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 1
SUMMARY

JUNE 1998

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

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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LIST OF REPORTS

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 has been 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 as study results are compiled on sixteen Smooth Sheets, which have been submitted to the Littoral States at the end of each study phase.

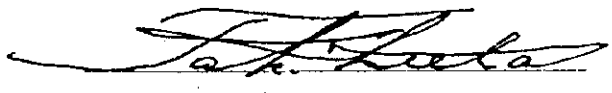
Dangerous eight shoals and one wreck detected during the field survey, were promulgated to all vessels by "Notices to Mariners" through responsible authorities of three Littoral States.

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 results of this study.

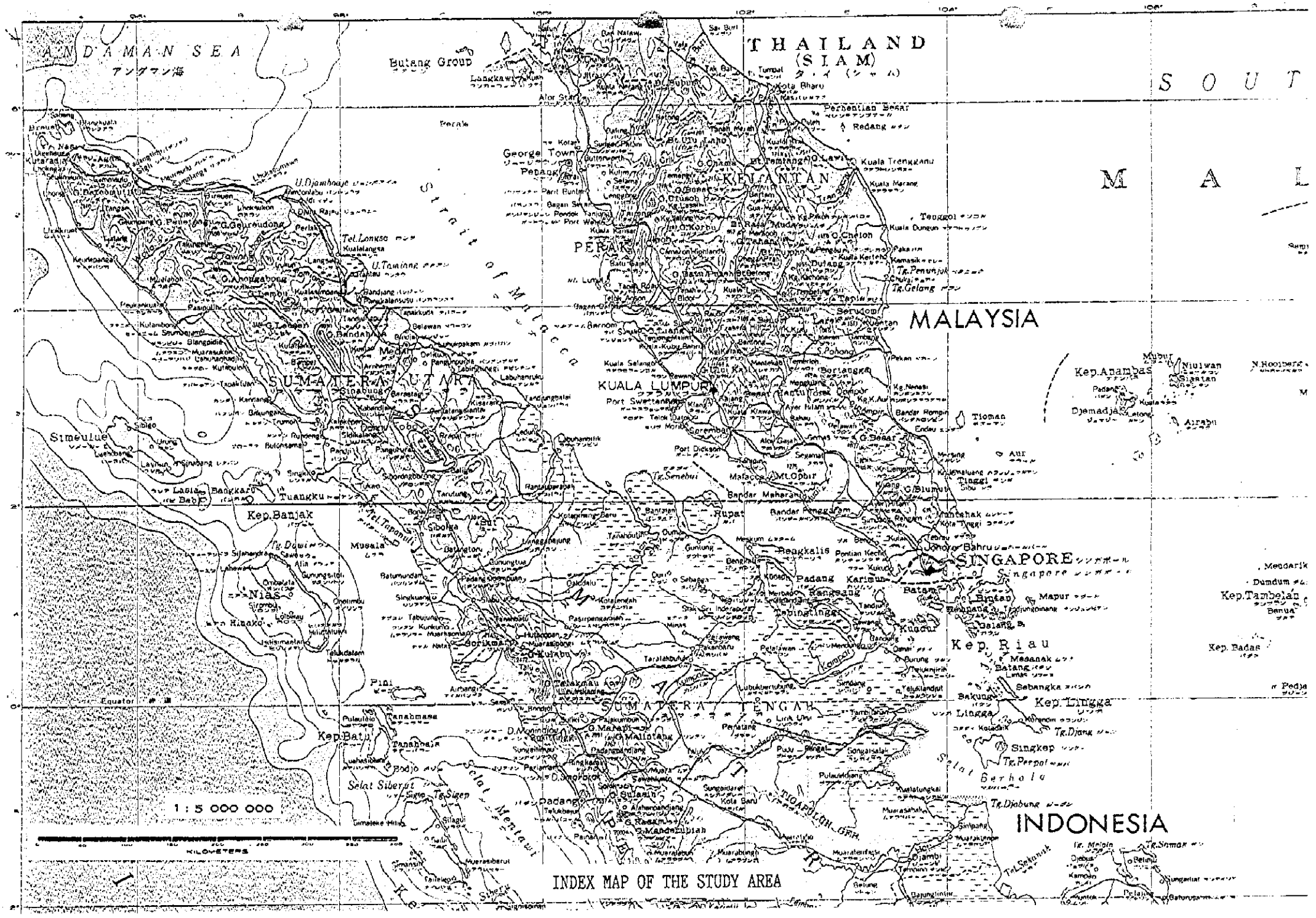
We hope that the results of the study will contribute to the enhancement of the safe navigation in the Straits of Malacca and Singapore.

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 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
George Town
Pedang
Perak
PERAK
KELANTAN
Kuala Trengganu
Kuala Dungun
Tioman
Kep.Anambas
Djemadja
Airabu
MALAYSIA
KUALA LUMPUR
Port Swettenham
Malacca
Mt.Ophir
Bandar Maharani
Bandar Pemggram
Rupat
Bengkalis
SINGAPORE
Singapore
Johor Bahru
Batam
Bintan
Mapur
Kep. Riau
Kep.Tambelan
Kep. Badas
Kep.Lingga
Singkep
Selat Berhala
Tg.Djabung
INDONESIA
Tg.Sinmar
Tg.Mnjola
Djambi
Muara Sabak
Selat Malaka
SUMATERA UTARA
Medan
Belawan
Simeulue
Nias
Sibolga
Kep.Banjak
Kep.Batu
Musala
Padang
Padangsidempuan
Rangsang
Kuala Tungkal
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Selat Mentawai
Equator
1 : 5 000 000
KILOMETERS
INDEX MAP OF THE STUDY AREA

OUTLINE OF THE STUDY RESULTS

The outline of results on the Study is summarized as follows.

1. Study Areas

Critical areas including the investigation of dangerous/unconfirmed shoals and wrecks in the Straits of Malacca and Singapore were included in the Study (refer to Figure 1 and Table 1 in the text) :

No. of Sub-Area : Twelve (12) Sub-Areas (Sub-Area A to L)
No. of Point : Thirteen (13) Points (Point a to m)
Survey Area : Approximately 780 square kilometers

2. Study Items and Quantity

Control Point Survey : Fourteen (14) points
Tidal Observation : Nine (9) points
Hydrographic Survey (Sounding and Search)
: 6,739 line kilometers
Bottom Materials Sampling : 194 points

3. Standards, Coordinates and Datum Level

Ellipsoid : WGS-84 datum
Projection : Transverse Mercator Projection
Origin of Coordinates : Center of each Smooth Sheet
Chart Datum Level : Lowest Astronomical Tide (LAT)

4. Main Equipment Used for Field Survey

Control Point Survey : GPS Receiver (Trimble 4000SSi)
Tidal Observation : Digital Tide Gauge (Rigosya RM-5525WL)
Hydrographic Survey (Sounding and Search) :
Precise Four-Beam Echo Sounder (Senbon Denki PDR-601)
Sidescan Sonar (C-Max CM800/S)
Positioning : Short Range Differential GPS
(Trimble DGPS TRIM-MARK & TRIM-TALK)
Long Range Differential GPS (Aquapos SERCEL)
Bottom Materials Sampling : Cylindrical Dredge

5. Number of Wrecks and Shoals on the Study

	(Scope of Works)	(Actual Survey)	(Confirmed Ones)
No. of Wrecks :	18 wrecks	24 wrecks	22 wrecks
No. of Shoals :	13 shoals	14 shoals	21 shoals

6. Confirmation and Verification of Wrecks

Wrecks chosen as the subject of the Study are either charted with approximate positions "PA" or reported positions "Rep" and the most of them have no information on the least depth.

Some wrecks, whose positions and water depths are already confirmed, are also included in the survey areas. These wrecks were also chosen as the subject of the Study for the verification.

The result shows that the exact positions and least depths of twenty (20) wrecks within twenty four (24) wrecks chosen as the subject of the Study were confirmed and verified, and four (4) wrecks in Sub-Areas D, E and Points b, c were confirmed of no existence in the reported areas (refer to Table 12 and Table 13 in the text).

Other two (2) wrecks or obstructions, whose existences are not reported, were found in Sub-Area A and Point j.

7. Depth of Shoals

Most of shoals chosen as the subject of the Study are charted with reported positions "Rep". The field survey was carried out at fourteen (14) shoals including one point out of Sub-Area J.

The result shows that the exact positions and least depths of twelve (12) shoals within fourteen (14) shoals chosen as the subject of the Study were confirmed, and two (2) shoals in Sub-Areas A and H were confirmed of no existence in the reported areas (refer to Table 14 in the text).

Some other shoals, whose existences are not reported, were found in Sub-Areas B, C, H, J and Point a.

8. Notices to Mariners

During the field work of hydrographic survey, eight (8) dangerous shoals and one (1) dangerous wreck were detected. The informations were promulgated to all vessels by Notices to Mariners through responsible authorities of the three Littoral States (refer to Table 15 in the text).

The least depth of dangerous wreck detected at offshore area of Port Dickson (Point f), which is known as a sunken wreck "Royal Pacific", was 16.1 m to the reported depth of 40 m.

9. Production of Smooth Sheets

The final results of hydrographic survey under the Study were plotted on sixteen (16) smooth sheets of scale 1:20,000 (refer to Table 16 and Figures 7 to 12 in the text).

One set of smooth sheets was submitted to each Littoral State on the last stage of field works in the Littoral States.

10. Production of ENC Database

Electronic Navigational Charts (ENC) database covering six (6) sheets of common datum charts of the Straits of Malacca and Singapore was prepared in Japan (refer to Table 17 in the text). This database makes use of this study results.

One magnetic tape file of ENC database was submitted to each Littoral State together with this report.

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CONTENTS

1. INTRODUCTION

1.1 Background of the Study

The Straits of Malacca and Singapore greatly contribute to various trading and other economic activities, mainly as the main channel for the transport of crude oil supplies, thereby linking Middle East with East Asia, including Japan.

The hydrographic survey in the Straits was jointly carried out by the three Littoral States of Indonesia, Malaysia and Singapore bordering the Straits and Japan between the year 1969 and 1975 for the high priority areas of channels. After the survey, the common datum charts in the Straits were produced from 1976 to 1982 and the tides and tidal currents study in the Straits was performed from 1977 to 1979 through the joint effort of these four states. The results of these undertakings have contributed towards enhancing safe navigation in the Straits.

At present, aside from the fact that there are many dangerous spots in the topography, shallow patches formed by the wrecks and sand waves have also been reported and recorded on nautical charts. However, since thorough investigations were not carried out in these areas, they impede rather than facilitate the traffic of large vessels in the area.

The Tripartite Technical Experts Group (TTEG) held a meeting on February 1993 and proposed the conduct of a hydrographic re-survey on the Straits. The Governments of Indonesia, Malaysia and Singapore, fully recognised the importance and urgency of this re-survey and thereby, requested the technical cooperation to the Government of Japan.

In response to the request of the Governments of Indonesia, Malaysia and Singapore, the Government of Japan has decided to conduct the re-survey in the Straits jointly with the Littoral States and agreed upon the Scope of Work with the Littoral States on May 1996.

Based on these conditions, the Four Nation Joint Re-Survey of Critical Areas and Investigation of Dangerous/Unconfirmed Shoals and Wrecks in the Straits of Malacca and Singapore (hereinafter referred to as "the Study") was commenced in September 1996 and was completed in June 1998.

1.2 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.

1.3 Study Areas

The following twelve (12) sub-areas and thirteen (13) points in the Straits of Malacca and Singapore were included in the Study (refer to Figure 1 and Table 1). The total survey area was approximately 780 square kilometers.

(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, e, h and i
(6) Group Area 6 : Sub-Area I

1.4 Study Schedule

The field work was divided into three (3) phases and the hydrographic survey in the following areas was carried out in each phase:

(1) First Phase Study : October 1996 to March 1997
(Assigned Areas to the Government of 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 the Government of 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 the Government of 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

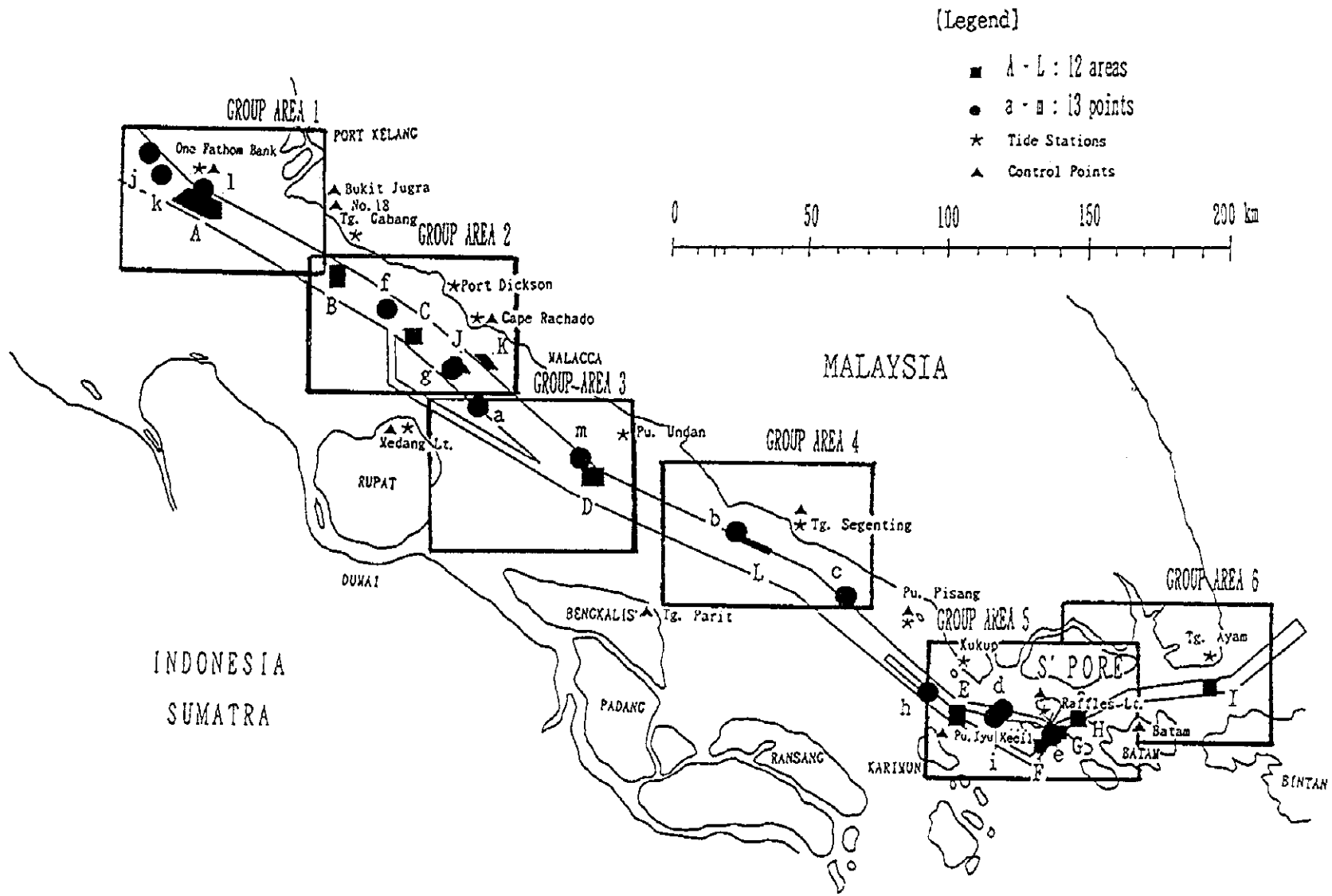


Fig. 1 Location Map of Study Areas and Points

Table 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	

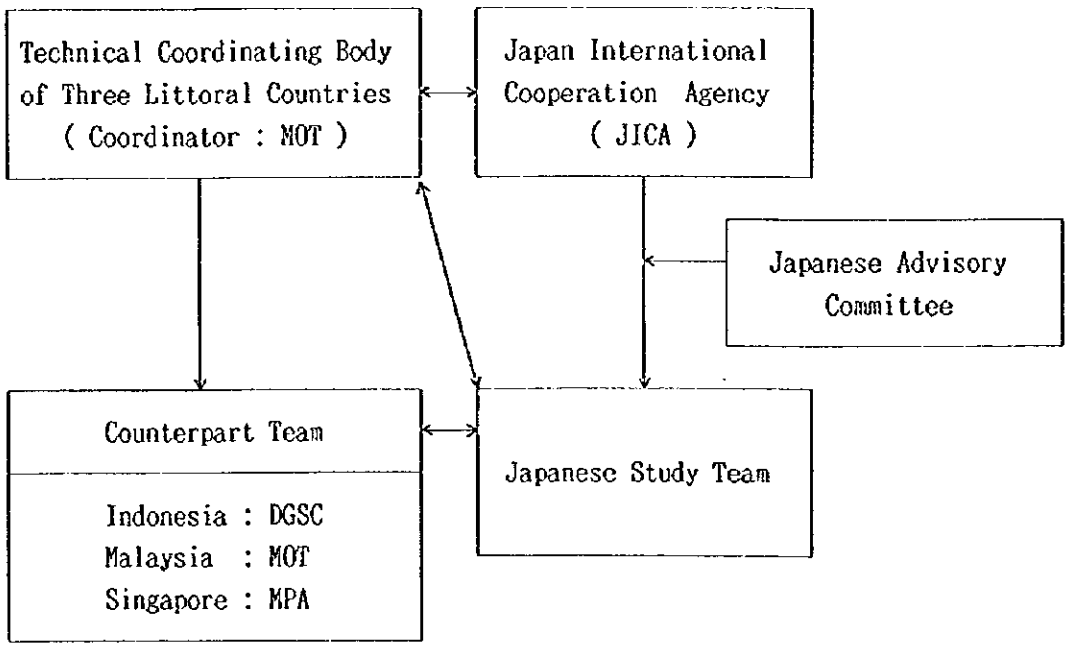
1.5 Organization for the Study

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 and the oganizational structure is shown in Figure 2.

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

The members of the Japanese Advisory Committee and Study Team are shown in Tables 2 and 3. The members of the Technical Coordinating Body and the Counterpart Team of the Littoral States are shown in Tables 4 and 5.



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

Fig. 2 Organizational Structure of the Study

Table 2 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 3 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 4 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 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

1.6 Reports

The final reports consist of two volumes ; Summary and Main Report.

During the field works, the following survey results including smooth sheets besides the above reports were prepared and submitted to each Littoral State on the final stages of each study phase:

(1) Control Point Survey
    1) Coordinates of Control Points
    2) Description of Control Points
    3) Location Map of Control Points
(2) Hydrographic Survey (Sounding and Search)
    1) Echogram
    2) Records of Sidescan Sonar
    3) Positioning Data of Survey Launch
    4) Track Charts (Scale : 1/20,000)
    5) Sounding Charts (Scale : 1/20,000)
(3) Tidal Observation
    1) Records of Tidal Observation
    2) Tidal Diagram
(4) Smooth Sheets (Scale : 1/20,000) : 16 sheets
(5) Digital Data
(6) Documentary Video

One magnetic tape file as the result of Electronic Navigational Charts database covering six sheets of common datum charts of the Straits of Malacca and Singapore was prepared in Japan and submitted to each Littoral State together with this report.

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 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 3.

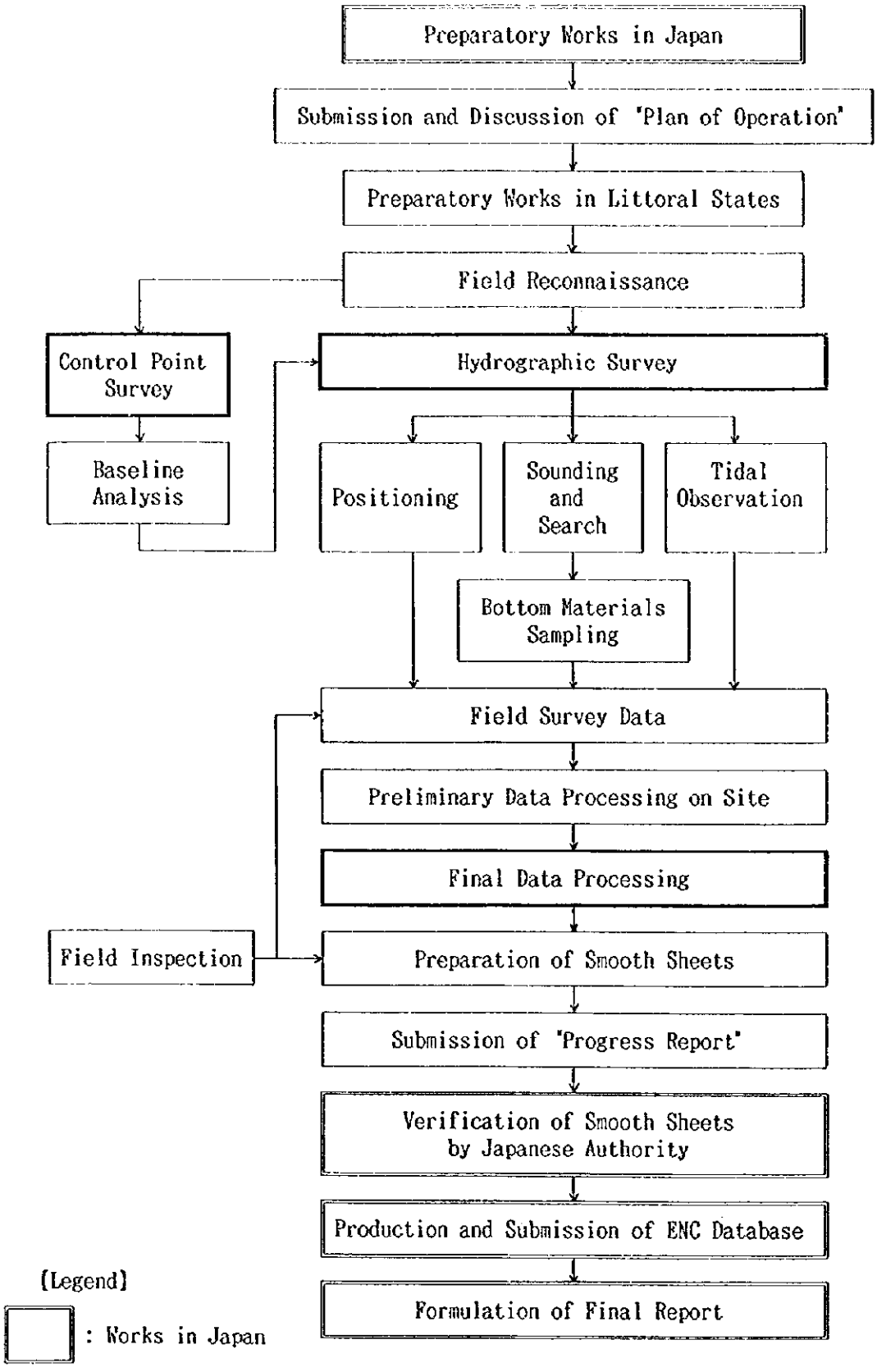


Fig. 3 Overall Flow-Chart of the Study

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 ENC database was produced in accordance with the International Standards and Specification for ENC, IHO S57 Edition 3.5.

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

Ellipsoid	: WGS-84 Datum
Projection	: Transverse Mercator Projection
Origin of Coordinates	: Center of Each Smooth Sheet
Chart Datum Level	: Lowest Astronomical Tide (LAT)

2.3 Equipment Used for Field Survey

Main equipment used for the field survey of the Study was as follows :

(1) Control Point Survey
GPS Receiver : Trimble 4000SSi

(2) Tidal Observation
Digital Tide Gauge : Rigosya RM-5525WL

(3) Hydrographic Survey (Sounding and Search)
Precise Four-Beam Echo Sounder : Senbon Denki PDR-601
Sidescan Sonar : C-Max CM800/S

(4) Positioning
Short Range Differential Global Positioning System (DGPS)
: Trimble DGPS TRIM-MARK & TRIM-TALK
Long Range Differential Global Positioning System (DGPS)
: Aquapos SERCEL DGPS

(5) Bottom Materials Sampling
Cylindrical Dredge

3. STUDY RESULTS

3.1 Control Point Survey

Prior to the hydrographic survey, control point survey was carried out at fourteen (14) points shown in Table 6, existing control points and other new points necessary for sounding operation.

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

Table 6 List of Control Surveying Points

Name of State	Control Point		
	St.No	Name of Control Point	Place
Singapore	St. 1	Raffles Lighthouse	Lighthouse
Malaysia	St. 2	Pulau Pisang	Fundamental Point
Singapore	St. 3	Bedok Lighthouse	Lighthouse
Indonesia	St. 4	Pulau Batam	SERCEL Batam Station
Indonesia	St. 5	Pulau Iyu Kecil	Lighthouse
Malaysia	St. 6	Segenting Lighthouse	Lighthouse
Indonesia	St. 7	Tanjung Parit	Lighthouse
Malaysia	St. 8	Malacca	Mahkota Medical Center
Indonesia	St. 9	Tanjung Medang	Lighthouse
Malaysia	St.10	Cape Rachado	Lighthouse
Malaysia	St.11	One Fathom Bank Lighthouse	Lighthouse
Malaysia	St.12	Jugra Lighthouse	Lighthouse
Malaysia	GP. 9	Labu	Control Point
Malaysia	GP.18	Morib	Control Point
Total	14 Points		

3.1.1 Network of Control Points

The network of control points used for the control point survey is shown in Figure 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.

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 7.

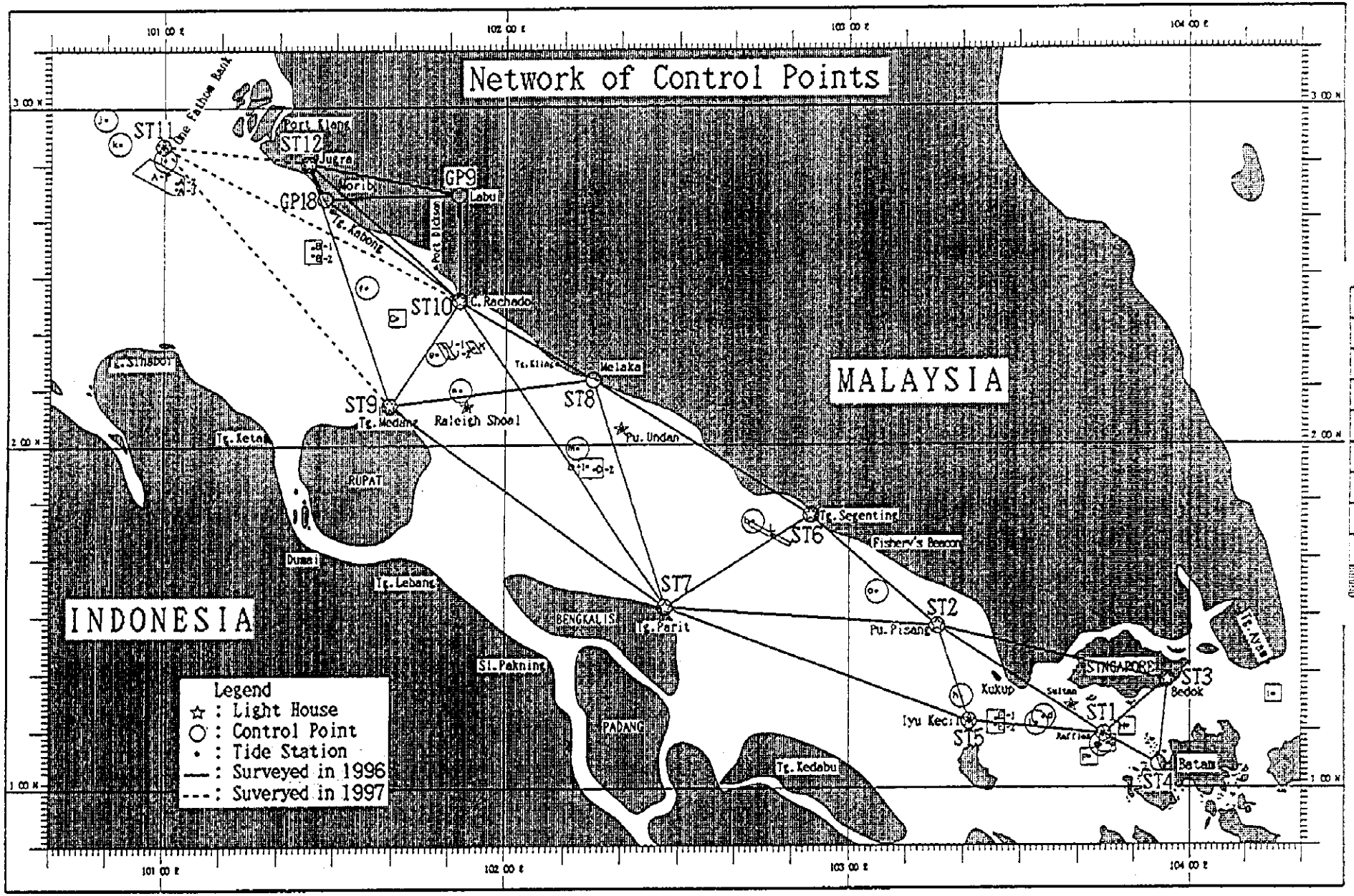


Fig. 4 Network of Control Point Survey

Table 7 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.

Therefore, tidal predictions at 17 stations along the Straits of Malacca and Singapore were carried out using existing tidal harmonic constants. The predicted lowest low water and highest high water were defined as Lowest Astronomical Tide (LAT) and Highest Astronomical Tide (HAT), respectively.

Table 8 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 distribution of LAT along the Straits is shown in Figure 5.

Table 8 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_0	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 Kabong	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_0)
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.

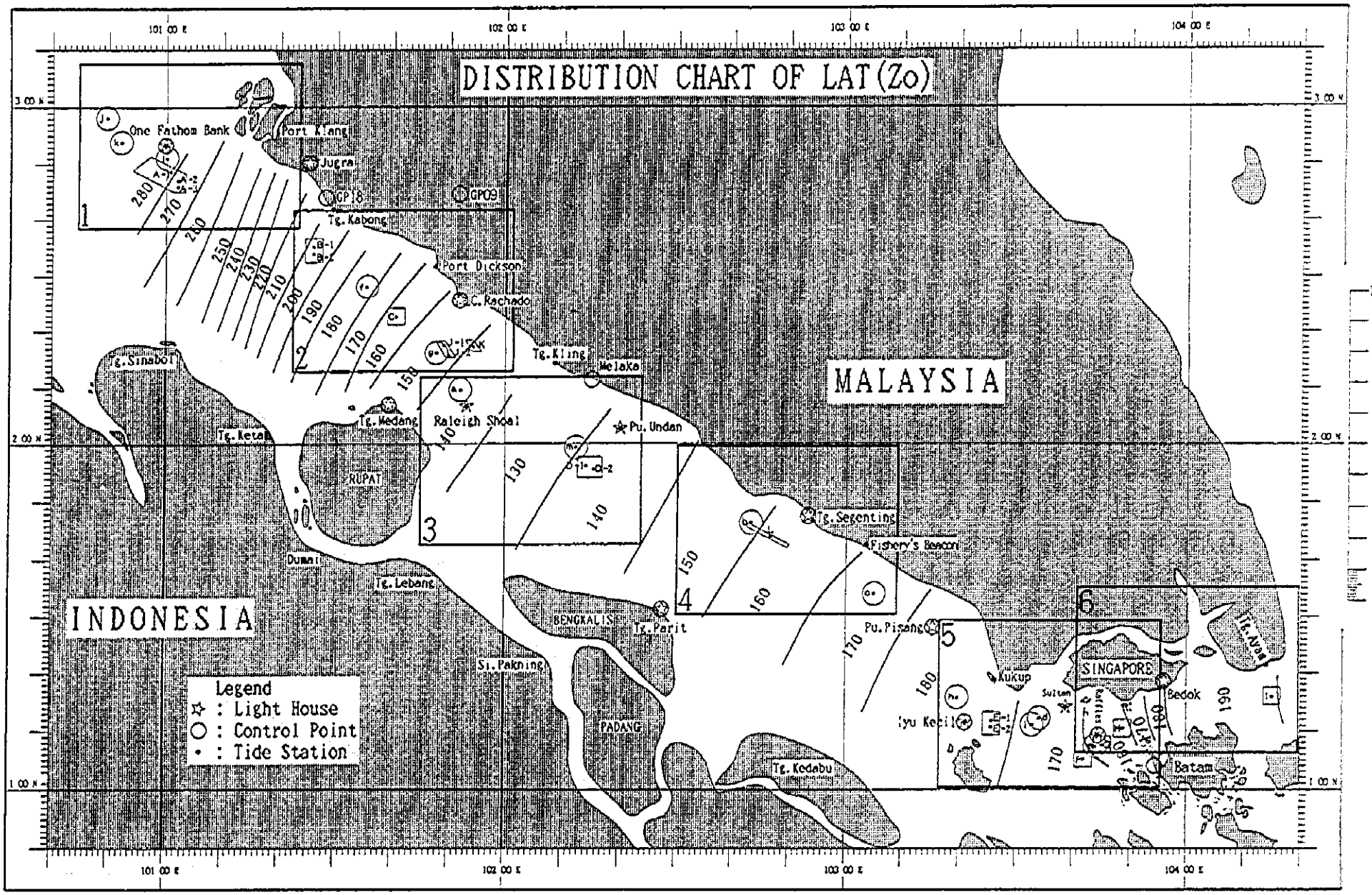


Fig. 5 Distribution of Lowest Astronomical Tide

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 9.

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.

Table 9 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

3.3 Hydrographic Survey (Sounding and Search)

3.3.1 Contents of Field Survey

Details of hydrographic survey contents at each sub-area and point are shown in Table 10.

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.

Table 10 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 11 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 f & e 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 11 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

3.3.3 Results of Hydrographic Survey

(1) Confirmation of Wrecks

The survey results for nineteen unconfirmed wrecks are summarised in Table 12.

The existence of fifteen wrecks within nineteen wrecks were confirmed and four wrecks in Sub-Areas D, E and Points b, c were confirmed of no existence in the reported areas. Other two wrecks or obstructions, whose existences are not reported, were found in Sub-Area A and Point j.

(2) Verification of the Existence of Wrecks

The charted wrecks identified for detailed investigation and verification of the existence were one wreck located at Sub-Area A (Wreck No.1), which is charted with 15.6 m of cleared depth by wire drag, and four wrecks at Sub-Areas G, H and Points e, f.

The results of the verification for the existence of wrecks are summarised in Table 13.

The existences of all wrecks were verified near the charted positions. The least depth of the cleared wreck at Sub-Area A was 26.3 m and that of the wreck, Royal Pacific, at Point f was 16.1 m to the charted depth 40 m.

(3) Depth of Shoals

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

The survey results for the shoals are tabulated in Table 14.

The existence of twelve shoals within fourteen shoals were confirmed and two shoals; 17.3 m in Sub-Area A (Shoal No.2) and 21 m in Sub-Area H (Shoal No.13) were confirmed of no existence in the reported areas. Some other dangerous shoals, whose existences are not reported, were found, especially in the area of Point a.

Table 12 Findings of Sunken Wrecks

Survey Area	Unconfirmed Information on Existing Charts/List		Confirmed Information (Surveyed Results)		Remarks
	Description on Chart	Position	Position (WGS-84)	Least Depth	
Point j	Wreck (PA)	2° 58' 12" N 100° 49' 30" E	2° 58' 35" N 100° 49' 35" E	23.6 m (4 m)	ADHAS (489 G.T.) 26.01.1980
			2° 57' 35" N 100° 48' 16" E	22.3 m (3 m)	
Sub-Area A	Wreck (Rep) [No. 3]	2° 46' 00" N 101° 02' 06" E	2° 48' 39" N 101° 03' 03" E	27.5 m (5 m)	CAHAYA BARU 10.10.1972
			2° 47' 27" N 100° 57' 01" E	43 m (4 m)	Obstruction
Point f	Wreck (PA)	2° 28' 00" N 101° 35' 24" E	2° 28' 37" N 101° 35' 50" E	44 m (2 m)	Steel Lighter
Point m	Wreck (PA) (Rep)	1° 59' 18" N 102° 12' 24" E	1° 58' 06" N 102° 12' 03" E	45 m (3 m)	JIH SHENG (785 G.T.) 24.11.1992
Sub-Area D	Wreck (PA) 15 m [No. 7]	1° 56' 06" N 102° 14' 06" E	1° 54' 19" N 102° 15' 18" E	40 m (5 m)	OH YANG NO. 57 29.03.1973
	Wreck (Rep) 17 m [No. 8]	1° 55' 30" N 102° 15' 24" E	NOT FOUND		
Point b	Wreck (PA)	1° 46' 24" N 102° 43' 18" E	NOT FOUND		Junk
Point c	Wreck (PD)	1° 34' 00" N 103° 05' 00" E	NOT FOUND		Tronoh (208 G.T.)
Point h	Wreck (PA)	1° 15' 48" N 103° 19' 48" E	1° 15' 53" N 103° 19' 48" E	24.2 m (5 m)	SAMBU INDAH (45 G.T.) 24.07.1988
	Wreck (PA)	1° 16' 30" N 103° 20' 30" E	1° 16' 55" N 103° 21' 02" E	31 m (2 m)	SHAHABAT MULIA 29.01.1996

(to be continued)

Survey Area	Unconfirmed Information on Existing Charts/List		Confirmed Information (Surveyed Results)		Remarks
	Description on Chart	Position	Position (WGS-84)	Least Depth	
Sub-Area E	Wreck (No. 9)	1° 11' 48" N 103° 25' 54" E	1° 11' 06" N 103° 27' 23" E	38 m (4 m)	MV NIAGA 40 (834 G.T.) 07.09.1986
	Wreck (No. 10)	1° 10' 48" N 103° 25' 48" E	NOT FOUND		
Point d	Wreck (PA)	1° 12' 12" N 103° 34' 18" E	1° 12' 45" N 103° 35' 05" E	25.0 m (2-3 m)	MV EKADJAYA (154 G.T.) 08.09.1978
Point i	Wreck (PA)	1° 11' 06" N 103° 33' 00" E	1° 11' 14" N 103° 35' 26" E	28.9 m (5 m)	Tug 06.03.1974
Sub-Area F	Wreck (PA) (No. 11)	1° 05' 12" N 103° 42' 06" E	1° 05' 47" N 103° 41' 54" E	20.4 m (4 m)	21.03.1977
Point e	Wreck (PA)	1° 07' 24" N 103° 44' 12" E	1° 07' 48" N 103° 43' 56" E	43 m (5-6 m)	Tug 14.10.1978
Sub-Area G	Wreck (PA) (No. 12)	1° 07' 36" N 103° 45' 24" E	1° 06' 45" N 103° 44' 31" E	42 m (4-5 m)	MV SINALAUT (71 G.T.) 01.07.1981
Sub-Area I	Wreck (PA) (No. 14)	1° 16' 00" N 104° 15' 00" E	1° 17' 10" N 104° 15' 29" E	35 m (3 m)	Sampan 26.09.1988
	Wreck (PA) 30 m	1° 15' 30" N 104° 17' 48" E	1° 15' 25" N 104° 18' 19" E	29m(mast) 53m(hull) (30 m)	JENSON (726 G.T.) 01.01.1991

(Note) 1) PA : Position Approximate
2) Rep : Reported
3) PD : Position Doubtful
4) Values in bracket of 'Least Depth' column : Heights of Wrecks

Table 13 Findings of Sunken Wreck
(Verification of the Existence of Wreck)

Survey Area	Information on Existing Charts		Confirmed Information (Surveyed Results)		Remarks
	Description on Chart	Position	Position (WGS-84)	Least Depth	
Sub-Area A	Wreck 15.6 m [No. 1]	2° 48' 42" N 101° 00' 48" E	2° 48' 42" N 101° 00' 47" E	26.3 m (11 m)	Coaster 01.1972
Point f	Wreck 40 m	2° 27' 24" N 101° 36' 18" E	2° 27' 12" N 101° 36' 10" E	16.1 m (54 m)	Royal Pacific mast ?
Point e	Wreck 21.5 m	1° 08' 18" N 103° 43' 18" E	1° 08' 11" N 103° 43' 27" E	23.6 m (16 m)	KYORYU MARU (3421 G.T.) 16.06.1973
Sub-Area G	Wreck 34 m	1° 08' 24" N 103° 45' 18" E	1° 08' 24" N 103° 45' 08" E	39 m (14 m)	MV NAIS 1975
Sub-Area H	Wreck 37 m	1° 11' 12" N 103° 50' 06" E	1° 11' 14" N 103° 50' 02" E	38 m (11 m)	TOSA MARU 1977

[Note] Values in bracket of 'Least Depth' column : Heights of Wreck

Table 14 Findings of Shoals

Survey Area	Information on Charts		Results of Survey		Remarks
	Least Depth	Position (Lat.& Lon.)	Least Depth	Position (WGS-84)	
Point k	11.6 m	2°53'54"N 100°52'00"E	12.6 m	2°53'53"N 100°51'58"E	1974(Joint Survey)
Point l	7.9 m (6.4*)	2°51'06"N 101°00'00"E	8.4 m	02°51'09"N 101°00'00"E	1967(Dampier), Amazon Maru Shoal
Sub-Area A	17.3 m (Rep) [No. 2]	2°47'00"N 101°02'06"E	Not Found		1975
Sub-Area B	17.6 m (Rep)	2°35'12"N 101°25'54"E	21.9 m	2°35'08"N 101°25'19"E	
			20.7 m	2°34'33"N 101°25'23"E	
	19.9 m (Rep)	2°33'54"N 101°26'00"E	21.1 m	2°34'10"N 101°25'33"E	
Sub-Area C	13.6 m (Rep)	2°22'36"N 101°40'36"E	19.7 m	2°22'36"N 101°40'11"E	
			19.9 m	2°22'34"N 101°41'01"E	
Point g	19.5 m (Rep)	2°16'00"N 101°47'42"E	17.9 m	2°16'00"N 101°47'34"E	
Sub-Area J	19.5 m	2°18'12"N 101°48'36"E	17.9 m	2°18'13"N 101°48'37"E	
	16.7 m	2°17'24"N 101°49'00"E	15.4 m	2°17'24"N 101°49'12"E	
			16.1 m	2°16'30"N 101°49'20"E	
	16.9 m (Rep)	2°15'36"N 101°49'36"E	18.6 m	2°15'47"N 101°49'29"E	
Sub-Area K	14.3 m	2°17'12"N 101°54'12"E	13.6 m	2°18'06"N 101°53'40"E	

(to be continued)

Survey Area	Information on Charts		Results of Survey		Remarks
	Least Depth	Position (Lat.& Lon.)	Least Depth	Position (WGS-84)	
Point a	19.4 m (Rep)	2°10'12"N 101°52'00"E	20.0 m	2°10'19"N 101°52'16"E	1972
			18.6 m	2°10'51"N 101°51'35"E	
			20.4 m	2°09'47"N 101°50'42"E	
			17.5 m	2°08'54"N 101°50'36"E	
Sub-Area L	16.7 m	1°43'00"N 102°48'36"E	16.5 m	1°42'52"N 102°48'40"E	
Sub-Area H	21 m (Rep) [No.13]	1°10'30"N 103°48'54"	Not Found		
			23.0 m	1°10'32"N 103°48'25"E	
			23.0 m	1°10'06"N 103°48'22"E	
			21.2 m	1°11'04"N 103°49'16"E	

[Note] 1) Rep : Reported
2) (6.4m*) : Depth on the Japanese Chart

(4) Characteristics of Sand Waves

The purpose of this study was to know the characteristics of sand waves in the Strait of Malacca. For that purpose, a survey area located at the south of One Fathom Bank was chosen. The survey area was in Sub-Area A having a depth around 30 meters (refer to Figure 6).

The general topography of seabed in the area trends northwest and the channel runs almost along the topography. Tidal currents in this area are northwest to southeast along the topography having a maximum speed of about three knots.

From sounding plots and echo sounder records, the dimension of typical sand waves can be obtained as follows:

	(Height of Sand Wave)	(Wave Length)	(Remarks)
Sub-Area A :	2 ~ 4 meters	70 ~ 180 meters	top of bank
	4 ~ 10 meters	150 ~ 400 meters	foot of bank
Point l :	3 ~ 5 meters	100 ~ 170 meters	
Point k :	3 ~ 6 meters	80 ~ 150 meters	

Considering the whole area surveyed, the height of sand waves, peak to trough, is 2 to 10 meters and wave length is 70 to 400 meters. Generally, the height and wave length at the top of bank is smaller than that at the foot of bank.

With respect to the strike of sand waves, wave ridges generally run to the direction of northeast-southwest, which is perpendicular to predominant tidal currents.

Bottom materials of the sand wave area comprised mainly fine sand and sand, and partly coarse sand.

The comparison between surveyed results and existing data shows that big sand wave variation cannot be recognized.

Sand Wave Area

Chart No. MAL 515 (Scale 1:200,000)

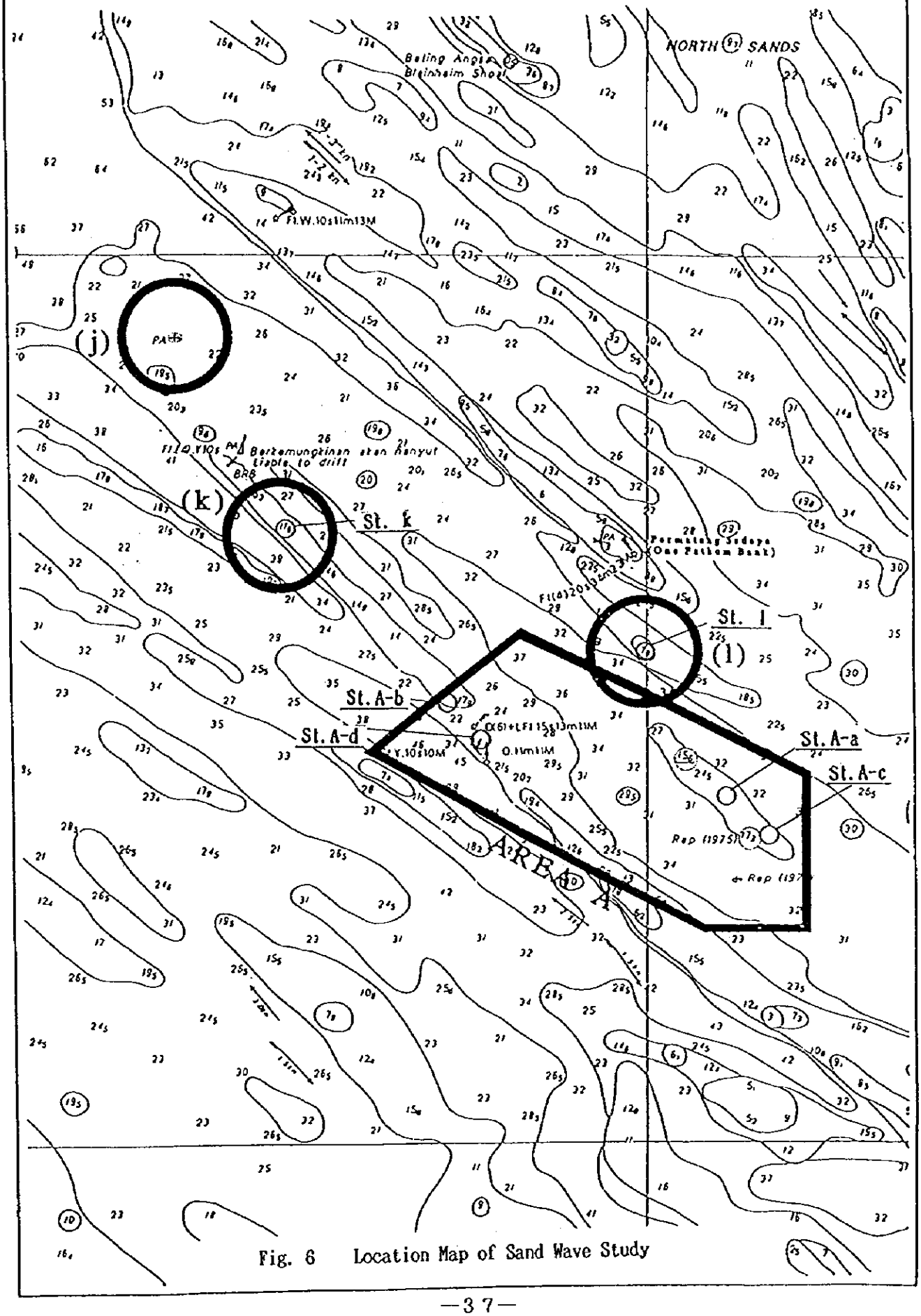


Fig. 6 Location Map of Sand Wave Study

3.4 Notices to Mariners

During field works of the hydrographic survey, some dangerous shoals were detected. The informations were promulgated to all vessels by radio broadcast as soon as possible and subsequently by Notices to Mariners through responsible authorities of the three Littoral States.

The informations promulgated as Notices to Mariners under the name of "The Four-Nation Joint Survey Team in Malacca and Singapore Straits" were as follows :

Table 15 Notices to Mariners

Date	Location		Least Depth	Remarks
	Point	Position(WGS-84)		
Nov. 28, 1996	Point f	2° 27.2' N 101° 36.2' E	15.1 m* (16.1 m)	Wreck
Dec. 26, 1996	Point g	2° 16.0' N 101° 47.6' E	17.9 m	Shoal
	Sub-Area J	2° 18.2' N 101° 48.6' E	17.9 m	Shoal
		2° 17.4' N 101° 49.2' E	15.4 m	Shoal
		2° 16.5' N 101° 49.3' E	16.3 m* (16.1 m)	Shoal
Dec. 6, 1997	Point a	2° 10.3' N 101° 52.3' E	20.0 m	Shoal
		2° 10.9' N 101° 51.6' E	18.6 m	Shoal
		2° 09.8' N 101° 50.7' E	20.4 m	Shoal
		2° 08.9' N 101° 50.6' E	17.5 m	Shoal

[Note] 15.1 m* : Reported Water Depth
(16.1 m) : Final Water Depth after tidal correction

3.5 Smooth Sheets

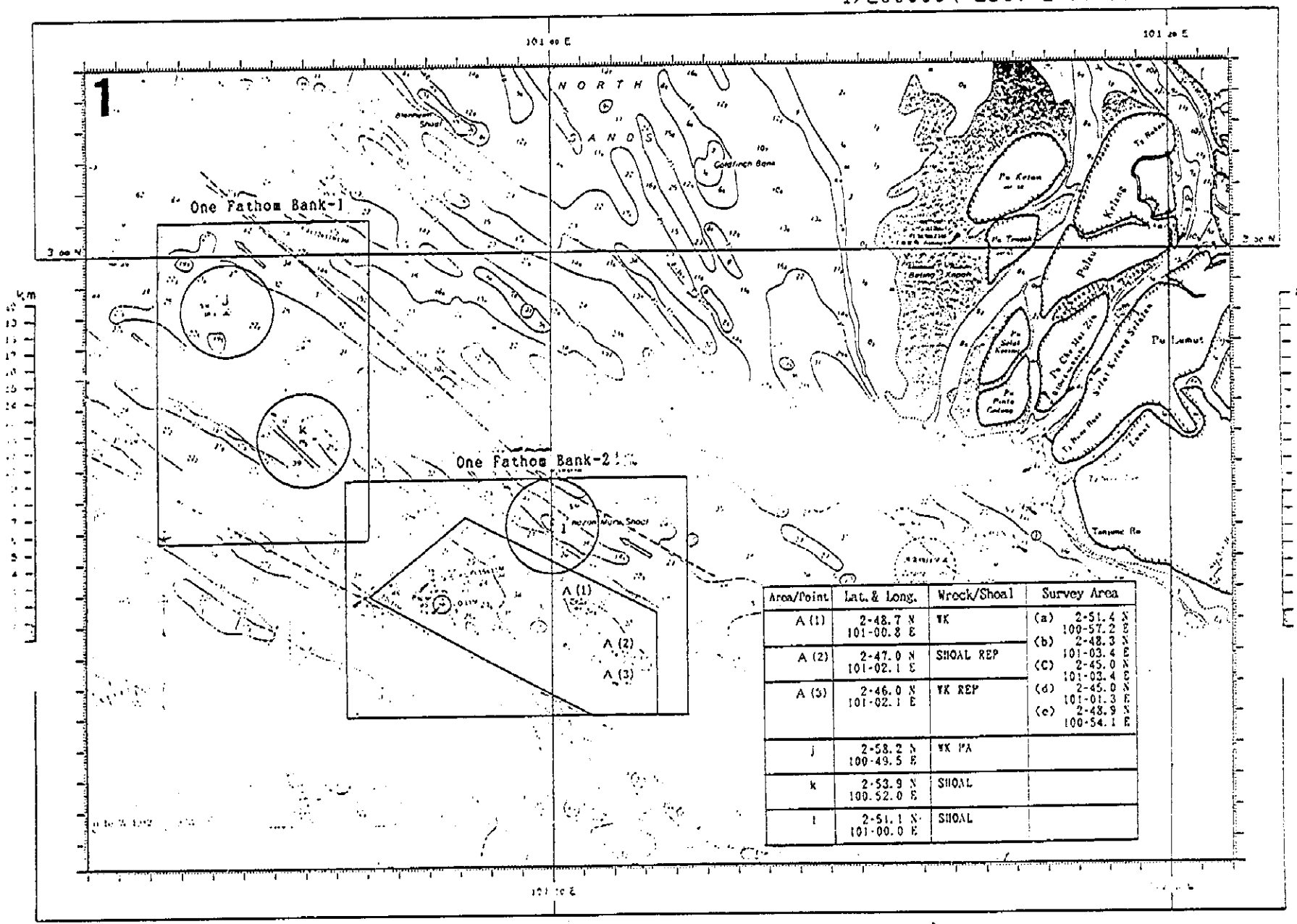
The hydrographic survey results under the Study were plotted on sixteen (16) smooth sheets of scale 1:20,000.

The details of the smooth sheets are tabulated in Table 16. Figures 7 to 12 show the coverage of each of the smooth sheets.

Table 16 Details of Smooth Sheets on the Study

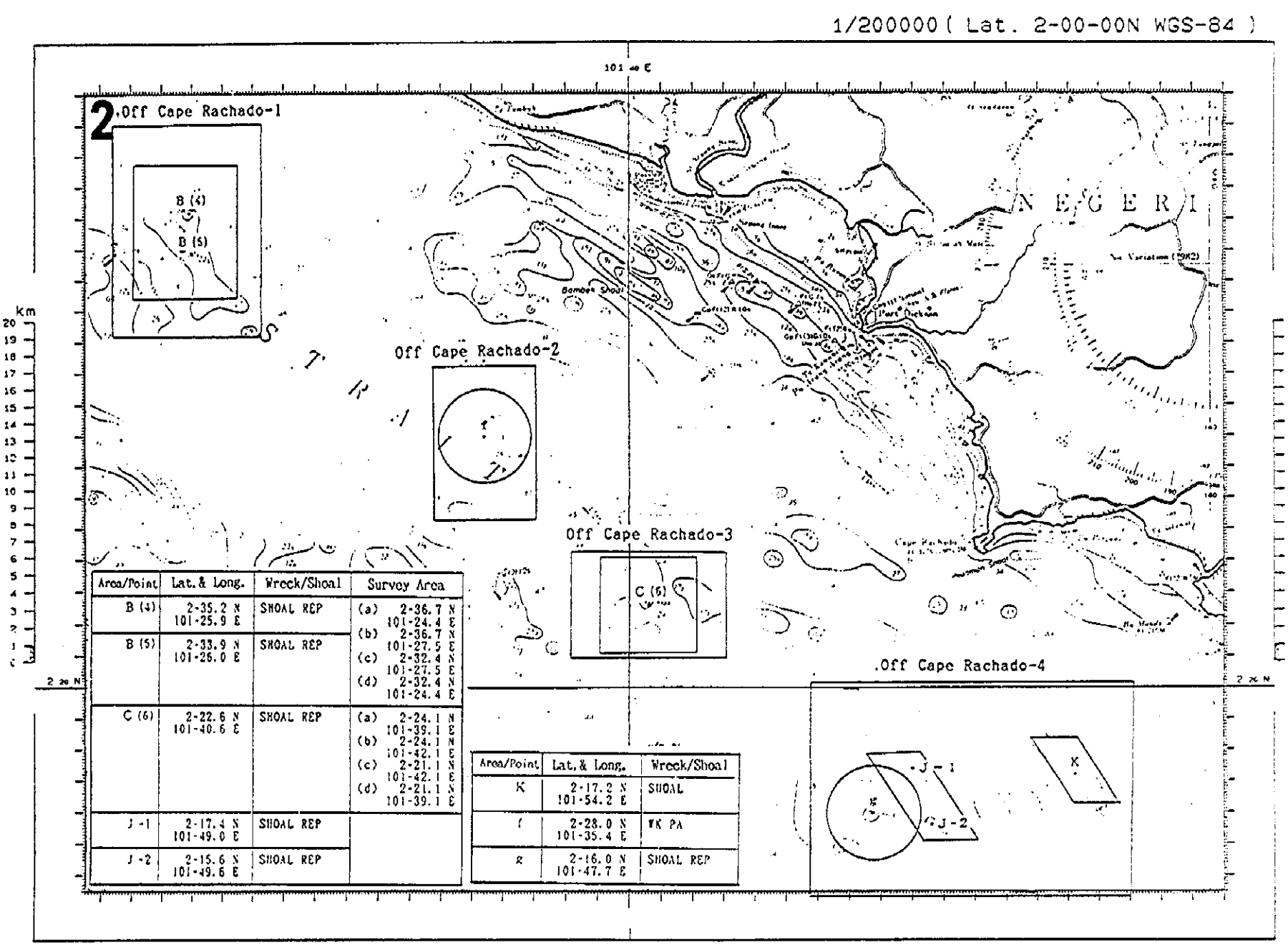
Group Area	Sub-Area Point	Name of Smooth Sheet	Scale
1	j、k	One Fathom Bank - 1	1 / 20,000
	A、l	One Fathom Bank - 2	1 / 20,000
2	B	Off Cape Rachado - 1	1 / 20,000
	f	Off Cape Rachado - 2	1 / 20,000
	C	Off Cape Rachado - 3	1 / 20,000
	J、K、g	Off Cape Rachado - 4	1 / 20,000
3	a	South of Cape Rachado	1 / 20,000
	D、m	West of Malacca	1 / 20,000
4	L、b	Off Segenting - 1	1 / 20,000
	c	Off Segenting - 2	1 / 20,000
5	h	North of Iyu Kecil	1 / 20,000
	E	East of Iyu Kecil - 1	1 / 20,000
	F	Pulau Takong	1 / 20,000
	d、i	East of Iyu Kecil - 2	1 / 20,000
	G、H、e	Raffles Light	1 / 20,000
6	I	South of Tanjung Ayam	1 / 20,000

1/200000 (Lat. 2-00-00N WGS-84)



Area/Point	Lat. & Long.	Wreck/Shoal	Survey Area
A (1)	2-48.7 N 101-00.8 E	WK	(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
A (2)	2-47.0 N 101-02.1 E	SHOAL REP	
A (3)	2-46.0 N 101-02.1 E	WK REP	
j	2-58.2 N 100-49.5 E	WK PA	
k	2-53.9 N 100-52.0 E	SHOAL	
l	2-51.1 N 101-00.0 E	SHOAL	

Fig. 7 Chart Sizes for Smooth Sheets (Group Area 1)



Area/Point	Lat. & Long.	Wreck/Shoal	Survey Area
B (4)	2-35.2 N 101-25.9 E	SHOAL REP	(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
B (5)	2-33.9 N 101-26.0 E	SHOAL REP	
C (6)	2-22.6 N 101-40.6 E	SHOAL REP	(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
J-1	2-17.4 N 101-49.0 E	SHOAL REP	
J-2	2-15.6 N 101-49.6 E	SHOAL REP	

Area/Point	Lat. & Long.	Wreck/Shoal
K	2-17.2 N 101-54.2 E	SHOAL
f	2-28.0 N 101-35.4 E	WK PA
g	2-16.0 N 101-47.7 E	SHOAL REP

Fig. 8 Chart Sizes for Smooth Sheets (Group Area 2)

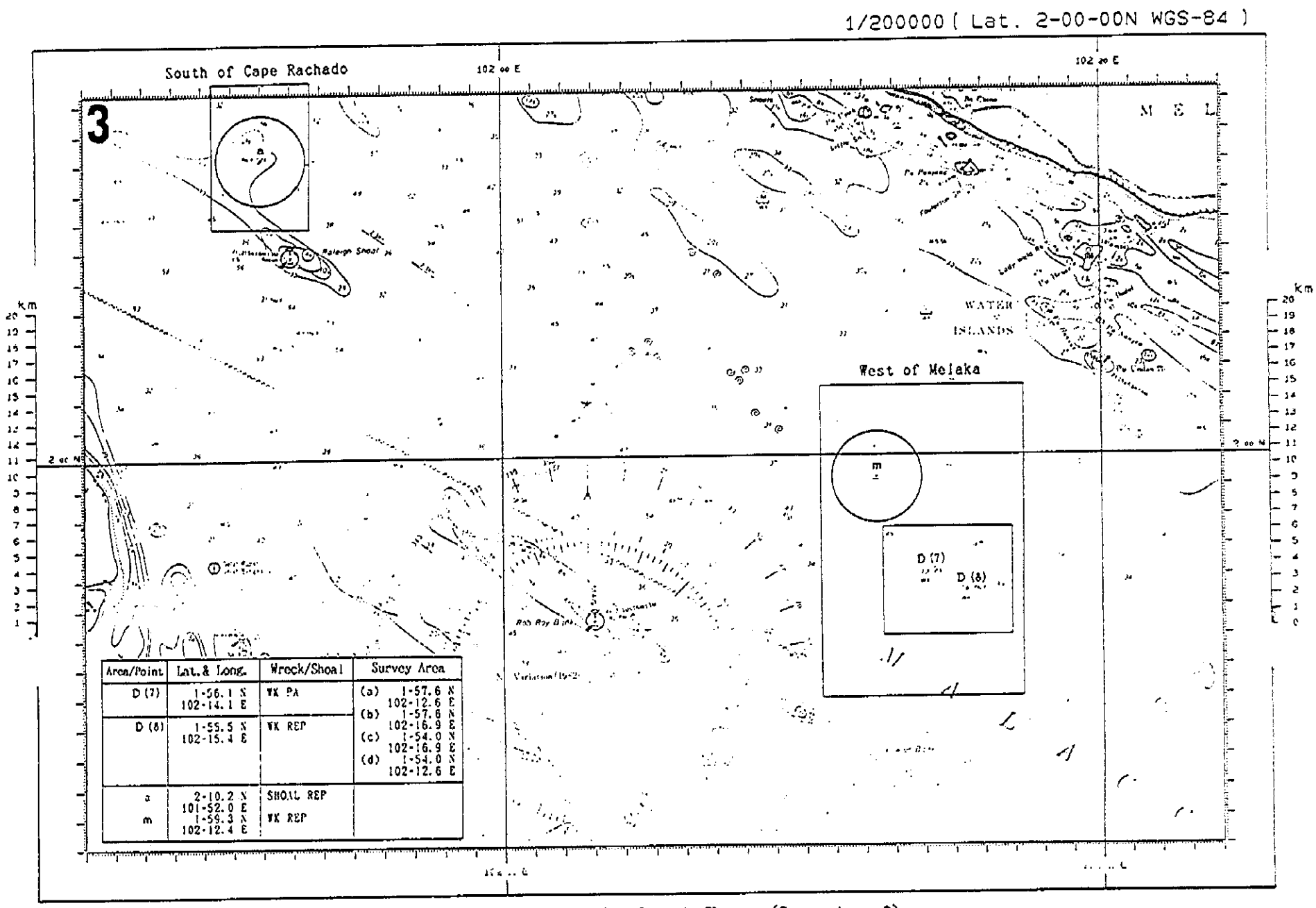
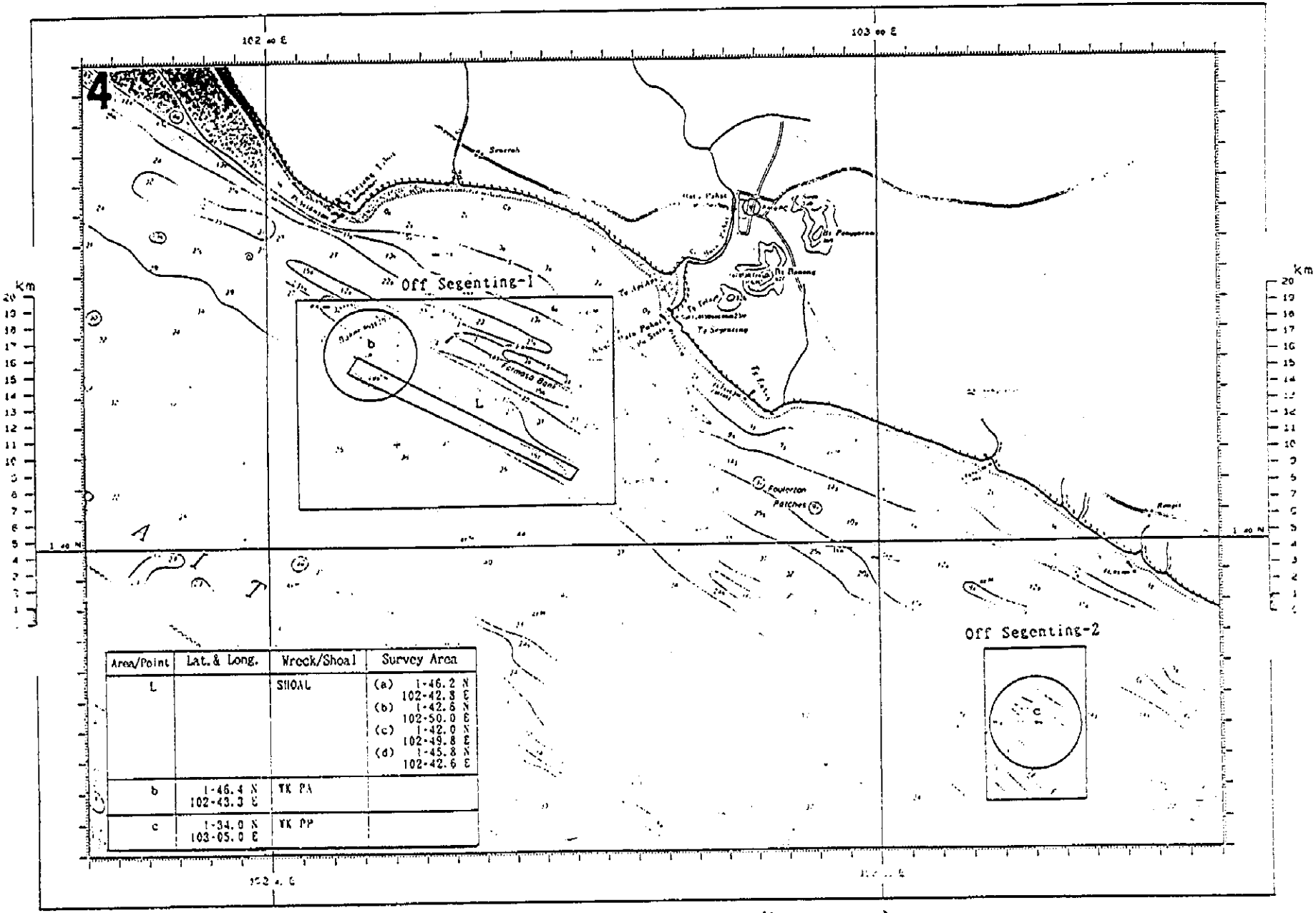


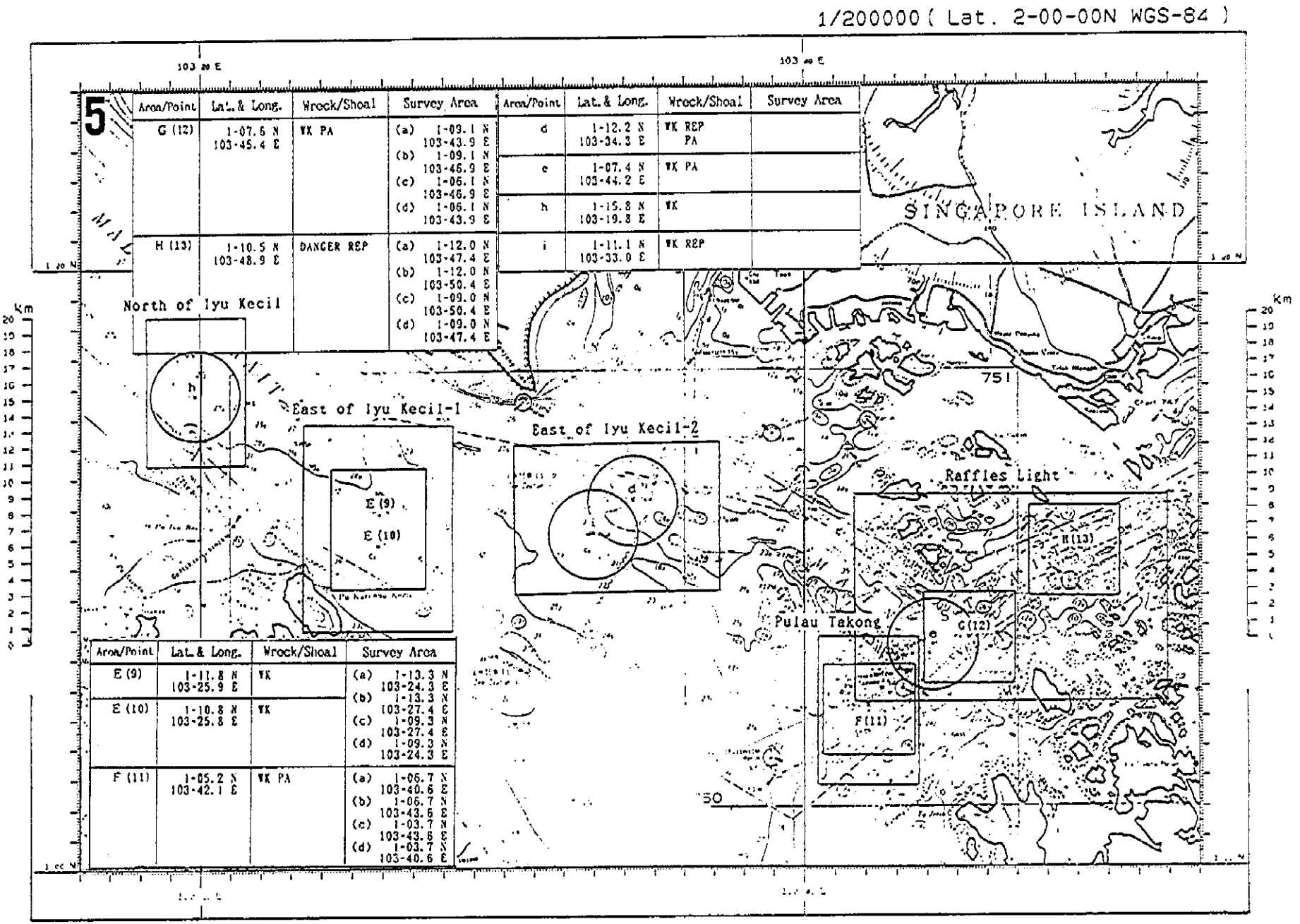
Fig. 9 Chart Sizes for Smooth Sheets (Group Area 3)

1/200000 (Lat. 2-00-00N WGS-84)



Area/Point	Lat.& Long.	Wreck/Shoal	Survey Area
L		SHOAL	(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
b	1-46.4 N 102-43.3 E	YK PA	
c	1-34.0 N 103-05.0 E	YK PP	

Fig. 10 Chart Sizes for Smooth Sheets (Group Area 4)



Area/Point	Lat. & Long.	Wreck/Shoal	Survey Area
G (12)	1-07.6 N 103-45.4 E	WK PA	(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
H (13)	1-10.5 N 103-48.9 E	DANGER REP	(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

Area/Point	Lat. & Long.	Wreck/Shoal	Survey Area
d	1-12.2 N 103-34.3 E	WK REP PA	
e	1-07.4 N 103-44.2 E	WK PA	
h	1-15.8 N 103-19.8 E	WK	
i	1-11.1 N 103-33.0 E	WK REP	

Area/Point	Lat. & Long.	Wreck/Shoal	Survey Area
E (9)	1-11.8 N 103-25.9 E	WK	(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
E (10)	1-10.8 N 103-25.8 E	WK	
F (11)	1-05.2 N 103-42.1 E	WK PA	(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

Fig. 11 Chart Sizes for Smooth Sheets (Group Area 5)

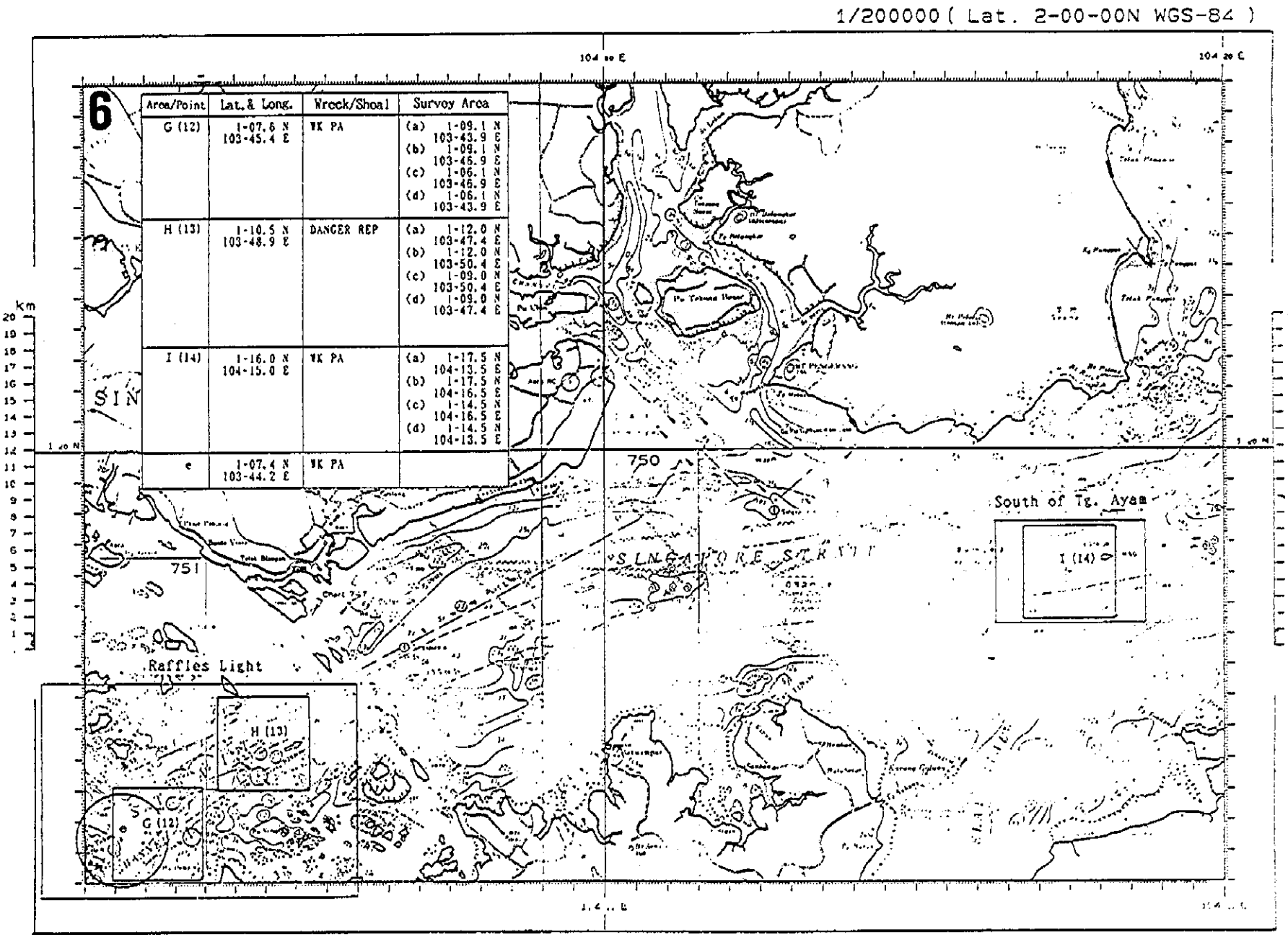


Fig. 12 Chart Sizes for Smooth Sheets (Group Area 6)

4. Electronic Navigational Charts Database

Electronic Navigational Charts (ENC) database covering six sheets of common datum charts of the Straits of Malacca and Singapore shown in Table 17 was prepared in Japan. This database makes use of this study results.

One magnetic tape file of ENC database was submitted to each Littoral State together with this report.

Table 17 Nautical Charts Used for ENC Database

Chart No.*	Title of Chart	Scale	Size	Published
621	Singapore Strait	1:200,000	Full**	Sep. 1982
622A	Tanjung Keling to Western Entrance of Singapore Strait	1:200,000	Full	Sep. 1982
622B	One Fathom Bank to Tanjung Keling	1:200,000	Full	Sep. 1982
749	Singapore Strait Eastern Portion	1: 75,000	Full	Mar. 1981
750	Singapore Strait Central Portion	1: 50,000	Full	Feb. 1996
751	Singapore Strait Western Portion	1: 50,000	Full	Feb. 1996

[Note] Chart No.* : Japanese Nautical Chart Number
Full** : about 96cm x 63cm at the inner neat line

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