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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE REPUBLIC OF INDONESIA
MALAYSIA
THE REPUBLIC OF SINGAPORE

THE FOUR NATION JOINT RE-SURVEY OF CRITICAL AREAS AND INVESTIGATION OF DANGEROUS/UNCONFIRMED SHOALS AND WRECKS IN THE STRAITS OF MALACCA AND SINGAPORE

FINAL REPORT

VOLUME 2
MAIN REPORT

JUNE 1998

KOKUSAI KOGYO CO., LTD.
SANYO TECHNO MARINE, INC.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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LIST OF REPORTS

VOLUME 1 : SUMMARY
VOLUME 2 : MAIN REPORT

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Malaysia and the Government of the Republic of Singapore, the Government of Japan decided to conduct "The Four Nation Joint Re-Survey of Critical Areas and Investigation of Dangerous/Unconfirmed Shoals and Wrecks in the Straits of Malacca and Singapore", and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia, Malaysia and Singapore a study team headed by Mr. Takeyasu Kikuta, Kokusai Kogyo Co., Ltd., from the first phase study to third phase study between October 1996 and March 1998.

The team held discussions with the officials concerned of the Governments of Indonesia, Malaysia and Singapore, and conducted field surveys in the study area. After its return to Japan, the team carried out further studies and consequently prepared the present report.

I hope that this report will contribute to the safe navigation in the Straits of Malacca and Singapore and to the enhancement of friendly relations between Japan and the Littoral States.

I wish to express my sincere appreciation to the officials concerned of the Governments of Indonesia, Malaysia and Singapore for the close cooperation they have extended to the team.

June 1998

Kimio Fujita
President
Japan International Cooperation Agency

June 1998

Mr. Kimio Fujita
President,
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit to you the final report on "The Four Nation Joint Re-Survey of Critical Areas and Investigation of Dangerous/Unconfirmed Shoals and Wrecks in the Straits of Malacca and Singapore". This report was prepared by the study team in accordance with the contract signed on September 6, 1996, April 25, 1997 and May 25, 1998 between the Japan International Cooperation Agency and Kokusai kogyo Co., Ltd./ Sanyo Techno Marine, Inc..

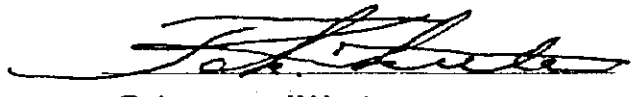
The report contains the study results on the unconfirmed shoals and wrecks in the Straits of Malacca and Singapore.

The positions and least depths of shoals and wrecks are compiled on sixteen smooth sheets, which have been submitted to the Littoral States as study results at the end of each study phase. Nine dangerous areas (eight shoals and one wreck) detected during the field survey, were promulgated to all vessels by " Notices to Mariners " through responsible authorities of the three Littoral States. The Electronic Navigational Charts database covering existing six sheets of common datum charts of the Straits of Malacca and Singapore was also prepared making use of the results of this study.

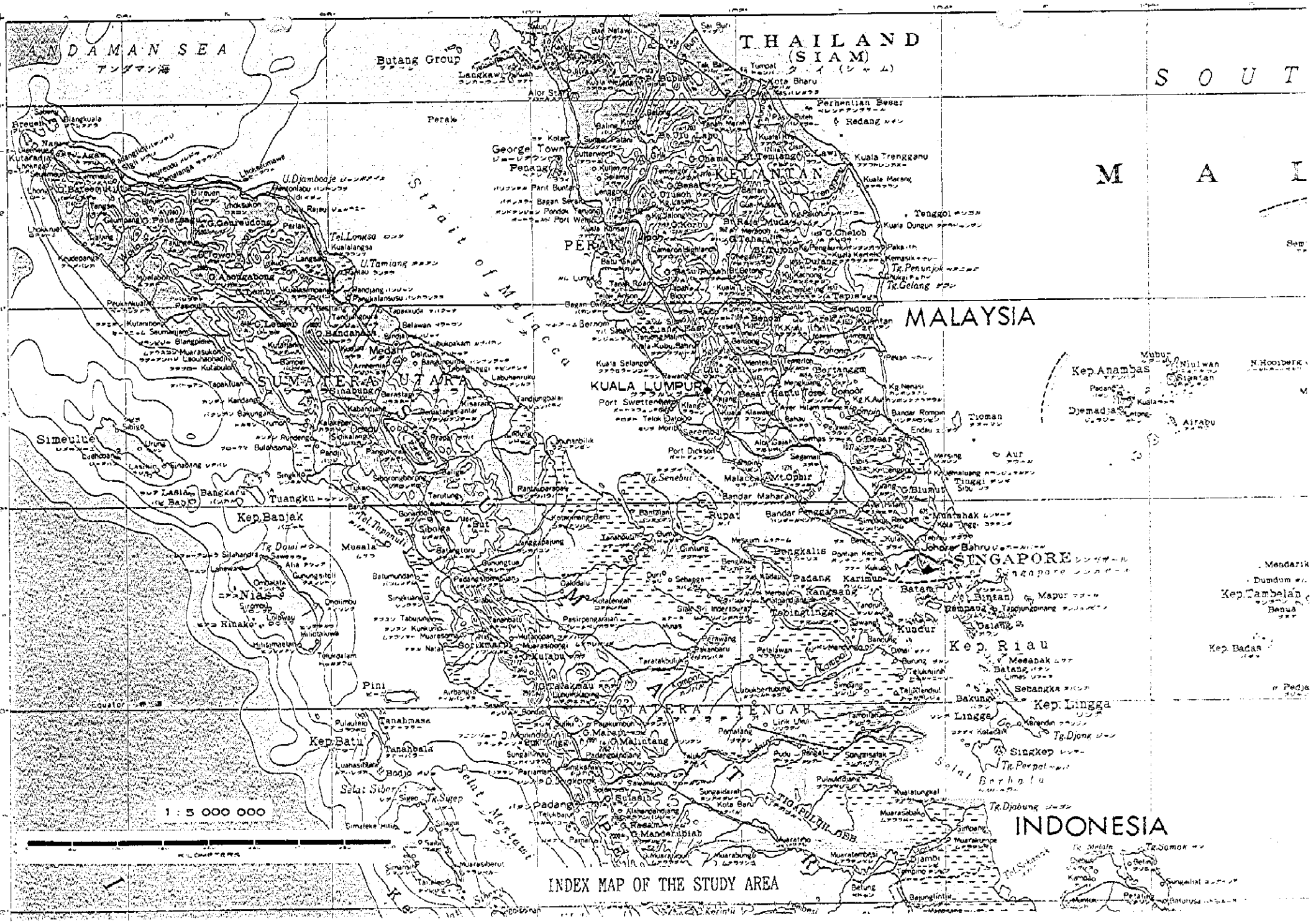
We hope that the results of the study will contribute to the enhancement of the safe navigation in the Straits of Malacca and Singapore.

All members of the study team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Transport, Embassy of Japan in Indonesia, Embassy of Japan in Malaysia, Embassy of Japan in Singapore and also to officials and individuals of the Governments of Indonesia, Malaysia and Singapore for the assistance they have extended to the study team.

Very truly yours,



Takeyasu Kikuta
Team Leader


ANDAMAN SEA
アンダマン海
THAILAND
(SIAM)
タイ(シャム)
Butang Group
SOUT
MAL
George Town
Penang
KELANTAN
PERAK
Selat of Malacca
MALAYSIA
KUALA LUMPUR
Port Swettenham
SUMATERA UTARA
Medan
Simeulue
Nias
Kep.Banjak
Kep.Batu
Kep.Anambas
Djemadja
Tioman
Kep.Tambelan
Benua
Kep. Riau
Kep. Lingga
Singkep
Batam
Bintan
SINGAPORE
Singapore
Johore Bahru
Pengkalis
Padang Karimun
Tanjungpinang
Kundur
Bengkalis
Rupat
Bandar Maharani
Port Dickson
Malacca
Mt.Ophir
Tg.Senebui
SUMATERA TENGAH
Padang
Sibolga
Pini
Tanahmasa
Tanahbala
Selat Berhala
Selat Singkep
Selat Malaka
TIGA PULUH-HEER
INDONESIA
1 : 5 000 000
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CHAPTER 1

INTRODUCTION

CHAPTER 1 : INTRODUCTION

1.1 Objective of the Study

The objective of the Study is to conduct hydrographic survey of critical areas, including the investigation of dangerous/unconfirmed shoals and wrecks, for the promotion of maritime safety in the Straits of Malacca and Singapore.

1.2 Study Areas

The following twelve (12) sub-areas and thirteen (13) points in the Straits of Malacca and Singapore were included in the Study :

(1) Group Area 1 : Sub-Area A
Points j, k and l
(2) Group Area 2 : Sub-Areas B, C, J and K
Points f and g
(3) Group Area 3 : Sub-Area D
Points a and m
(4) Group Area 4 : Sub-Area L
Points b and c
(5) Group Area 5 : Sub-Areas E, F, G and H
Points d, i, e and h
(6) Group Area 6 : Sub-Area I

The areas and points are shown in Figure 1-1 and Table 1-1; and the detailed survey areas are shown in the attached Appendix 1.

The total survey area was approximately 780 square kilometers.

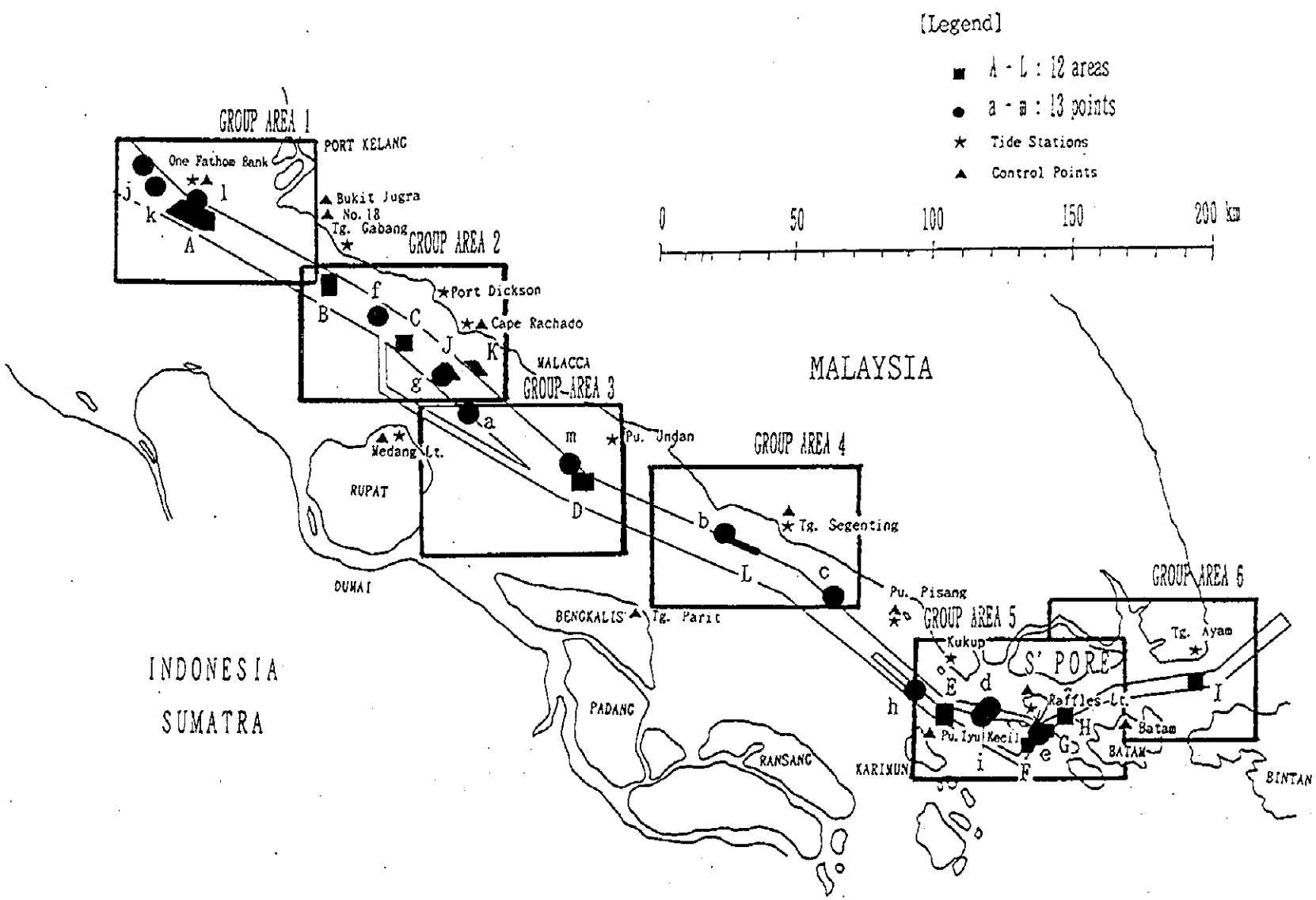


Fig. 1-1 Location Map of Study Areas and Points

Table 1-1 List of Study Areas and Points

Areas/Points	Position	Subject	Remarks
A	(a) 2° 51.4′ N 100° 57.2′ E (b) 2° 48.3′ N 101° 03.4′ E (c) 2° 45.0′ N 101° 03.4′ E (d) 2° 45.0′ N 101° 01.3′ E (e) 2° 48.9′ N 100° 54.1′ E	Wrecks Shoal Sand Wave	(1) 2° 48.7′ N 101° 00.8′ E (2) 2° 47.0′ N 101° 02.1′ E (3) 2° 46.0′ N 101° 02.1′ E
B	(a) 2° 36.7′ N 101° 24.4′ E (b) 2° 36.7′ N 101° 27.5′ E (c) 2° 32.4′ N 101° 27.5′ E (d) 2° 32.4′ N 101° 24.4′ E	Shoals	(4) 2° 35.2′ N 101° 25.9′ E (5) 2° 33.9′ N 101° 26.0′ E
C	(a) 2° 24.1′ N 101° 39.1′ E (b) 2° 24.1′ N 101° 42.1′ E (c) 2° 21.1′ N 101° 42.1′ E (d) 2° 21.1′ N 101° 39.1′ E	Shoal	(6) 2° 22.6′ N 101° 40.6′ E
D	(a) 1° 57.6′ N 102° 12.6′ E (b) 1° 57.6′ N 102° 16.9′ E (c) 1° 54.0′ N 102° 16.9′ E (d) 1° 54.0′ N 102° 12.6′ E	Wrecks	(7) 1° 56.1′ N 102° 14.1′ E (8) 1° 55.5′ N 102° 15.4′ E
E	(a) 1° 13.3′ N 103° 24.3′ E (b) 1° 13.3′ N 103° 27.4′ E (c) 1° 09.3′ N 103° 27.4′ E (d) 1° 09.3′ N 103° 24.3′ E	Wrecks	(9) 1° 11.8′ N 103° 25.9′ E (10) 1° 10.8′ N 103° 25.8′ E

(to be continued)

Areas/Points	Position	Subject	Remarks
F	(a) 1° 06.7′ N 103° 40.6′ E (b) 1° 06.7′ N 103° 43.6′ E (c) 1° 03.7′ N 103° 43.6′ E (d) 1° 03.7′ N 103° 40.6′ E	Wreck	(11) 1° 05.2′ N 103° 42.1′ E
G	(a) 1° 09.1′ N 103° 43.9′ E (b) 1° 09.1′ N 103° 46.9′ E (c) 1° 06.1′ N 103° 46.9′ E (d) 1° 06.1′ N 103° 43.9′ E	Wreck	(12) 1° 07.6′ N 103° 45.4′ E
H	(a) 1° 12.0′ N 103° 47.4′ E (b) 1° 12.0′ N 103° 50.4′ E (c) 1° 09.0′ N 103° 50.4′ E (d) 1° 09.0′ N 103° 47.4′ E	Danger	(13) 1° 10.5′ N 103° 48.9′ E
I	(a) 1° 17.5′ N 104° 13.5′ E (b) 1° 17.5′ N 104° 16.5′ E (c) 1° 14.5′ N 104° 16.5′ E (d) 1° 14.5′ N 104° 13.5′ E	Wreck	(14) 1° 16.0′ N 104° 15.0′ E
J	(1) 2° 17.4′ N 101° 49.0′ E (2) 2° 15.6′ N 101° 49.6′ E	Shoals	
K	2° 17.2′ N 101° 54.2′ E	Shoal	
L	(a) 1° 46.2′ N 102° 42.8′ E (b) 1° 42.6′ N 102° 50.0′ E (c) 1° 42.0′ N 102° 49.8′ E (d) 1° 45.8′ N 102° 42.6′ E	Shoal	

(to be continued)

Areas/Points	Position	Subject	Remarks
a	2° 10.2′ N 101° 52.0′ E	Shoal	
b	1° 46.4′ N 102° 43.3′ E	Wreck	
c	1° 34.0′ N 103° 05.0′ E	Wreck	
d	1° 12.2′ N 103° 34.3′ E	Wreck	
e	1° 07.4′ N 103° 44.2′ E	Wreck	
f	2° 28.0′ N 101° 35.4′ E	Wreck	
g	2° 16.0′ N 101° 47.7′ E	Shoal	
h	1° 15.8′ N 103° 19.8′ E	Wreck	
i	1° 11.1′ N 103° 33.0′ E	Wreck	
j	2° 58.2′ N 100° 49.5′ E	Wreck	
k	2° 53.9′ N 100° 52.0′ E	Shoal	
l	2° 51.1′ N 101° 00.0′ E	Shoal	
m	1° 59.3′ N 102° 12.4′ E	Wreck	

1.3 Study Schedule

The field work was divided into three (3) phases, the first phase study in the areas assigned to the Government of Malaysia, the second phase study in the areas assigned to the Government of Singapore and the third phase study in the areas assigned to the Government of Indonesia ; and the hydrographic survey in each phase was carried out in the following areas :

(1) First Phase Study : October 1996 to March 1997
(Assigned Areas to Malaysia)
1) Group Area 2 : Sub-Areas B, C, J and K、 Points f and g
2) Group Area 4 : Sub-Area L、 Points b and c

(2) Second Phase Study : May 1997 to August 1997
(Assigned Areas to Singapore)
1) Group Area 5 : Sub-Areas G and H、 Points d, e and i
2) Group Area 6 : Sub-Area I

(3) Third Phase Study : August 1997 to March 1998
(Assigned Areas to Indonesia)
1) Group Area 1 : Sub-Area A、 Points j, k and l
2) Group Area 3 : Sub-Area D、 Points a and m
3) Group Area 5 : Sub-Areas E and F、 Point h

These field works include the final data processing and preparation of smooth sheets in Littoral States.

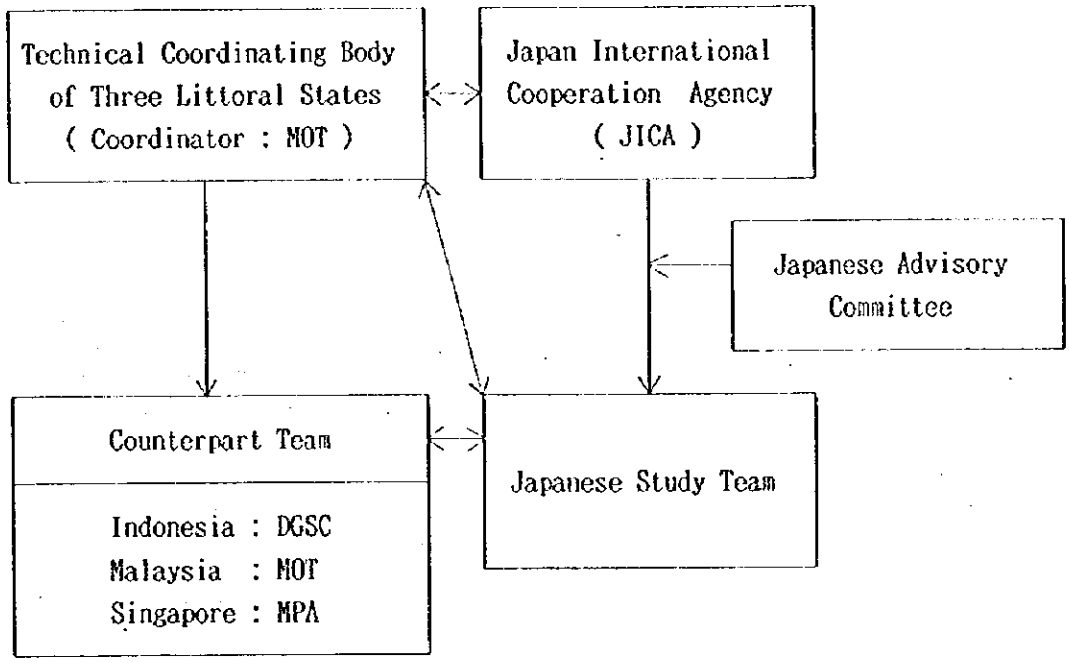
1.4 Organization

The study was carried out by JICA through the Study Team with the cooperation of Technical Counterparts and the Advisory Committee organized by JICA.

The organization consists of the following interrelated elements :

(1) Japan International Cooperation Agency (JICA)
(2) Technical Coordinating Body
(3) Japanese Advisory Committee
(4) Japanese Study Team
(5) Counterpart Team

The organizational structure is shown in Figure 1-2.



[Note] DGSC : Directorate General of Sea Communication in Indonesia
MOT : Ministry of Transport in Malaysia
MPA : Maritime and Port Authority of Singapore

Fig. 1-2 Organizational Structure of the Study

1.4.1 Technical Coordinating Body of Three Littoral States

The Technical Coordinating Body, represented by government agencies of the three Littoral States, is responsible for the planning, organization and execution of the Study. The government of Malaysia, through its Ministry of Transport, coordinates the work of the Study for the three Littoral States.

The members of the Technical Coordinating Body for the Study are listed in Table 1-2.

1.4.2 Advisory Committee

JICA organized an Advisory Committee headed by Dr. Hideo Nishida to advise the Study Team.

The committee was made up of three experts from the Hydrographic Department, Maritime Safety Agency of Japan, as shown in Table 1-3.

1.4.3 Japanese Study Team

The Japanese Study Team, which was engaged by JICA to effect the implementation of the Study, was headed by Mr. Takeyasu Kikuta.

The members of the Japanese Study Team are listed in Table 1-4.

JICA also dispatched inspectors from the Japan Hydrographic Association, to the Littoral States to conduct quality inspection ; Mr. Masayoshi Hirao for the first phase study, Mr. Motoji Kawanabe and Mr. Masayoshi Hirao for the second phase study and Mr. Ryoichi Horii and Mr. Masayoshi Hirao for the third phase study.

1.4.4 Counterpart Team

The Counterpart Team consisted of technical experts from the respective government agencies representing each of the Littoral States. These members are from DGSC of Indonesia, MOT of Malaysia and MPA of Singapore. They cooperated with

the Japanese Study Team and jointly executed the works.

The Counterpart Team members for the Study are listed in Table 1-5.

1.4.5 Acknowledgements

A number of organizations and persons, both local and from the organizations of the respective Littoral States, had extended their cooperation and assistance to the Study Team throughout the Study.

The Study Team greatly appreciates their cooperation and assistance which have facilitated the smooth progress and timely completion of the field survey. The Study Team would like to express their gratitude to the people and organizations including the crews of MV Pedoman, Investigator, MV Bimasakti and MV Mizan.

Table 1-2 List of the Technical Coordinating Body Members

Name	Post / Institution
(Coordinator)	
O. C. Phang (until Sep. 1997)	Under-Secretary, Maritime Division, Ministry of Transport (MOT)
Rogayah Ismail (from Nov. 1997)	Under-Secretary, Maritime Division, MOT
Abdullah Yusuff Basiron	Principal Ass. Secretary, Maritime Safety, MOT
Zainal Abidin Ishak	Assistant Secretary, Maritime Safety, MOT
(Indonesia)	
Nisfan	Director of Navigation, Directorate General of Sea Communication(DGSC), Ministry of Communications
A. Tonny Budiono	Chief, Navigational Survey Section, Directorate of Navigation, DGSC
Nicolas P. Ello	Chief Hydrographer, Hydro Oceanographic Service
Tarcisius Walla	Communication Attache, Indonesian Embassy in Singapore
Nazri Emnel	Communication Attache, Indonesian Embassy in Malaysia
(Malaysia)	
Raja Malik S. R. K.	Acting Deputy Director General, Marine Department Peninsular Malaysia, MOT
Ahmad Othman	Acting Director, Safety of Navigation Division, Marine Department Peninsular Malaysia
Roslee Mat Yusof	Principal Assistant Director, Safety of Navigation Division, MDPM
Mohd Rasip Hassan	Director General, Hydrographic Department
(Singapore)	
Wilson N. F. Chua	Hydrographer, Maritime and Port Authority of Singapore (MPA)
Chiew Chee Mun	Deputy Hydrographer, MPA
Peggy Koh	Cartographer, MPA
Low Koon Tiong	Assistant Hydrographer, MPA

Table 1-3 List of the Advisory Committee Members

Name	Post / Organization
Hideo Nishida	Chairman Hydrographic Department, Maritime Safety Agency, Ministry of Transport
Shoichi Kokuta	Hydrographic Department, Maritime Safety Agency, Ministry of Transport
Kenzo Imai	Hydrographic Department, Maritime Safety Agency, Ministry of Transport

Table 1-4 List of the Japanese Study Team Members

Name	Role / Company
Takeyasu Kikuta	Team Leader (Geophysicist) Kokusai Kogyo Co., Ltd.
Sachio Ozawa	Sub-Team Leader (Hydrographer) Sanyo Techno Marine, Inc.
Akira Nakanishi	Chief Hydrographer Kokusai Kogyo Co., Ltd.
Kenji Sakai	Hydrographer Kokusai Kogyo Co., Ltd.
Mitsuo Yuge	Hydrographer Sanyo Techno Marine, Inc.
Yukiyoshi Fujita	Surveyor Kokusai Kogyo Co., Ltd.
Hiroshi Miyake	System Engineer Kokusai Kogyo Co., Ltd.
Hiroyuki Nakai	Coordinator Kokusai Kogyo Co., Ltd.

Table 1-5 List of the Counterpart Team Members

Name	Charge
(Indonesia)	
Suryo	Control Point Survey, Hydrographic Survey Data Processing
Iswinardi	Control Point Survey, Data Processing
Masjhuri	Hydrographic Survey, Data Processing
Suyitno	Hydrographic Survey, Data Processing
Tuparman	Hydrographic Survey
Dwi Santosa	Hydrographic Survey
B. Imron Toha	Hydrographic Survey
Salamet	Hydrographic Survey
Rosyid	Hydrographic Survey
Soetjahjo Nth	Hydrographic Survey
Purwadi	Hydrographic Survey
Bagus Puji Wahyono	Hydrographic Survey
Jaka Prasetya	Hydrographic Survey
Endoh Surachman	Hydrographic Survey
Abdul Azis	Hydrographic Survey
Kawit	Hydrographic Survey
Soeko Tri. H.	Hydrographic Survey
Adi Susanto	Hydrographic Survey
Gentio Harsono	Hydrographic Survey
Tri Wiyanto	Hydrographic Survey
Supriyono	Hydrographic Survey
Eko Maulana A. S.	Data Processing
(Malaysia)	
Yusof Latip bin Ali	Control Point Survey, Hydrographic Survey, Data Processing
Mohd. Nazam bin Sulaiman	Control Point Survey, Hydrographic Survey
Abd Razak bin Abu Hassan	Control Point Survey, Hydrographic Survey, Data Processing
Mohamad Sharahi bin Abu. Yamin	Hydrographic Survey
Ismail bin Mohd. Deni	Hydrographic Survey
Abdul Aziz bin Darawi	Hydrographic Survey
Norhizam bin Hassan Abd. Ghani	Hydrographic Survey
Khairul Anwar bin Mohd Sapon	Hydrographic Survey
Roslan bin Ahmad	Hydrographic Survey
Mohd Eza bin Dato' Yaacob	Hydrographic Survey
Abdul Halim bin Mohd Ashaari	Data Processing
Azhan bin Abdul Mutalib	Data Processing

(to be continued)

Name	Charge
(Singapore)	
Chiew Chee Mun	Control Point Survey
Lam Swee Kiong	Control Point Survey, Hydrographic Survey
Chua Weng Kuan	Control Point Survey, Hydrographic Survey Data Processing
Moktar bin Mohd Amin	Control Point Survey, Hydrographic Survey Data Processing
Sahlan bin Ali	Hydrographic Survey
Wong Chee Kwong	Hydrographic Survey
Chee Kian Siong	Hydrographic Survey
Choy Kum Weng	Hydrographic Survey
Ngeow Siong Wei	Hydrographic Survey
Chen Yin Kiat	Hydrographic Survey
Lim Kar Wooi	Hydrographic Survey
Abdullah bin Sarmani	Hydrographic Survey, Data Processing
Chai Chee Meng	Hydrographic Survey, Data Processing
Lam Yan Kei	Hydrographic Survey, Data Processing
Seetoh Hon	Hydrographic Survey, Data Processing
Lee Kok Keong	Data Processing
Wong Tuck Meng	Data Processing

CHAPTER 2

STUDY ITEMS AND PROCEDURE

CHAPTER 2 : STUDY ITEMS AND PROCEDURE

2.1 General Outline

The Study covered the following items :

(1) Preparatory Works in Japan
(2) Discussions concerning the Plan of Operation
(3) Preparatory Works in the Littoral States
(4) Control Point Survey
(5) Tidal Observation
(6) Hydrographic Survey (Sounding and Search)
(7) Data Processing
(8) Preparation of Smooth Sheets
(9) Preparation and Submission of Progress Reports
(10) Verification of Smooth Sheets by Japanese Authority
(11) Production of ENC Database in Japan
(12) Preparation and Submission of Final Report

The flow-chart of the Study is shown in Figure 2-1.

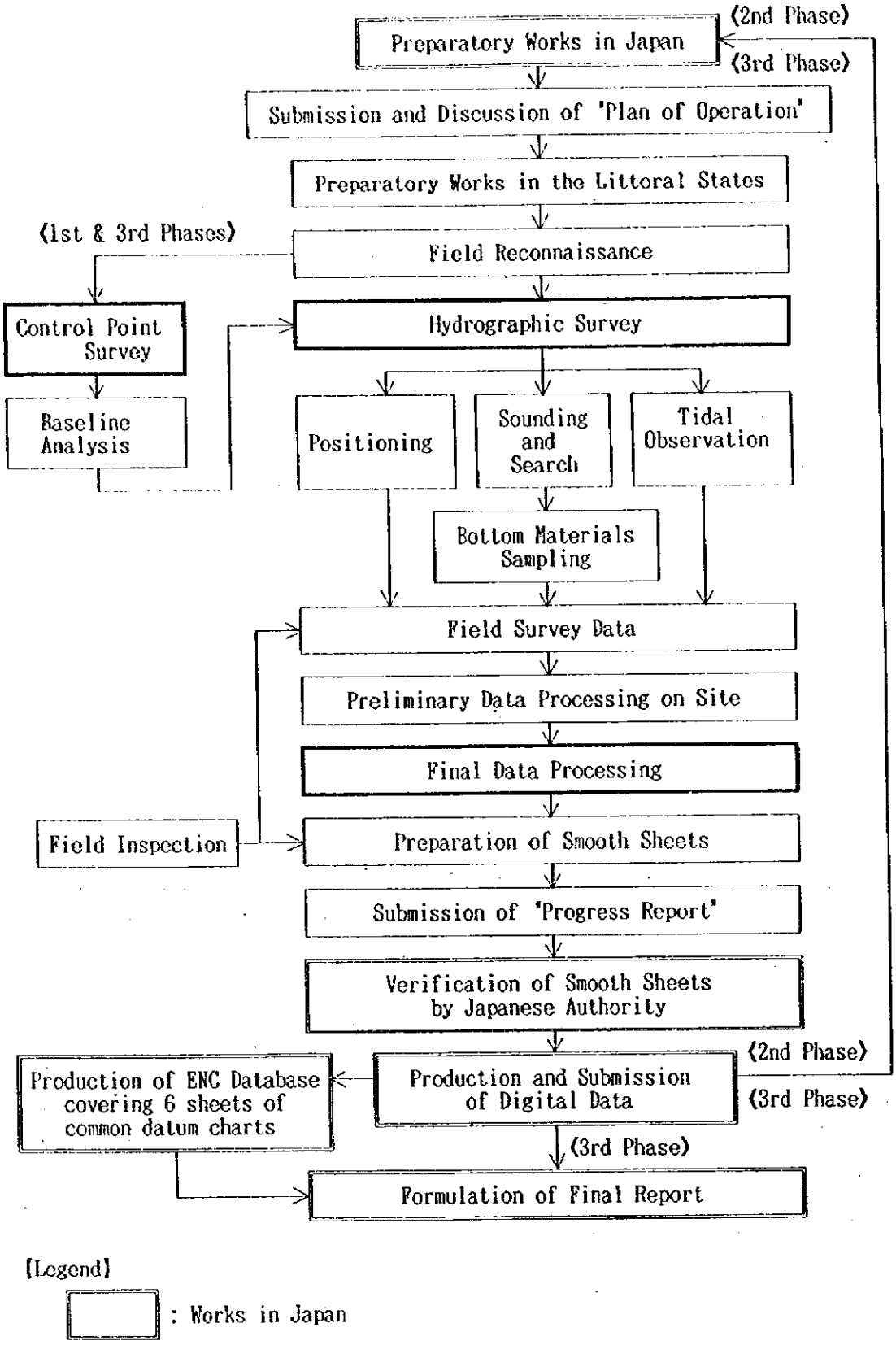


Fig. 2-1 Overall Flow-Chart of the Study

2.2 Standards, Coordinates and Datum Level

The Study was carried out in accordance with the International Hydrographic Organization (IHO) standards for hydrographic survey (second order of the fourth edition of S-44).

The ellipsoid, projection, origin of coordinates and chart datum level used for the Study were as follows :

Ellipsoid : WGS-84 Datum
Semimajor Axis : 6378137 m
Flattening : 1/298.257223563
Projection : Transverse Mercator Projection
Origin of Coordinates : Center of Each Smooth Sheet
Chart Datum Level : Lowest Astronomical Tide (LAT)

The ENC database was produced in accordance with the International Standards and Specification for ENC, IHO S57 Edition 3.

2.3 Control Point Survey

Prior to the hydrographic survey, control point survey was carried out at fourteen (14) points shown in Table 2-1 of existing control points and other new points necessary for sounding operation.

The coordinates of control points were determined by a static method of Differential Global Positioning System (DGPS) using GPS Receivers : Trimble 4000SSi. The observation was carried out for over two hours at three points on a day.

The fundamental point on Pulau Pisang is the origin of the control point survey under the Study.

Table 2-1 List of Control Surveying Points

Name of Country	Control Points			Remarks
	St. No	Name	Height	
Singapore	St. 1	Raffles Lighthouse	32m	
Malaysia	St. 2	Pulau Pisang	150m	Fundamental Point
Singapore	St. 3	Bedok Lighthouse	76m	
Indonesia	St. 4	Pulau Batam	--	
Indonesia	St. 5	Pulau Iyu Kecil	41m	
Malaysia	St. 6	Segenting Lighthouse	86m	
Indonesia	St. 7	Tanjung Parit	42m	
Malaysia	St. 8	Malacca	—	
Indonesia	St. 9	Medang Lighthouse	52m	
Malaysia	St. 10	Cape Rachado	118m	
Malaysia	St. 11	One Fathom Bank Lighthouse	34m	
Malaysia	St. 12	Jugra Lighthouse	146m	
Malaysia	GP. 9	Labu	59m	Control Point
Malaysia	GP. 18	Morib	- 0m	Control Point
Total	14 points			

[Note] Refer to Figure 1-1 for the location of control points

2.4 Tidal Observation

In order to determine the chart datum level for the tidal reduction to sounding data, temporary tide stations using digital tide gauges (Rigosya RM-5525WL) and tide poles were established at the following nine locations :

(1) Tanjung Gabang for Sub-Area B
(2) Port Dickson for Sub-Area C and Point f
(3) Cape Rachado for Sub-Areas J, K and Point g
(4) Segenting for Sub-Area L and Points b and c
(5) Tanjung Ayam for Sub-Area I
(6) Pulau Iyu Kecil for Sub-Area E and Point h
(7) One Fathom Bank Lighthouse for Sub-Area A and Points j, k, l
(8) Raleigh Shoal Beacon for Point a
(9) Pulau Undan for Sub-Area D and Point m

Existing tide stations at Raffles Lighthouse and Sultan Shoal were used for the tidal reduction for Sub-Areas F, G, H and Points d, e, i. The locations of tide stations are shown in Figure 1-1.

The chart datum Level (CDL) in each survey area was determined using the tidal harmonic constants and the results obtained during the tidal study carried out by Japan and the three Littoral States from 1977 to 1979.

The long-term mean sea level of the temporary tide station was obtained by comparing the short-term mean sea level observed at the station with the mean sea level of the same period at the nearest standard tide station.

2.5 Hydrographic Survey (Sounding and Search)

The sounding and search operation was conducted using the survey launch 'Zeta I' supported by a mother vessel 'Pedoman' on the first phase, 'Investigator' on the second phase and 'Nizan' supported by a mother vessel 'Bimasakti' on the third phase, equipped with a precise four-beam echo sounder, Senbon Denki PDR-601, and a sidescan sonar, C-Max CM800/S (refer to Figure 2-2).

The position of survey launch was determined by real-time short range Trimble Differential Global Positioning System (DGPS), or long range Aquapos SERCEL DGPS. The reference station of long range DGPS is located at Batam Island.

The standard interval between sounding lines was 200 meters. For the detailed identification of wrecks and determination of the least depth of shoals, sounding lines were intensified to ensure full investigation of the features.

The speed of survey launch was kept at about five knots in order to obtain favourable records. The position fixing interval was 5 meters.

Sounding depths were corrected for sound velocity in sea water by bar-check method and verified by sound velocity meter frequently. Observed tidal heights were used for the reduction of soundings.

The planned lengths of survey lines of each survey area in the Study are listed in Table 2-2.

Table 2-2 Planned Total Length of Survey Lines in Each Area

Group Area	Sub-Area Point	Planned Length of Survey Lines	
		Excluding Supplementary Lines	Including Supplementary Lines
1	A	623 Kilometers	810 Kilometers
	j	159	207
	k	102	133
	l	102	133
2	B	263 Kilometers	342 Kilometers
	C	159	207
	J	154	200
	K	126	164
	f	159	207
	g	120	156
3	D	289 Kilometers	376 Kilometers
	a	150	195
	m	150	195
4	L	139 Kilometers	181 Kilometers
	b	120	156
	c	159	207
5	E	263 Kilometers	342 Kilometers
	F	150	195
	G	159	207
	H	159	207
	d	143	186
	e	120	156
	h	159	207
	i	159	207
6	I	159 Kilometers	207 Kilometers
Total		4,445 Kilometers	5,783 Kilometers*

[Note] 5,783 Kilometers* : including 30% supplementary lines

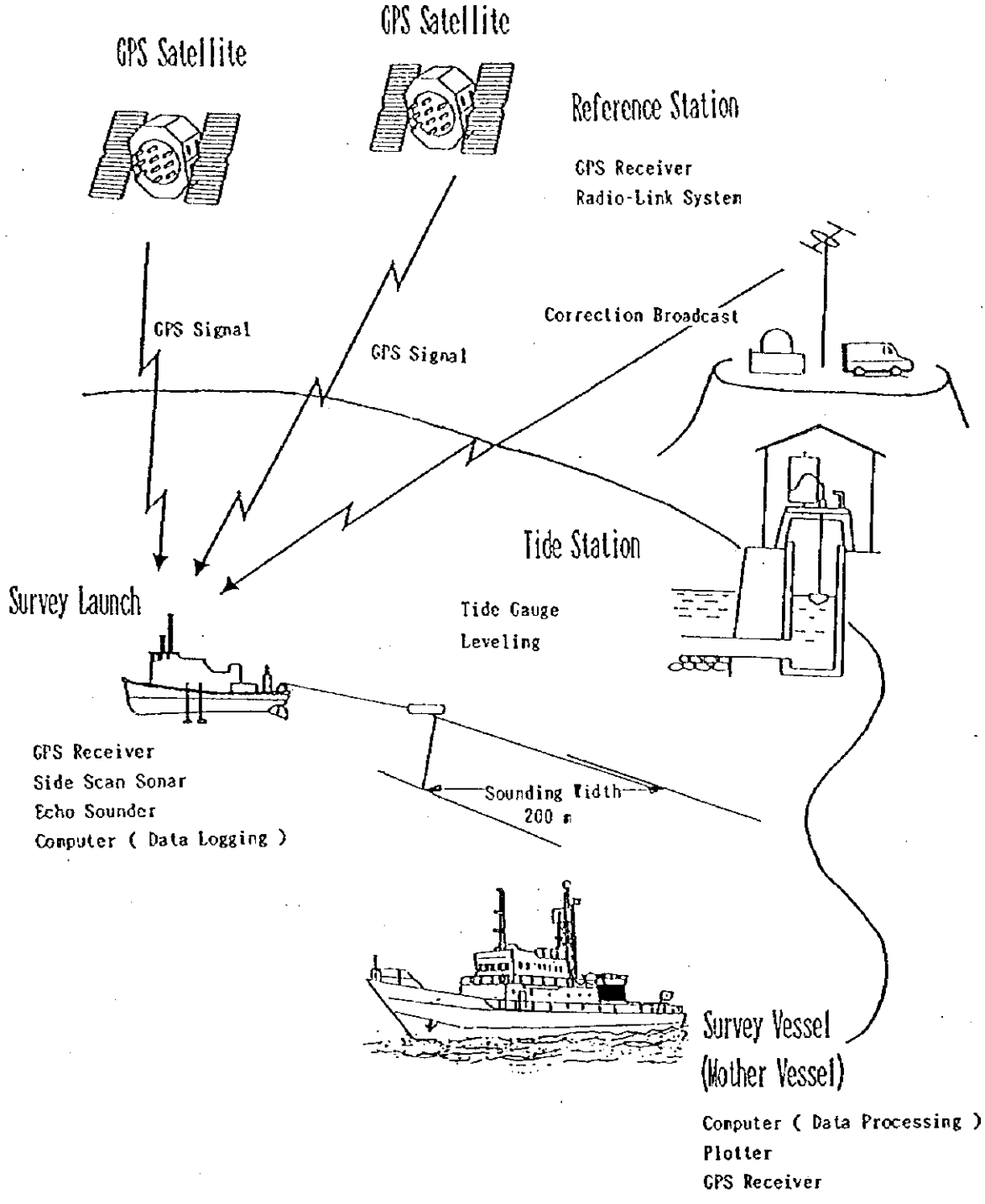


Fig. 2-2 Illustration of Hydrographic Survey

2.6 Bottom Materials Sampling

The sampling of bottom materials using a cylindrical dredge was carried out near the shoals and patches of every survey area in order to determine the nature of seabed.

2.7 Data Processing

Daily preliminary data processing was carried out in the mother vessel on site in order to check the coverage of survey areas and the existence of shoals and wrecks. The procedure was as follows :

(1) Storing positioning and sounding data, including the time they were acquired, in floppy disks on board survey launch.
(2) Developing preliminary track charts to confirm the survey area coverage by computer/plotter.
(3) Interpreting sidescan sonar records to confirm shoals and wrecks.
(4) Developing preliminary sounding plots to confirm the shapes and position of shoals and wrecks by computer/plotter.
(5) Selecting detailed survey areas to confirm the precise positions and the shallowest depths.

Final data processing, including tidal reduction for sounding data, was carried out in the offices of relevant authorities following the completion of the field works. Final track plots and sounding plots were produced using a computer/plotter.

Finally, smooth sheets of each survey area were prepared on Matte Films at a scale of 1:20,000 incorporating the results of survey.

2.8 Digital Data and ENC Database

Digital files of smooth sheets were prepared after completion of smooth sheets. Electronic Navigational Charts (ENC) database covering six (6) sheets of common datum charts of the Straits of Malacca and Singapore was prepared in Japan.

CHAPTER 3

STUDY RESULTS

CHAPTER 3 : STUDY RESULTS

3.1 Control Point Survey

3.1.1 Network and Session of Control Points

In order to perform the control point survey effectively, fourteen (14) points including existing control points, covering the whole survey areas, were selected after careful examination and field reconnaissance considering topographic features and locations of survey areas.

The network and list of control points used for the survey are shown in Figure 3-1 and Table 3-1. Detailed descriptions of the control points are shown in the attached Appendix 2.

Table 3-1 General Description of Control Points

St.No	Name of Control Point	Place	Height	Remarks
St. 1	Raffles Lighthouse	Lighthouse	37 m	Marker Plate
St. 2	Pulau Pisang	Fundamental Point	136	Marker Stone
St. 3	Bedok Lighthouse	Lighthouse	84	Marker Plate
St. 4	Pulau Batam	Batam Station	11	
St. 5	Pulau Iyu Kecil	Lighthouse	49	Marker Plate
St. 6	Segenting Lighthouse	Lighthouse	89	Marker Plate
St. 7	Tanjung Parit	Lighthouse	48	Marker Plate
St. 8	Malacca(Mahkota M.C.)	Building	49	Marker Plate
St. 9	Tanjung Medang	Lighthouse	0.3	Marker Plate
St.10	Cape Rachado	Lighthouse	102	Marker Plate
St.11	One Fathom Bank	Lighthouse	30	Marker Plate
St.12	Jugra Lighthouse	Lighthouse	140	Marker Plate
GP. 9	Labu	Control Point	59	Marker Stone
GP.18	Morib	Control Point	- 0.1	Marker Stone

[Note] Height is above Ellipsoid.

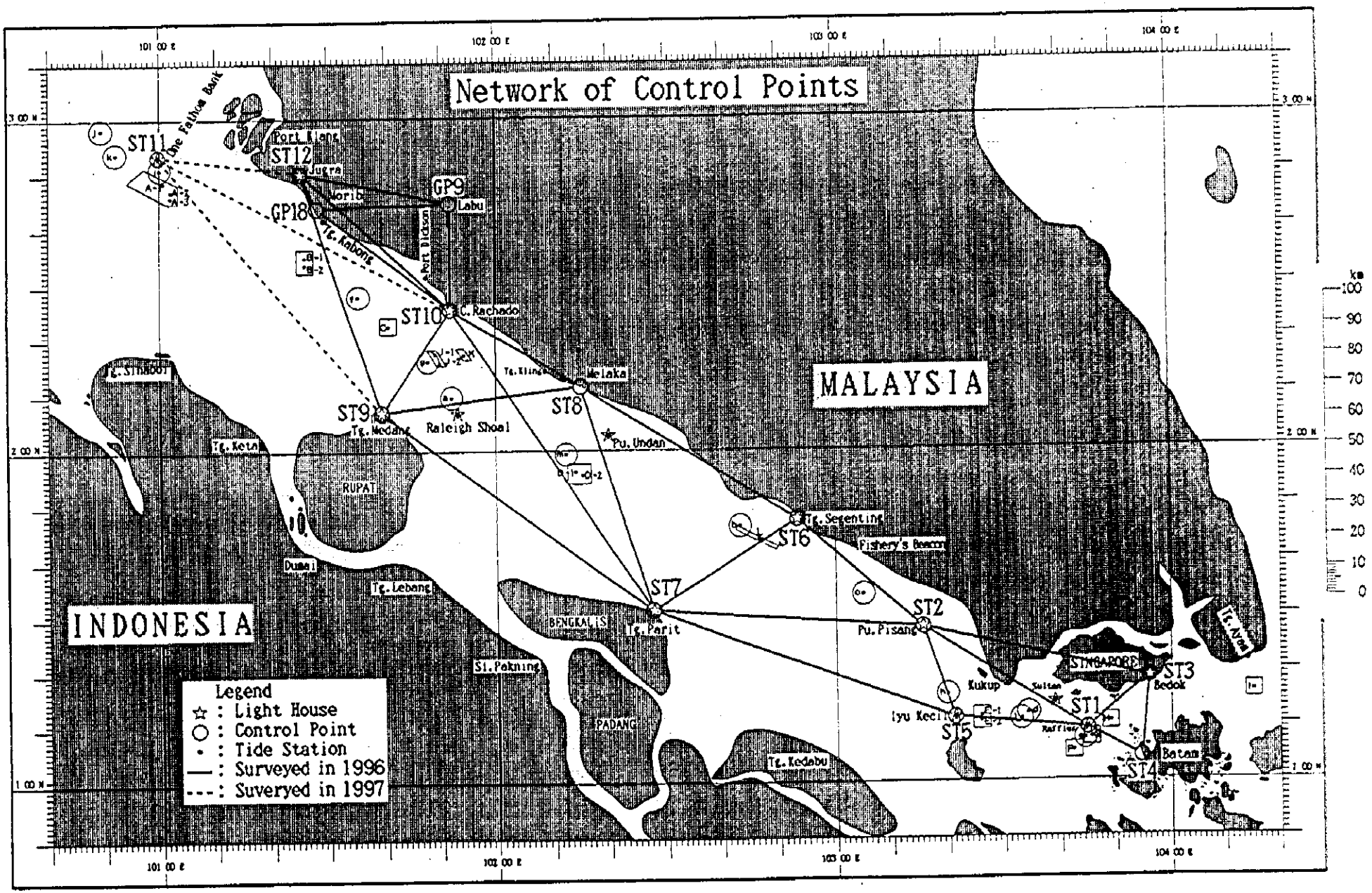


Fig. 3-1 Network of Control Points

The session of control point survey is summarized in Table 3-2 and observation date of each session is shown in Table 3-3. Twelve (12) sessions, ten sessions on the first phase and two sessions on the third phase, were developed and the observation at each session was carried out for over two hours.

Table 3-3 Observation Date of Each Session

Session	Observation Date and Time
	1996
Session I	October 18 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session II	October 19 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session III	October 21 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session IV	October 22 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session V	October 23 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session VI	October 24 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session VII	October 25 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session VIII	October 26 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session IX	October 28 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
Session X	October 30 : $12^h00^m-13^h10^m$ & $13^h20^m-14^h30^m$
	1997
Session XI	October 9 : $10^h19^m-12^h50^m$ & $15^h16^m-17^h50^m$
Session XII	October 10 : $10^h11^m-12^h30^m$

Table 3-2 Session of Control Point Survey

St.No	Observation Point	Session											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
St. 1	Raffles Lighthouse	①	①	①									
St. 2	Pulau Pisang		④	④	④	④							
St. 3	Bedok Lighthouse	②	②										
St. 4	Pulau Batam	③											
St. 5	Pulau Iyu Kecil			③	③								
St. 6	Segenting Lighthouse					①	①						
St. 7	Tanjung Parit				②	②	②	②					
St. 8	Malacca						③	③	③				
St. 9	Tanjung Medang							④	④	④		①	
St.10	Cape Rachado							①	①	①	①	②	
St.11	One Fathom Bank											③	③
St.12	Jugra Lighthouse									②	②		②
GP. 9	Labu										④		
GP.18	Morib										③		

【Note】 ① ～ ④ : Name of GPS Receiver (No.1 to No.4)

3.1.2 Results of Control Point Survey

The control point survey was performed by a static method of Differential Global Positioning System (DGPS) using GPS Receivers : Trimble 4000SSi. The fundamental point on Pulau Pisang : St.2 was selected as the origin of this survey.

At additional two points in the Batam Island other than the above mentioned fourteen points, the control point survey was also carried out to confirm the exact location of reference stations for SERCEL's long range and medium range systems.

Finalized coordinates after baseline analysis using a Trimble's software system "GPSurvey" under the condition of fixing three points at Pulau Pisang (St.2), Labu (GP.9) and Morib (GP.18) are shown in Table 3-4.

As a reference, the coordinates under the condition of fixing one point at Pulau Pisang (St.2) and those of centers of lighthouses on which control points were settled are shown in the attached Appendix 3.

Table 3-4 Results of Control Point Survey

Control Point		Coordinates		Height above Ellipsoid
St.No	Name	Latitude	Longitude	
St. 1	Raffles Lighthouse	1° 09' 36.418320" N	103° 44' 26.972352" E	36.9446m
St. 2	Pulau Pisang	1° 28' 08.251640" N	103° 15' 23.163590" E	136.0750m
St. 3	Bedok Lighthouse	1° 18' 32.671883" N	103° 55' 58.319961" E	83.5214m
St. 4	Pulau Batam	1° 03' 57.854990" N	103° 54' 31.752835" E	10.9447m
St. 4L	-ditto- (Long R.)	1° 03' 57.820930" N	103° 54' 31.741840" E	—
St. 4M	-ditto-(Medium R.)	1° 03' 58.010205" N	103° 54' 31.632358" E	—
St. 5	Pulau Iyu Kecil	1° 11' 27.752264" N	103° 21' 07.805106" E	48.7887m
St. 6	Segenting Light H.	1° 47' 27.619195" N	102° 53' 21.352601" E	88.6688m
St. 7	Tanjung Parit	1° 31' 08.354259" N	102° 27' 29.465920" E	47.7923m
St. 8	Malacca	2° 11' 15.870786" N	102° 15' 05.569874" E	49.3313m
St. 9	Medang Lighthouse	2° 07' 27.395573" N	101° 39' 21.260730" E	0.3058m
St.10	Cape Rachado	2° 24' 26.141474" N	101° 51' 07.459113" E	102.0560m
St.11	One Fathom Bank	2° 53' 15.633675" N	100° 59' 43.949758" E	30.1730m
St.12	Jugra Lighthouse	2° 50' 08.812012" N	101° 25' 03.362285" E	140.3778m
GP. 9	Labu	2° 44' 26.335750" N	101° 51' 39.829810" E	59.1140m
GP.18	Morib	2° 43' 21.512270" N	101° 27' 22.586780" E	- 0.1130m

[Note] 1. St.4L and St.4M are centers of reference stations of SERCEL's Long Range System and Medium Range System, respectively.
2. St.2 : Pulau Pisang, GP.9 : Labu and GP.18 : Morib are fixed on baseline analysis.

3.2 Tidal Observation

3.2.1 Lowest Astronomical Tide

The Lowest Astronomical Tide (LAT) was agreed to be used as a chart datum level for the hydrographic survey of this study.

Therefore, tidal predictions at 17 stations along the Straits of Malacca and Singapore were carried out using existing tidal harmonic constants, which were obtained during the tidal study carried out by Japan and the three Littoral States in the Straits from 1977 to 1979 (refer to the attached Appendix 7 for the tidal harmonic constants used for the prediction).

On the tidal theory, it is known that any tidal variations associated with lunar declination will have a regular variation in a period of 18.61 years (generally referred to briefly as the nineteen-yearly variation).

Accordingly, the tidal prediction was performed for the period of nineteen years at each station by Hydrographic Department, Maritime Safety Agency of Japan, and the predicted lowest low water and highest high water were defined as a Lowest Astronomical Tide (LAT) and a Highest Astronomical Tide (HAT), respectively.

Table 3-5 shows the predicted LAT and HAT as well as the sum of principal four constituents, present Z_0 and Nearly Highest High Water (NHHW). The relation between each water level is shown in Figure 3-2.

The distribution of LAT and co-tidal chart of M_2 constituent along the Straits are shown in Figures 3-3 and 3-4, respectively.

Table 3-5 Lowest Astronomical Tide and Highest Astronomical Tide in the Straits of Malacca and Singapore

(Unit : m)

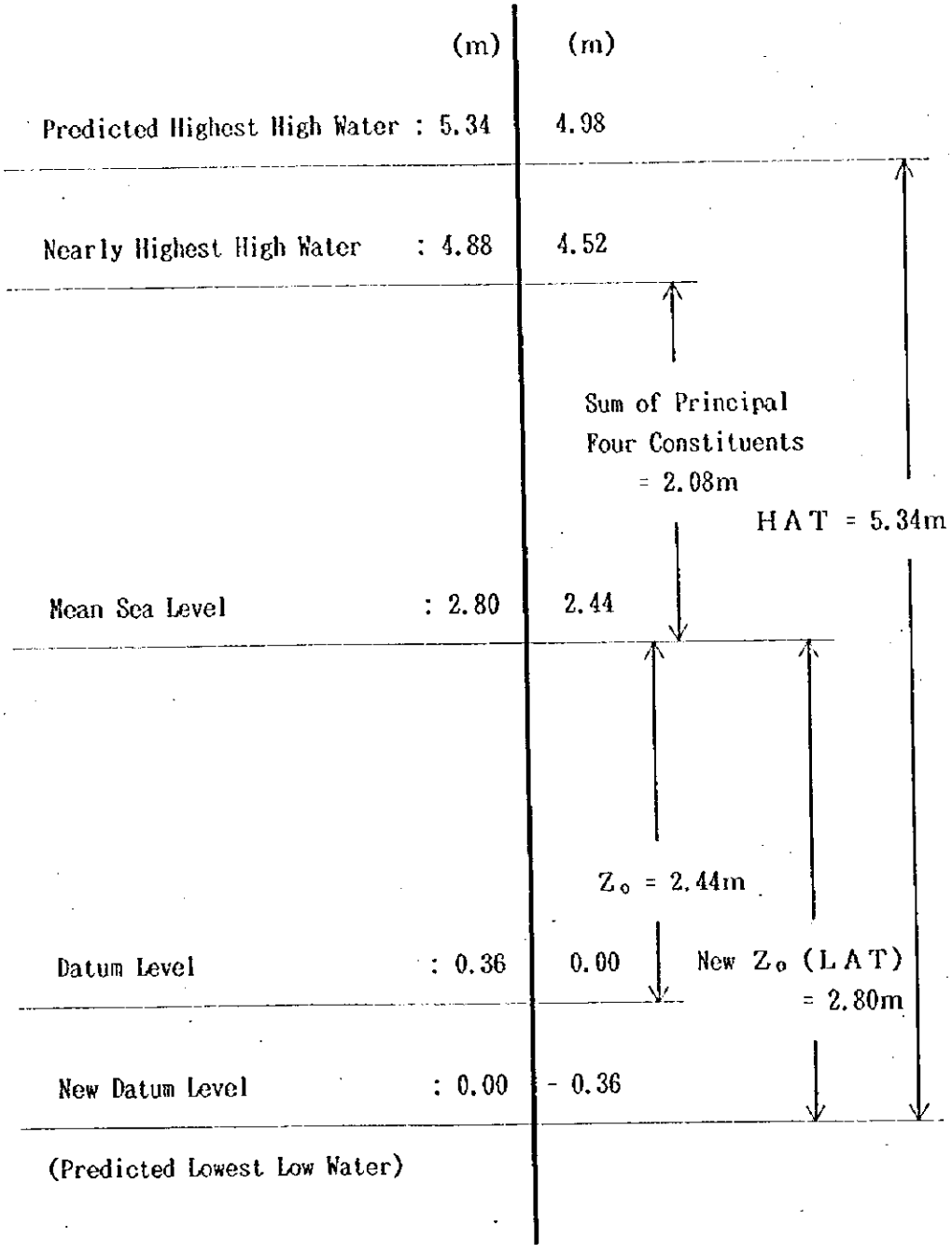
Name of Tidal Station	Sum of Principal Four Constituents	Present Z_o	Predicted Value		Nearly Highest High Water***
			LAT*	HAT**	
1. One Fathom Bank	2.08	2.44	2.72 (2.80)	5.34	4.88
2. Tanjung Gabang	1.73	1.83	1.96 (2.00)	4.21	3.73
3. Port Dickson	1.46	1.50	1.56 (1.60)	3.49	3.06
4. Malacca (Tg.Kling)	1.21	1.48	1.24 (1.30)	2.72	2.51
5. Tanjung Segenting	1.60	1.50	1.60 (1.60)	3.39	3.20
6. Pulau Pisang	1.86	1.80	1.78 (1.80)	3.82	3.66
7. Iyu Kecil	1.90	1.80	1.80 (1.80)	3.85	3.70
8. Raffles Lighthouse	1.72	1.71	1.59 (1.60)	3.35	3.32
9. Angler Bank	1.62	1.70	1.89 (1.90)	3.44	3.52
10. Tanjung Ayam	1.46	1.67	1.83 (1.90)	3.16	3.36
11. Horsburgh L.H.	1.30	1.55	1.74 (1.80)	3.03	3.10
12. Batu Ampar	1.65	1.70	1.86 (1.90)	3.43	3.55
13. Tanjung Medang	1.36	1.70	1.44 (1.50)	3.17	2.86
14. Tanjung Parit	1.46	1.46	1.50 (1.50)	3.14	2.96
15. Tanjung Senebui	1.97	2.32	2.44 (2.50)	4.82	4.47
16. Sultan Shoal L.H.	1.77	1.69	1.64 (1.70)	3.54	3.47
17. Kepala Jernih	1.76	1.76	1.68 (1.70)	3.61	3.46

〔Note〕 LAT* : Difference between Lowest Low Water predicted for 19 years (1990 to 2008) and Mean Sea Level. 〈 New Z_o 〉
Round values in parentheses were adopted on this study.

HAT** : Height of Highest High Water predicted for 19 years (1990 to 2008) above New Datum Level.

Nearly Highest High Water***
: Water level of Sum of Principal Four Constituents above Mean Sea Level.

【In case of One Fathom Bank】



【Note】 LAT : Lowest Astronomical Tide
HAT : Highest Astronomical Tide

Fig. 3-2 Definition of New Datum Level

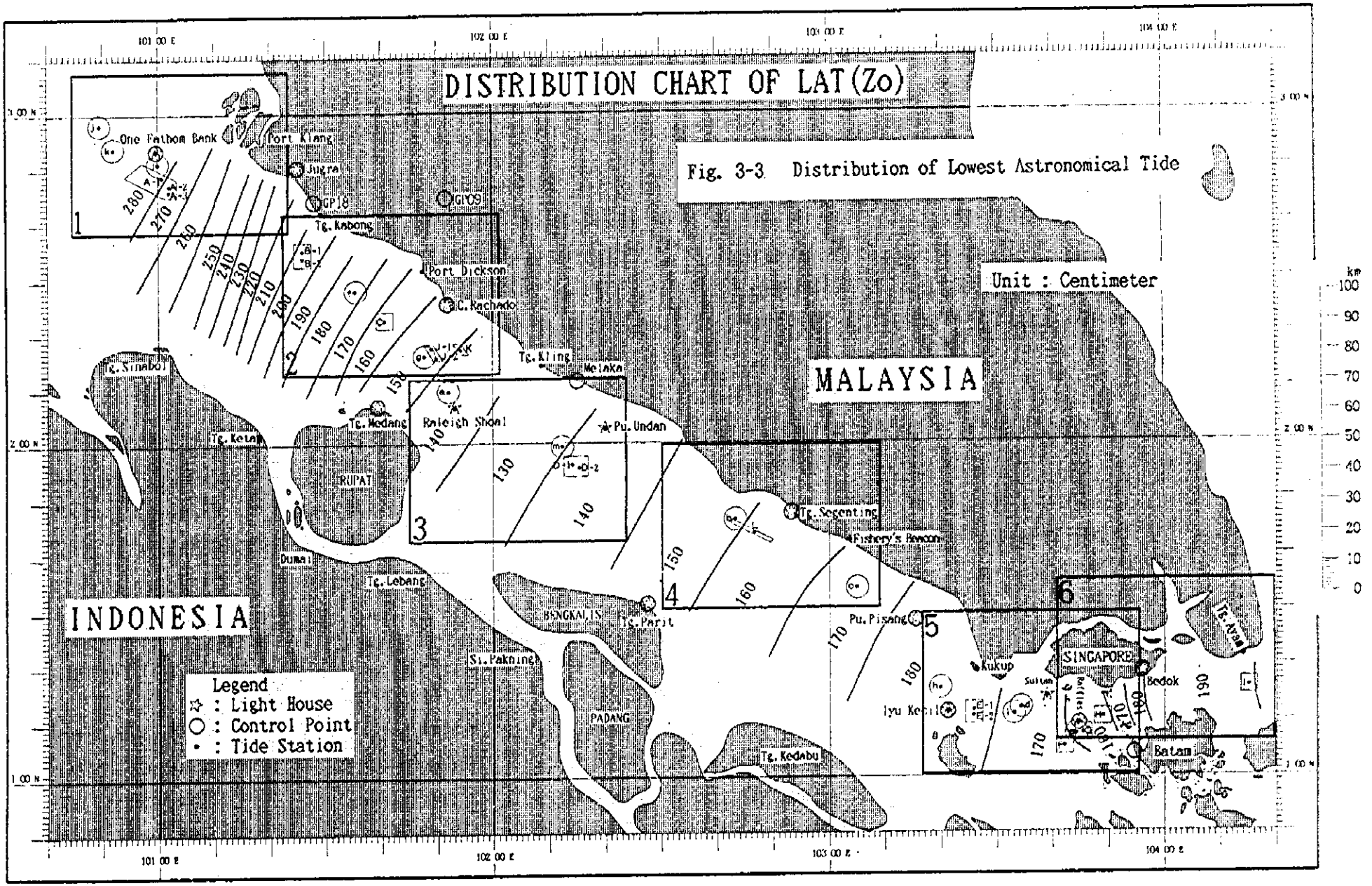


Fig. 3-3 Distribution of Lowest Astronomical Tide

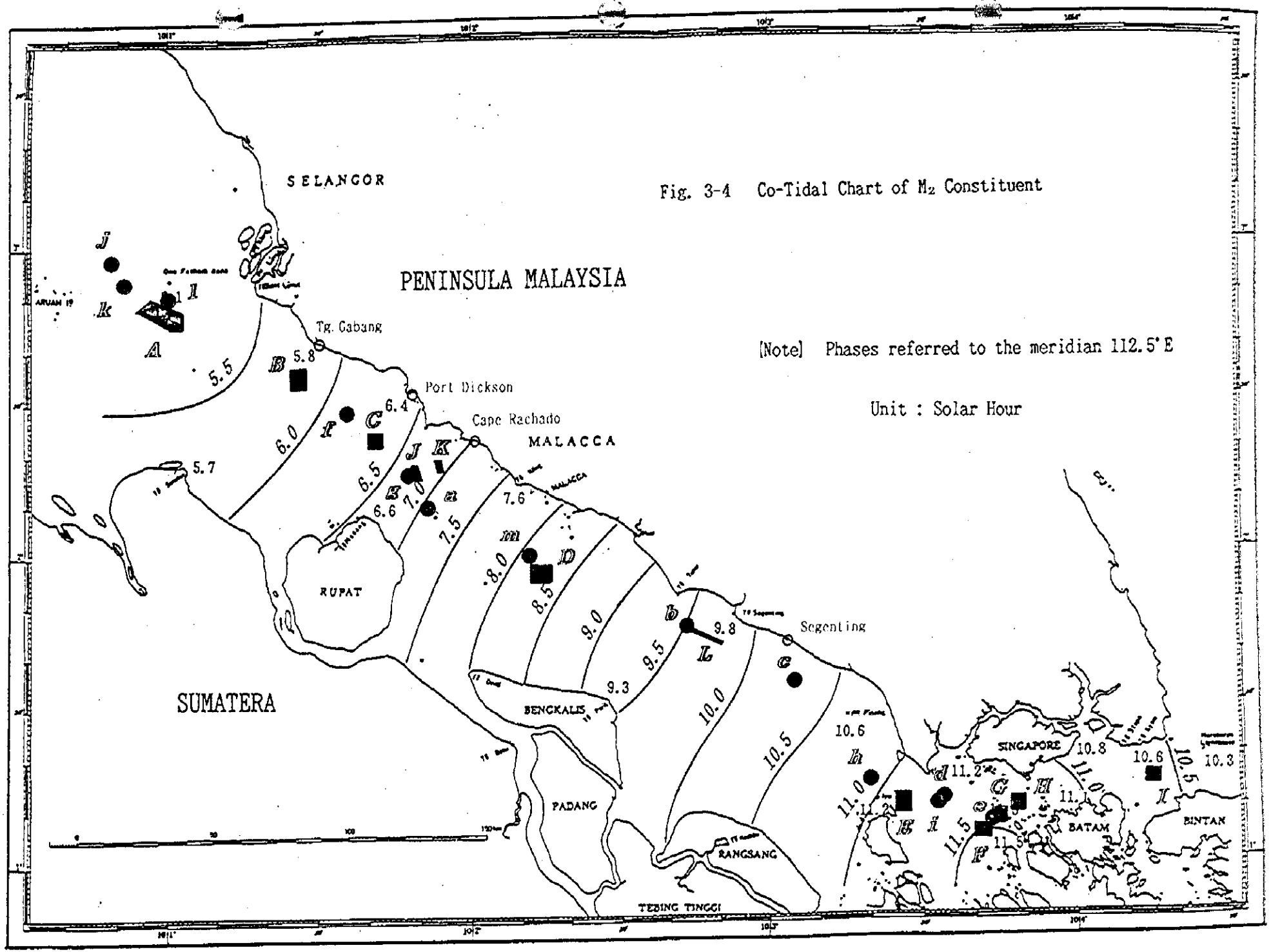


Fig. 3-4 Co-Tidal Chart of M_2 Constituent

[Note] Phases referred to the meridian 112.5°E

Unit : Solar Hour

3.2.2 Results of Tidal Observation

In order to determine the chart datum level for tidal reduction to sounding data, temporary tide stations using automatic tide gauges and tide poles were established at nine (9) points along the Straits as shown in Table 3-6.

Table 3-6 Location and Tidal Observation Period at Each Temporary Tide Station

Name of Station	Location		Observation Period
	Latitude	Longitude	
Tanjung Gabang	2°41.0′ N	101°29.2′ E	Nov. 8 to Nov.27, 1996
Port Dickson	2°31.5′ N	101°47.4′ E	Nov.25 to Dec.26, 1996
Cape Rachado	2°24.9′ N	101°53.9′ E	Nov.24 to Jan. 9, 1997
Segenting	1°42.5′ N	103°03.6′ E	Dec. 8 to Jan.16, 1997
Tanjung Ayam	1°21.4′ N	104°14.0′ E	May 30 to Jun.30, 1997
Iyu Kecil	1°11.5′ N	103°21.1′ E	Sep. 7 to Oct. 5, 1997
One Fathom Bank	2°53.3′ N	100°59.7′ E	Oct. 9 to Nov.17, 1997
Raleigh Shoal	2°06.8′ N	101°53.1′ E	Nov.18 to Nov.28, 1997
Pulau Undan	2°02.9′ N	102°20.0′ E	Nov.19 to Dec.17, 1997

The long-term mean sea levels at temporary stations were obtained by comparing the monthly mean sea levels with those at the nearest standard stations on principle (refer to the attached Appendix 6 for the long-term mean sea levels at temporary stations).

On practical tidal reduction for sounding data, above-mentioned temporary tide stations and two existing tide stations were used for the following survey areas and points :

1) Tanjung Gabang Station for Sub-Area B,
2) Port Dickson Station for Sub-Area C and Point f,
3) Cape Rachado Station for Sub-Areas J, K and Point g,

4) Segenting Station for Sub-Area L and Points b, c,
5) Tanjung Ayam Station for Sub-Area I,
6) Raffles Lighthouse Station* for Sub-Areas F, G, H and Point e,
7) Sultan Shoal Station* for Points d and i,
8) Iyu Kecil Station for Sub-Area E and Point h,
9) One Fathom Bank Station for Sub-Area A and Points j, k, l,
10) Raleigh Shoal Station for Point a, and
11) Pulau Undan Station for Sub-Area D and Point m.

(Note : Station* means an existing station)

Tidal diagrams showing the relation among Bench Mark, Chart Datum Level and Mean Sea Level at each temporary station are shown in Figures 3-5 to 3-13.

Station : Tanjung Gabang

position { 2° 41.0′ N
101° 29.2′ E

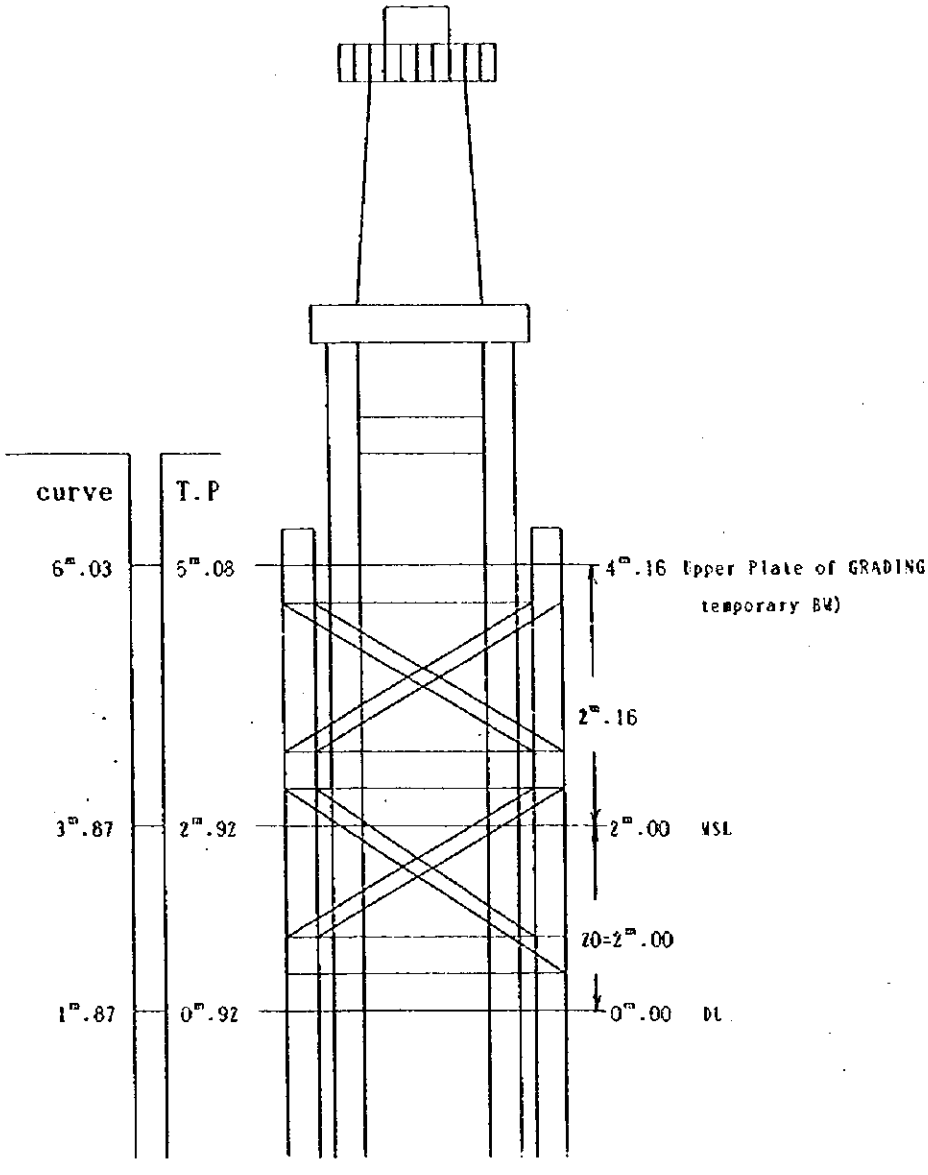


Fig. 3-5 Tidal Diagram of Temporary Tide Station

Station : Port Dickson

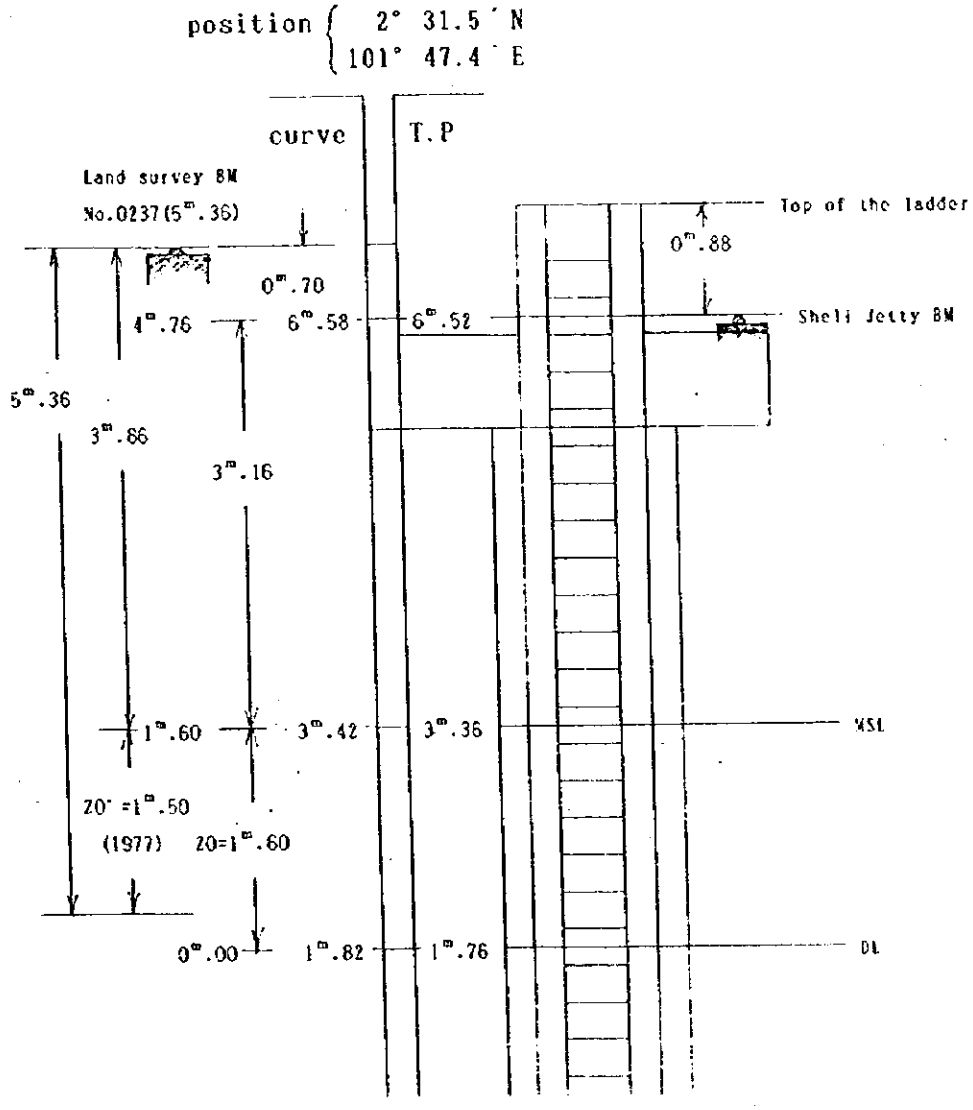


Fig. 3-6 Tidal Diagram of Temporary Tide Station

Station : Cape Rachado

POSITION { 2-24.9 N
101-53.9 E

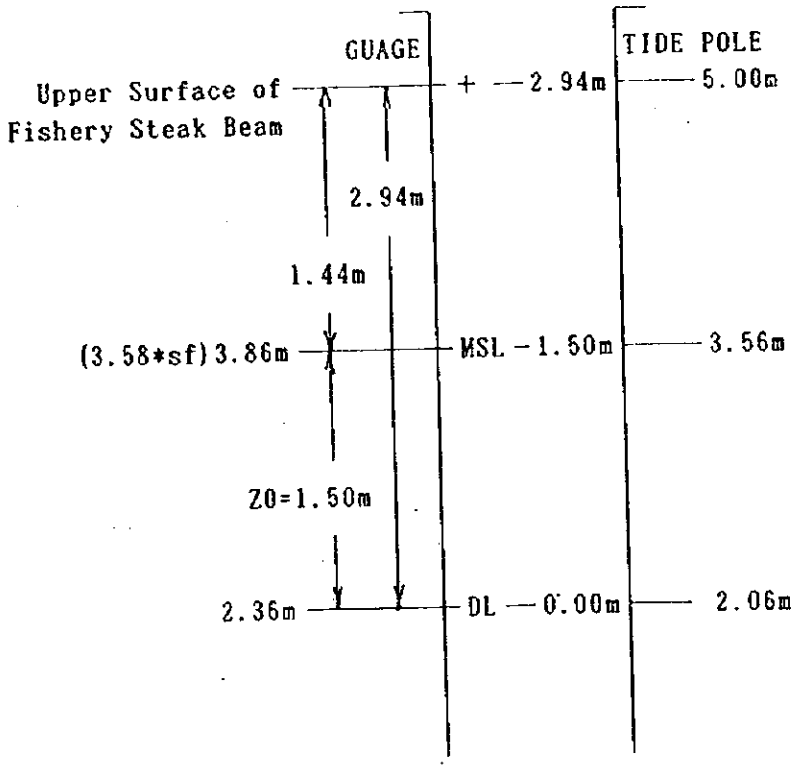


Fig. 3-7 Tidal Diagram of Temporary Tide Station

Station : Segenting

position { 1° 42.5′ N
103° 03.6′ E

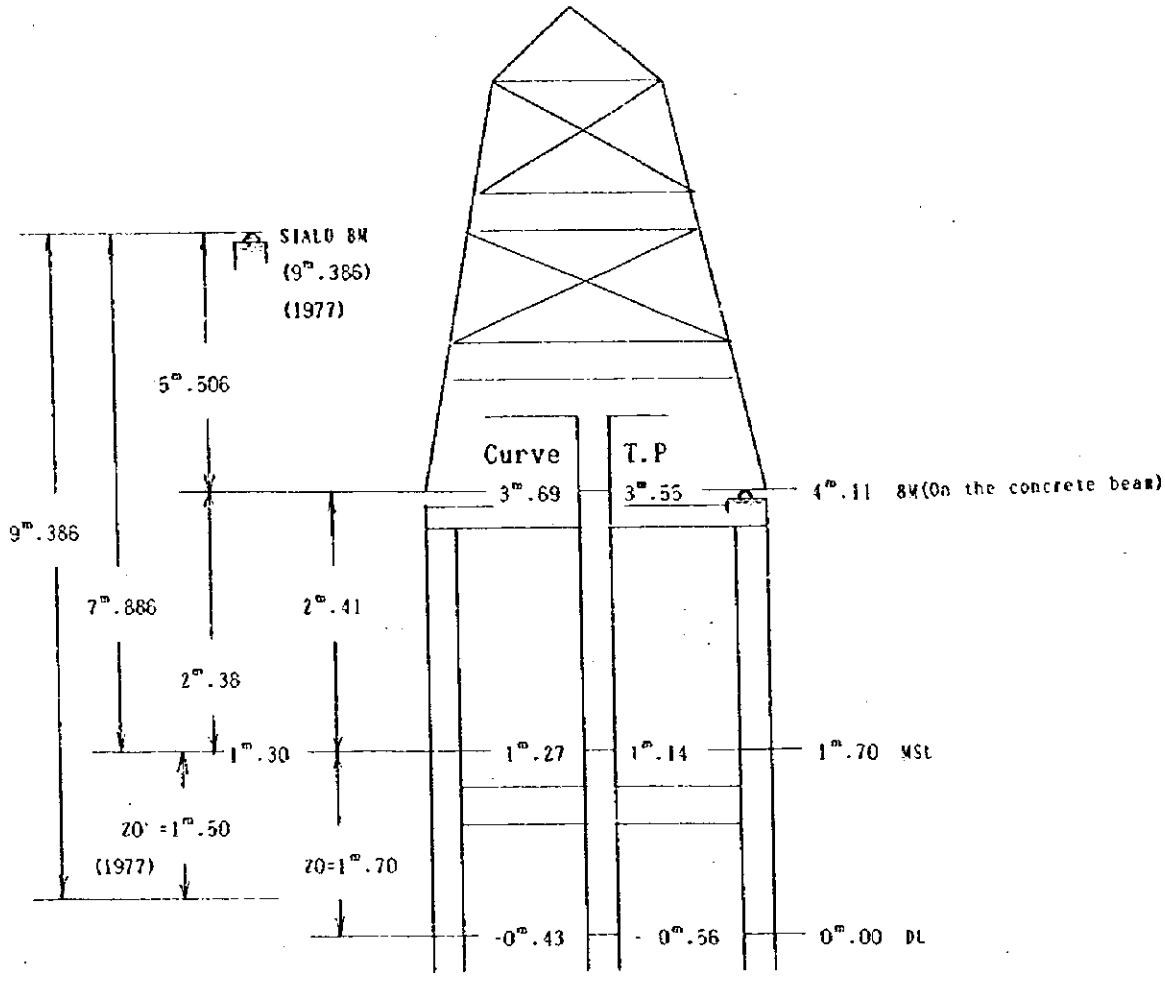
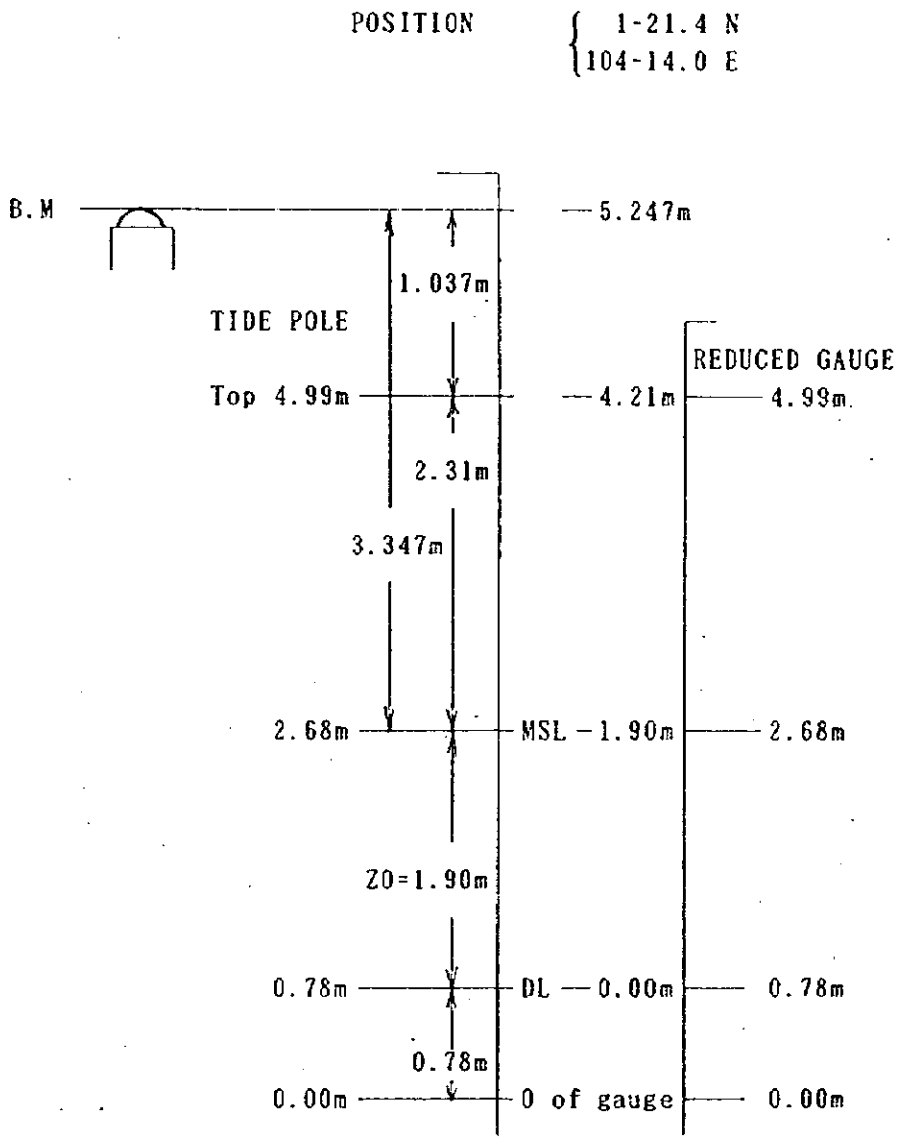


Fig. 3-8 Tidal Diagram of Temporary Tide Station

Station : Tanjung Ayam

(Bauxite Jetty in Telok Ramunia)

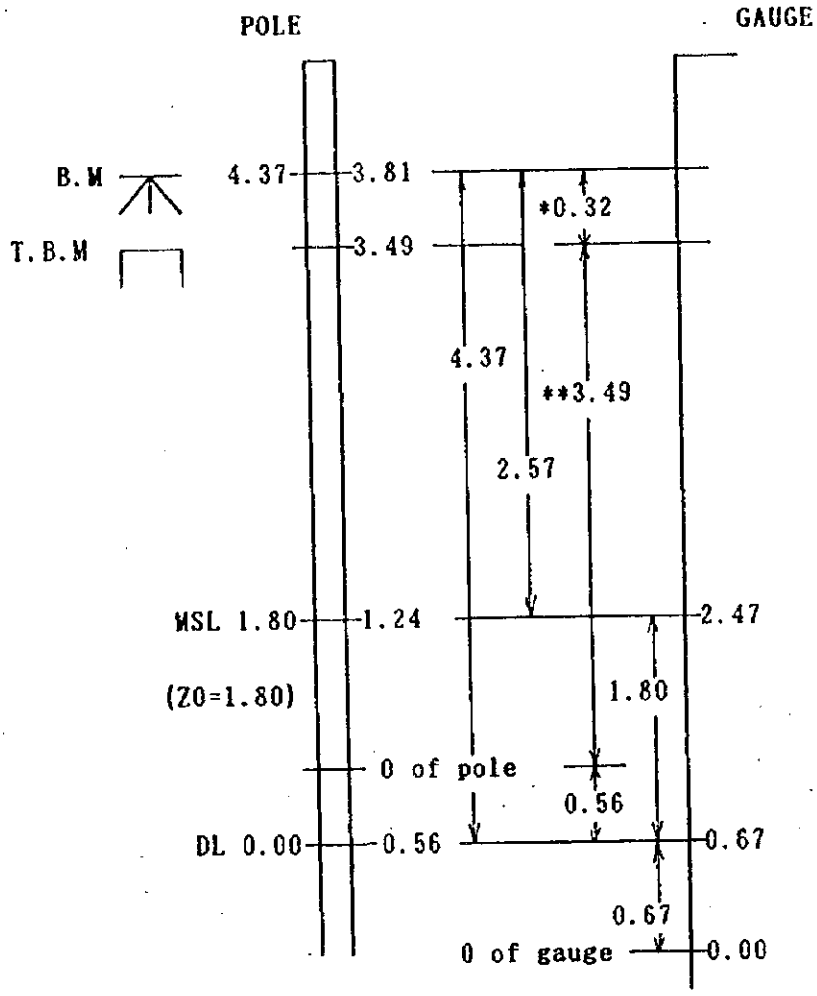


·B.M is set on the eastern side of jetty about 300m from the shore.

Fig. 3-9 Tidal Diagram of Temporary Tide Station

Station : Iyu Kecil

Position { 1-11.5 N
103-21.1 E



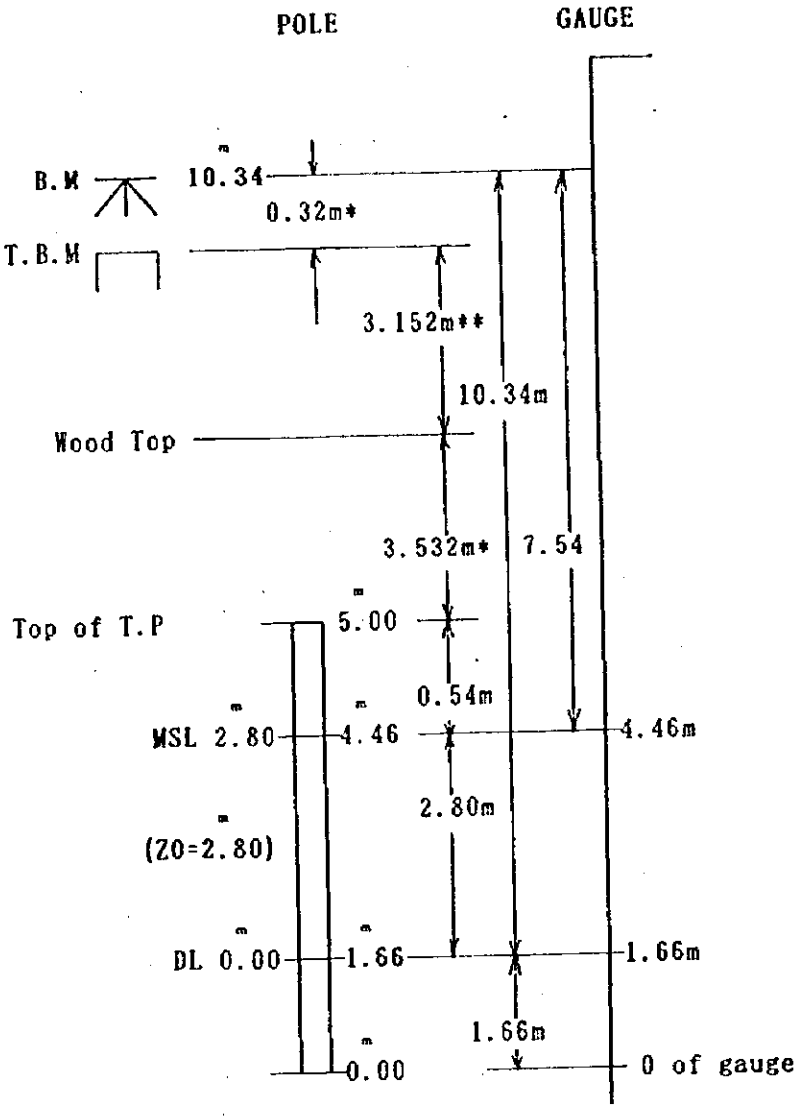
Remarks : (1) The numerical value with the mark(*) is a measurement value by measuring tape
(2) The numerical value with the mark(**) is a measurement value by leveling

D.L: 4.37m below B.M. (不) engraved on the side of a boulder at the beach of Pulau Iyu Kecil

Fig. 3-10 Tidal Diagram of Temporary Tide Station

Station : One Fathom Bank

Position { 2° 53.3′ N
100° 59.7′ E



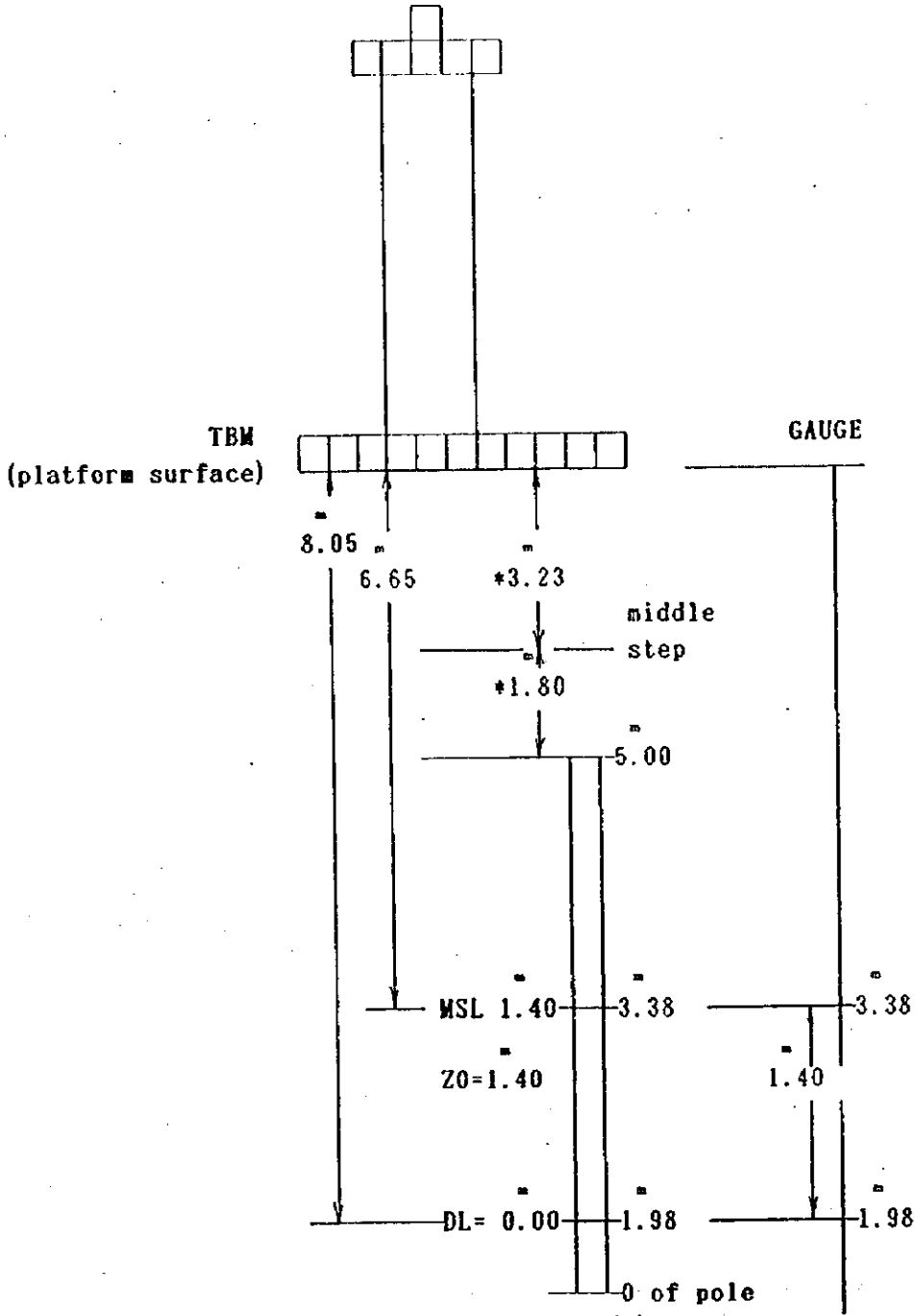
Remarks: (1) The numerical value with the mark (*) is a measurement value by measuring tape
(2) The numerical value with the mark (**) is a measurement value by leveling

DL: 10.34 m below BM (cut mark (下) H.M.S. Dampier 1967) on the south Wall of the first story of One Fathom Bank Lighthouse

Fig. 3-11 Tidal Diagram of Temporary Tide Station

Station : Raleigh Shoal

Position { 2-06.8 N
101-53.1 E



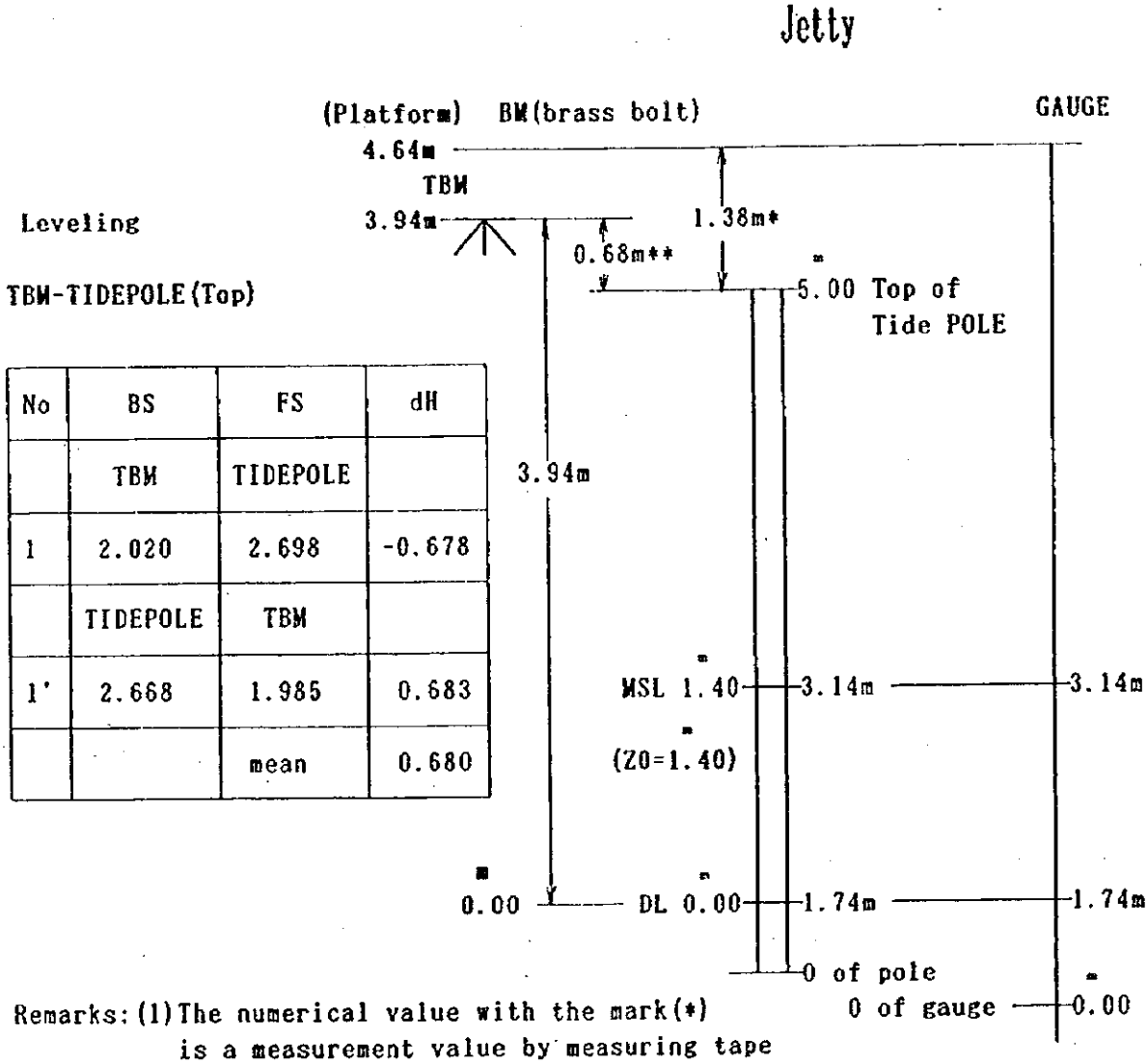
Remarks : The numerical value with the mark(*) is a measurement value by measuring tape

D.L: 8.05m below the platform surface of the light beacon

Fig. 3-12 Tidal Diagram of Temporary Tide Station

Station : Pulau Undan

Position { 2-02.9 N
102-20.0 E



No	BS	FS	dH
	TBM	TIDEPOLE	
1	2.020	2.698	-0.678
	TIDEPOLE	TBM	
1'	2.668	1.985	0.683
		mean	0.680

Remarks: (1) The numerical value with the mark(*) is a measurement value by measuring tape
(2) The numerical value with the mark(**) is a measurement value by leveling

DL: (1) 3.94m below TBM(cut mark) engraved on the side of a boulder at the end of the jetty
(2) 4.64m below BM which is set up at NE corner of the jetty

Fig. 3-13 Tidal Diagram of Temporary Tide Station

3.3 Hydrographic Survey (Sounding and Search)

3.3.1 Contents of Field Survey

The sounding and search operation was conducted using survey launch equipped with a precise four-beam echo sounder and a sidescan sonar (refer to Figure 3-14).

The total length of survey lines completed was 6,739 kilometers. This represents an increase of 17 % over the planned survey lines including supplementary lines of 5,783 kilometers. Details of hydrographic survey contents at each subarea and point are shown in Table 3-7.

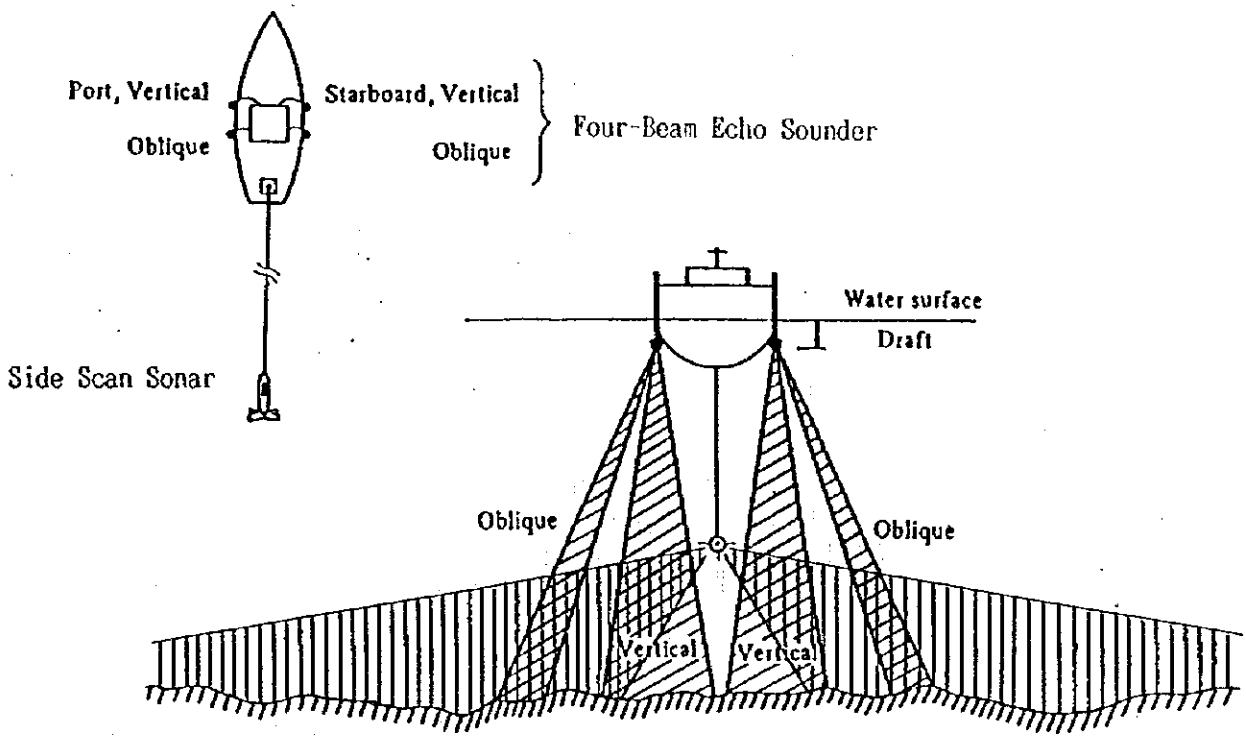


Fig. 3-14 Sounding and Search Operations

Table 3-7 Contents of Hydrographic Survey

Group Area No.	Sub-Area Point No.	Field Survey Period (Date)	Length of Survey Line		Onshore Reference Station	Tide Station for Tidal Reduction	Remarks
			Surveyed (Km)	Planned (Km)			
1	j	1997 Oct. 27 to Nov. 12	288.0	207.	One Fathom Bank Light-house	One Fathom Bank Light-house	Wreck
	k	Oct. 30 to Nov. 3	150.4	133.			Shoal
	l	Oct. 11 to Nov. 12	84.6	133.			Shoal
	A	Oct. 12 to Nov. 16	975.0	810.			Wrecks Shoal Sand W.
2	B	1996 Nov. 18 to Nov. 24	321.4	342.	Jugra L.H.	Tg. Gabang	Shoal
	f	Nov. 24 to Dec. 4	225.2	207.		Port Dickson	Wreck
	C	Dec. 2 to Dec. 6	229.4	207.	Cape Rachado		Shoal
	g	Dec. 7 to Dec. 20	395.6	356.		Cape Rachado	Shoal
	J						Shoals
	K	Dec. 21 to Dec. 26	188.6	164.			Shoal
3	a	1997 Nov. 25 to Nov. 28	262.2	195.	Malacca Medical Center	Raleigh Sh.	Shoal
	m	Nov. 24 to Dec. 13	231.2	195.		Pulau Undan	Wreck
	D	Dec. 1 to Dec. 16	491.6	376.			Wrecks
4	b	1996-1997 Dec. 30 to Jan. 5	220.4	156.	Segenting L.H.	Segenting	Wreck
	L	Jan. 2 to Jan. 5	126.2	181.			Shoal
	c	Jan. 6 to Jan. 14	237.4	207.			Wreck
5	d	1997 May 12 to May 24	421.4	393.	Raffles L.H. and Batam Island	Sultan Shoal	Wreck
	i						Wreck
	e	May 26 to Jun. 12	401.4	363.	Raffles L.H.	Raffles L.H.	Wreck
	G						Wreck
	H	May 31 to Jun. 13	286.6	207.			Danger
	h	Sep. 26 to Oct. 3	308.8	207.	Iyu Kecil	Iyu Kecil	Wrecks
	E	Sep. 19 to Oct. 5	361.4	342.			Wrecks
	F	Sep. 10 to Sep. 18	261.0	195.		Raffles L.H.	Wreck
6	I	1997 Jun. 18 to Jun. 28	271.4	207.	Bedok L.H. and Batam Island	Tanjung Ayam	Wreck
Total Length of Survey Lines			Km 6,739.2 (117%)	Km 5,783. (100%)			

3.3.2 Classification of Hydrographic Survey

Objects of the hydrographic survey in the Study consist of dangerous/unconfirmed shoals and wrecks, and some sand waves. These objects will be classified as shown in Table 3-8 from the existing charts and information.

Namely, the following objects in each sub-area and point were the aim of this hydrographic survey :

(1) Unconfirmed Wreck (Total: 19 wrecks)

These wrecks are either charted with approximate positions (PA) or reported positions (Rep) and the most of them have no information on the least depth.

(2) Confirmed Wreck (Total: 5 wrecks)

A wreck at Sub-Area A was cleared by wire drag with depth of 15.6 m. However, the exact depth is unknown.

Known wrecks at Sub-Areas G & H, and Points e & f were also verified.

(3) Dangerous/Unconfirmed Shoal (Total: 14 shoals)

Five dangerous shoals and nine reported shoals were chosen for detailed investigation.

(4) Sand Wave (Total: 1 area)

Sub-Area A was a subject of detailed investigation for sand waves.

Table 3-8 Classification on Objects of Hydrographic Survey

Survey Area	Description on Existing Chart			
	Unconfirmed Wreck	Confirmed Wreck	Dangerous/Unconfirmed Shoal	Sand Wave
Sub-Area A	Wreck 2°46.0'N (Rep) 101°02.1'E [Wreck No.3]	Wreck 2°48.7'N 101°00.8'E 15.6m, [Wreck No.1]	17.3m 2°47.0'N (Rep) 101°02.1'E [Shoal No.2]	Sand Wave
Sub-Area B			17.6m 2°35.2'N (Rep) 101°25.9'E [Shoal No.4]	
			19.9m 2°33.9'N (Rep) 101°26.0'E [Shoal No.5]	
Sub-Area C			13.6m 2°22.6'N (Rep) 101°40.6'E [Shoal No.6]	
Sub-Area D	Wreck 1°56.1'N (PA) 102°14.1'E 15 m [Wreck No.7]			
	Wreck 1°55.5'N (Rep) 102°15.4'E 17 m [Wreck No.8]			
Sub-Area E	Wreck 1°11.8'N 103°25.9'E [Wreck No.9]			
	Wreck 1°10.8'N 103°25.8'E [Wreck No.10]			
Sub-Area F	Wreck 1°05.2'N (PA) 103°42.1'E [Wreck No.11]			
Sub-Area G	Wreck 1°07.6'N (PA) 103°45.4'E [Wreck No.12]	Wreck 1°08.4'N 103°45.3'E 34 m		
Sub-Area H		Wreck 1°11.2'N 103°50.1'E 37 m	21 m 1°10.5'N (Rep) 103°48.9'E [Shoal No.13]	

(to be continued)

Survey Area	Description on Existing Chart			
	Unconfirmed Wreck	Confirmed Wreck	Dangerous/Unconfirmed Shoal	Sand Wave
Sub-Area I	Wreck 1°16.0'N (PA) 104°15.0'E [Wreck No.14]			
	Wreck 1°15.5'N (PA) 104°17.8'E 30 m			
Sub-Area J			19.5m 2°18.2'N 101°48.6'E	
			16.7m 2°17.4'N 101°49.0'E	
			16.9m 2°15.6'N (Rep) 101°49.6'E	
Sub-Area K			14.3m 2°17.2'N 101°54.2'E	
Sub-Area L			16.7m 1°43.0'N 102°48.6'E	
Point a			19.4m 2°10.2'N (Rep) 101°52.0'E	
Point b	Wreck 1°46.4'N (PA) 102°43.3'E			
Point c	Wreck 1°34.0'N (PD) 103°05.0'E			
Point d	Wreck 1°12.2'N (PA) 103°34.3'E			
Point e	Wreck 1°07.4'N (PA) 103°44.2'E	Wreck 1°08.3'N 103°43.3'E 21.5 m		
Point f	Wreck 2°28.0'N (PA) 101°35.4'E	Wreck 2°27.4'N 101°36.3'E 40 m		
Point g			19.5m 2°16.0'N (Rep) 101°47.7'E	
Point h	Wreck 1°15.8'N (PA) 103°19.8'E			
	Wreck 1°16.5'N (PA) 103°20.5'E			

(to be continued)

Survey Area	Description on Existing Chart			
	Unconfirmed Wreck	Confirmed Wreck	Dangerous/Unconfirmed Shoal	Sand Wave
Point i	Wreck 1°11.1'N (PA) 103°33.0'E			
Point j	Wreck 2°58.2'N (PA) 100°49.5'E			
Point k			11.6m 2°53.9'N 100°52.0'E	
Point l			7.9m 2°51.1'N (6.4※) 101°00.0'E	
Point m	Wreck 1°59.3'N (PA) 102°12.4'E (Rep)			

[Note] (6.4m※) : Depth on the Japanese Chart