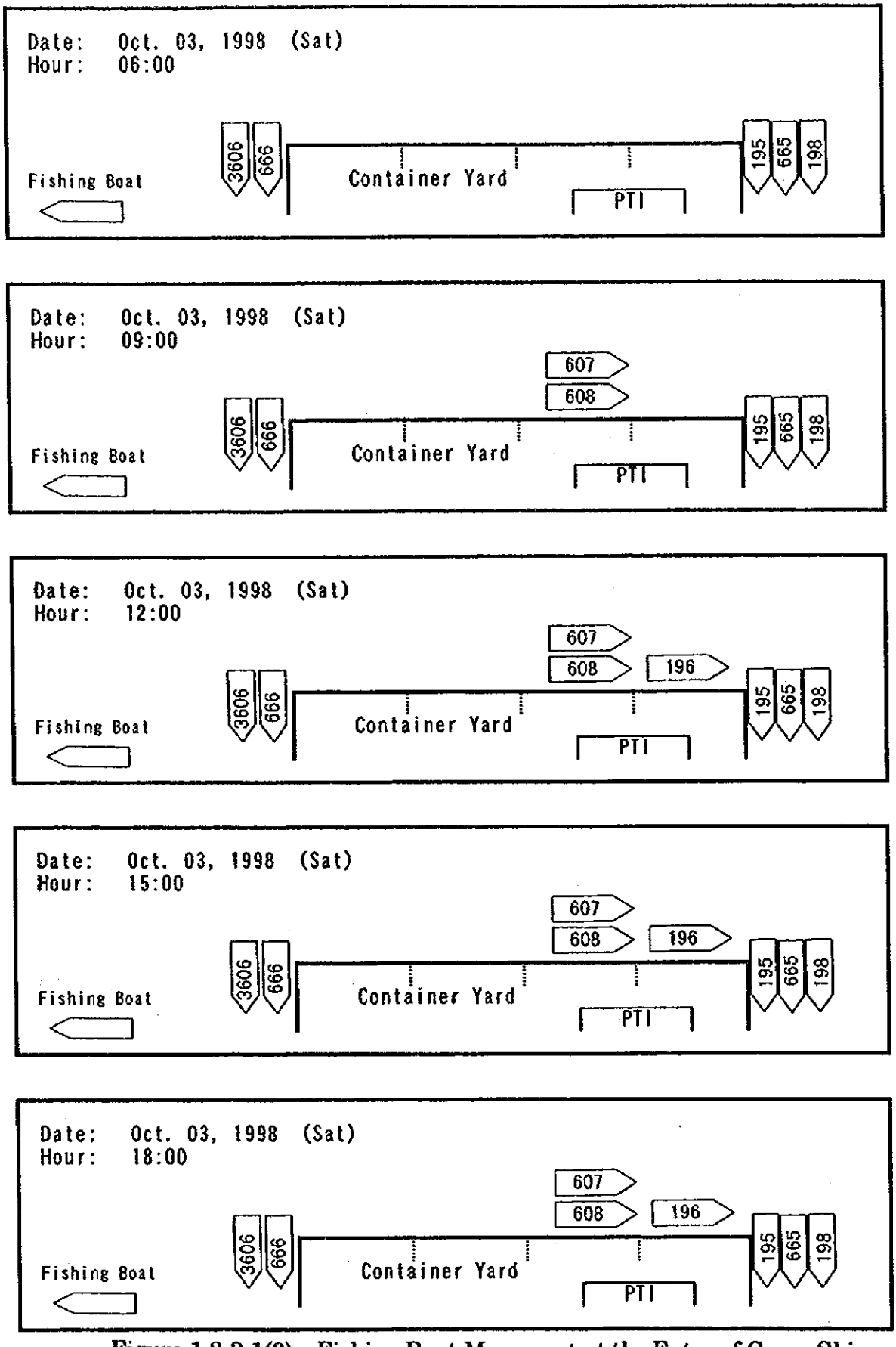


Figure 1.2.3.1(3) Fishing Boat Movement at the Entry of Cargo Ship

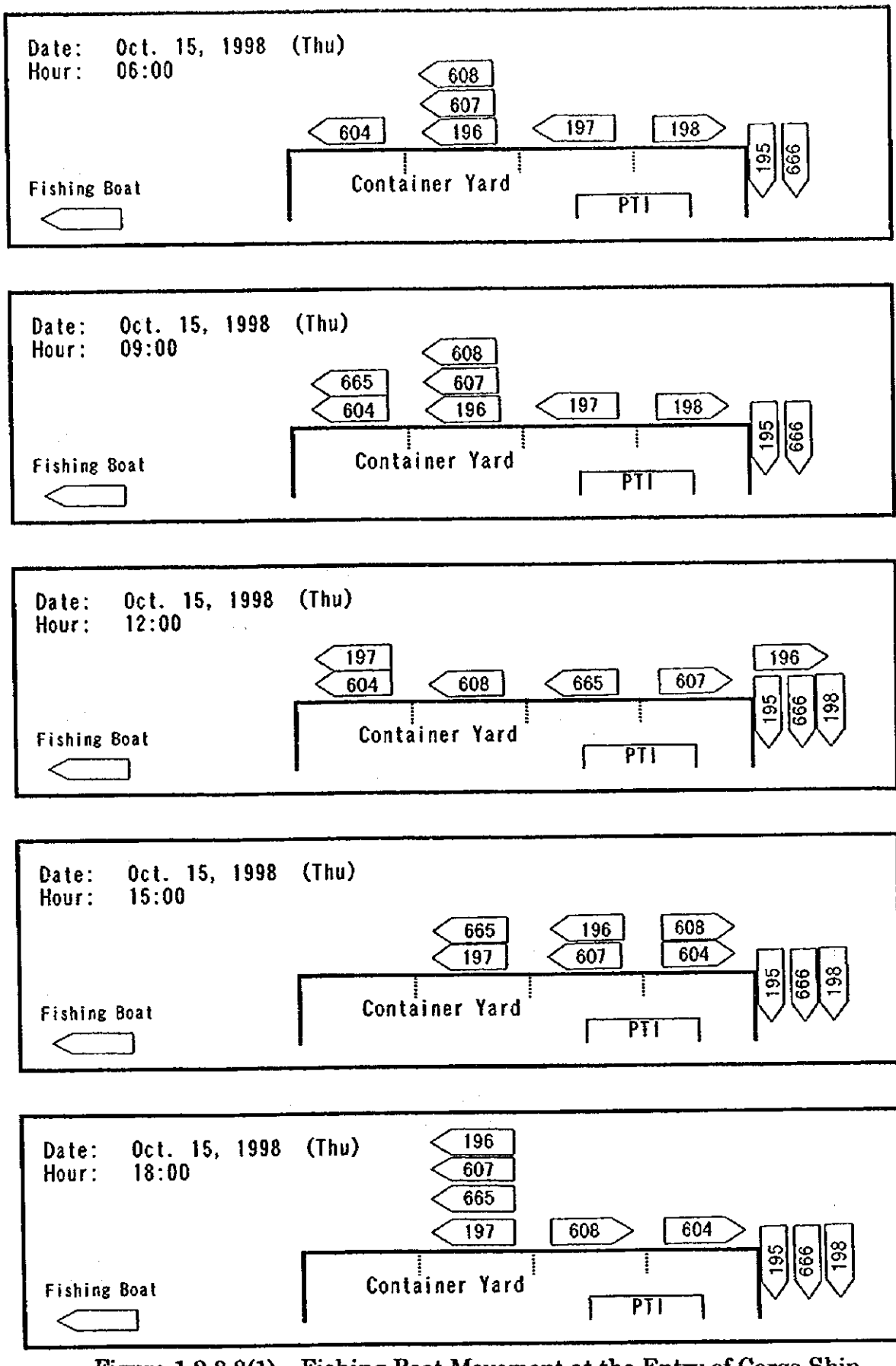


Figure 1.2.3.2(1) Fishing Boat Movement at the Entry of Cargo Ship

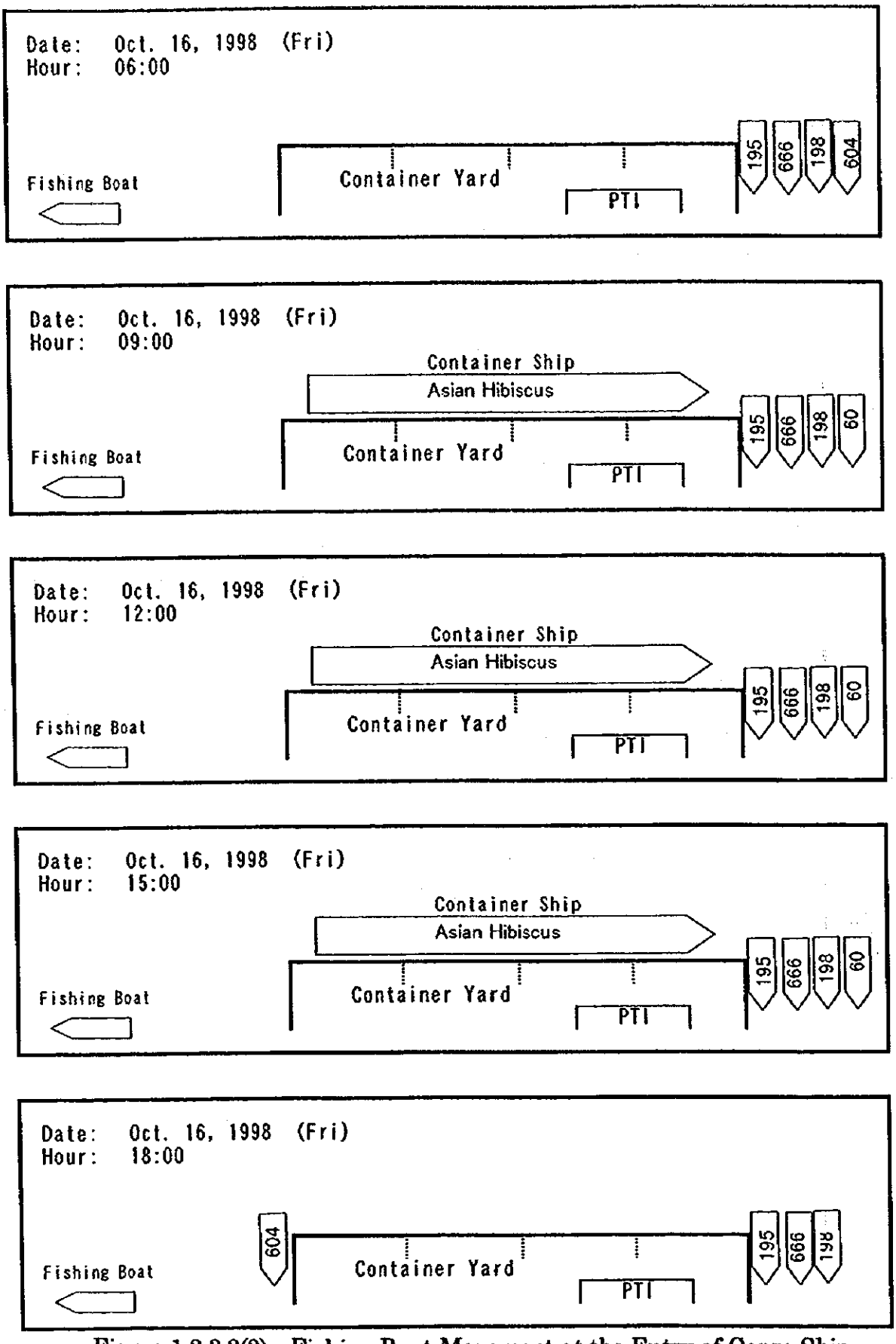


Figure 1.2.3.2(2) Fishing Boat Movement at the Entry of Cargo Ship

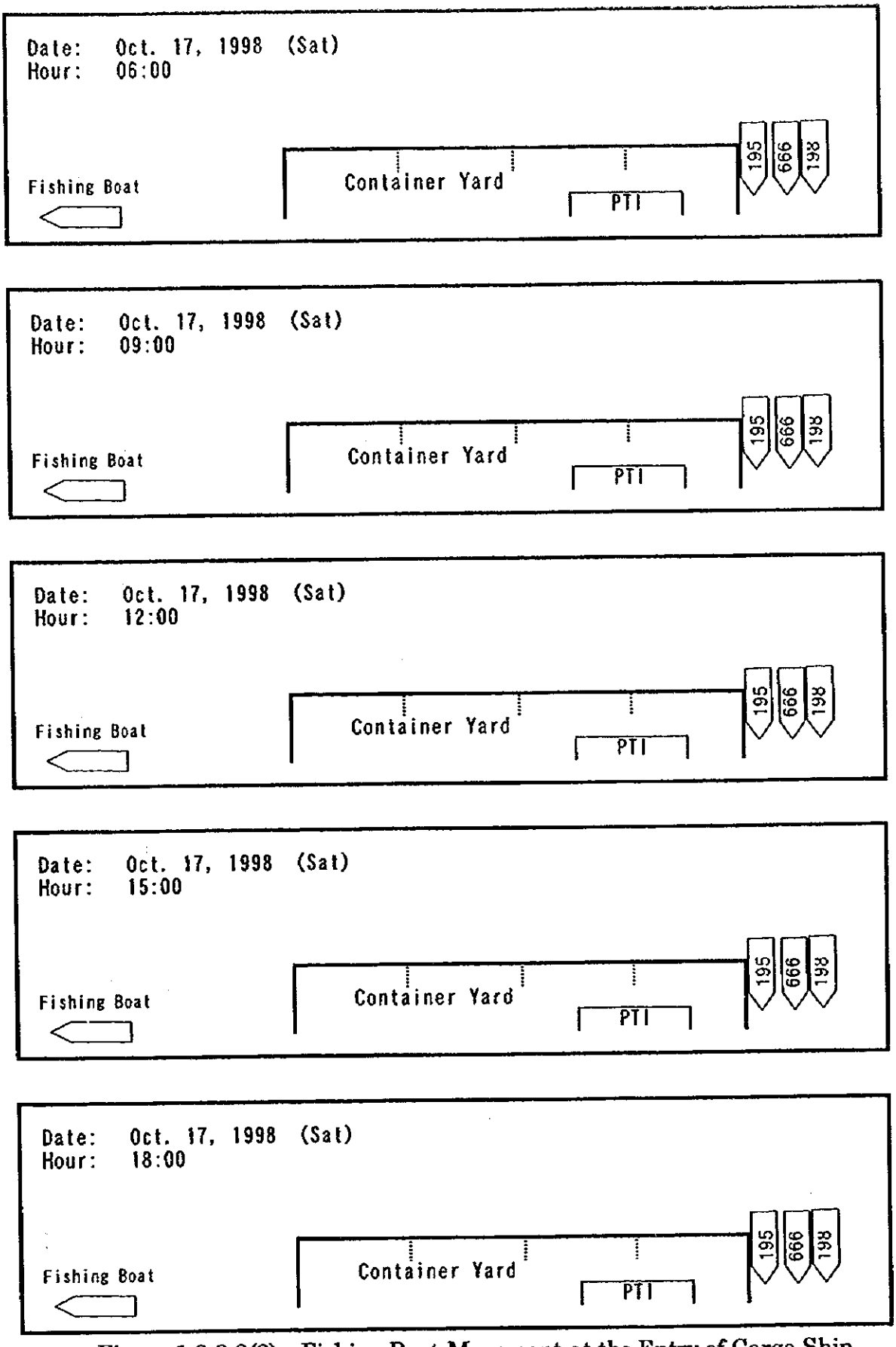


Figure 1.2.3.2(3) Fishing Boat Movement at the Entry of Cargo Ship

2) Approach Line of Cargo Ships

Figure 1.2.3.3 shows the approach line of large container ships of PM&O Lines and Kyowa Shipping Co. observed during the field survey. Figures 1.2.3.4 and 1.2.3.5 illustrate the movement of each vessel in the course of arrival, berthing and departure from the quay.

An on-board survey was carried out on Asian Hibiscus of Kyowa Shipping C. The outcome of the ship operation is as follows.

i) Pilot boarded the vessel at pilot point of one n. mile off the port.
ii) Entry direction was established by leading lights.
iii) Port entrance was ascertained by radar to enter access channel.
iv) Changed its direction by 45 degree beside the red buoy and proceed toward the quay.
v) Approached the quay with bow ahead and turn around to change the direction in front of the quay.
vi) When departing, the vessel set the course toward the veering point beside the red buoy.
vii)Vessel changed the direction beside the red buoy and proceed toward outside.

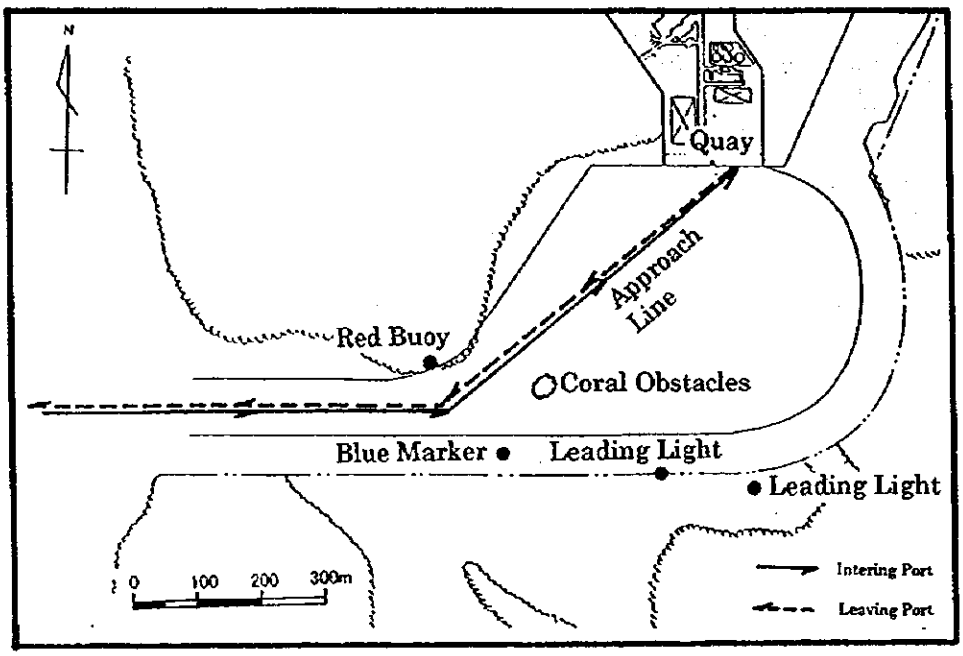
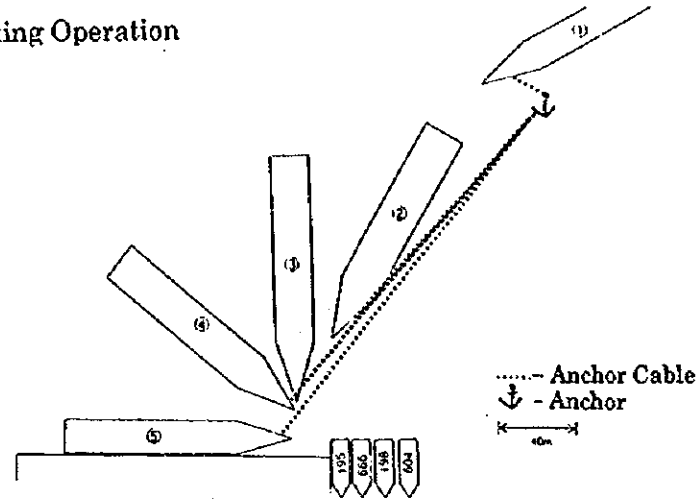
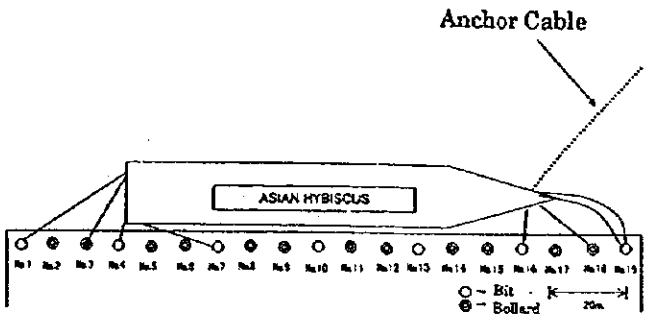


Figure 1.2.3.3 Approach Line of Cargo Ships

① Docking Operation



② Berthing Condition



③ Undocking Operation

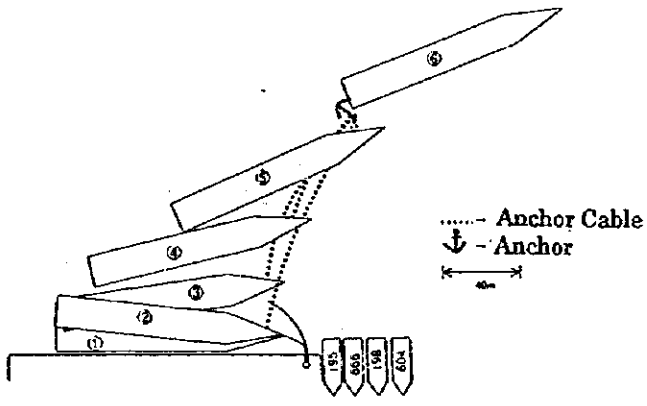


Figure 1.2.3.4 Docking and Undocking Operation (A. Hibiscus)

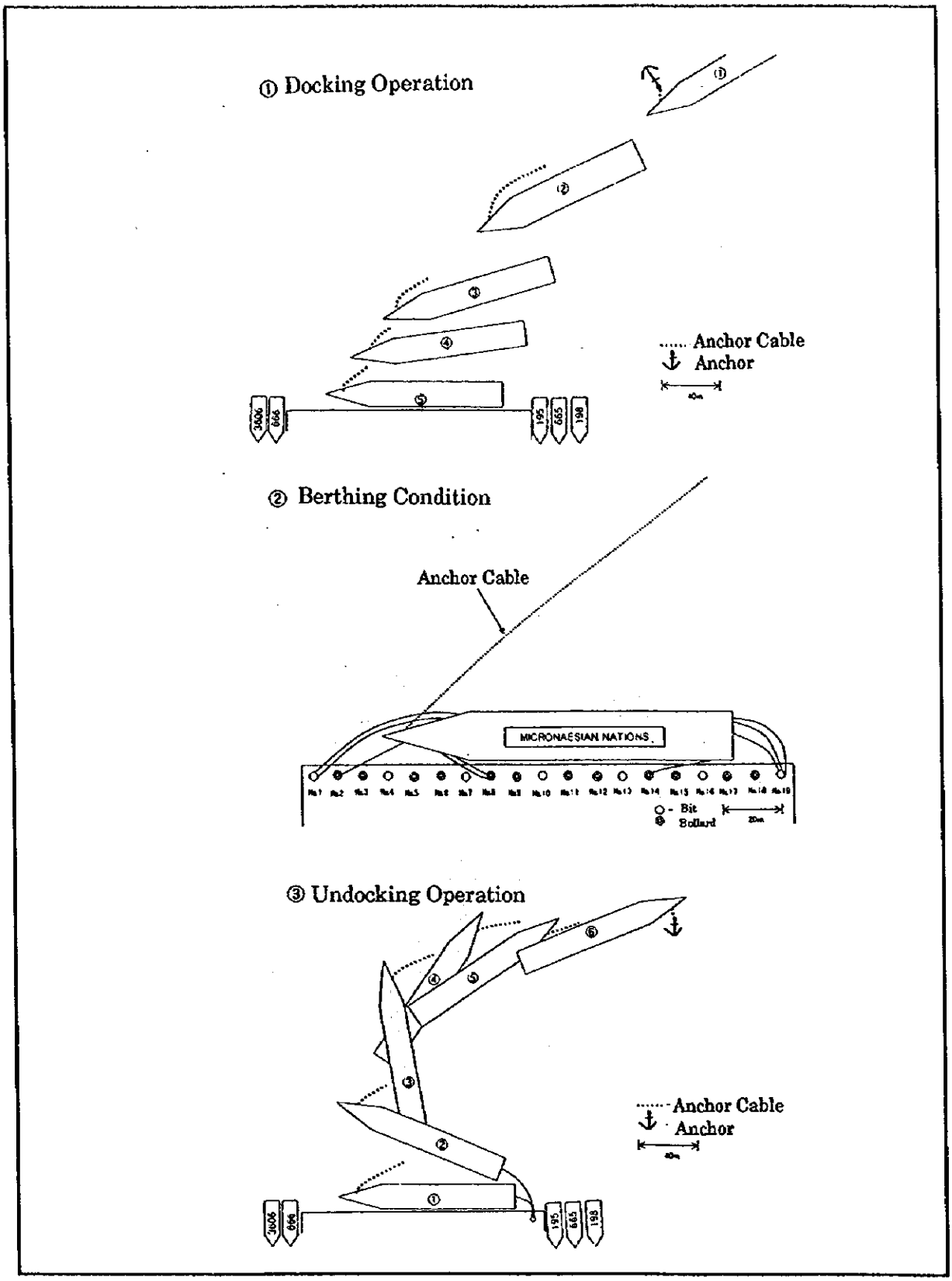


Figure 1.2.3.5 Docking and Undocking Operation (M. Nations)

3) Time Required from Arrival to Departure

The operational process of large cargo ship of Micronesian Nations from arrival to departure is as follows.

i) Entry to the port
ii) Docking the quay
iii) Stevedoring
iv) Undocking the quay
v) Outgoing from the port

The required time for the container ship of PM&O Lines to enter and depart from the port is shown in Table 1.2.3.7. A total time of 245 minutes (4 hrs. 5 min.) was required for the ship to complete the whole operation, during that time 28 laden containers unloaded and 25 empty containers loaded on the ship.

Table 1.2.3.7 Required Time of Container Ship Operation

Operation	Time spent (min.)
Entry to the port	7 min.
Approach to the quay	14 min.
Preparation	7 min.
Unloading containers	74 min.
Preparation	23 min
Loading containers	70 min.
Preparation	28 min
Leave the quay	17 min.
Departure	5 min.
Total	245 min.

(4) Existing Condition of Container Yard

1) Layout of Container Yard

The container yard is located in the center of the eastern side of Okat Port. As shown in Figure 1.2.3.6, there is a sufficient space between the quay apron and the shed. At present, the eastern side of the container yard is utilized for stocking empty containers, while the

laden containers are placed in the central part of the yard. The utilization rate of the container yard is considered about 30%.

2) Utilization of Container Yard

There were 33 of 20 foot containers and one 40 foot container stocked on the yard when the PM&O container ship arrived. It may be considered that about 30 to 40 containers always remain on the yard. The laden containers are placed in the area between the front side of the shed and along the port road. Cargoes are taken out of the containers and are delivered by trucks according to the needs until the next container ship arrival. This means that the container yard is used as a sort of the container freight station and the warehouse. On the other hand, empty containers are piled in two layers at the eastern part of the container yard.

The shed is used as a store room to keep bulk cargoes such as sucked cements, general cargoes and pallets as well as forklifts. The copra storage is no longer used now for keeping copra for export.

3) Cargo Handling Flow

Okat Port is not equipped with a container crane at the quay front. Unloading and loading of containers to and from the quay apron are carried out by the crane equipped on the ship.

The container ship of PM&O Lines has a powerful container crane to enable to unload and load containers efficiently, whose capacity is much higher than the on-land transport capacity of forklifts used at the container yard. Unloaded containers are handled and placed in order by container forklifts. On the other hand, the containers are transported out or in by trailers of private sectors. In most cases, cargoes are however discharged out of the containers placed in the container yard and delivered by trucks to customers.

The average time required for containers for loading and unloading is as follows.

- Unloading of Containers

Required Time	: 74 min.
Number of Containers	: 28 units

Average Time : 2.64 min./unit

- Loading of Containers:

Required Time : 70 min.

Number of Containers : 25 units

Average Time : 2.80 min./unit

(5) Ship Accidents

Ship accidents of cargo ships such as stranding has not been reported, while the interview with captains revealed that there had been minor accidents in several occasions. These included slight grounding on coral reefs, toughing over coral reefs, etc. Okat Port has the narrow access channel and moreover the area of the port basin is small and there are reef obstacles in the port. Okat Port is regarded as the difficult one for ship maneuvering.

Following two long liners were reported to have stranded on the southern part of the port entrance. According to the staff concerned, the stranding was caused by the engine trouble, which made the boat to drift leading to grounding.

- 1992: Chinese long liner of 100 GRT
- 1997: Chinese long liner of 100 GRT

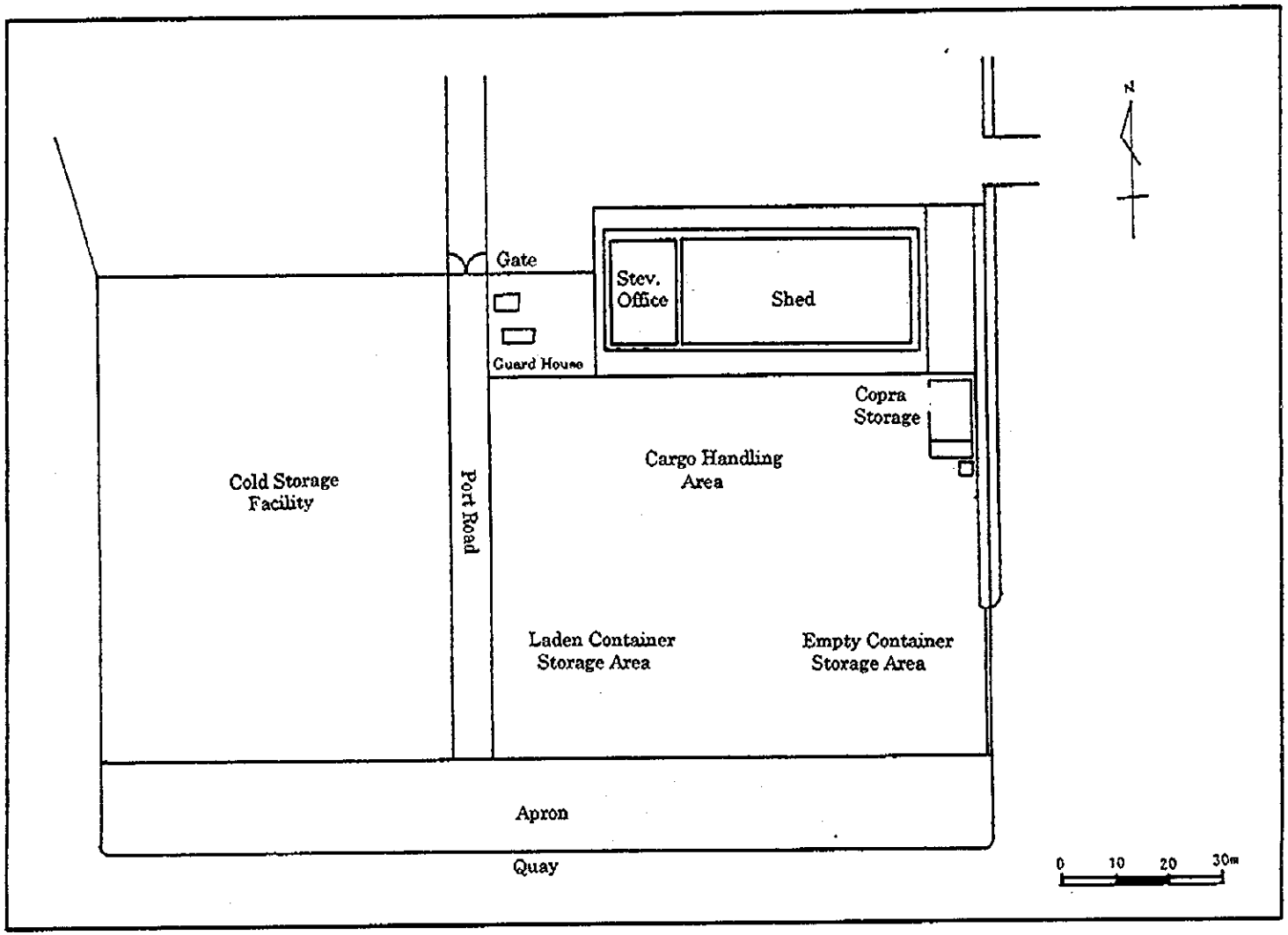


Figure 1.2.4.6 Layout of Container Yard

1.3 Environmental Aspect

The following two environmental aspects are to be taken into account in the implementation of the Project.

1) Negative impacts to be exerted on corals through the friction of mooring chains with corals when lighting buoys and mooring buoys are dragged on the seabed.

2) Negative impacts caused by chips and dust of wood and concrete scattered when fenders are removed or installed.

It can be foreseen that coral reefs will be damaged when the mooring chains attached to lighted buoys and mooring buoys are dragged on the seabed. However, so far coral reefs which require preservation have not been detected within the port area. Moreover, it can be considered that the sphere of influence by mooring chains seems to be quite limited, which is more favorable for coral reef than random anchoring of fishing boats damaging coral of wider area. It is considered that the environmental impact to be exerted by construction work of the project might be minimal.

It can be foreseen that chips and dust of wood as well as of concrete may be spread when the existing fenders are removed and new fender are installed. However, damages to environment could be minimized since the scattering of wood and concrete materials may be temporary and could be prevented if appropriate methods to prevent the scattering of these materials. Therefore, it may be concluded that the impact of construction work of the fenders would be minimal.

CHAPTER 2

CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2.1 Objective of the Project

Okat Port is the only international commercial port in Kosrae State. If the functions of the port are degraded or ceased, the residents in Kosrae State, who depend largely on imported goods for daily commodities, will suffer severely. Especially, if a wreck accident of a large ship occurs at the port entrance, other large ships cannot enter the port, which causes the economical activities to cease. Additionally, huge costs will be required to remove the wreck ship. In a case of a tanker accident, damages will be much severe because of the ocean pollution by the spilled oil from the tanker. Therefore, it is very important to ensure the navigation safety of calling cargo ships, tankers and fishing boats for the living conditions of the Kosrae residents.

According to "Kosrae State Action Plan" released in 1997, Kosrae State is trying to construct and expand the transportation facilities to establish the powerful economy and to realize the social stability. In addition, the area of Okat Port and Kosrae Airport will be promoted as an international commercial base of the State, declared in the development guideline "Okat Dock & Airport Runway Expansion Project" revised in 1995.

Based on the above background, Kosrae State plan to develop a new commercial port in addition to the existing port which is utilized as a fishing port of exclusive use. In order to realize the plan, the comprehensive port development project, comprising the expansion of quay facility, container yard, dredging and others has been requested to a grant aid of the Government of Japan. As a result of the preliminary survey, the large scaled development of the port included in the requests was considered premature. However, installation of navigation aids, replacement of fenders and so on was revealed to be significant to secure the navigation safety of calling ships.

The objectives of the project are followings.

- To secure a navigation safety of calling ships
- To improve an efficiency of the existing port facility

In order to attain the above objectives, establishment of navigation aids, replacement of fenders, fielding consultant for safety advice and other relevant components will be considered.

Regarding the project components through the discussion with the basic study mission, following major components are included in the Minutes of Meeting to examine more preferentially than other requested items. Seven minor components mentioned below were requested besides the major components, of which validity and necessity are examined.

Requested items

(1) Major Components

1) Establishment of navigation aids
2) Replacement of fenders
3) Fielding consultant for safety advice

(2) Minor Components

1) Radio communication system
2) Personal computers for port management
3) Dredging along the revetment located at both ends of quay
4) Cargo handling equipment
5) Pavement of container yard
6) Mooring buoys for fishing boats
7) Lighting facility for quay apron and container yard

2.2 Basic Concept of the Project

2.2.1 Basic Concept

The objectives of the Project are set to improve the navigation safety of calling ships and to make more efficient use of the existing facilities of Okat Port by shortening the cargo handling time. This Project will aim at the efficient utilization of the existing port facilities and the improvement of maritime safety rather than the expansion of the port.

2.2.2 Problems and Constraint of Okat Port

The problems and constraint of Okat Port relating to facilities, such as the waterway and basin, quay facility, on-land facility and control facility are described below.

(1) Waterway and Basin

- The waterway and basin are located in the reef shoal, so that the port entrance and the access channel are very difficult to recognize, because the boundary are always submerged. The entrance width of the port is quite narrow as 91.4 m (300 feet) which can accepts only one way traffic of a large sized ship.

- There are some submerged obstacles of coral reef in the port basin, so that very careful maneuvering of the incoming and outgoing ship operation is required.

- In the turning basin, coral obstacles located in the basin makes turning operation of a large ship difficult and makes the turning basin not to use properly.

- The lighted buoys and beacons which indicate the port entrance have been flown away and it is difficult to find out the accurate position of the port entrance. There are not enough markers that indicate the location of the submerged obstacles or boundaries of the turning basin.

- Because the leading lights are set at insufficient height, there is some difficulty in recognizing them from a large ship. Furthermore, the approach direction defined by the leading lights is deviated from the exact centerline of the access channel.

- Though not prohibited, it is very dangerous to enter and leave the port during night time.

- A large ship of first call of the port is compulsory to accept a pilotage service.

(2) Quay Facilities

- The wooden fenders set on the front face of the quay are completely damaged which sometimes gives a damage to a ship hull and quay body itself.

- Both large ships and fishing boats use the port simultaneously, so that fishing boats cannot berth along the quay while cargo ship occupies the quay.

- While a large ship is berthing along the quay, fishing boats have to be moored along the revetment of both sides of the quay due to no temporary mooring facilities available in the port.

- The berthing area along the revetment is not sufficient for fishing boat mooring, which causes a part of the body of fishing boat to step out from the face line of the quay. Therefore, while a large ship is approaching the quay, these fishing boat are the obstacles for berthing operation.

- There is a wrecked small working boat near the east side of the quay which affects the mooring work of the fishing boats and restricts the use of that mooring area.

(3) On-land Facilities

- Because the forklift for container handling is decaying, the lifting capability is degrading and mechanical troubles occur frequently which affects the cargo handling work adversely.

- Shed does not function as a container freight stations. Cargo handling works of container are done outside which is frequently suspended due to rain.

- The container yard is not paved with bumpy surface, so that careful operation of the container forklift is needed for container handling to prevent turnover.

- There is no lighting facilities for night time work which makes port workers and relevant staff risky and dangerous to work.

(4) Control Facilities

- The basic knowledge and information regarding a port management and operation is not sufficient.

- No radio communication system between ships and the port control station is equipped. Radio communication with a ship through a handy radio transceiver is available, which enable the communication in short range, immediately before entering the port.

- Documents for port management and statistic data of port activities are not well sorted to be utilized.

- The office of the port manager is not located in the port area.

2.2.3 Examination on Project Components

Effects and subjects according to the implementation of the project components are examined as below.

(1) Examination on Major Components

1) Installation of Navigation Aids

Installation of navigation aids, which indicate the accurate location of the port entrance, the access channel and submerged obstacles, contribute to improve the maritime safety of incoming and outgoing ships. It also attributes to avoid possible ship accidents in the port area.

2) Replacement of Fenders

The berthing operation of a large ship to the quay is made easier and more efficient by replacement of the existing damaged wooden fenders to rubber fenders, which are more durable and are more shock absorbable. The damages of the ships and the quay structure are avoided, because ship berthing impact is well absorbed by rubber fenders.

3) Instruction of Safety Management and Operation

To utilize effectively and to control smoothly the existing port facilities, it is very important to secure and train the port staff.

Guidance on the safety control of the incoming and outgoing vessels which is a very important matter for a harbor administration and control will be carried out to promote a fundamental knowledge.

(2) Examination on Minor Components

1) Radio Communication System

The installation of the radio communication system makes it easier to communicate with incoming or outgoing ships and makes cargo handling works more efficient with easy communication of each other. The system can be also used when maritime emergencies occur on a ship sailing in the vicinity area, thus the setup of the system is recommended to be included from the view of maritime safety of calling ships.

2) Personal Computers for Port Management

The arrival and departure of calling ships and the collection of port charges are recorded on a log book and no statistical processing is applied currently. Furthermore, some of the past records have

disappeared when the former port manager resigned. It is recommended to use personal computers to record and analyze the port affairs.

3) Dredging along the Revetment Located both End of Quay

When a fishing boat is moored along the both side of revetment of the quay, a part of the body of fishing boats steps out from the face-line of the quay, because of the insufficient berthing area. This will adversely affect berthing operation of a large ship to the quay. Dredging of the alongside area of the revetment may solve this problem and also improve the navigation safety during the berthing operation of a large ship, because the mooring capacity of fishing boats increases.

However, design documents and drawings about the quay structure is required to examine the possibility of dredging in the vicinity area of the quay wall. This component is not accepted, because the design documents are not available in addition to the expected extension plan of the quay remaining in the original development plan of Okat Port.

4) Cargo Handling Equipment

A large container forklift is considered to be necessary as a cargo handling equipment. The existing container forklift was introduced 18 years ago, which affects that the lifting capability is degraded and critical malfunctions occur frequently. If troubles occur in the container forklift, there is no alternative equipment in Kosrae, which causes the cargo distribution problem in the State and give a damage significantly to the economical activity in the State.

Replacement of a new container forklift will prevent a distribution of cargoes from suspending due to malfunctions of the existing forklift and also it will improve the efficiency of the cargo handling works. Therefore, providing a container forklift as a cargo handling equipment is considered to be very effective.

5) Pavement of Container Yard

The container handling works by forklift is improved by paving the container yards. The pavement of the container yard, however, is

not so urgent and the State Government is capable to fix the yard by itself. Therefore, this component is not included in the Project.

6) Mooring Buoys for Fishing Boats

The utilization of fishing boats is promoted and the maritime safety is improved by installation of mooring buoys for temporary use during a large ship berthing along the quay. This makes it possible to control the mooring of fishing boats along the revetment, which is an obstruction for berthing operation of a large ship to the quay, and the maneuvering safety of the large ship during docking and undocking is improved.

7) Lighting Facility for Quay Apron and Container Yard

Cargo loading and unloading works are sometimes carried out through night. Additionally, landing of fresh tunas is done even in night time or early in a morning to catch up the flight schedule for their transportation. Considering the working safety in night time, the installation of lighting facility is considered to be effective.

2.3 Basic Design

2.3.1 Design Concept

(1) Design Standards

Because no design standard on the port construction is legislated in the Federated States of Micronesia, the Japanese standard such as "Technical Standards for Port and Harbour Facilities in Japan" is to be applied. "Standard Design Method of Fishing Port Construction" is also used for the design relating to fishing boats.

(2) Basic Design Concepts of Port Structure

The requested items relating to the port constructions in this Project include the replacement of fenders, the installation of navigation aids and mooring buoys for fishing boats. Following factors should be taken into account in the planning and design process.

- To take account into the port expansion plan of Okat Port
- To design the construction machinery and materials taking into account the natural and social conditions at site for easy maintenance after completion
- To make a plan taking into account the technical limitation at site so that the cost and term of works are minimized
- To make a construction plan that does not affect the port activities.
- To procure labors and materials from the State as much as possible to stimulate the local society and economy
- To perform the construction under the regulation and guideline relating to the environment stipulated by the Government of Kosrae State

2.3.2 Basic Design

(1) Contents of Project Components

As prescribed, the facilities and equipment included in the Project are as follows.

1) Facilities

- Installation of Navigation Aids
- Replacement of Fenders
- Mooring Buoys for Fishing Boats
- Lighting Facility for Quay Apron and Container Yard

2) Equipment

- Radio Communication System
- Personal Computer for Port Management
- Cargo Handling Equipment

3) Soft Component

- Instruction of Safety Management and Operation

(2) Basic Design of Project Facilities

The required items concerning the harbor structure include the replacement of the fender, the installation of the navigation aids, and the installation of the mooring buoys for fishing boats. These components are planned and designed as described below.

1) Installation of Navigation Aids

a) Design Concept

Regarding the planning for the installation of the navigation aids, each of the lighted buoys should be installed to indicate the location of the port entrance, the access channel and coral reef obstacles. As for the approach line along the access channel, the leading lights which is indicating the approach line, however, due to the fact that the installed position is deviated somewhat from the exact approach line, as well as the shortage of tower height of the leading light. Thus, leading lights should be concluded to newly installed.

The lighted buoys are to apply for the markers, and when selecting the type, a sufficient visibility from outside of the port should be taken into consideration.

b) Layout Plan

In order to recognize the location of the port entrance, approach line of the access channel and coral reef obstacles, the starboard and the portside lighted buoys, obstacle marker and the leading lights should be installed in each water area as shown in Figure 2.3.2.1.

As for the canal entrance for small fishing boats which is located on the east side of the quay, the small lighted buoys should be installed so as to make clear the canal entrance. This canal is used by fishing boats of Okat Fishing Marina and by ships for the dockyard.

Followings are the location and the number of lighted buoys and leading lights considered in the Plan.

- Port Entrance:
  A pair of lighted buoys at starboard and portside
- Access Channel:
  A pair of lighted buoys at starboard and portside
- Submerged Obstacles:
  A lighted buoy for obstacles
- Canal Entrance beside the Quay:
  A pair of lighted buoys at starboard and portside
- South Side of Turning Basin:
  A pair of leading lights

c) Design Conditions

Design conditions of the lighted buoys are set as follows:

- Design Water Depth:
  Water depth required for 10,000DWT class cargo ships
- Design Tide Level:
  Mean spring tide
- Design Waves:
  Waves hindcasted by Typhoon "Axel" in 1992
- Design Wind:
  Maximum wind speed recorded by Typhoon "Axel" in 1992
- Design Current Speed:
  Current speed measured by the field survey

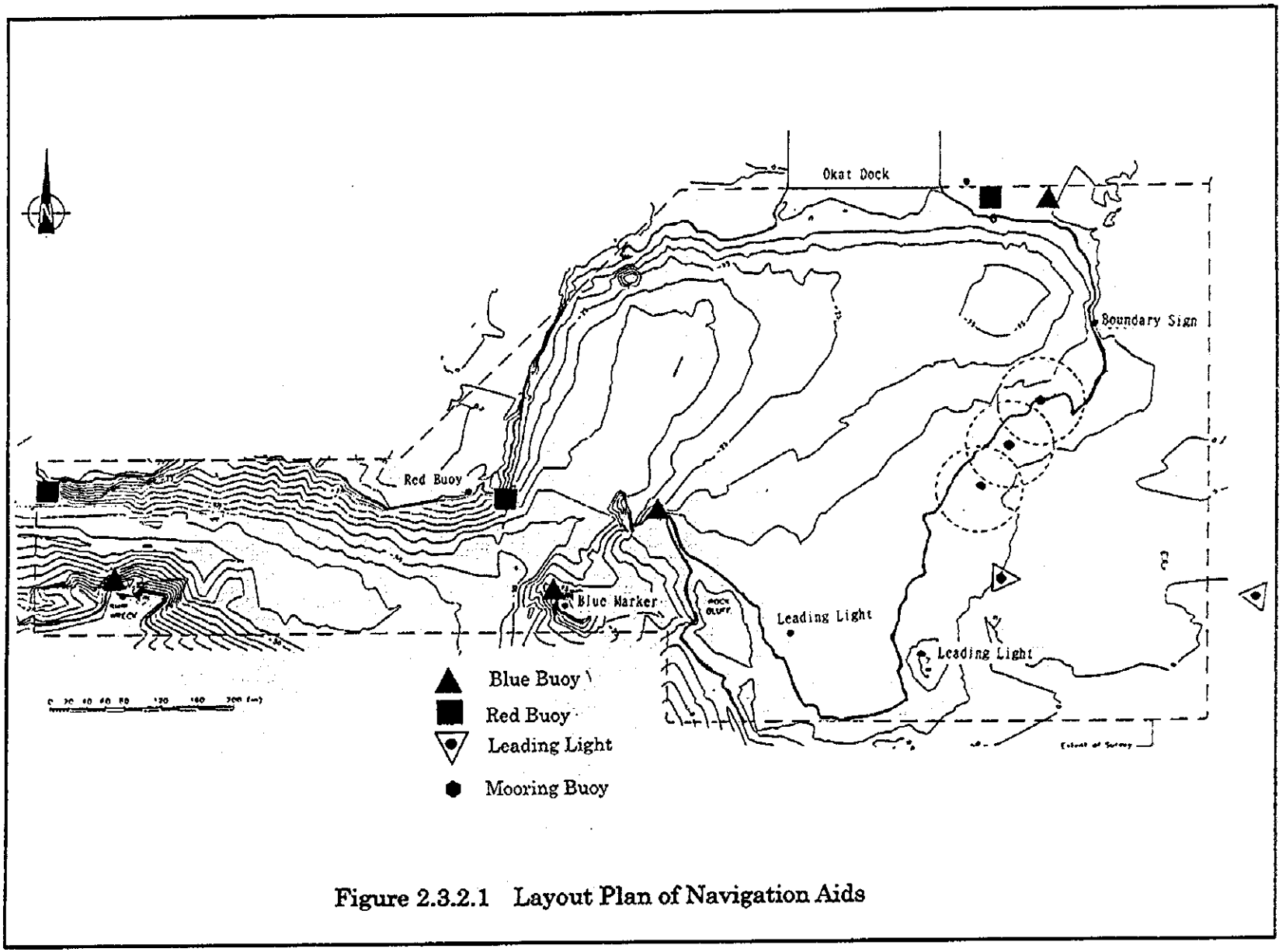


Figure 2.3.2.1 Layout Plan of Navigation Aids

Each design conditions are set as shown in Table 2.3.2.1.

Table 2.3.2.1 Design Conditions of Lighted Buoys

Location	Port Entrance	Access Channel	Canal Entrance
Design Water Depth	DL - 10.0m	DL - 10.0m	DL - 5.0m
Design Tide Level	1.84 m	1.84 m	1.84 m
Design Wave Height	4.0 m	1.0 m	1.0 m
Design Tidal Current	0.5 knot	0.5 knot	0.5 knot
Design Wind Speed	13 m/s	13 m/s	13 m/s
Seabed Condition	Coral Rock	Coral Rock	Coral Rock

As for the installation level and distance between each leading light, the cargo ships of the 10,000DWT class is applied. And they are to be set that the ship enters the access channel from the pilot point one nautical mile away from the port entrance, where a pilot embarks the ship by collimating leading lights. The relation between the leading lights and the ship is shown in Figure 2.3.2.2.

- Height of front leading light: 18.0 m
  (Bridge height of cargo ship of the 10,000DWT class)
- Interval of each leading lights: 290 m
  (1/10 of the distance between the front light and pilot point)

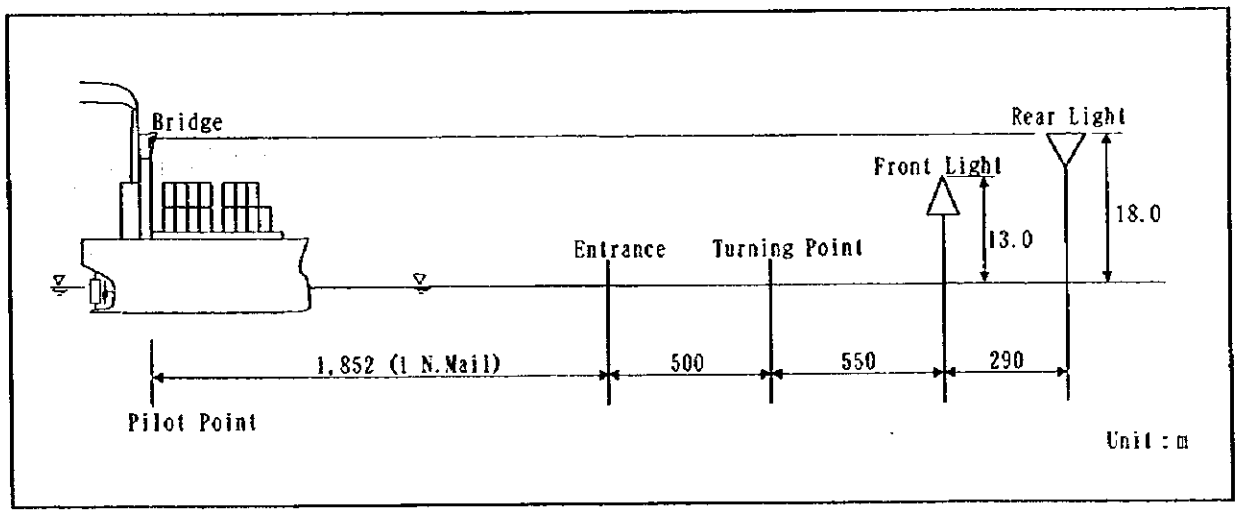


Figure 2.3.2.2 Layout Plan of Leading Lights

d) Basic Design

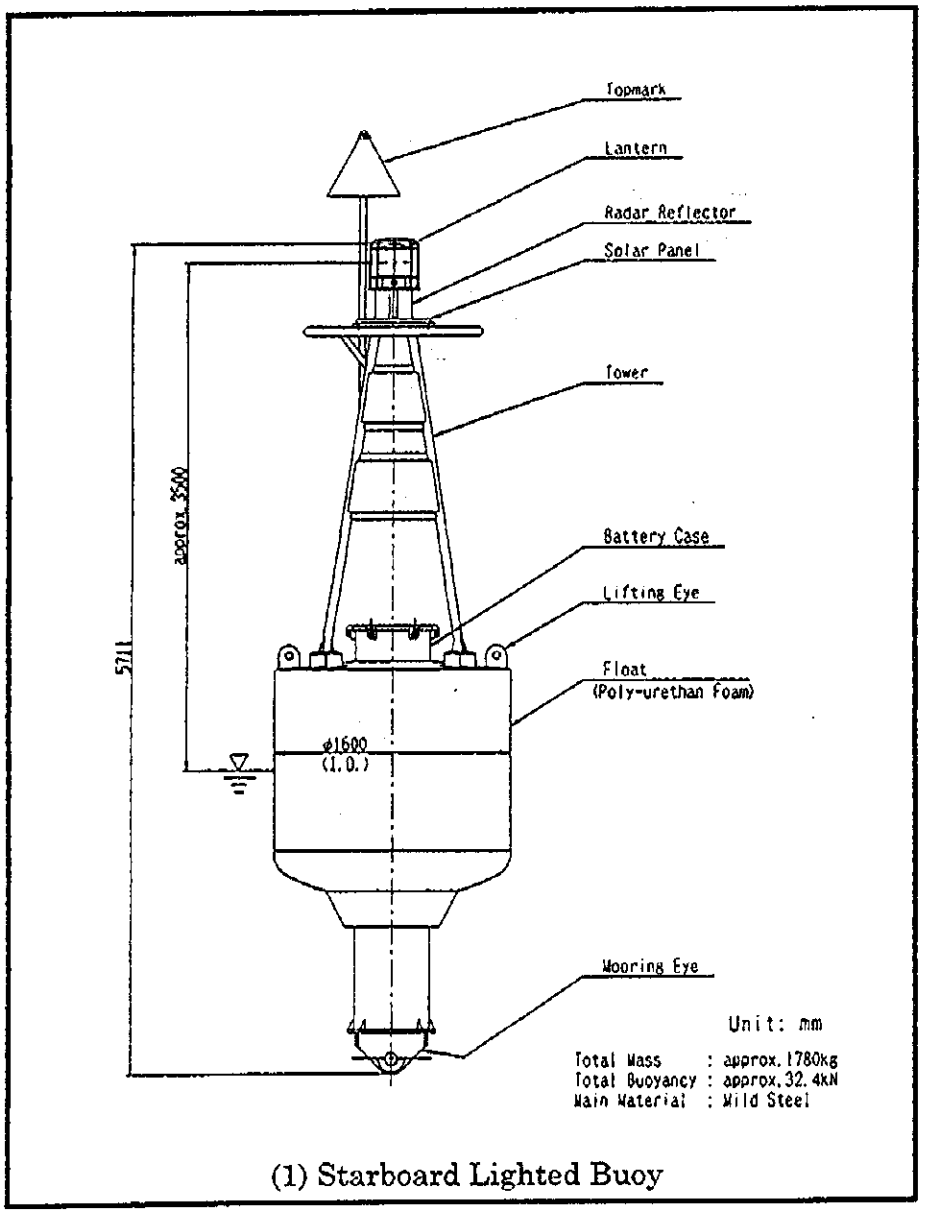
The lantern and the radar reflector are equipped on the top of the lighted buoys and the leading lights. The lantern of the luminous part should adopt a LED type, which is more durable and brings an easy maintenance. The life year of painting of the lighted buoys and the leading lights is designed as five years. The life year of the mooring chain of the buoy, however, should be designed to be 3 years at maximum, because it is easily worn away due to rough bottom surface of coral rock at the installation points.

The specifications of the lighted buoys and the leading lights are shown in Table 2.3.2.2 and respective basic configurations are shown in Figures 2.3.2.3. to 2.3.2.6.

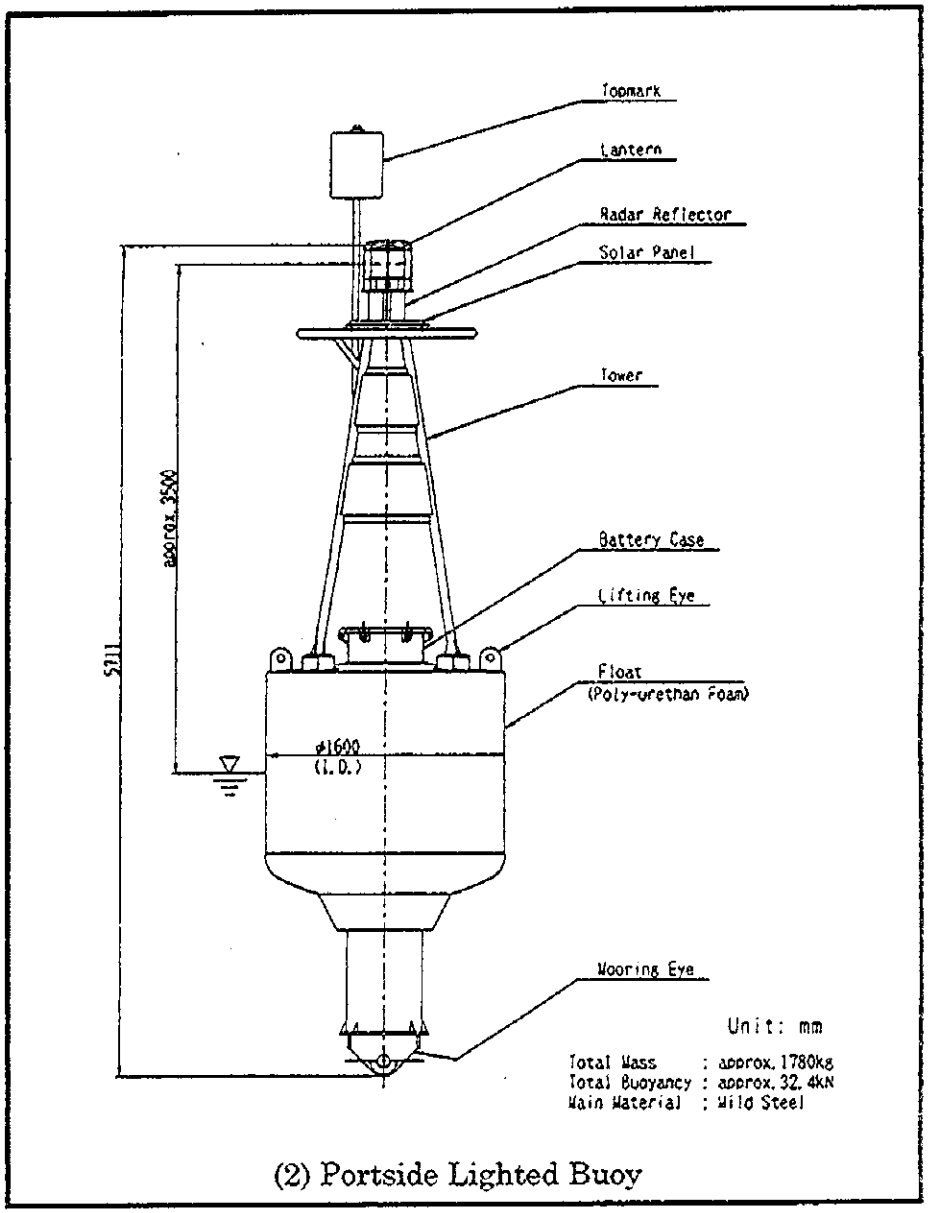
Table 2.3.2.2 Specifications of Lighted Buoys and Leading Lights

Location	Q'ty	Buoy	Lantern	Type	Light Color	Flashing Character	Range
Port Entrance	Lighted Buoys of Starboard and Portside	D1.6m H5.7m	LED Lantern	Solar Battery	Blue Red	Fl.3s (0.5+2.5)	5.1 n. miles 5.7 n. miles
Access Channel	Lighted Buoys of Starboard and Portside	D1.15 m H5.2m	LED Lantern	Solar Battery	Blue Red	Fl.4s (0.5+3.5)	3.1 n. miles 3.3 n. miles
Access Channel	Obstacle Lighted Buoy of Starboard	D1.15 m H5.2m	LED Lantern	Solar Battery	Blue	Fl.4s (0.5+3.5)	3.1 n. miles
Canal Entrance	Lighted Buoys of Starboard and Portside	D1.0m H3.5m	LED Lantern	Solar Battery	Blue Red	Fl.4s (0.4+3.5)	4.4 km 4.7 km
Leading Light	Front Light and Rear Light	H16m H13m	LED Lantern	Solar Battery	White White	ISO 3s Fix	4.9 n. mile 5.0 n. mile

D: Diameter, H: Height

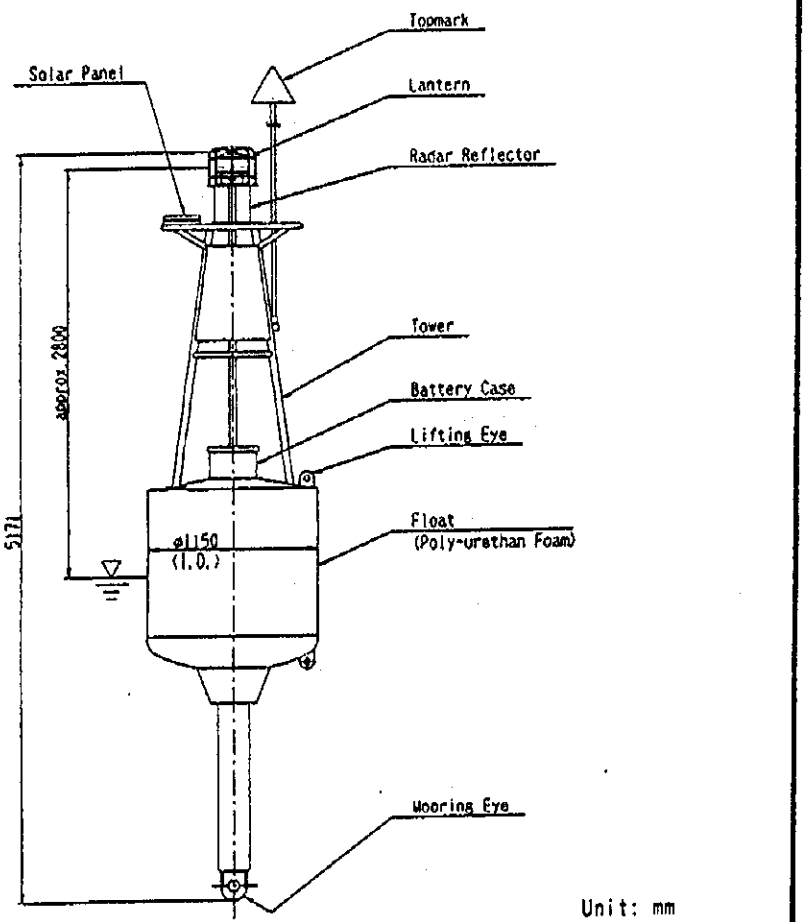


(1) Starboard Lighted Buoy

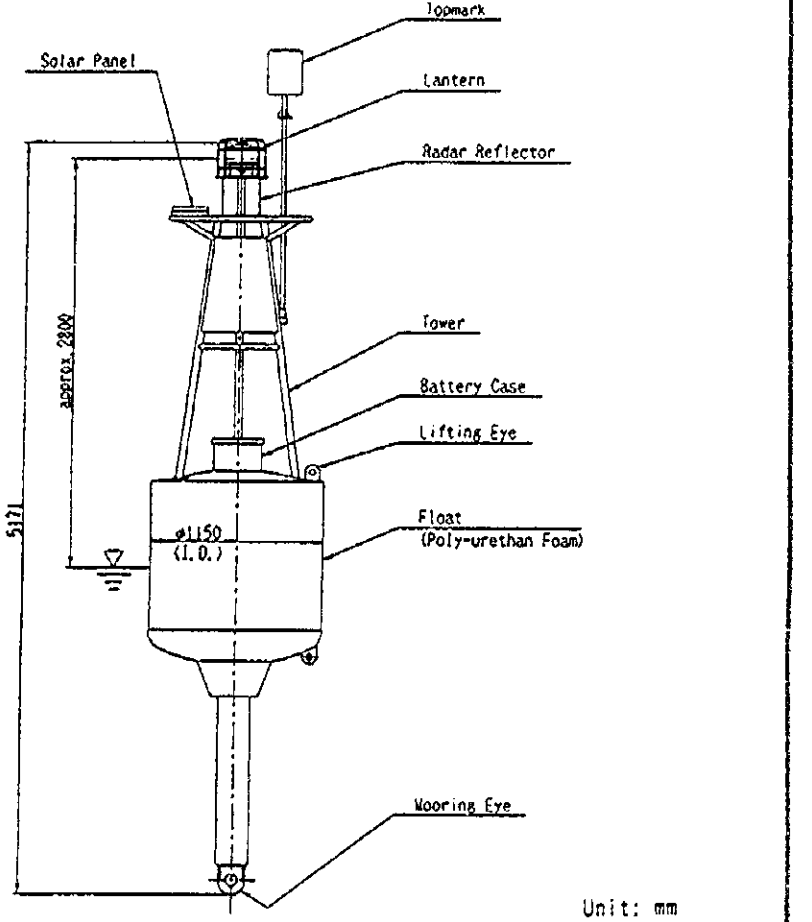


(2) Portside Lighted Buoy

Figure 2.3.2.3 Basic Configurations of Lighted Buoys at Port Entrance



(1) Starboard Lighted Buoy and Obstacle Buoy



(2) Portside Buoy

Figure 2.3.2.4 Basic Configurations of Lighted Buoys and Obstacle Buoy

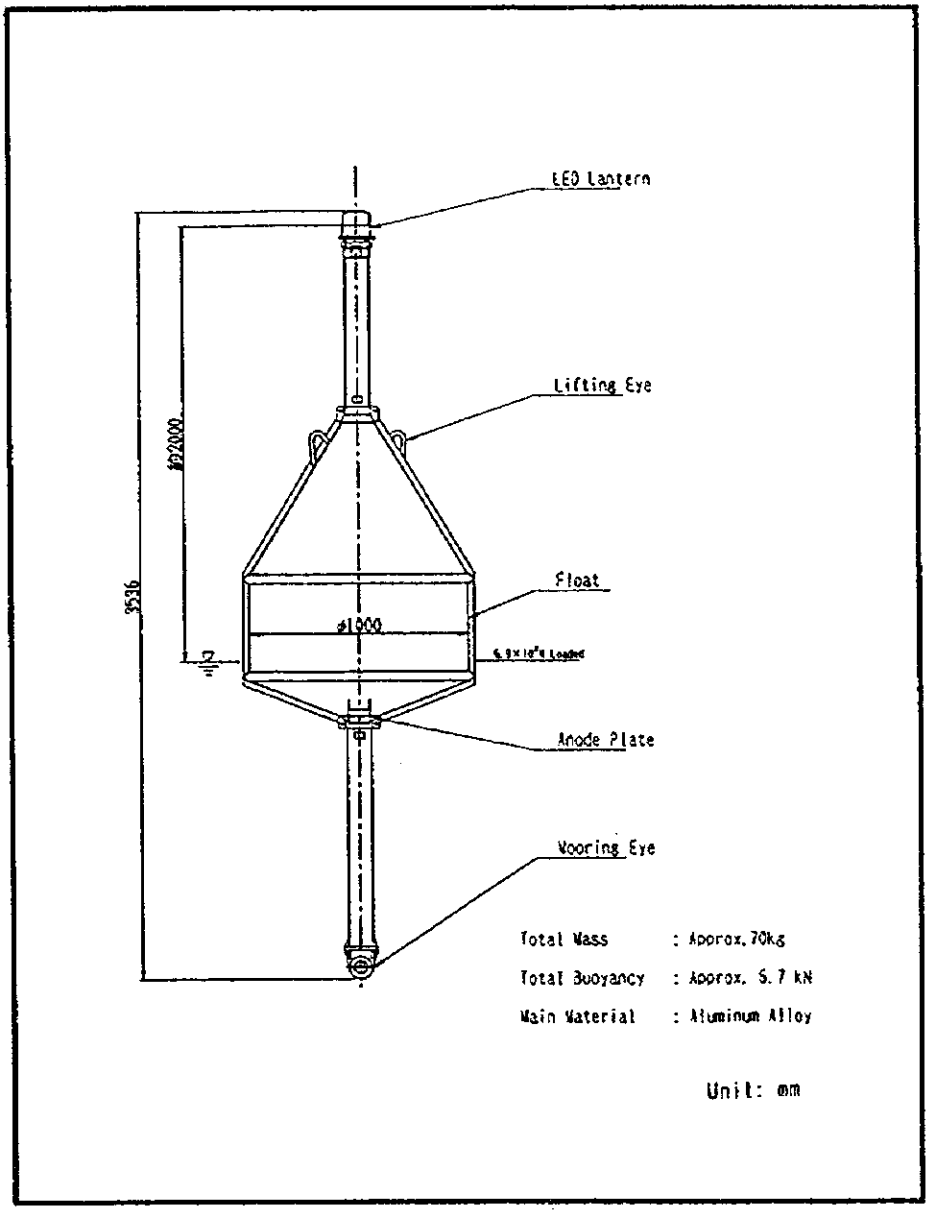
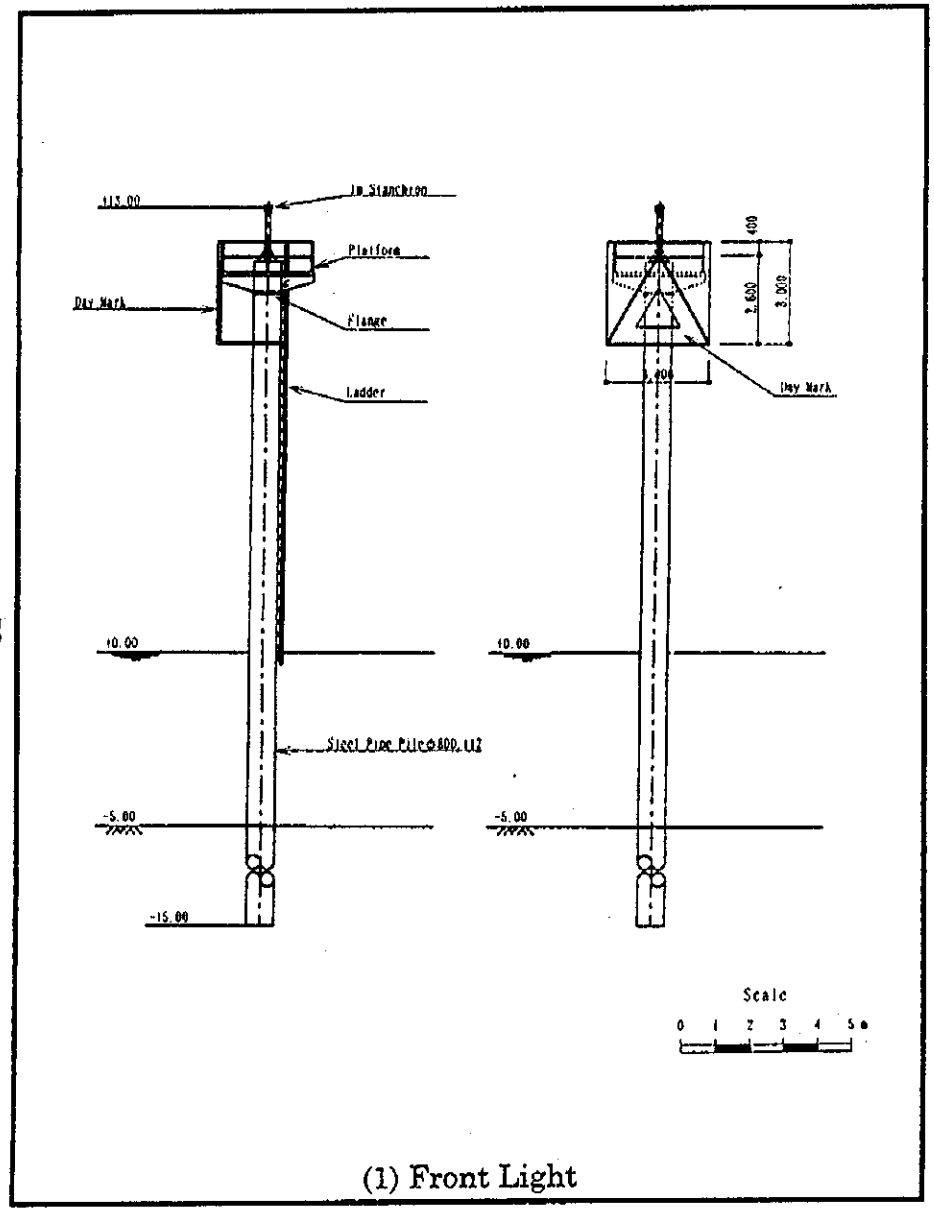
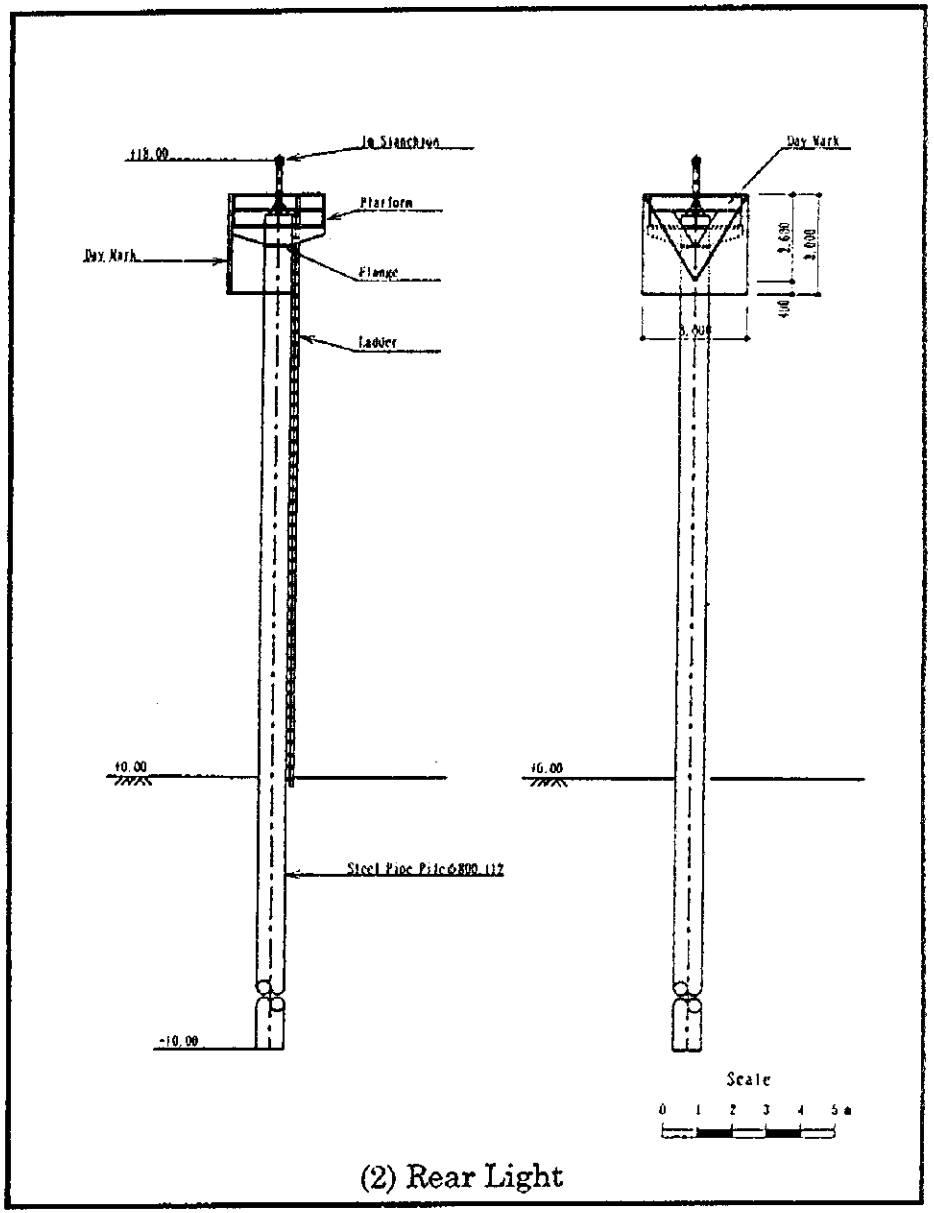


Figure 2.3.2.5 Basic Configurations of Lighted Buoys at Canal Entrance



(1) Front Light



(2) Rear Light

Figure 2.3.2.6 Basic Configurations of Leading Lights

2) Replacement of Fenders

a) Design Concept

The fenders made of woods should be replaced with the rubber fenders, which have more durability compared to the existing wooden ones. In case of Okat Port, various ships such as big and small cargo ships, and small fishing boats and so forth, call the port. The dimension and interval of fenders should be selected according to the large ship, however, the small to medium sized ships must be taken into account. Only the fishing boats are moored to the revetment on both sides of the quay, therefore, the dimension and interval of fenders are to be set for the fishing boats.

Just in case the person working along the quay apron might fall into the sea, the life ladder should be installed in the quay front.

b) Design Conditions

In Okat Port, various ships, such as the big container ship of the 12,000 DWT class of the PM&O Line, the small cargo ships and small tankers in the 1,000 to 4,000DWT class, the patrol boat of the Central Government and so forth, enter into the port. Furthermore, the Chinese fishing boats of the 100 tons class, which are using the port as a fishing base, and the Japanese purse seiners sometimes visit the port for the change of crews and for the supply of necessary items.

The target ship for the design of fenders is the above mentioned cargo ship, however, the medium sized cargo ships of the 4,000DWT class or less as well as small boats and also the fishing boats should be taken into consideration. Design conditions of the fenders are to be set as shown below.

[Front Side of Quay]

- Design Ships	: All ships calling Okat Port
- Max. Ship Size	: PM&O line (Micronesian Nations) 12,713DWT Approaching speed 0.15m/s
- Designed Tide Level	: 1.84m (mean spring tide difference)

[Revetment of Quay]

- Design Ship : Fishing boats of frequent use
- Max. Ship Size : Tuna long liner
  100 tons
  30 m Length
- Designed Tide Level : 1.84 m (mean spring tide difference)

c) Basic Design of Fender of Quay Front

The size and layout of fenders are classified according to the water depth at the quay, in other words, the size of the ships. As shown in Table 2.3.2.3, the size and layout of fenders installed on the quay of 10 m water depth or less is changed by 4,000DWT ship. In case of 4,000DWT or more, the installation interval is 7.5m by the horizontal arrangement, and in case of 4,000DWT or less, it is 5.0m by the vertical arrangement.

Size and interval of the fenders are defined for the ships in the 10,000 and 4,000DWT classes berthing alongside the quay and are set as follows.

- 10,000DWT : V-type fender 500mm height, 3,000mm length
- 4,000DWT : V-typed fender 400mm height, 2,000mm length

Table 2.3.2.3 Standard Layout and Size of Fenders for Commercial Port

Quay Depth	Design Ship	Fender Size	Interval	Arrangement
7.0 ~ 10.0 m	10,000~4,000DWT	500mm (H)	7.5 m	Horizontal
3.0 ~ 7.0 m	4,000 DW or less	400mm (H)	5.0 m	Vertical

Various ships, such as the big cargo boats of the 10,000DWT class or less, enter in Okat Port, so that installation of the fender to enable big vessels of the 10,000DWT class and the small to medium sized ships of the 4,000DWT class or less is planned.

Considering the target ships utilizing the quay of the big cargo ships rated the 10,000DWT class and the small to medium sized ships, the following two alternatives are selected as shown in the figure 2.3.2.7, as the layout alternatives for the fenders to deal with the respective vessels.

- Alternative (1):

The size of fenders sized as 500mm (H) x 3,000mm (L) are set to be for the big ships and the interval of fenders ranged 5.0 m is set to be for the medium sized ships.

- Alternative (2):

Each fender for the big ships and for the medium sized ships is installed, respectively. Fenders of 500mm (H) x 3,000mm (L) for the big ships are installed horizontally in 7.5 m interval. And fenders of 300mm (H) x 2,000mm (L) for the medium sized ships are set vertically in 5.0 m interval below the big fenders.

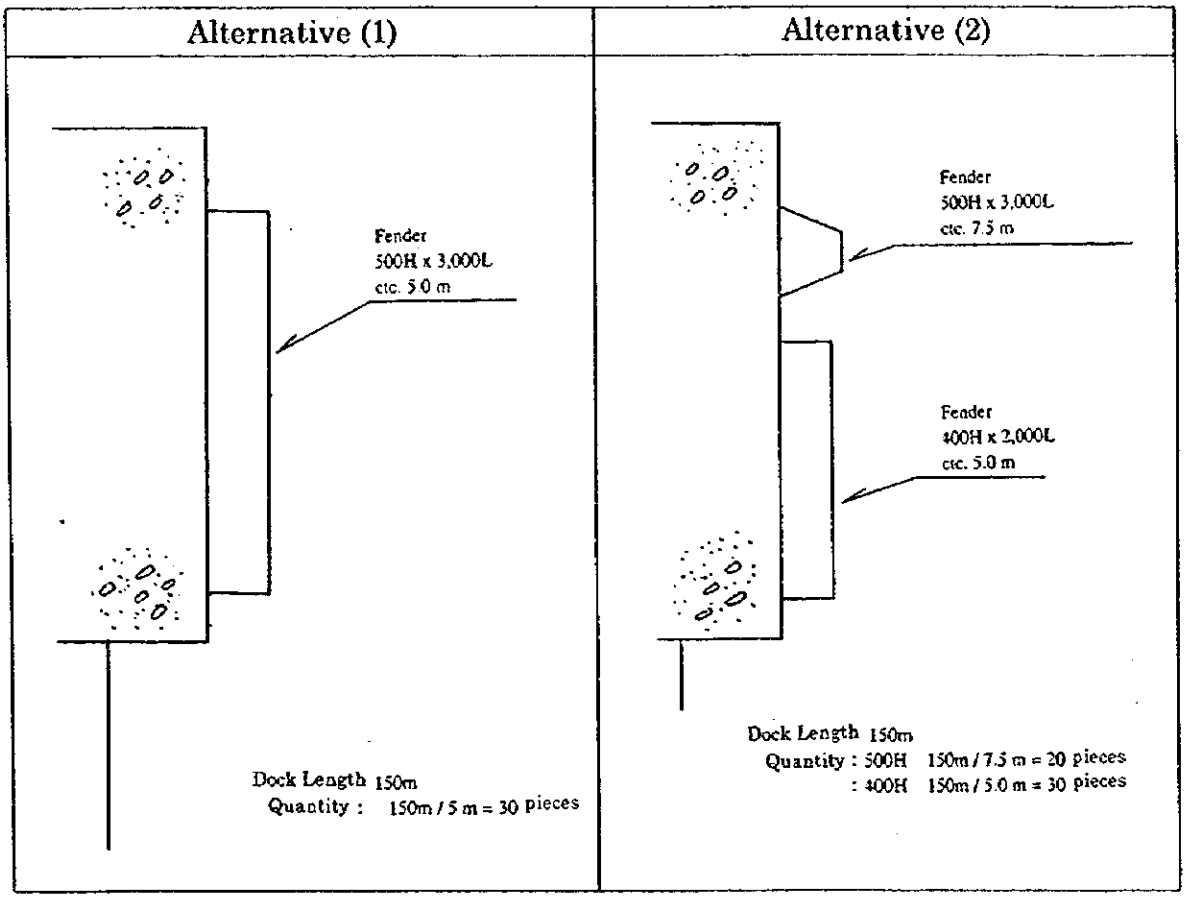


Figure 2.3.2.7 Alternative of Fender Alignment

The comparison on the utilization and economical efficiency concerning each alternative plan is shown in Table 2.3.2.4. As a result, the alternative (1) is employed, because in case of the alternative (2), the fenders placed horizontally may catch small boats due to the excursion of tide and the fender replacement cost is more expensive. Additionally, the installation interval is one-sixth as long as the length of the typical fishing boat, so that mooring the fishing boats utilizing the quay more frequently is quite possible.

[Quay Front]

- Size of fender: 500mm (H) x 3,000mm (L)
- Interval: 5.0m
- Arrangement: Vertical type

Table 2.3.2.4 Comparison of Alternatives of Fender Layout

Items	Alternative (1)	Alternative (2)
Installed Fenders		
500mm(H) x 3,000mm(L)	30	20
400mm(H) x 2,000mm(L)	- - -	30
Workability		
Large Ship	◎	◎
Middle Ship	◎	○
Small Ship	◎	△
Fishing Boat	◎	△
Evaluation	◎	○
Cost	1.0	1.12
Total Evaluation	Applied	

Note ◎: Very Good ○: Good △: Bad

(Number of fenders : per 150 m of the quay extension)

d) Basic Design of Fender for Revetment

The revetment of the quay, where only the fishing boats are moored, should be planned for the fishing boats that are utilized most frequently. According to "Standard Design Method of Fishing Port Construction" published by the Fishery Agency in Japan, the typical

interval of fenders at fishing ports is the one-sixth of the length of the design fishing boat. The relation between water depth of quays, type of fenders and installation interval, which are shown in Table 2.3.2.5, are normally adopted.

In case of Okat Port, the fishing boat that are most utilized weighing 100tons or so, therefore, the installation interval and the size are to be 5.0m and 250mm(H), respectively. And also, the fenders should be installed vertically, and the length of it is to be 3,000mm as a result of taking the vessel type and size, tide condition and the quay dimension into consideration.

[Revetment]

- Size of fender: 250H x 3,000L
- Interval: 5.0m
- Arrangement: Vertical type

Table 2.3.2.5 Standard Layout and Size of Fenders in Fishing Port

Water Depth of Quay	Ship Size	Landing Quay	Idle Berthing Quay	Size of Fender
-3.5 ~ -4.0m	90t	5.0m	5.0m	250mm(H)
-4.0 ~ -4.5m	150t	5.0m	5.0m	250 mm(H)
-4.5 ~ -5.0m	250t	5.0m	5.0m	350 mm(H)

e) Number of Required Fenders

The basic configuration and the layout figure of the fenders to be arranged in the front face of the quay and at the revetment are shown in Figures 2.3.2.8 and 2.3.2.9. Each number of the required fenders of the front part of the quay and the revetment is calculated as shown below. And also, as for the both corner of the quay, the one piece is to be added to each corner.

[Number of Required Fenders (500H x 3,000L)]

- Fenders along Quay Front

  Number of Fenders

  = quay extension / installation interval

  = 167.64 / 5.0 = 33.5 = 34 pcs.

- Extra Fenders for Corners

  Number of Fenders

  = each piece for both corners

  = 2 pcs.

- Total Number 36 pcs.

[Number of Required Fenders (250H x 3,000L)]

- Fenders along Revetment

  Number of Fenders

  = (revetment extension / interval + 1) x 2 sides

  = (20 / 5 + 1) x 2 = 10 pcs.

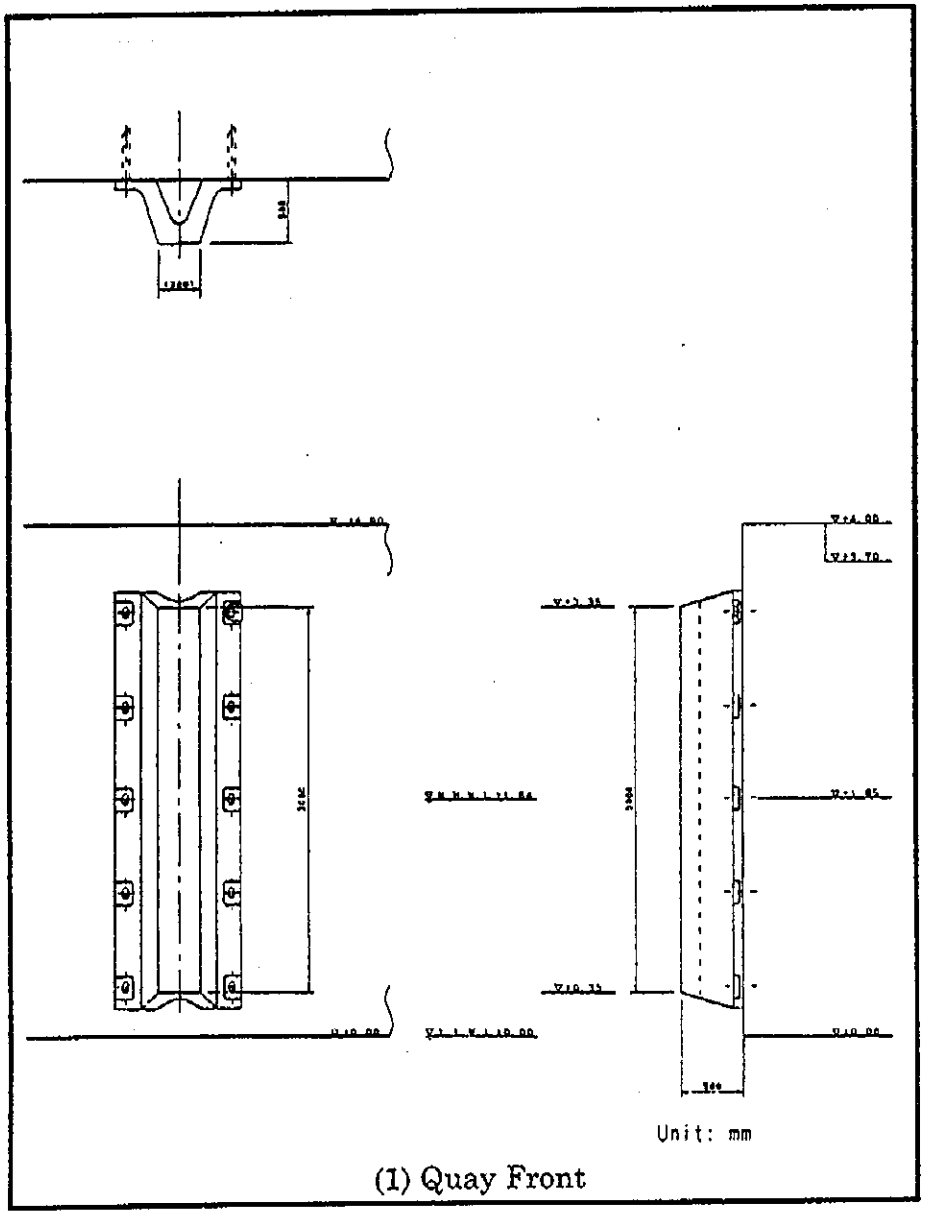
f) Safety Ladder

The safety ladder included in the project is to be installed as the safety measures for the working persons in Okat Port. As for the arrangement, the utilization conditions of the quay are taken into consideration, and the position and the number of the ladder are set up to enable the concerned persons to use it safely for the big cargo ships as well as the small fishing boats.

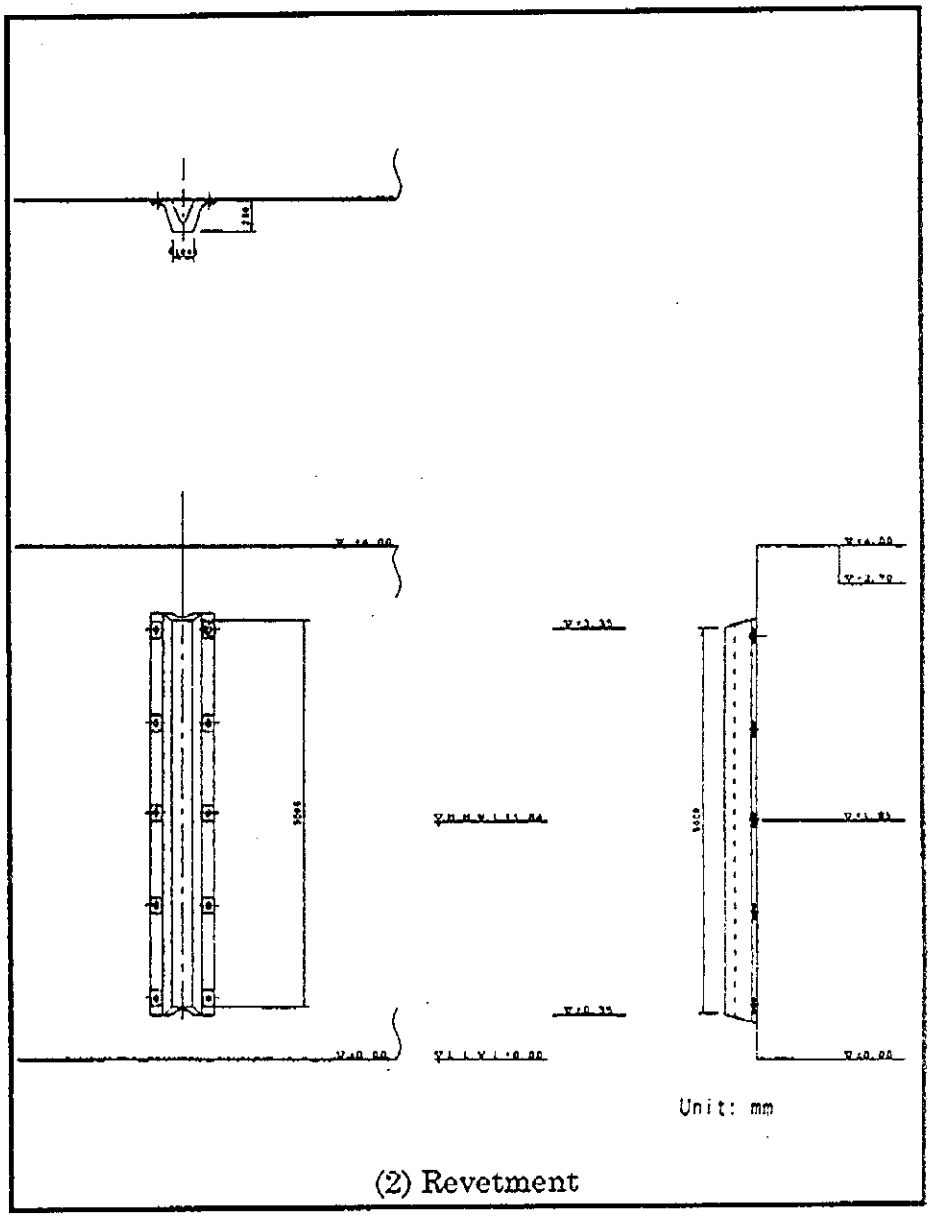
The typical mooring conditions of cargo ships and fishing boats are shown in Figure 2.3.2.10. Based on the relation between the berthing condition of the ships and the location of the life ladder, it is also possible to cope with the big ships and the fishing boats by installing the one ladder to both ends of the quay and the center part, respectively.

[Safety Ladder]

- Type of Ladder : Rubber made of 50cm width
- Position : Both corner and center part
- Number : 3 pcs.



(1) Quay Front



(2) Revetment

Figure 2.3.2.8 Basic Arrangement of Fender

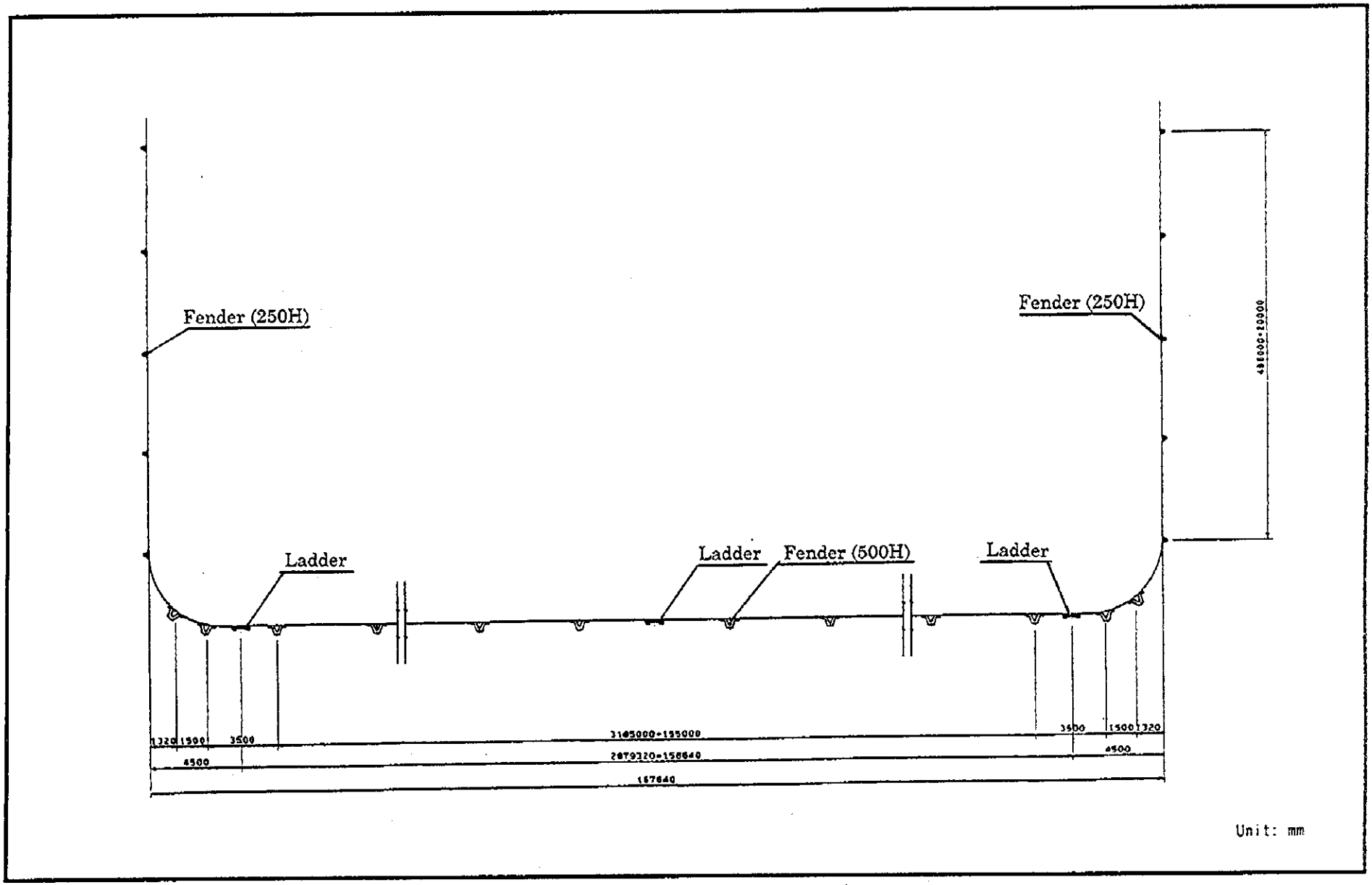


Figure 2.3.2.9 Layout Plan of Fenders and Ladders

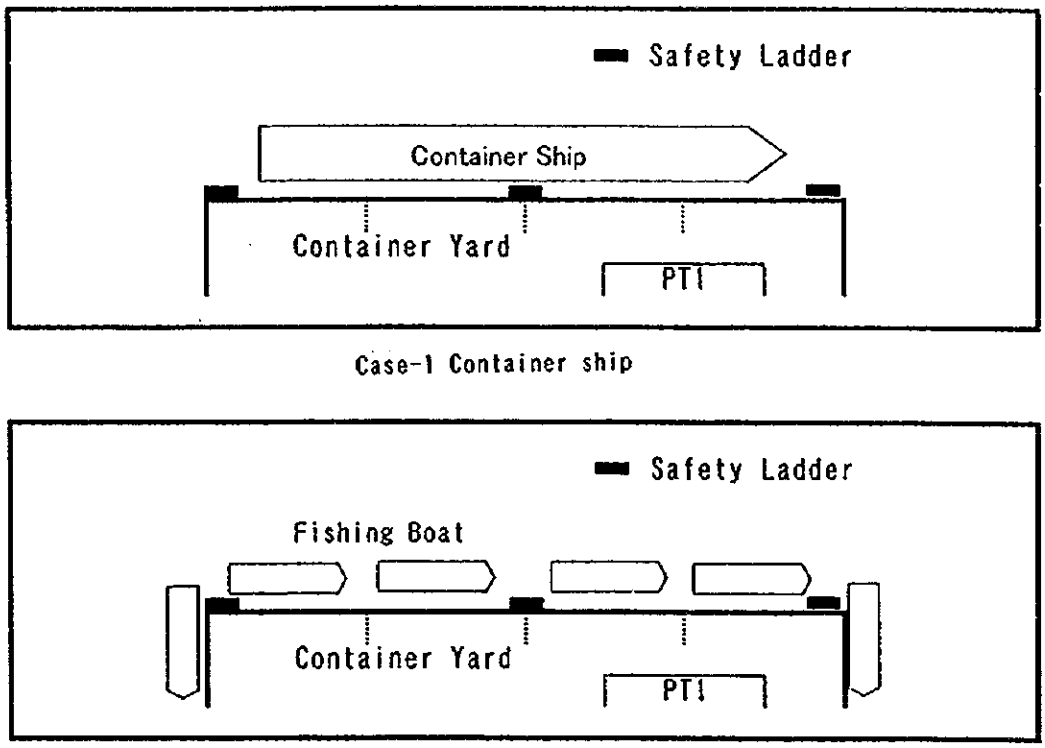


Figure 2.3.2.10 Layout Plan of Safety Ladders

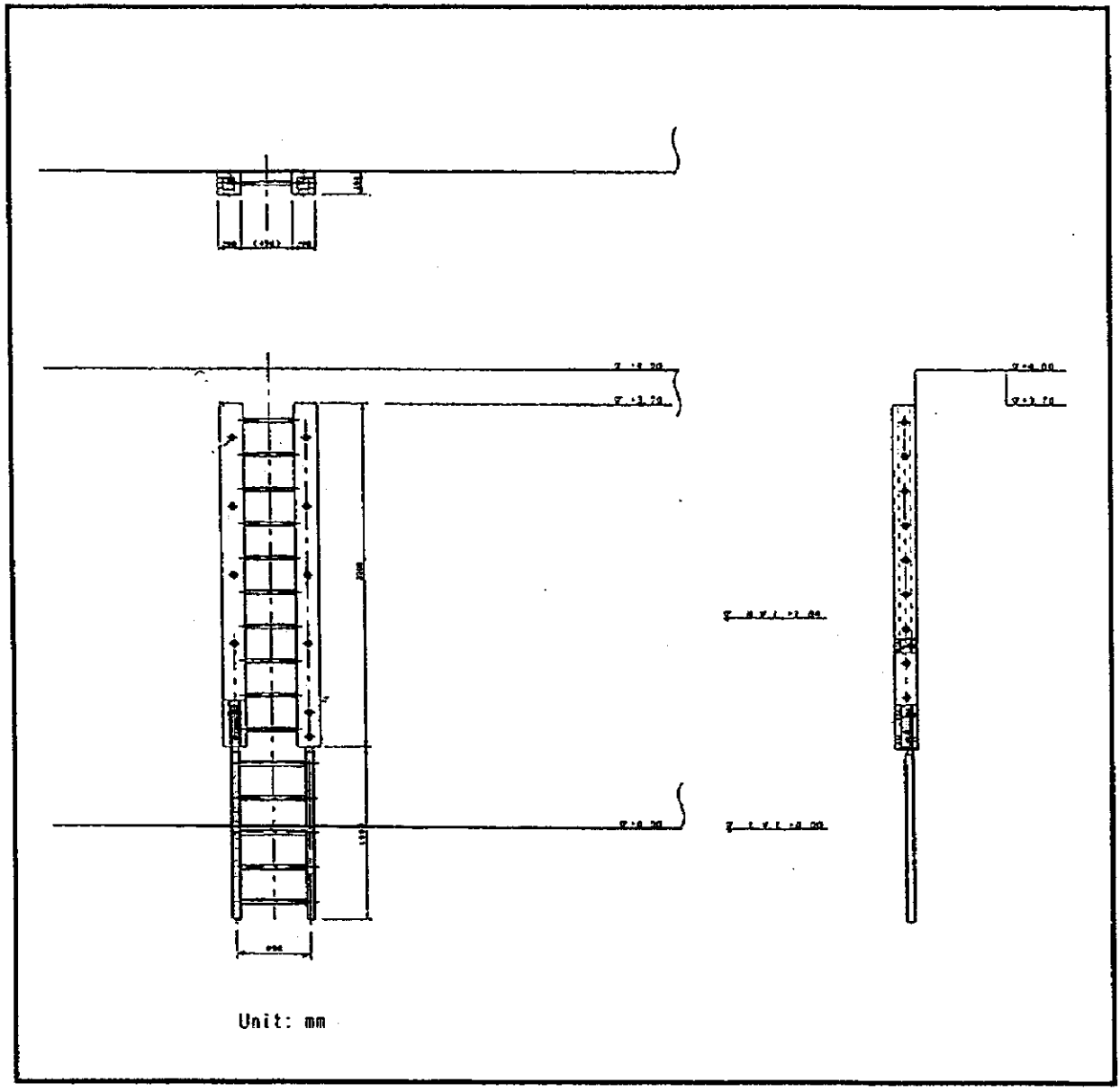


Figure 2.3.2.11 Basic Arrangement of Ladders

3) Mooring Buoys for Fishing Boats

a) Basic Concept

The fishing boats cannot be moored alongside the quay while the big cargo ship stays in the port, therefore, the mooring buoy is to be set in order to moor the fishing boat temporarily until the big ships leave the port. The mooring water area should be allocated to the north side of the turning basin so as not to interfere with the maneuvering of the big ships.

b) Installation Plan

The installation of the mooring buoys for the fishing boats should be planned on the basis of the number of the fishing boats, which are berthing in the port when the big cargo ship enters in the port.

The number of the fishing boats in the port when the big ship enters in the port should be estimated as the standard days which is set as top one-third of the number of the berthing fishing boats measured during the field survey. There were 18 fishing boats in total which were operating at Okat Port during the survey. The 10 days list in order of the number of the fishing boats in the port are shown below from Tabel 1.2.3.6, which is for one-third of the 29 days of the field survey period.

Number of Fishing Boats	Days	Boat x Day
12 ships	1 day	12 boat day
11 ships	2 days	22 boat day
10 ships	3 days	30 boat day
9 ships	1 day	9 boat day
8 ships	2 days	16 boat day
7 ships	1 day	7 boat day
Total	10 days	96 boat day

Average = 96/10 = 9.6 boats/day ⇒ 10 boats/day

The average number of the ships in the port during top 10 days can lead to set the standard number of the ships to 10 ships/day.

The revetment and the mooring buoys are considered to be the area to moor the fishing boats when the big ship stays in the port. The

east side of the revetment is prohibited from mooring the fishing boats during the docking operation of the big ships, so that only the west side of the revetment is allowed to moor the fishing boats. 4 fishing boats at maximum can be moored at the west side of the revetment, therefore, the remaining fishing boats are to be catered at the mooring buoys.

The number of the necessary mooring buoys is calculated as follows, setting that the mooring of the two fishing boats per buoy.

[Number of Required Mooring Buoys]

- Fenders along Quay Front
- Number of Mooring Buoys

= (number of mooring boats - number of boats berthing along revetment) / number of mooring boats per piece

= (10 − 4) / 2 = 3 pcs.

The north side of the turning basin is an appropriate area where nothing interferes with the maneuvering of big ships, by interview survey from the harbor staffs and the captains of the cargo ship. Therefore, it is to be selected for the basin for installation of the mooring buoys.

c) Basic Design

The mooring buoys should not be fragile against the collision with the ships, and also should be made of the polyethylene, which is more durable than other materials. Figure 2.3.2.12 shows the basic configuration of the mooring buoys.

[Mooring Buoys for Fishing Boats]

- Dimensions : Diameter 1.4m, Height 2.2m
- Color : Yellow
- Material : Polyethylene
- Number : 3 pcs.

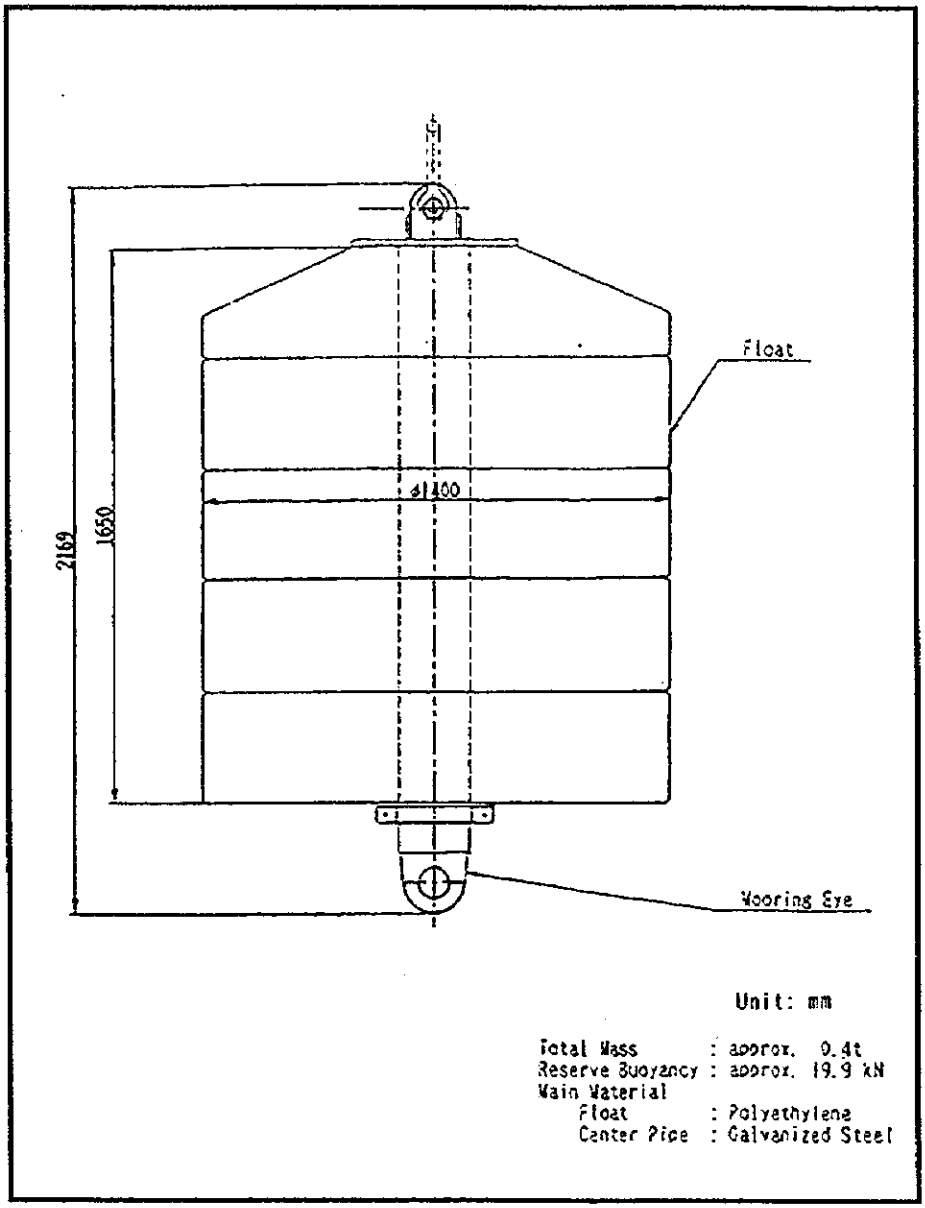


Figure 2.3.2.12 Basic Configuration of Mooring Buoys

4) Lighting Facility for Quay Apron and Container Yard

a) Design Concept

The standard intensity of illumination of a quay apron and a container yard is set to 30 lx and 20 lx, respectively in accordance with the "Technical Standard for Port and Harbour Facility in Japan". In case of Okat Port, however, it is to be the supplementary use for the ship's lighting gear due to the fact that the working hours during the night is very limited. Comparing to the normal container yard whereby the frequency of use of the lightning facilities will be low. Therefore, the lighting facilities are planned to be the concentrated lightning to the quay apron and the container yard where the night work is mostly done.

b) Installation Plan

The lighting facilities are to be planned for the quay apron and the container yard as follow.

As shown in Figure 2.3.2.13, the average intensity of illumination is 8 lx or so, which is a little bit darker than the night lighting of the road. But as for the area where the lighting is necessary, it almost enables to work. Details of the lighting facility are shown in Figure 2.3.2.14.

[Lighting Facility]

- Installation Places : 3 places
- Pole Height : 8 m
- Number of Lamps : 2pieces/place
- Lamp Size : 1,000 Watts

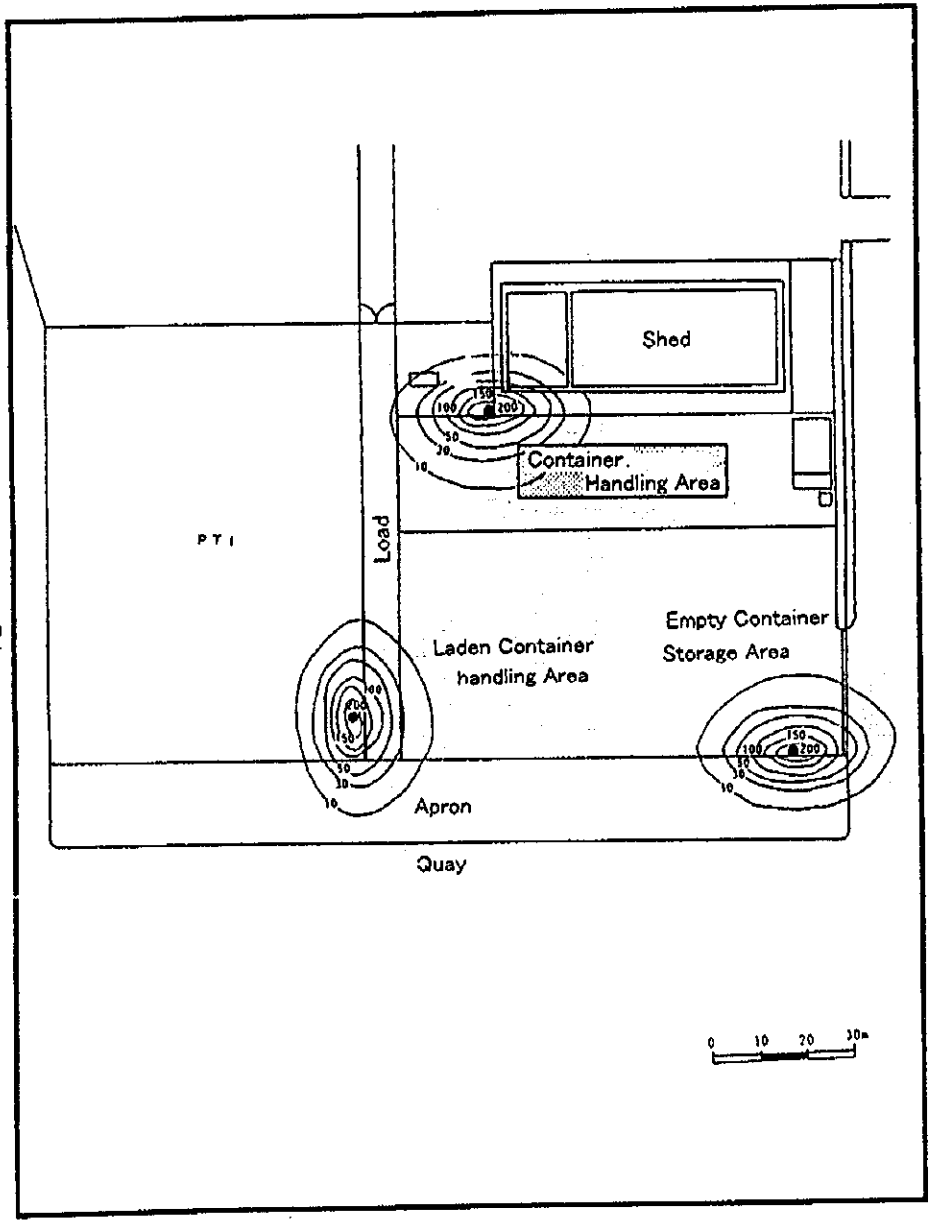


Figure 2.3.2.13 Layout Plan of Lighting System

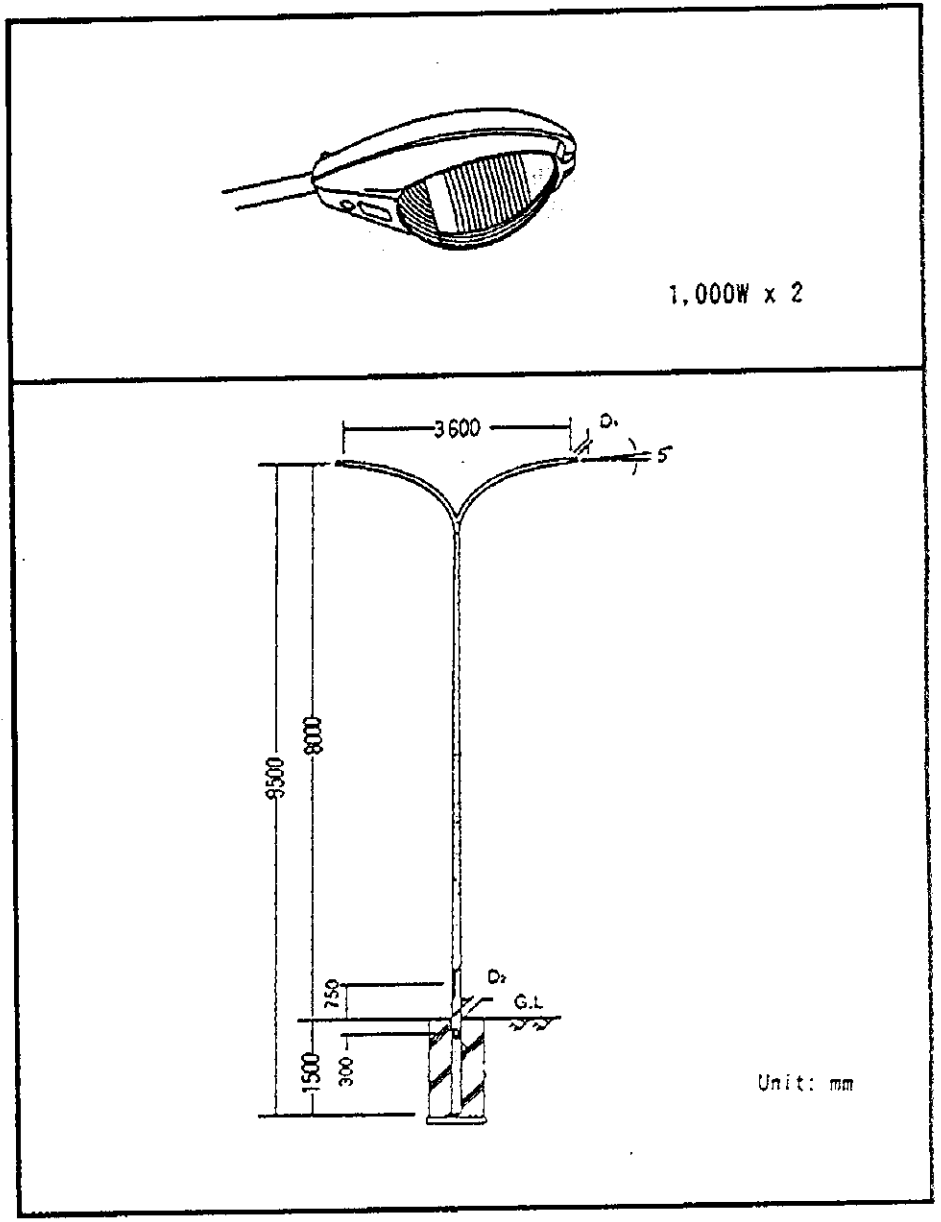


Figure 2.3.2.14 Basic Configuration of Lighting System

(3) Basic Design of Equipment

As the project components in relation to the equipment, the radio communication system, personal computers for port management and equipment for cargo handling work are described and are planned as below.

1) Radio Communication System

a) Design Policy

The radio communication system for ships is to communicate with the large ships calling Okat Port, and is to be the same fixed type as the radio communication system equipped on large ships.

b) Basic Design

The radio communication system for ships is to be the fixed type and has the capacity of 25 Watts which is almost the same as the radio communication system equipped normally on large ships.

[Radio Communication System]

- Type	: Fixed type VHF transceiver
- Output	: about 25 Watts
- Number	: One set

2) Personal Computer for Port Management

a) Design Policy

The personal computer concerned has to be able to issue the certificate of port clearance, make the bill of port charges, etc., and collect and process the statistics about the records of the ship's arrival and departure, etc. And the relevant application of software and the related equipment such as the printer and so on, are to be included.

b) Basic Design

The personal computer available in the market is to be adopted and the application of software for the word processor and the spreadsheet are to be included. The laser printer is also to be included.

[Personal Computer]

- Type : Desktop personal computer
- Attachment : Laser printer

3) Equipment for Cargo Handling Works

a) Design Policy

The equipment for cargo handling works except a big forklift for handling the container is not to be included in this project, because the trailer, chassis for carrying containers and small sized forklift are considered to be able to be provided by the consignee and the stevedoring company. As for the capacity of the container forklift, though the demand for the 40 feet container seems to increase in the future, most of the transports are done by the 20 feet container under the existing conditions, therefore, the 20 feet container forklift which is almost the same as the existing one is to be introduced.

b) Basic Design

The cargo handling capacity and the specifications of the container forklift are as follows.

[Container Forklift]

- Handling Capacity : Laden 20 feet container
- Work Height : Two layer of containers
- Attachment : Side shift device
  : Hood covered driving cabin
  : without air conditioning

(4) Soft Component

The instruction concerning the safety management and operation in the port is to be performed against the counterpart in charge of the port in accordance with the following action plan.

1) Requested Items

- Instruction concerning the safety management and operation in the port

2) Background

The port manager, who is engaged in port management and operation of Okat Port after the completion of this Project, is not sufficiently experienced in this field. More basic knowledge about port management and operation, and maintenance of the newly installed facilities and equipment are necessary.

Therefore, instruction of the port manager is required to understand the safety management in the port, which is the most important for the port management and the basic knowledge.

3) Goal

The goal of the instruction is as follows:

- To ensure the maritime safety in the port
- To manage and maintain the port facilities properly

4) Effect

It is recommended to make a pamphlet for port users, which includes the basic information about operation and management of Okat Port, together with the port manager and the instructor. The following effects can be expected by editing the pamphlet.

- The port manager understands the data of the waterway/basin and on-land facilities by the guideline of the utilization of the port facilities, thus his ability of port operation will be improved.

- The port users understand the data of the waterway/basin and on-land facilities by the guideline of the utilization of the port facilities, thus the traffic in the port will become smoother and the navigation safety will be improved.

- Both the port manager understands the radio communication system, thus the communication with the calling ships and reaction to emergencies are made more efficient.

- The port manager understands the contents and maintenance of the installed facilities, thus the life years of them will be prolonged.

- Collecting and processing the basic data required for the port management will be made easier.

5) Activity Plan

The pamphlet, which includes the following basic information for the utilization and management of the port, will be published together with the counterpart of this Project. Contents of the pamphlet are as follows.

- Guideline of the utilization of waterway and basin of Okat Port
- Outline of the on-land facilities and details of waterway and baisn
- Locations and types of the installed navigation aids
- Details of radio communication and procedure

To publish the pamphlet, the followings will be undertaken together with the counterpart.

- To edit the rules related to the use of Okat Port as a guideline
- To directly observe the bathymetry of the access channel and the turning basin and to make drawings indicating dangerous points.
- To use the international standard related to the navigation aids and to make drawings indicating positions and types of the lighted buoys in Okat Port, as well as to ensure the roles of the navigation aids installed newly.
- To collect the required information about radio communication according to the international radio communication regulation.

The contents of the basic jobs of the port manager are considered as follows.

- To study on the reaction system to emergencies such as communication system and rescue system and to instruct them using examples in Japan.

- To give them information about maintenance of the fenders and the navigation aids to be installed.
- To make formats for collecting and processing basic data of the port activities such as radio communication log, records of the regular check up of the navigation aids, ship call records, port charge, using a personal computer and to explain how to use them.

6) Output

- Pamphlet on utilization and management of the port
- Instruction Records

7) Staffing

- Maritime safety expert for 1.0 manmonth

8) Schedule

- End of the construction supervision period