THE [illegible] ROUTE SURVEY REPORT

[illegible] PIPE LINE PROJECT

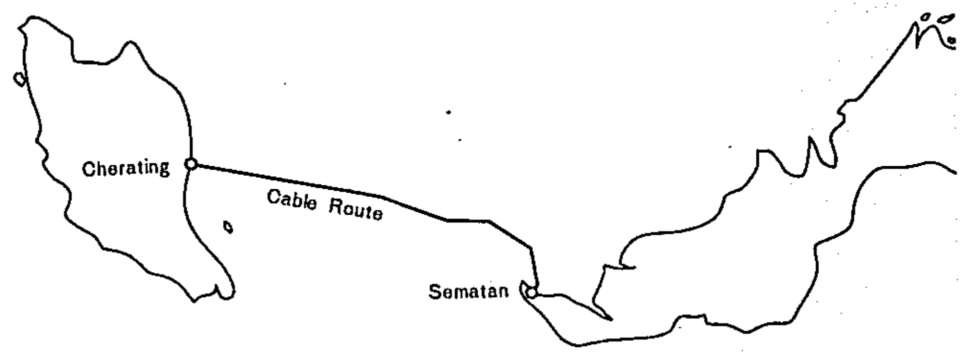
DECEMBER 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY AND ROUTE SURVEY REPORT
OF
THE KUANTAN-KUCHING SUBMARINE CABLE PROJECT
IN
MALAYSIA

DECEMBER 1977

JAPAN INTERNATIONAL COOPERATION AGENCY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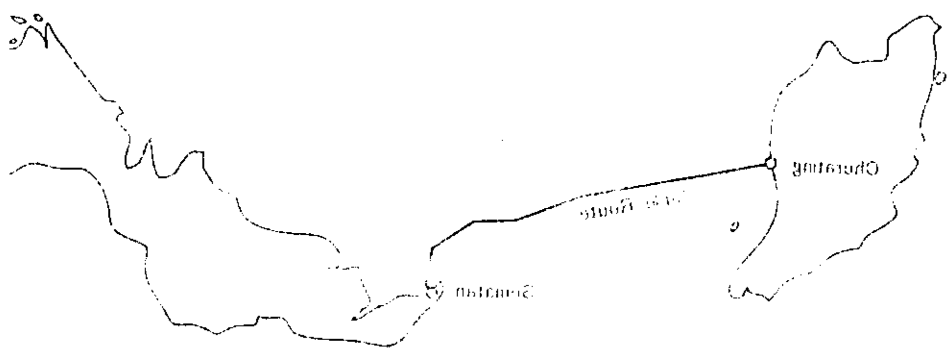

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NEGERI THAI
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REPUBLIK KHMER
Phnom Penh
Angkor Wat
Teluk Siam
SAIGON
Cholon
P Phu Quoc
P Condore
Hue
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Quang Tri
Dong Hoi
Nha Trang
LAUT CHINA SELATAN
Pulau2 Andaman (India)
Gugusan Pulau2 Mergui
Port Blair
Ten Degree Channel
Pulau2 Nikobar (India)
Chumphon
STG KRA
P.Langkawi
George Town
Selat Melaka
Kota Bahru
MALAYSIA
SEMENANJUNG MALAYSIA
Kuala Lumpur
Medan
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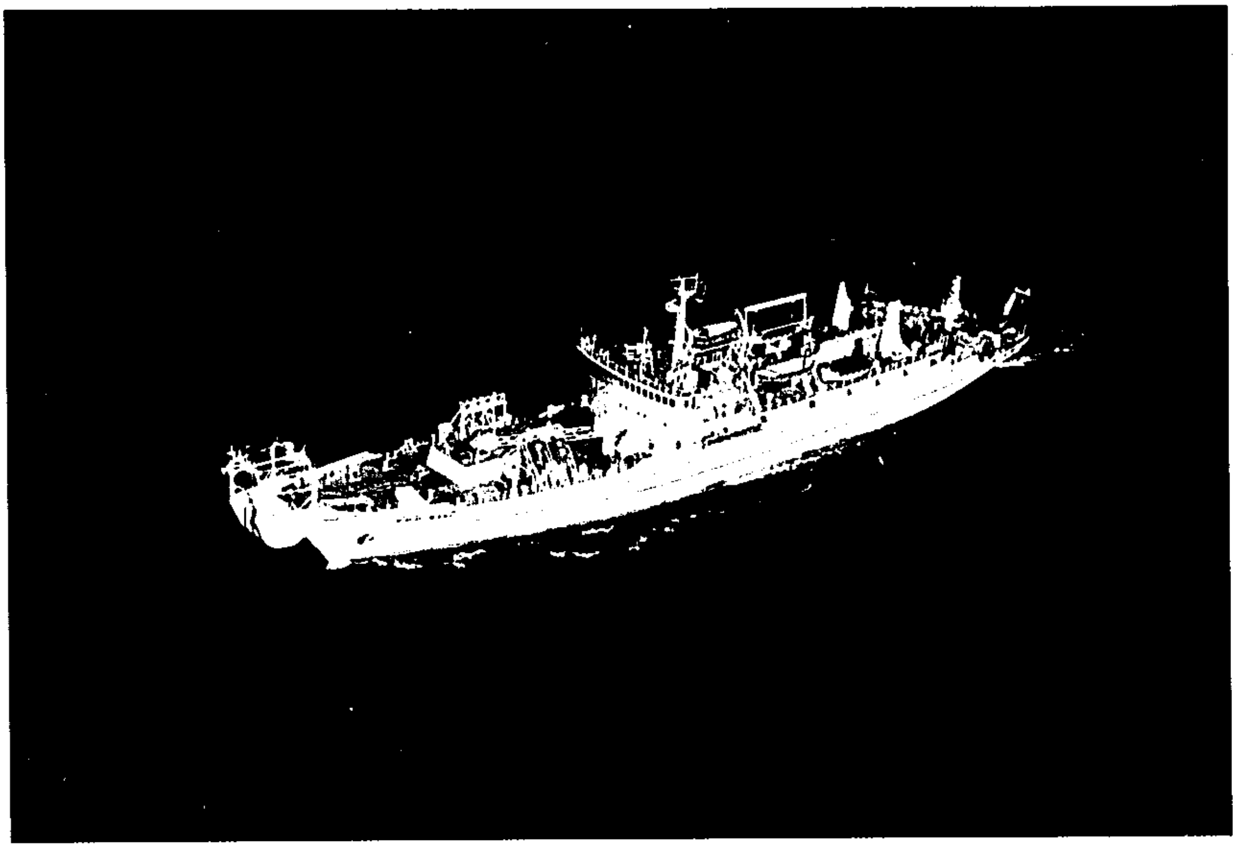
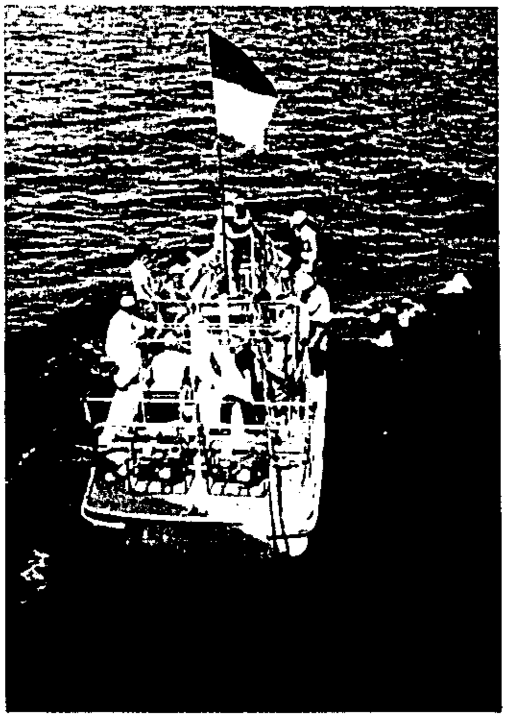


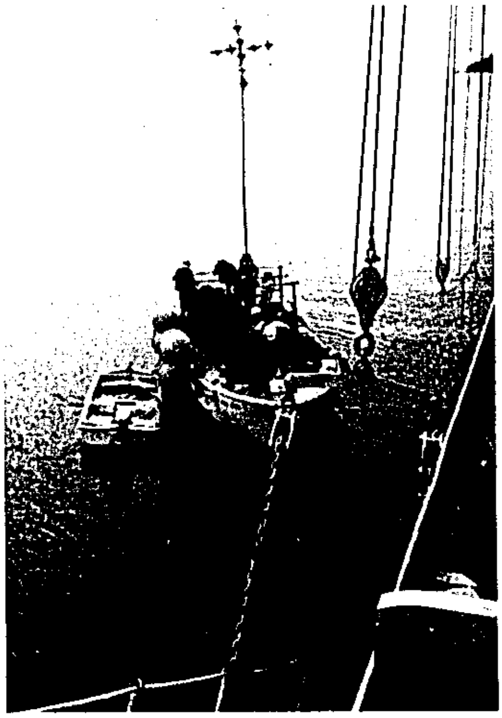
Cable Ship KDD MARU, the ship used for the cable route survey

Cable Ship KDD MARU

Keel Laid	Nov. 5, 1966
Launching	Feb. 25, 1967
Completion	Jun. 29, 1967
Length (O.A.)	113.84 m
Breadth Reg.	15.4 m
Depth Reg.	7.9 m
Gross Tonnage	About 4,300
Normal Speed	16 Kt
Range	7,000 N.M.
Complement	76
Propulsion	
Main Engine	Diesel 2,200 H.P.x2
Screw	C.P.P. 2
Rudder	2
Anti-Rolling & Anti-Pitching Device Equipped	
Main Power Generator	600 KVAx3
Bow Thruster	260 KWx1
Cable & Repeater Handling Equip.	BELL SYSTEM
Bow sheave	3 m Dia.x3
Bow Cable Engine	STBD & PORT
Drum	3.6 m Dia.
Motor	160 KW
Max. Picking up Ability	25 ton x 0.6 Kt
Cable Tank	
Diameter	8.7 mx1 13 m x2
Total Capacity	899 m^3
Crane	5 tonx1 7 tonx1
Builder	Mitsubishi Heavy Industries Ltd. Shimonoseki Shipyard
Owner	Kokusai Cable Ship Co., Ltd., Tokyo

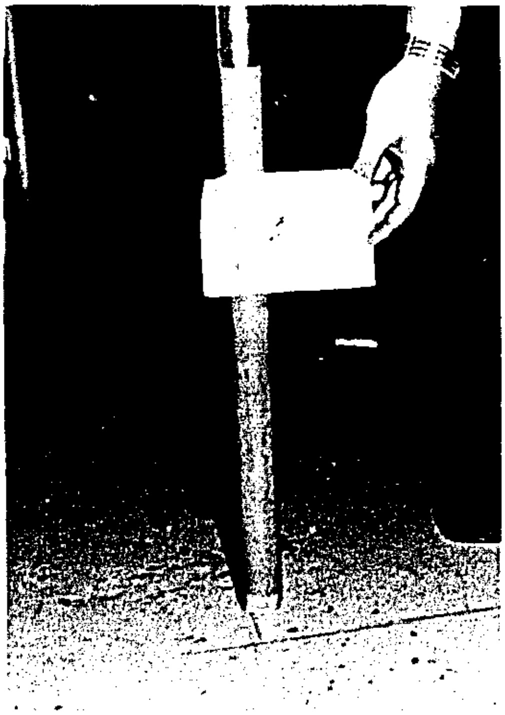


A working boat for the survey
in the shore portion



During land survey
at Sematan

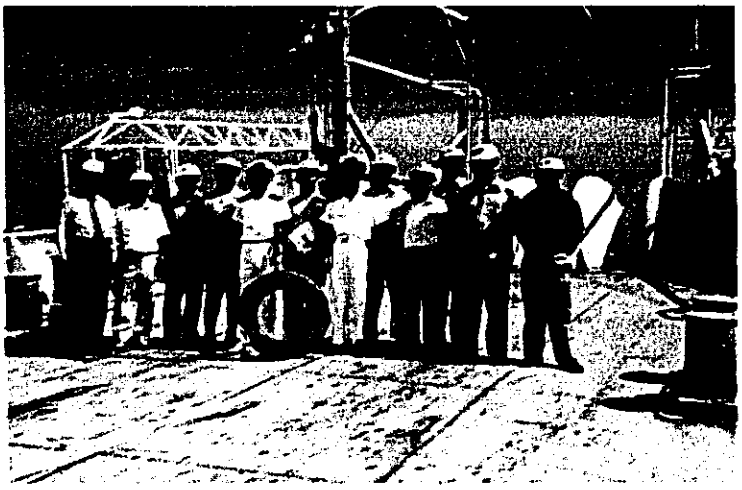
Preparation for bottom sampling



A core sample taken from the sea bottom

In the saloon of
C.S. KDD MARU

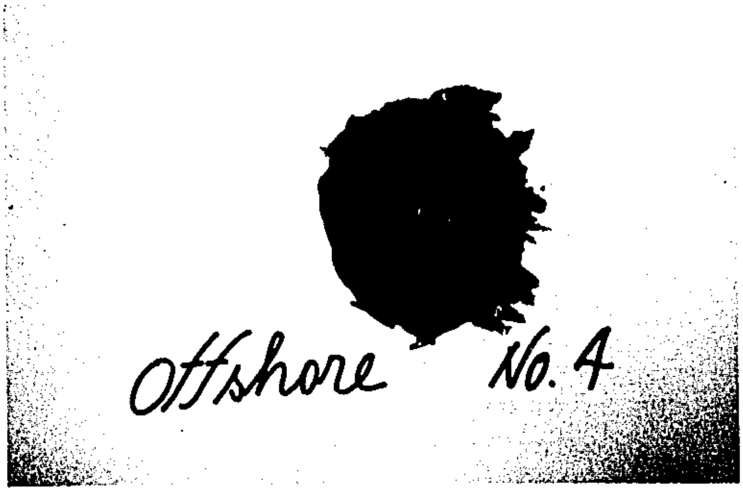
A meeting held in the Malaysian Telecommunication Department prior to the cable route survey



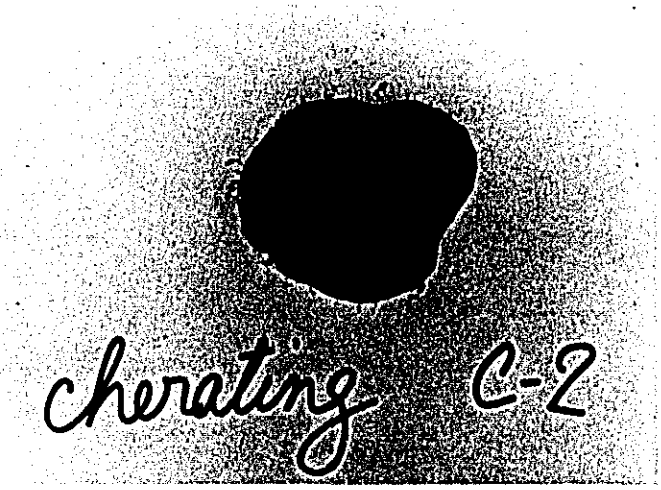
On board C.S. KDD MARU

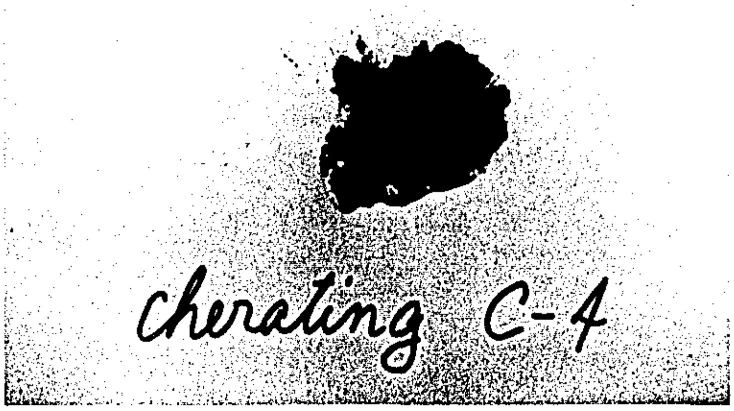
In the saloon of C.S. KDD MARU

Samples taken from the sea bottom in the off shore portion



Samples taken from the sea bottom in the shore portion





PREFACE

In response to the request of the Government of Malaysia, the Government of Japan decided to carry out a feasibility study and route survey of the Kuantan-Kuching Submarine Cable Project in Malaysia as part of Japan's overseas technical cooperation programmes and the said study and survey were executed by the Japan International Cooperation Agency (JICA).

JICA dispatched to Malaysia a preliminary study team of 6 experts, headed by Mr. Mitsugi Iijima of the Ministry of Posts & Telecommunications from July 17 to 31, 1977 and an ocean survey team of 7 experts, headed by Mr. Fujio Kinoshita of the Kokusai Denshin Denwa Co., Ltd. from August 30 to September 30, 1977, to make a feasibility study and route survey of the project.

The preliminary study and ocean survey were carried out very smoothly with full cooperation of the Government of Malaysia. An interim report on the route survey was submitted to the authorities concerned of the Government of Malaysia by the ocean survey team during their stay in Malaysia. After careful review of it in Japan, this report was prepared and is now submitted as the final report ofthe study.

I sincerely hope that this report will contribute to the progress of this project in the future and promotion of friendly relations between Malaysia and Japan.

Finally, I would like to express my deep appreciation to all the people of the Government of Malaysia who participated in this study for their full cooperation extended to the teams.

December, 1977

President
Japan International Cooperation Agency

CONTENTS

I SUMMARY

1. SUMMARY

Route survey and feasibility study of Kuantan-Kuching submarine cable system were undertaken by Japan International Cooperation Agency at the request of the Government of Malaysia. A Japanese survey team was sent to malaysia for each of the two phases of the survey and study: preliminary survey and cable route survey.

During the preliminary survey made in July 1977, Japanese delegates and Malaysian officials had several meetings, where the scope of work was agreed and informations of operational and financial aspects of the telecommunication service in Malaysia were presented to the survey team for the feasibility study. After the field inspections by the team of the possible landing sites proposed by Malaysian Telecommunication Department, a main and alternative survey routes were settled and requirements for the cable route survey were formulated.

In September 1977, the cable route survey was undertaken by C.S. KDD MARU with JICA survey team and three officials from Malaysian Telecommunication Department on board.
Sounding, subbottom profiling, picking up bottom sediment, water temperature observation, detecting obstacles on the bottom surface and short term current observation were carried out in the survey.

As a result, the proposed main survey route which passed by Natuna Island was found to be the shortest and suitable one for laying a submarine cable. The selected route has been determined in terms of the positions of course alteration points from the cable terminal site in Cherating through to that in Sematan. The route covers a distance of 461.8 nautical miles (or 855.3 Km) in total with muddy to sandy sediment on the bottom, and includes some noticiable depressions in the south of Natuna Island, where the maximum sea depth of about 110 meters (or 60 fathoms) was encountered. Bed rocks were observed only in the south east of Natuna but they did not penetrate the bottom surface. Some data of the temperature observation showed the existence of remarkable thermocline in the depths of 50 to 70 meters (or 27 to 38 fathoms).
The seasonal temperature variation on the bottom surface of the selected route was estimated from temperature data in the southern part of the South China Sea which were compiled in Japan Oceanographic Data Center.

According to the result of the route survey, a technical specification for the cable system to be laid on the selected route has been prepared.

Examples of submarine cable system configuration are given in the two probable cases: one with 24.5 mm (or 1.0 inch) armoured cable and the other with 38 mm (or 1.5 inches) armourless one to be buried into the sea bed. Based on the system operation cost estimated from the configuration examples and informations given by Malaysian Telecommunication Department, the feasibility of the submarine cable project was studied.

In the present state of demand for telecommunication survice between Peninsular Malaysia and Sabah/Sarawak, provision of a submarine cable so as to introduce subscriber trunk dialling system has proved to be enough feasible and an opportune scheme as a result of the study.

2 INTRODUCTION

2. INTRODUCTION

The Government of Malaysia is planning out to provide a wideband submarine telecommunication cable system between Peninsular Malaysia and Sabah/Sarawak.

These areas are presently connected by the following telecommunication media:

(i) Troposcatter system between Johor Baru - Kuching with a capacity of 48 channels.

(ii) Domestic satellite link between Kuantan and Kota Kinabaru with a present capacity of 12 circuits to be increased to 72.

(iii) SEACOM cable link between Singapore and Kota Kinabaru with 18 circuits.

In order to cover the recent trend of increasing demand for the telecommunication service between Peninsular Malaysia and Sabah/Sarawak, a subscriber trunk dialling system is in need of being introduced with some additional circuits which may be reasonably provided by a submarine cable system.

The Government of Malaysia requested the Japanese Government to provide with technical assistance on the Kuantan - Kuching submarine cable project. In compliance with the request, the Government of Japan made arrangements for the implementation of the cable route survey and feasibility study by Japan International Cooperation Agency.

From the 17th to 31st of July, a preliminary survey team, headed by Mr M. Iijima, was sent to Malaysia so as to make preparations for translating the survey program into practice.
The scope of work to be undertaken by the Japanese Government was agreed and requirements for the cable route survey were stipulated between the Japanese delegates and officials of the Malaysian Government as described in the "Report of Meetings on the Scope of Work for the Route Survey of Submarine Cable between Kuantan and Kuching in Malaysia" given in Appendix 1.

The team was given informations of operational and financial aspects of telecommunication service in Malaysia for its feasibility study on the project, and visited possible cable landing sites, accompanied by Malaysian officials, at Cherating, Chendor near Kuantan in Pahang and Sematan near Kuching in Sarawak which were suggested by Malaysian Telecommunication Department. After the field observation of the sites, Cherating and Sematan landing sites were confirmed to be suitable places for terminating the Submarine Cable in view of conditions for cable landing and for the access to the microwave link to the central office in Kuantan and Kuching.

From August 30th to September 30th in 1977, a cable route survey team from JICA, headed by Mr F. Kinoshita, was dispatched to Malaysia. The team joined C.S. KDD MARU at Kuching new port and carried out the survey which was observed by the following Malaysian officials;

Mr Mohamed Ali Yusoff, Controller of Telecoms,
Telecoms Headquarters, Kuala Lumpur.

Mr Ahmad Sobri Ismail, Assistant Controller,
Telecoms Headquarters, Kuala Lumpur.

Mr Fu Kok Kwang, Assistant Controller,
Telecoms Department, Kuching.

According to the agreement of the scope of work, an interim report on the main survey result was submitted by the team to Malaysian Telecommunication Department immediately after completion of the survey work.

Here presented is a final report on the route survey and feasibility study of Kuantan - Kuching submarine cable which includes all the results of the cable route survey, specifications for the submarine cable system to be laid on the selected route, suggested requirements for cable installation and for cable terminal building, examples of system configuration, estimate of construction cost and economic evaluation of the cable system. Daily events and team members of the preliminary survey and cable route survey are as follows.

(1) Preliminary Survey

(Team Members)

Mr. Mitsugi IIJIMA (Leader)

Counsellor of Telecommunications
Ministry of Posts & Telecommunications (MPT)

Mr. Kazunaga MATSUDA (Sub-leader)

Deputy Manager of Engineering Department
Submarine Cable Construction Headquarters
Kokusai Denshin Denwa Co., Ltd. (KDD)

Mr. Taisuke KITAMURA

Assistant to Manager
Construction Department
Submarine Cable Construction Headquarters, KDD

Mr. Atsuo EBATA

Assistant Chief of Outside Plant Section
Engineering Department
Submarine Cable Construction Headquarters, KDD

Mr. Toru SAMPEI

Staff of Office of Telecommunications
Administration MPT

Mr. Akio ITOH (Coordinator)

Special Assistant to Director
Social Development Cooperation Department
Japan International Cooperation Agency (JICA)

(Daily events)

Jul. 17 Lv. Tokyo 09:30 MH811 Ar. Kuala Lumpur 18:20

18 Salutation to Embassy of Japan and meeting at Telecommunication Headquarters

19 Study with counterparts

20 ditto

21 Meeting at the Economic Planning Department

22 Lv. Kuala Lumpur 09:40 MH152 Ar. Kuantan 10:30
Observation of proposed cable landing sites

23 Lv. Kuantan 12:15 MH153 Ar. Kuala Lumpur 13:05
Lv. Kuala Lumpur 16:00 MH831A Ar. Singapore 16:45

24 Survey of port for ocean survey ship

25 Lv. Singapore 17:30 MH683 Ar. Kuching 19:20

26 Observation of proposed cable landing site

27 Meeting at Telecommunication Department, Sarawak
Lv. Kuching 16:05 MH502 Ar. Kuala Lumpur 17:05

28 Study with counterparts

29 Meeting at the Economic Planning Department

30 Report to Embassy of Japan and final meeting at Telecommunication Headquarters

31 Lv. Kuala Lumpur 09:25 JL714 Ar. Tokyo 18:50

(ii) Cable Route Survey

(Team Members)

Mr. Fujio KINOSHITA (Leader)

Former Chief of Marine Engineering Section Construction Department
Submarine Cable Construction Headquarters, KDD

Mr. Taisuke KITAMURA

Assistant Chief of Marine Engineering Section
Construction Department
Submarine Cable Construction Headquarters, KDD

Mr. Akio MIZUKOSHI

Marine Engineering Section
Submarine Cable Construction Headquarters, KDD

Mr. Kyoji SERIGUCHI

Manager of Survey Department
Sanyo Hydrographic Survey Co., Ltd. (SSS)

Dr. Shigeaki KUBO

Manager of Geological Department
SSS

Mr. Yukiharu WATANABE

Chief of Survey Section
Moji Branch Office
SSS

Mr. Akio ITOH (Coordinator)

Special Assistant to Director
Social Development Cooperation Department
JICA

(Dailay events)

Aug. 30	Lv. Tokyo 11:20 JL715 Ar. Kuala Lumpur 18:25
31	Preparation of survey
Sep. 1	Meeting at Telecommunication Headquarters
2	Lv. Kuala Lumpur 10:10 MH501 Ar. Kuching 12:10 Meeting at Telecommunication Department, Sarawak
3	Preparation of survey
4	Boarding on C.S. KDD MARU
5-7	Survey of shallow water portion and landing site at Sematan
8-12	Route survey between Kuching and Kuantan
13-14	Survey of shallow water portion and landing site at Cherating
15-20	Route survey between Kuantan and Kuching
21-22	Study of survey data
23	Lv. Kuching 16:05 MH502 Ar. Kuala Lumpur 17:05
24-26	Preparation of interim report
27	Report to Embassy of Japan and submitted interim report to Telecommunication Headquarters
28	Examination of interim report by the counterparts
29	Meeting at Telecommunication Headquarters
30	Lv. Kuala Lumpur 09:25 Ar. Tokyo 18:50

3 CABLE ROUTE SURVEY

3. CABLE ROUTE SURVEY

3.1 Preface

An ocean survey to select a route for laying Kuantan - Kuching submarine cable system was undertaken in the South China Sea from 5th to 20th of September in 1977. The ship used for the survey was Cable Ship KDD MARU (4,300t) owned by Kokusai Cable Ship Company Ltd. and based at Yokohama, Japan.

The objectives of the survey were to determine the shortest and suitable route for laying a submarine cable in the South China Sea between Cherating in Pahang and Sematan in Sarawak, and to provide informations of the sea or sea bed conditions on the selected route, so that the design of the cable system and the planning of cable installation work may be carried out.

Survey method and procedures were determined basing upon the survey requirements and conditions given in the preliminary survey. C.S. KDD MARU entered Kuching new port before and after the survey work, where the Japanese survey team, led by Mr F. Kinoshita, joined and left the ship together with three observers from Malaysian Telecommunication Department led by Mr M. Ali Yusoff.

3.2 Survey Area

Fundamental survey track had been suggested and agreed in the meetings during the preliminary survey. It connects Cherating on the east coast of Penisular Malaysia and Sematan on the west coast of Sarawak passing through north of Anambas Islands, between Great Natuna and Midai Islands, and north of Subi Besar as shown in Figure 3.2-1. In the south of Natuna, another track branching off the main and taking a roundabout way to the south of Midai, had also been suggested as an alternative. As a whole cable route between the cable terminal locations was to be selected in the survey, each land portions from the beach to the site for cable terminal building was also included in the survey area.

Since no problematic bottoms were found in the first sounding run along the main survey track, a decision was made through discussions between the survey team and observers from Malaysian Telecom Department on board that the alternative track might be left unsurveyed and instead of this, an attempt should be made to look for more favourable bottom along the additional track which was settled approximately ten nautical miles south of the main without increasing the total route length.

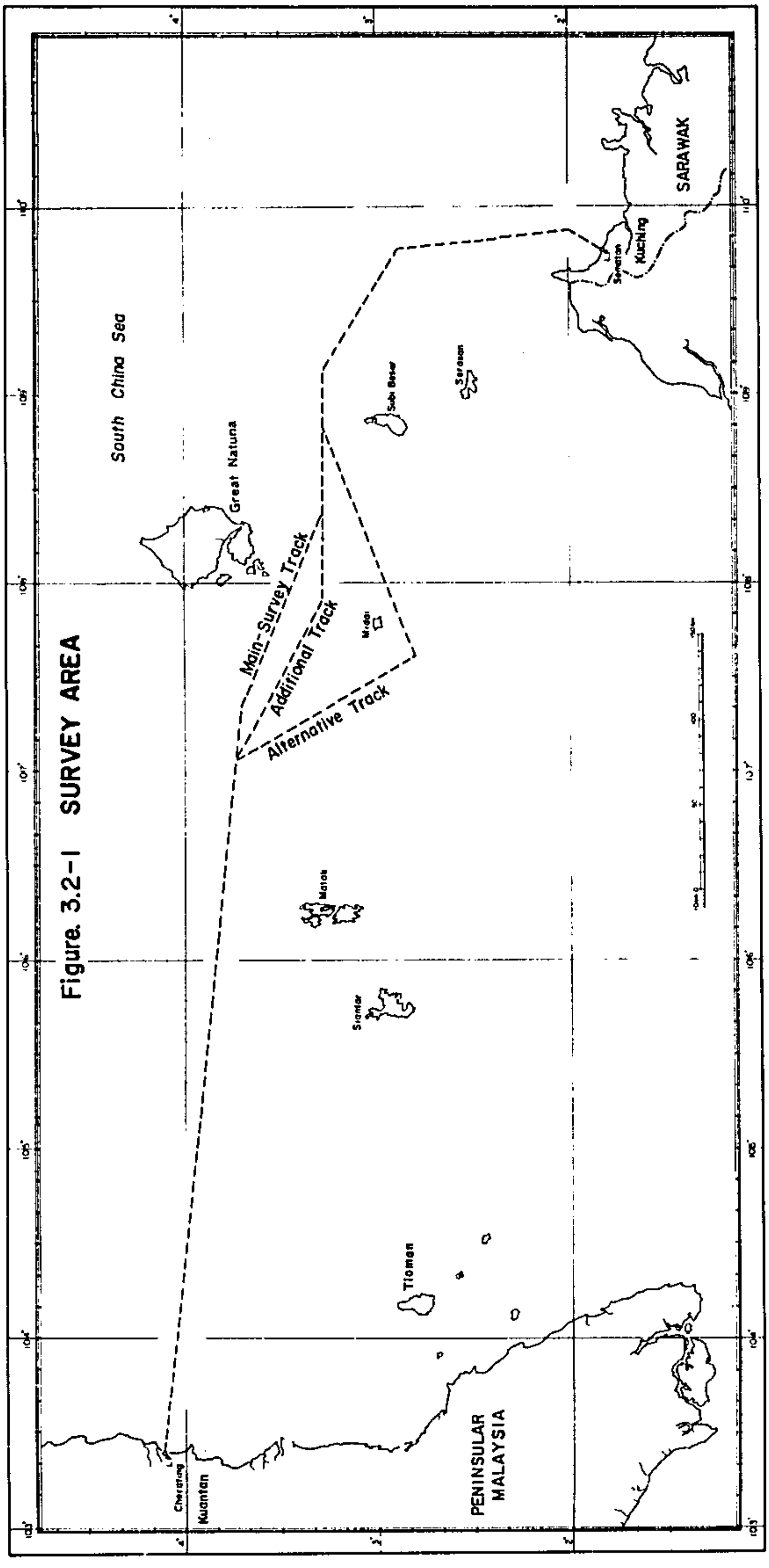


Fig. 3.2-1 SURVEY AREA

3.3 Outline of Survey Work

The survey work was carried out dividing the survey area into three kinds of portions; offshore portion deeper than 10 meters in water where to be surveyed by C.S. KDD MARU, shore portion where inaccessible by KDD MARU and to be surveyed by using working crafts and land portion from the beach to the cable terminal building site.

3.3.1 Survey work in the offshore portion

In the offshore portion, two runs, going and returning, were made by C.S. KDD MARU along the main and sub survey tracks, the latter of which was settled about two nautical miles apart from and in parallel with the main on either side.
In the going run,

(1) bottom sounding by using a shallow water type depth recorder,
(2) subbottom profiling by using SPARKER in order to know the thickness of bottom sediment and to detect any existence of bed rock near the bottom surface

and (3) detecting obstacles on the bottom surface by using SIDE SCAN SONAR,

were made simultaneously in a ship speed of around four knots along the main survey track. Ship positions during the survey were fixed at intervals of twelve minutes by using a Doppler Sonar Navigater and these positions were checked and corrected with the data from Navigation Satellite Receiver or Radar where targets were available.
Survey tracks and positions with radar targets used are shown in Figure 3.3-1.

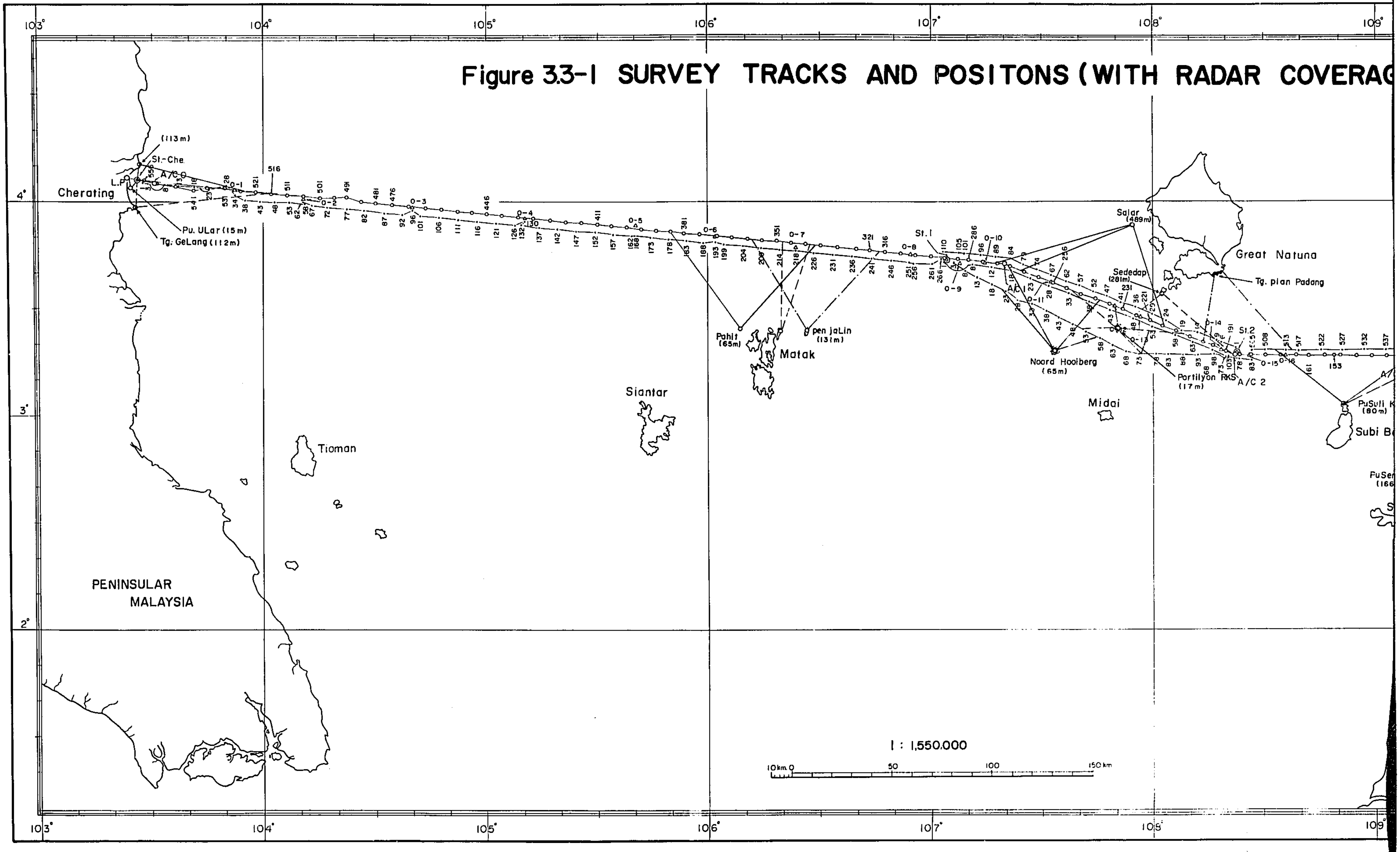


Figure 3.3-1 SURVEY TRACKS AND POSITONS (WITH RADAR COVERAG

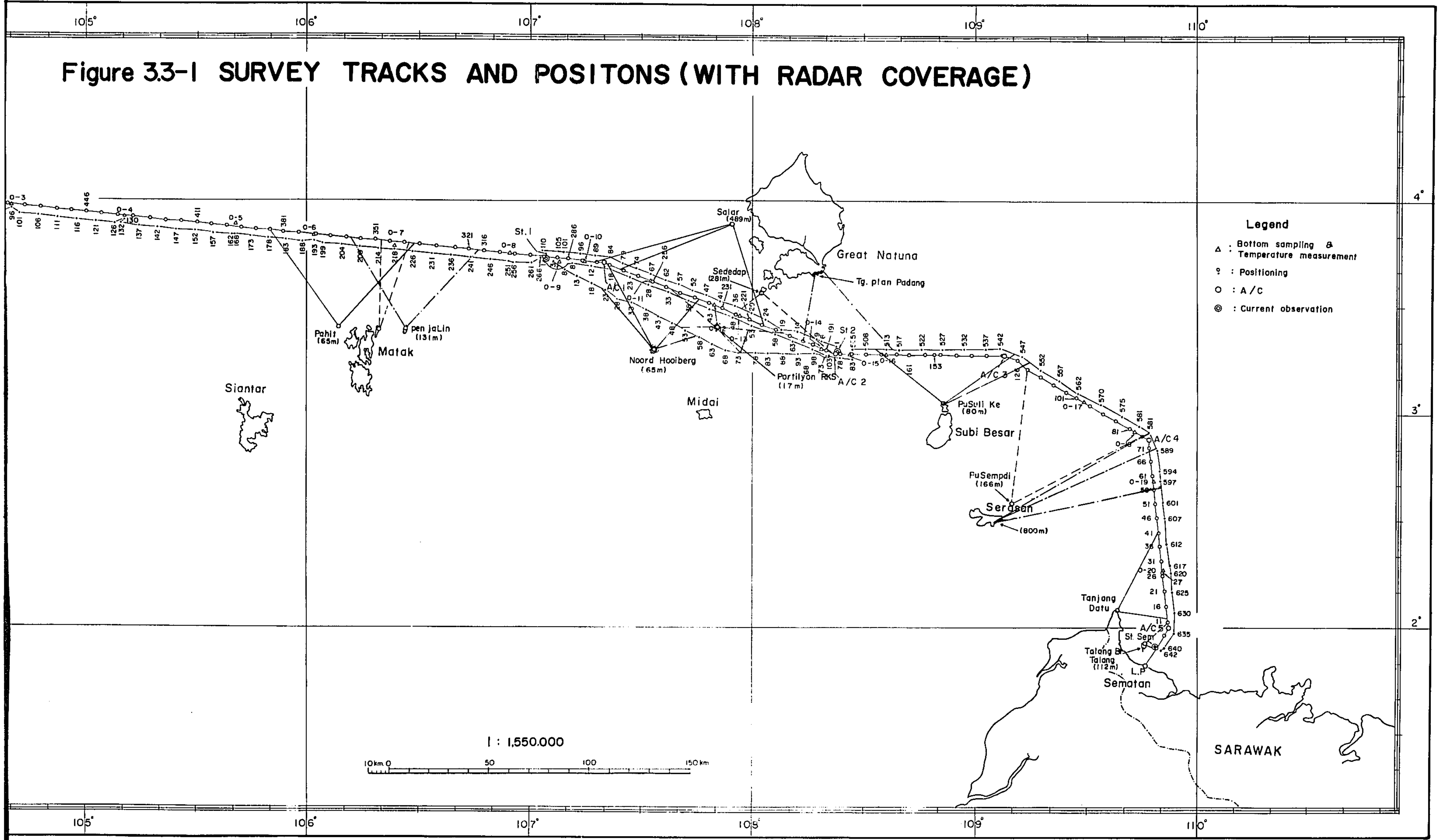


Figure 3.3-1 SURVEY TRACKS AND POSITONS (WITH RADAR COVERAGE)

In the returning run,

(1) sounding in a speed of eight to ten knots along the sub track settled two miles apart from and in parallel with the main track,

(2) picking up samples of bottom sediment,

(3) observation of water temperature on the bottom

and (4) short term current observation

were made. (2), (3) and (4) were carried out by stopping the ship at positions on the main track which had been chosen from the result of immediate interpretation of the record obtained in the preceded going run survey.

From the result of going run survey, the main track seemed to be feasible for laying a submarine cable though some noticiable undulations and depressions were found in the inter-islands area around Natuna extending over about one hundred nautical miles along the track. Therefore decision was made on board that the suggested alternative track, which took a round about way to the south of Midai Island, might be left unsurveyed and another going-run survey should be made along an additional track which was established about ten miles south of the main without increasing a total route length, so as to look for much smoother bottom. As the result of the going-run survey showed that the bottom conditions on the main track were still better, another sounding run was made by the main track in order to confirm the bottom topography in the interislands area. Current recorders were placed and left during the above sounding at both ends of the inter-islands area and current direction and speed were recorded for more than twenty four hours.

3.3.2 Survey work in the shore portion

In the shore portions at Cherating and Sematan,

(1) sounding,

(2) subbottom profiling,

(3) detecting obstacles on the bottom surface,

(4) picking up samples of bottom sediment

and (5) water temperature observation

were carried out by using working crafts lowered from C.S. KDD MARU along the three parallel tracks about 250 meters apart and extending four to five miles offshore. The working crafts were guided on these survey tracks by the shore transit and positioned with the aid of a radio distance meter, HYDRO DIST.

3.3.3 Survey work in the land portion

Whilst the survey was made in the shore portion, some of survey members and Malaysian officials went ashore to select and measure the land portion of the cable route from the beach to the inland site for cable terminal station building. Wooden stakes were placed at all turning and end points of the selected route and relative positions of neighbouring trees, fences, roads, houses etc were taken so as to ensure easy relocation of the route in the future.

3.4 Survey Equipment

Main equipment used in the route survey are as follow.

(1)	Depth recorder for sounding	----- PS-10 Depth Recorder for Shallow Water, SD-1500 Depth Recorder for Shallow and Medium Depth Water and PS-6 Depth Recorder for Shallow water*
(2)	Subbottom profiler	----- NE-19C SPARKER (NEC)
(3)	Bottom sonar for detecting obstacles on the bottom	----- MARK 1B SIDE SCAN SONAR (EG&G)
(4)	Sampler for picking up bottom sediment	----- Piston Corer, Gravity Corer*, Smith Nclntyre Grab Sampler, and Bucket Type Dredger*
(5)	Thermometer for water temperature observation	----- ET-5 Electric Thermometer and Expendable Bathy-thermograph (XBT - T.S.K./Sippican)
(6)	Current recorder	----- Ono Type Current Recorder (T.S.K.)

(7) Positioning equipment ----- JLE-300 Satellite Navigator, (J.R.C.)
JLN-1001 Pulse Doppler (J.R.C.)
Sonar, Radio Distance Meter*
(HYDRO DIST) and RADAR

* shows equipment used only in the shore portion.

Principal functions and technical parameters of these survey equipment are described below. Out fitting of survey equipment to KDD MARU is shown in Figure 3.4-1.

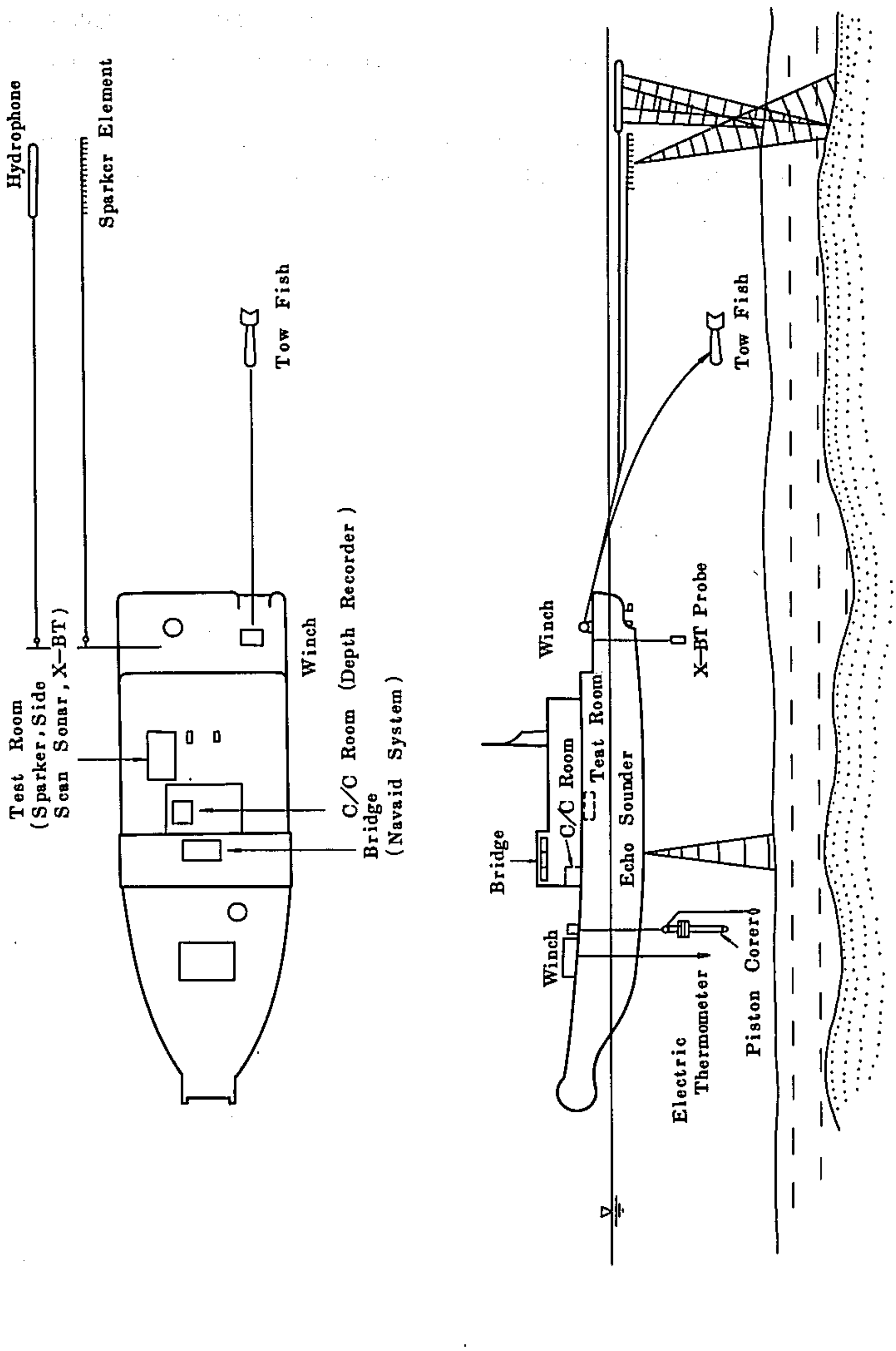


Figure 3.4-1   Outfitting of KDD MARU for the survey

3.4.1 Depthe Recorder

Depth recorder is an essential equipment for examining the bottom topography. It gives the sea depth directly beneath the survey ship by measuring the time period from the time a sonic pulse is transmitted down to the sea bottom until a reflected pulse from the bottom surface is received. Depth marks in light to shade according to the strength of a received signal, are printed continuously at positions corresponsing to the sea depths.

As shown in the block diagram of Figure 3.4-2, "SYNCHRONIZING OSCILLATOR" feeds A/C power of acculate and stabilized frequency to a driving motor in "RECORDER". "RECORDER" gives "TRANSMITTER" timing signals for transmitting pulses. "TRANSMITTER" generates electric pulses of enough power according to timing signals from "RECORDER" and transmit them into water converting them into accoustic pulses through "TRANSDUCER". Received echo pulses are converted to electric ones by receiving "TRANSDUCER", amplified by "RECEIVER" and fed to "RECORDER", in which echo pulses are recorded on the recorder paper in a form of continuous depth profile according to time intervals between the emitted pulses and their echoes received. Sounding by the depth recorder is illustrated in Figure 3.4-3. Technical parameters of "PS-10" Depth Recorder are shown below.

Technical parameters of PS-10 D.R.

Recording Range	0 - 10 m (or 0-5.5 fm)
Maximum Sounding Depth	106 m (or 58 fm)
Recording Error	$\pm 0.05 + 10^{-3}D$ (in m)
Dimension of Recording Paper	150 mm x 10 m (or 5.9in x 33ft)
Paper Drive Speed	60 mm/minutes (or 2.4in/minutes)
Directivity of Emission	3°
Ultra Sonic Frequency	200 kHz

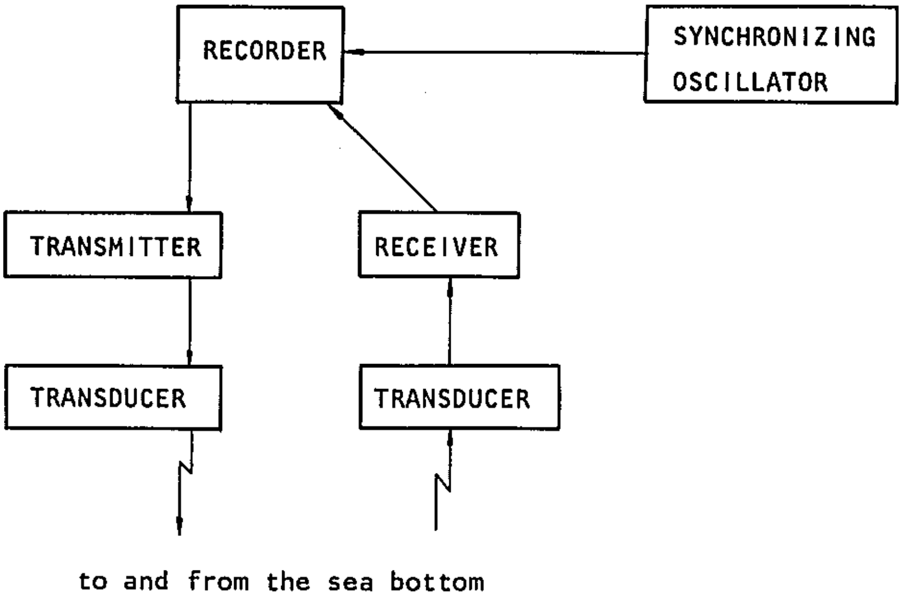
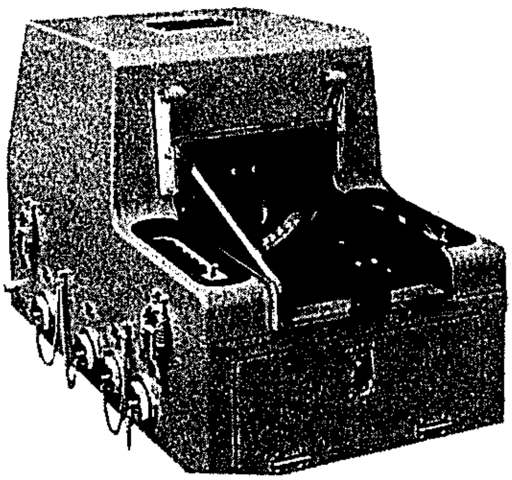
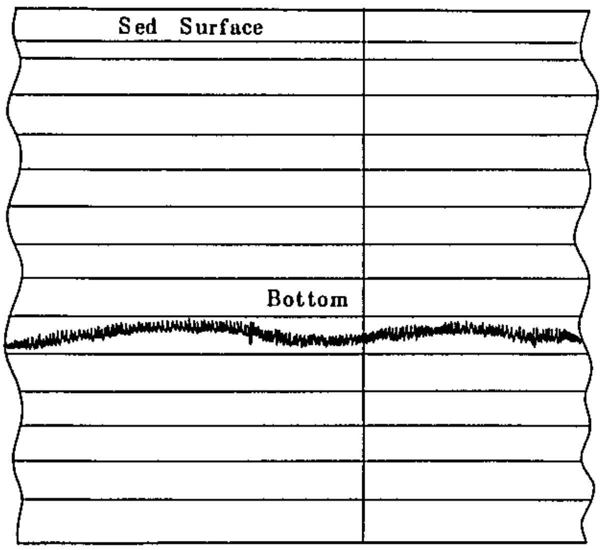


Figure 3.4-2 Brock Diagram of Depth Recorder



PS-10 Recorder



Record of Ocean Bottom

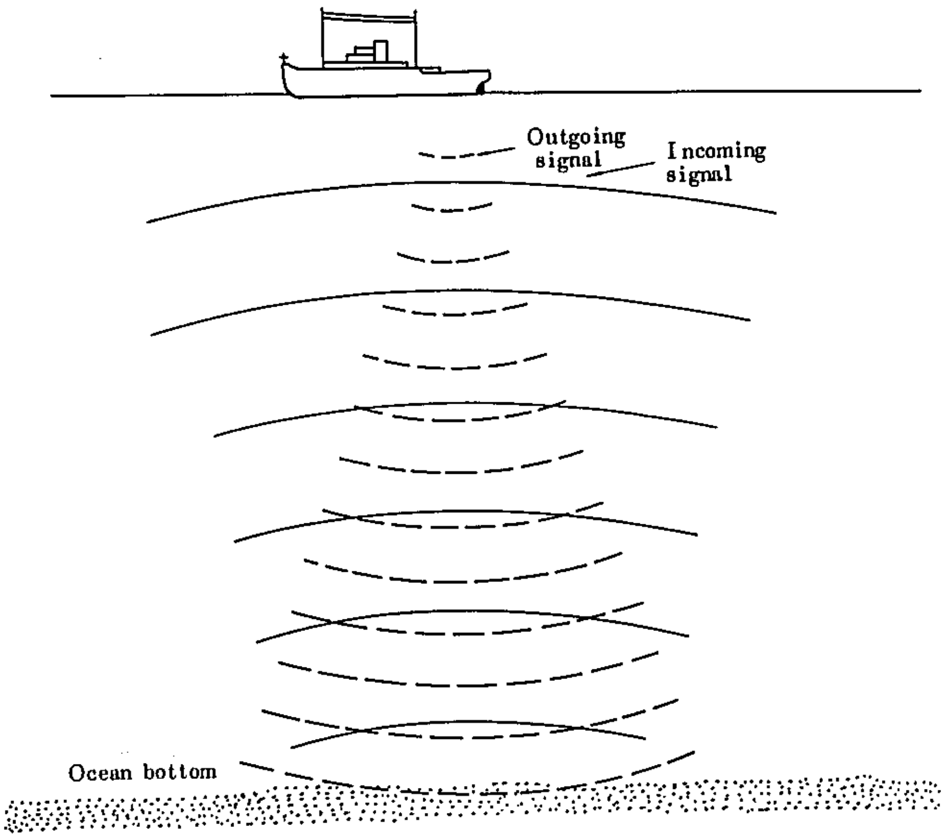


Figure 3.4-3 Sounding by Depth Recorder

3.4.2 Subbottom Profiler

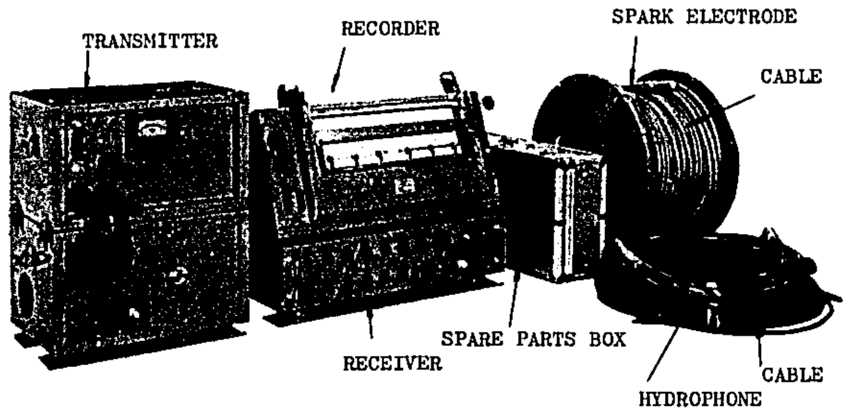
Sonic wave of low frequency less than several hundred Hz penetrates well into the bottom soil and reflected by planes of discrete accoustic impedance corresponding to boundaries of subbottom layers.
Pulse transmission and recording echoes are made similarly to that of Depth Recorder. Subbottom profiler transmit pulses of higher power and lower frequency than those of Depth Recorder. Subbottom profilers are classified into various types mainly according to types of generation method of accoustic impulse. "SPARKER" which was used in the route survey, makes use of spark discharges in water for generating accoustic pulses.

Operation of subbottom profiler is illustrated in Figure 3.4-4. Technical parameters of NE-19C "SPARKER" are given below.

NE-19C "SPARKER" (NEC)

TRANSMISSION ENERGY	200 Joule
Recording Range	100, 200 , 400 and 800 m (or 55,

	110, 220 and 440 fm)
Recording Width	200 mm x 2 (or 7.9 in x 2)
Dimension of Recording Paper	490 mm x 30 m (or 19.4 in x 100 ft)
Paper Drive Speed	120, 60 mm/minutes (or 4.8, 2.4 in/min.)
Receiving Frequency Range	100 - 5,000 Hz



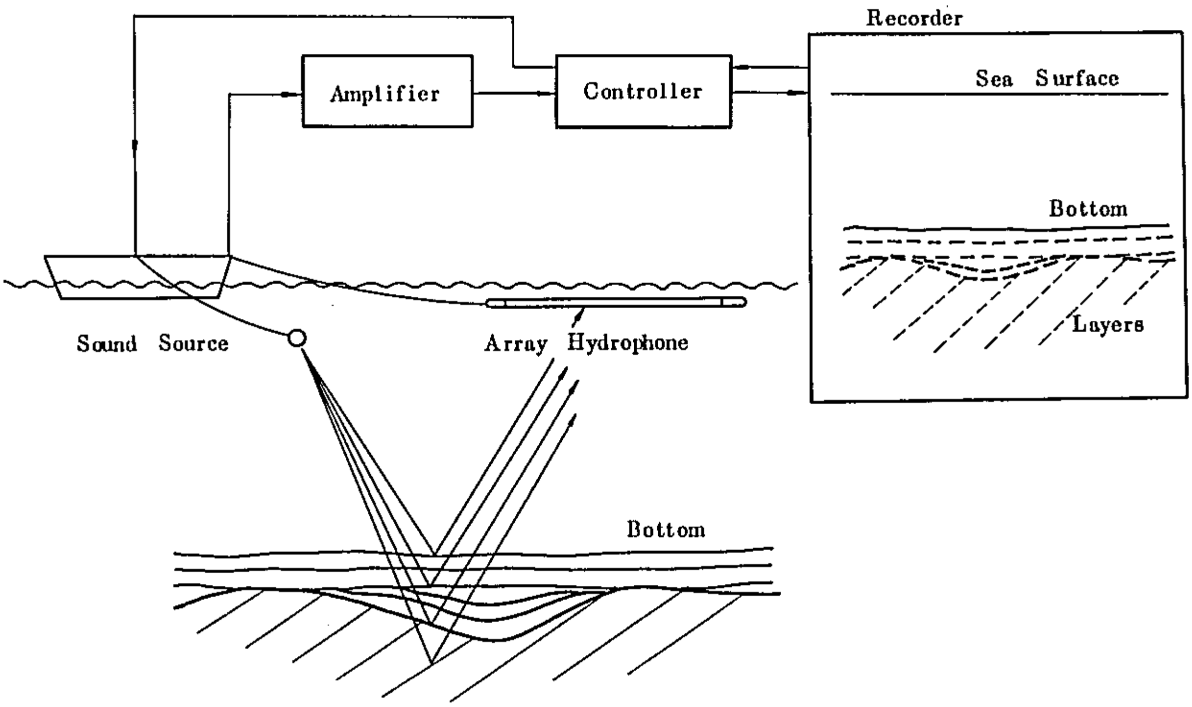


Figure 3.4-4 Sub-bottom Profiling

3.4.3 Bottom Sonar

Bottom sonar is an equipment to investigate configuration of the bottom surface. Basic functions of the bottom sonar are also similar to depth recorder. Depth recorder makes use of accoustic pulses transmitted directly downward in a narrow beam by a transmitting element located near the water surface, while in case of bottom sonar, pulses are emitted slantly to the bottom surface by transmitting elements mounted on a "fish" towed near the bottom. Transmitting and receiving transducer elements are mounted on a "tow fish" so that they may face perpendicularly to the towing direction on each side of the "fish", and acoustic wave pulses are transmitted covering wide angle of several tens degrees in a vertical plane and narrow angle of about one degree in a horizontal plane as shown in Figure 3.4-5. Reflected sonic waves are received continuously with a time delay coresponding to a distance from the "tow fish" to the place of reflection on the bottom. A sound wave suffers an attenuation according to its propagation distance. Differences in strength of received signals corresponding to each propagation distance are equalized by a time varied gain amplifier.

The out put signal of the amplifier is printed at a position, on the recorder paper, corresponding to a distance from the tow fish to the place of reflection.

By towing the fish, aspects of the bottom surface are recorded in the two dimensions like a photograph with light to shade patterns corresponding to ups and downs of the bottom surface.

MARK 1B SIDE SCAN SONAR and its block diagram are shown in Figure 3.4-6.

Technical Data of Mark 1B Side Scan Sonar (EG&G)

259-3 Recorder

Range Scales: 50, 100, 125, 200, 250, 500 meters

Scale Lines: every 15 meters

Paper Speed: 40, 60, or 80 lines/cm (100, 150, or 200 lines/inch)

Input Power: 24-30 volts DC, 4-8 amperes depending on range scale.

Recording Paper: Type: Moist paper. Width: 28 cm(11"): Width each channel: 13cm(5"): Length: 37M(120 ft.)

Weight: 38 kg (84 lb.)

Dimensions: 28 cm(11") high, 84 cm(33") wide, 44 cm(17") deep

272 Saf-T-Link Tow Fish

Operating Frequency: 105 ± 10 kHz

Pulse Length: 0.1 msec

Peak Output: 128 db ref 1 ubar at 1 meter

Horizontal Beam Width: (3 db points) 1.2°

Vertical Beam Width: 20° or 50°, tilted down 10° or 20°

Coverage: up to 1000 M (500 M each side)

Towing Speed: 0-28 KM/hr. (0-15 knots)

Max Depth: 600 M (2000 ft.)

Weight: 22 Kg (48 lb.)

Dimensions: 118 cm(47") long, 30 cm(12") tail, 11.4 cm(4.5") diameter

Cables: Type: Double armored, steel
- Diameter: .95 cm(.38")
- Length: 150 M(500 ft.) or 600 M(2000 ft.)
- Strength: 5000 Kg(11,000 lb.)
- Weight: .35 Kg/M(.23 lb./ft.)

Type: Lightweight, flexible
- Diameter: 1.2 cm(.50")
- Length: 50 M(150 ft.)
- Strength: 400 Kg(900 lb.)
- Weight: .3 Kg/M(.2 lb./ft.)

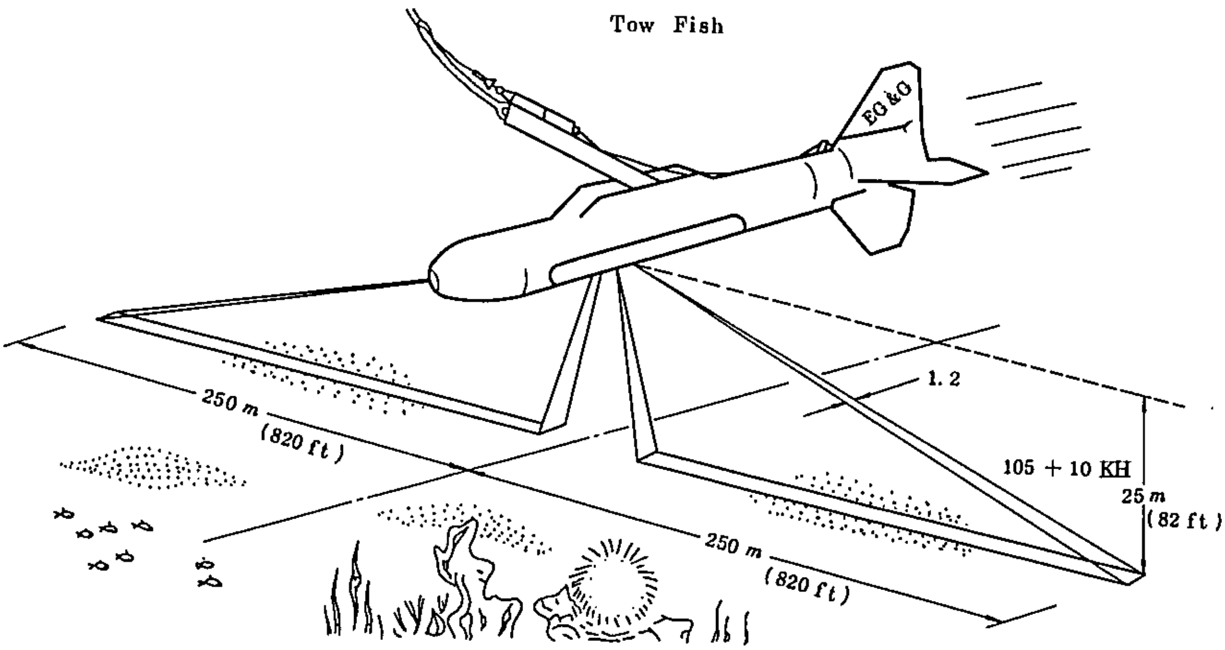
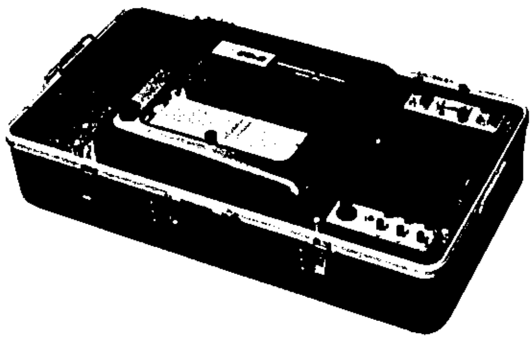
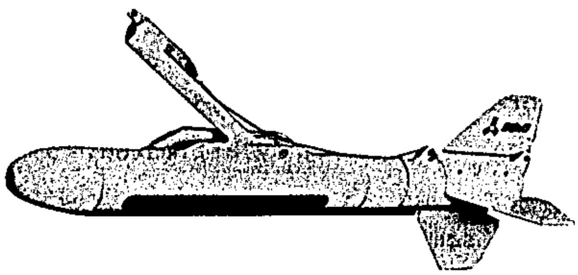


Figure 3.4-5 Scanning Coverage of Side Scan Sonar





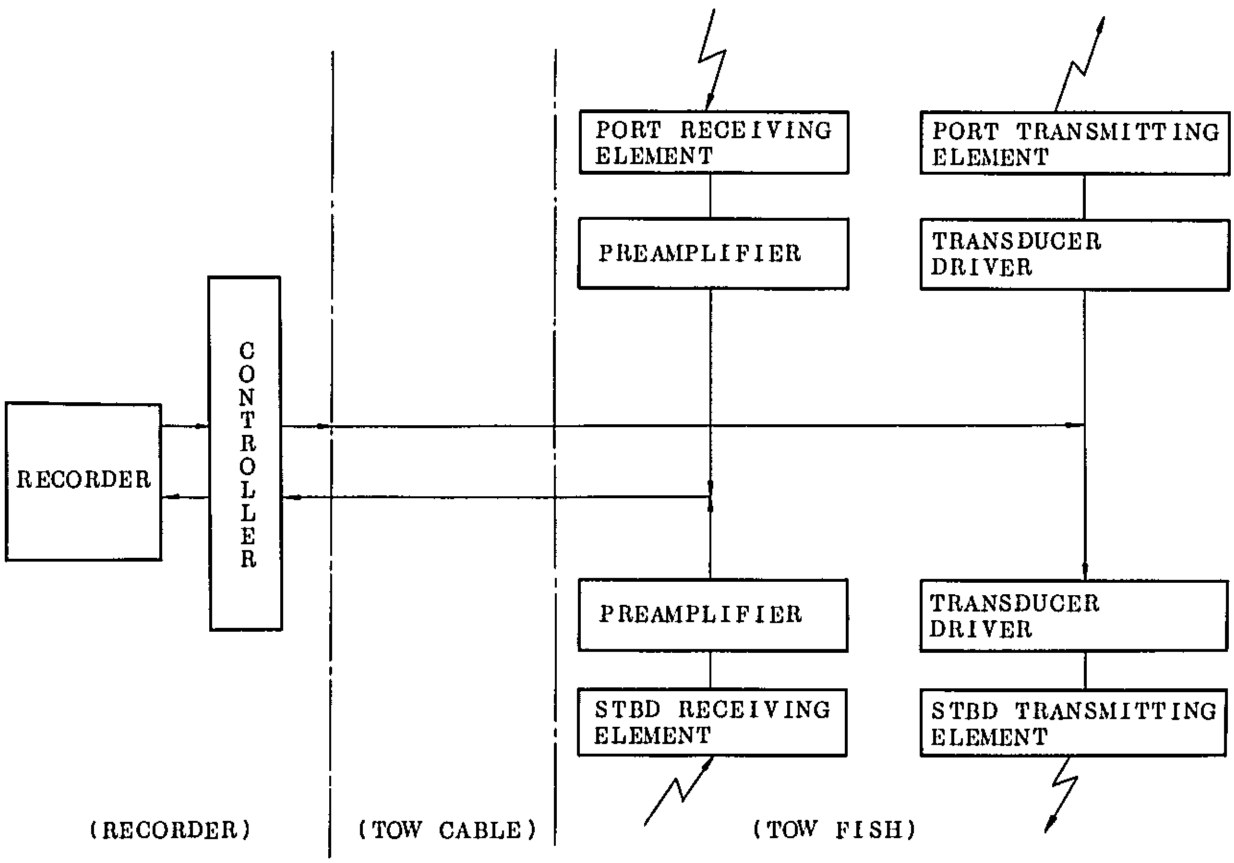


Figure 3.4-6 Mark 1B Side Scan Sonar

3.4.4 Bottom Sampling Device

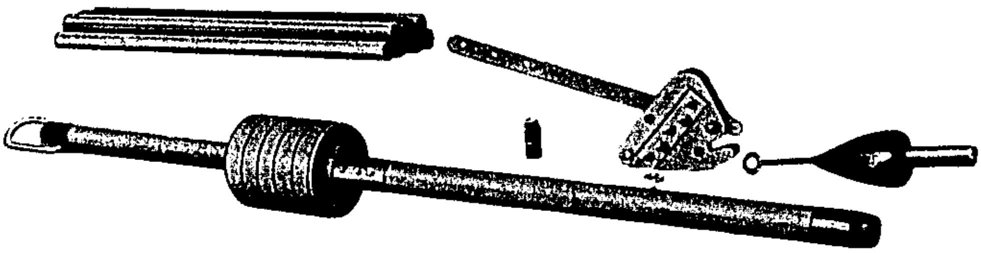
Piston corer, smith McIntyre grab sampler, small gravity corer and bucket dredger were used for picking up samples of bottom sediment in the survey. They are shown in Figure 3.4-7.

Piston corer is dropped from about two meters above the bottom surface by a lever action initiated by bottom touching of a precedingly lowered weight. When the corer is picked up a piston brings bottom material into the acrylic pipe and hold them in it. A stainless steel catcher at the mouth of the corer which allows only inward moving of core material, also holds the material during picking up of the corer. From the depth of the corer's interpenetration to the sea bed, plowability by a cable burying machine can be roughly estimated.

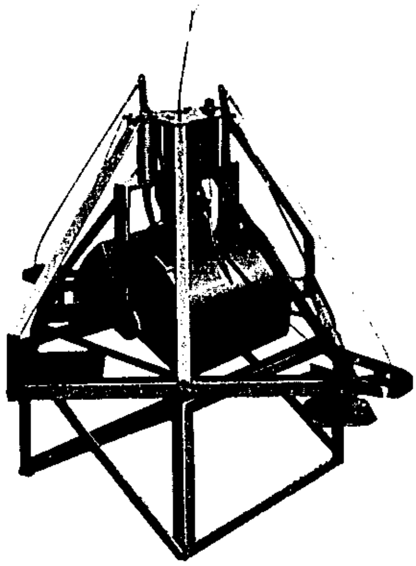
Smith McIntyre grab sampler catches bottom material in the grab by releasing the pre-strained springs at its touching the bottom.

Gravity corer has fins, weights and a cylinder with a catcher at the tip, and is simply thrown into water for taking samples.

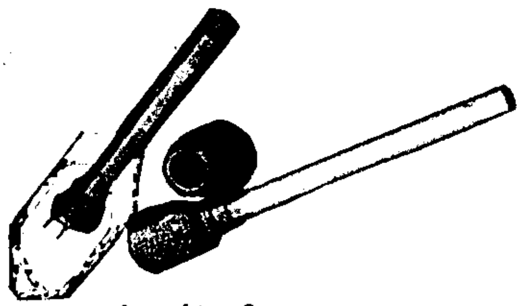
Backet dredger is a cast iron bucket with an edge at the brim of opening and small drainage holes at the upper bottom. Bottom samples are taken by dragging it on the bottom.



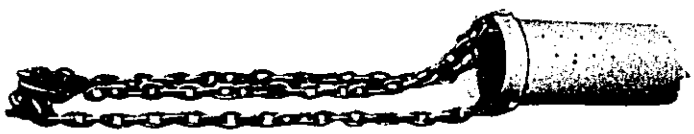
Piston Corer



Smith McIntyre Grab



Gravity Corer



Bucket Dredger

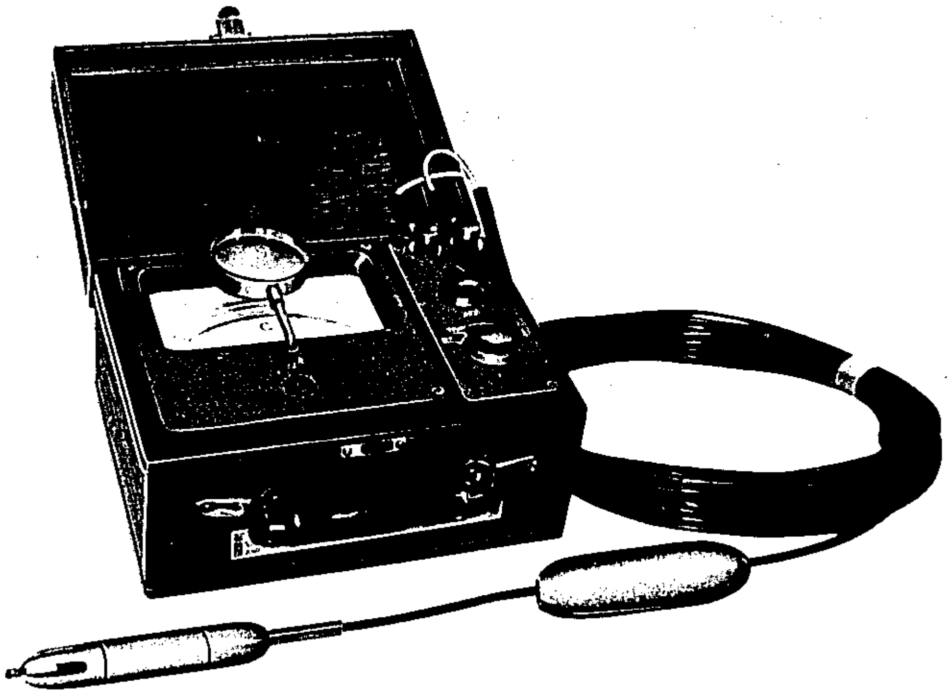
Figure 3,4-7 Bottom Sampling Devices

3.4.5 Thermometer

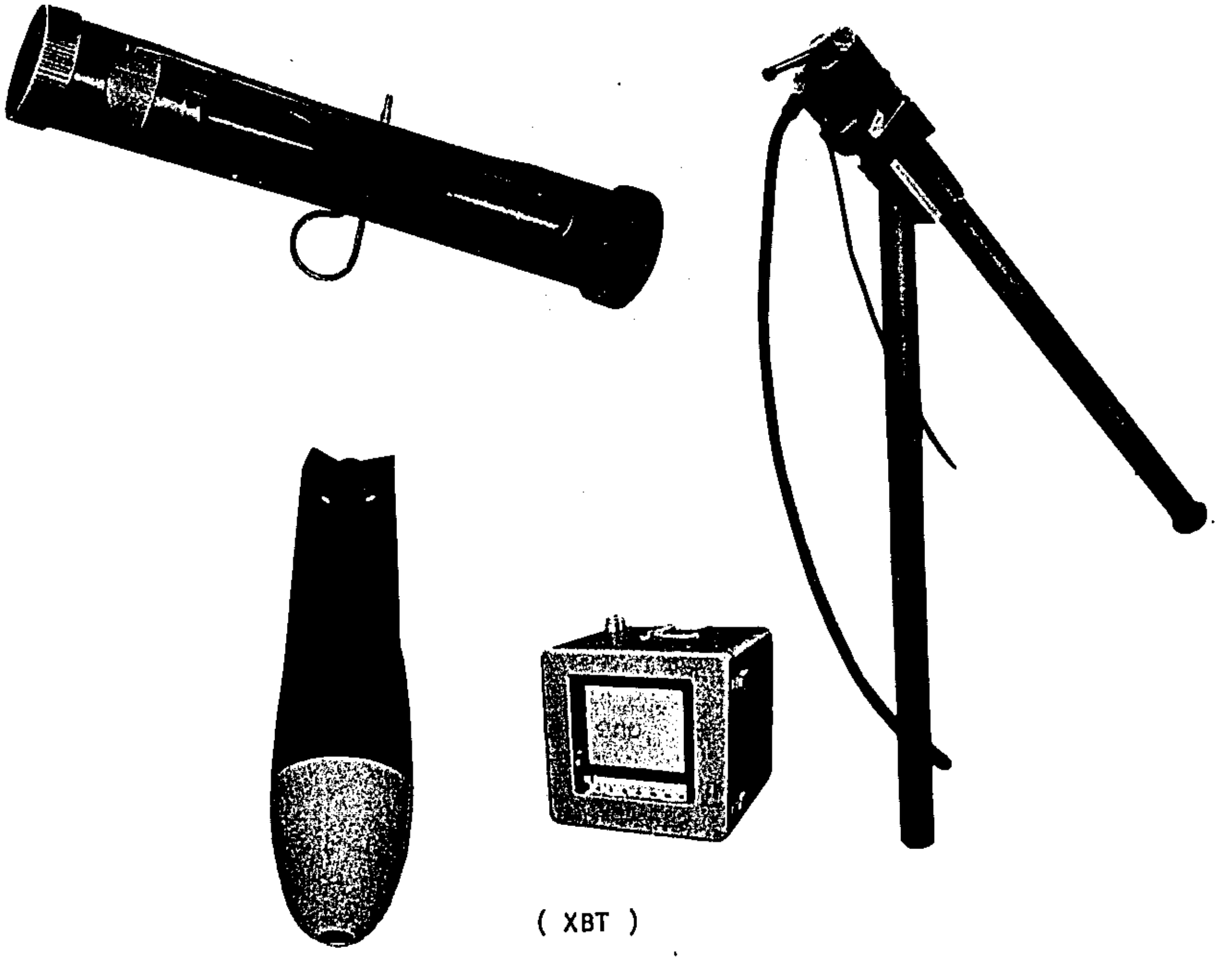
ET-5 Electric Thermometer was mainly used for temperature observation in the survey. Expendable bathy thermograph was used to confirm the thermocline observed by ET-5. They are shown in Figure 3.4-8.

ET-5 Electric Thermometer is a device to know the water temperature by measuring the resistance of thermistor, lowered from the ship down into water through lead lines attached to it. ET-5 has a temperature observation range of -5°C to 40°C (or 23°F to 104°F) with a minimum scale of 0.1°C.

Expendable bathythermography (XBT) also gives water temperature in a form of thermistor resistance. Temperature probe with a fine conductive line is thrown into water and the water temperature corresponding to the depth of water is recorded continuously until the proble touches the bottom. The probe is unrecovered but observation can be made without stopping the ship. The probe is designed to sink in water at a constant speed and paper of temperature recorder is driven at the same rate. Temperature coverage of XBT is -2°C to 35°C and minimum reading is ± 0.15°C.



(ET-5 Thermometer)



(XBT)

Figure 3.4-8 ET-5 Thermometer and XBT

3.4.6 Current Recorder

Figures 3.4-9 and 10 show Ono type current recorder used in the survey and configurations for observation in water respectively.

Ono type current recorder has a blade wheel and fins, and can record current velocity and direction simultaneously on the recording paper. Revolutions of the blade wheel are conveyed to a gear system of the recorder in the water tight Capsule through magnet coupling, and recorded on the paper driven by a spring force. At the same time current directions are marked by pens associated with a magnet compass.

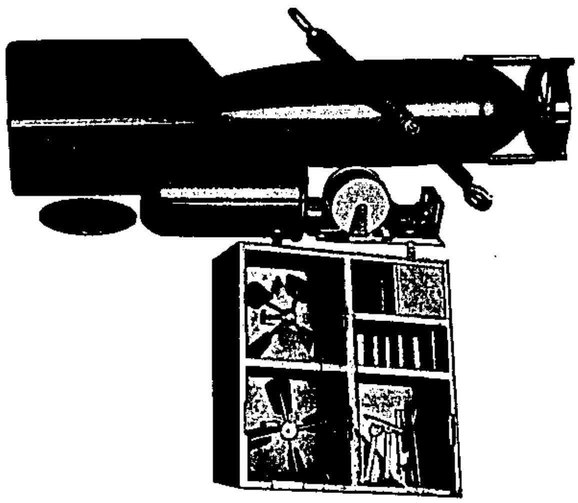
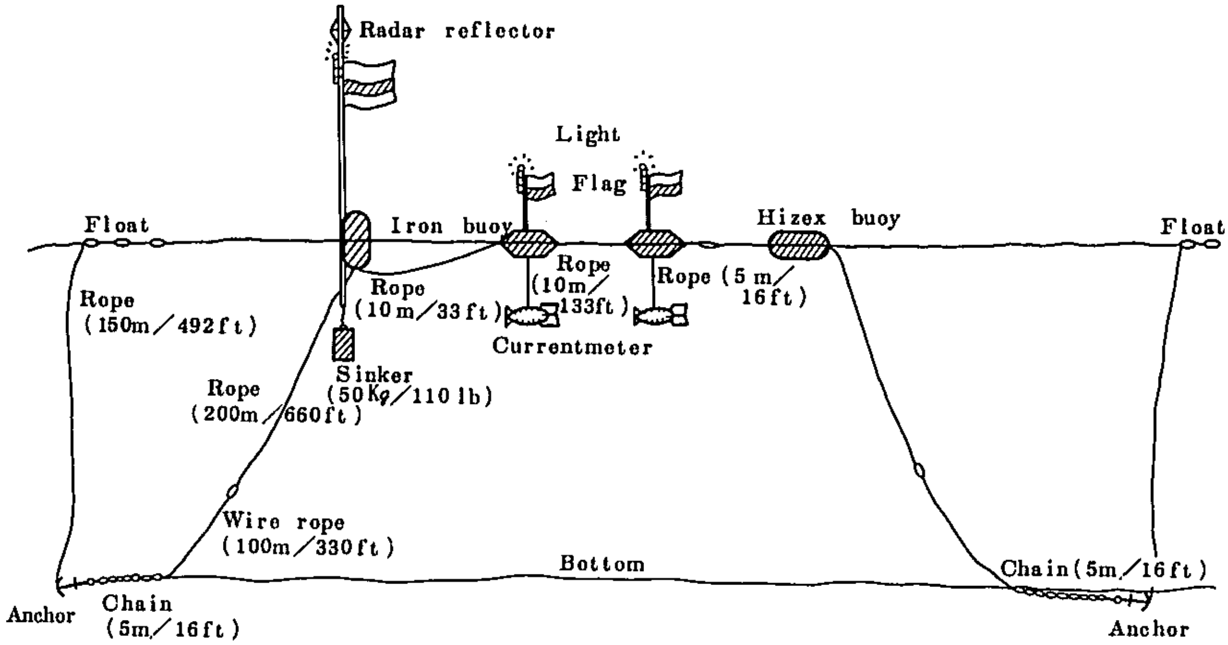


Figure 3.4-9 ONO Type Currentmeter

Offshore Portion



Shore Portion

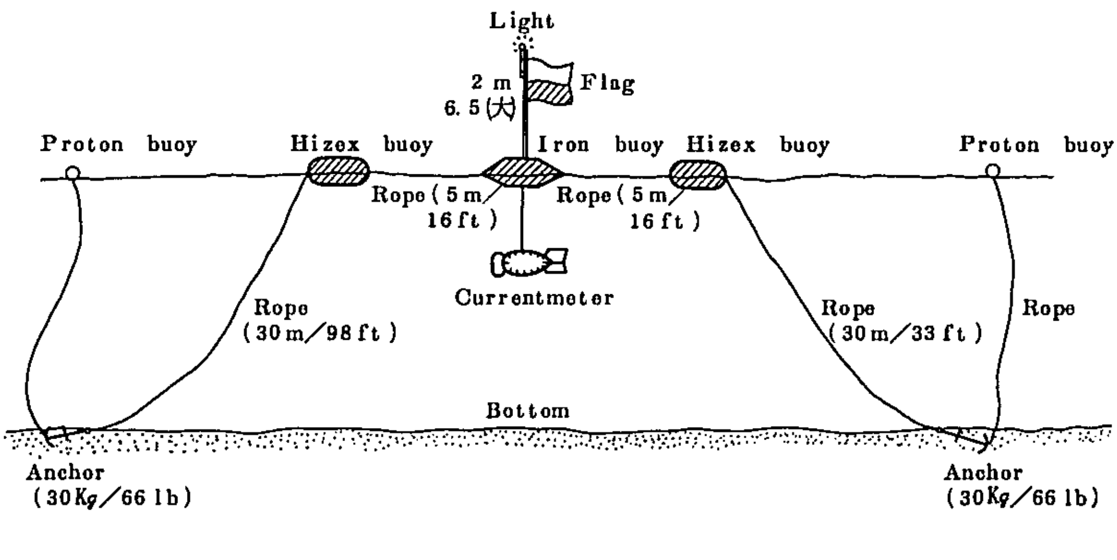


Figure 3.4-10 Configuration of Current Observation

3.4.7 Positioning Equipment

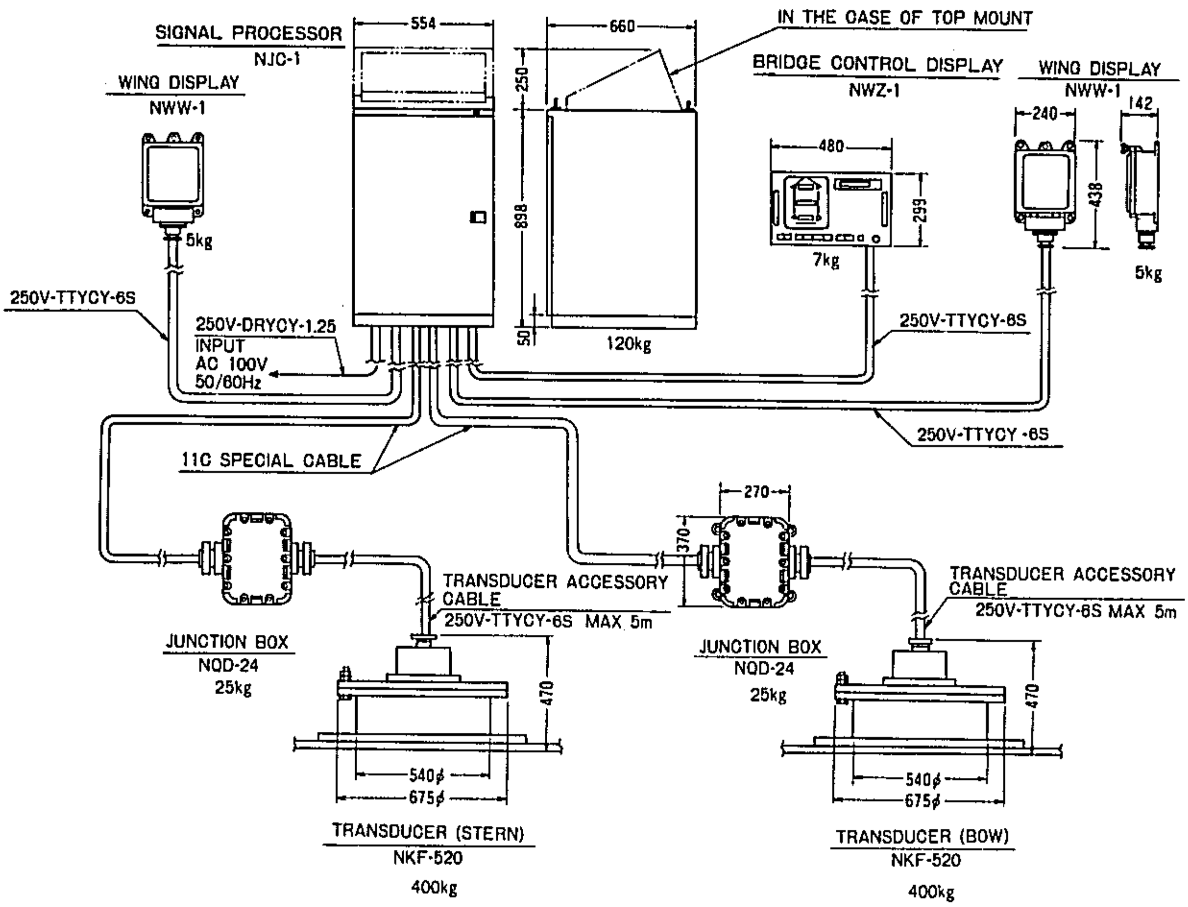
Ship positions during the survey in the off-shore portion are fixed by Radar or Satellite navigator and positions between those fixed ones were determined by using Doppler Sonar equipment. In the shore portion, Transit and Hydro Dist were used to fix positions of survey craft on the sea.

Doppler Sonar navigator is an equipment to know the ship speed relative to the ground by detecting frequency change due to doppler effect in the reflected ultrasonic wave from the sea bottom. Four Pairs of elements for transmitting ultrasonic wave beams and for receiving reflected ones are mounted on the ship bottom. By applying integral calculus in time to the ship speed data, ship positions relative to the original one can be obtained. Some important technical parameters of JLN-1001 Pulse Doppler Sonar is given below.

JLN-1001 Pulse Doppler Sonar

Mode	Pair beams in three axises
Frequency	300 kHz
Maximum depth for operation	200 m (or 110 fm)
Speed coverage	(a) Fore/Aft 0 - 39.99 knots
	(b) Port/Starboard 0 - 9.99 knots
minimum detectable speed	0.02 knot
accuracy	$\pm$ (1.0% + 0.02) knot
Correction of Sound Velocity	Automatically corrected
Correction of pitching and Rolling	0 - $\pm 5°$ automatically corrected by pair beam system

Configuration and dimensions of JLN-1001 Pulse Doppler Sonar equipment are shown in Figure 3.4-11.



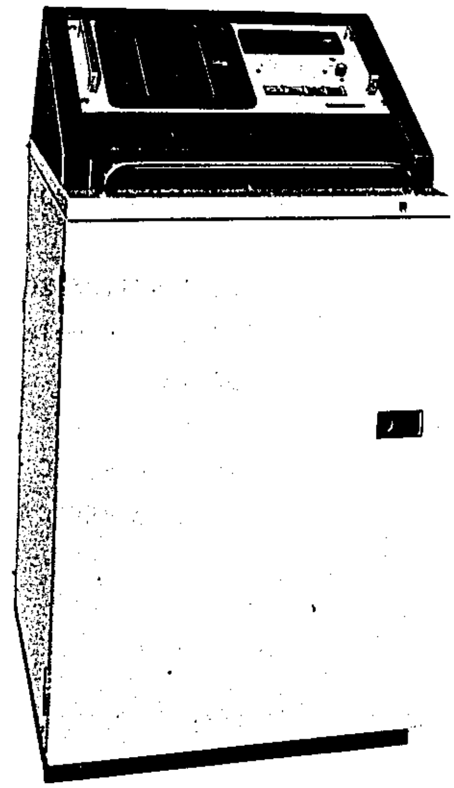


Figure 3.4-11 Configuration and Dimensions of Pulse Doppler Sonar

Satellite Navigator is an equipment to determine the ship's position by making use of Navigation Satellites which are moving around the earth at a rate of one revolution per 108 minutes. Six satellites are available at present and positioning by them can be made approximately once an hour in average. The Satellite Navigator receives informations of the satellite orbit and time signals sent out from the Satellite. In the Figure 3.4-12, A, B and C are satellite positions 2 minutes apart on its orbit, which can be calculated from the orbit informations. By detecting a doppler sift in the time signal received from the satellite, differences between distances from the ship position to the satellite positions A and B or B and C can be obtained. The ship position is fixed as a cross point of the earth surface and the two hyperboloids, each of which gives a constant difference of distances from the ship to the two successive satellite positions.
JLE-3000 Satellite Navigator is given in Figure 3.4-13.

JLE-3000 Technical parameters

Positioning Error	0.1 NM (RMS) for still ship
	0.5 NM (RMS) for sailing ship
o Receiver	
Receiving Frequency	299.968 MHz ± 12 kHz
Tuning	Automatic
Minimum Sensibility	-145 dBm
Dynamic Range	-145 dBm - -90 dBm
o Power supply	
Voltage	A/C 100/110/220 V ± 10%
Frequency	50/60 Hz single phase
Consuming Power	450 VA
o Temperature Coverage	
Airial	-20°C to +70°C (or -4°F to +158°F)
Other Equipment	0°C to +50°C (or 32°F to +122°F)

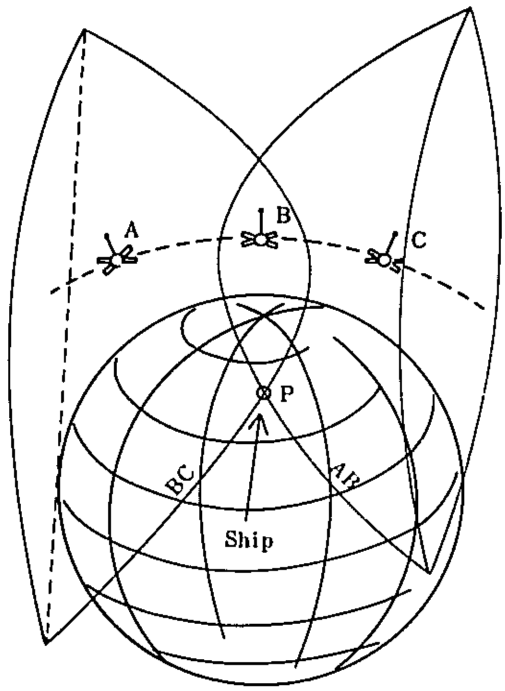


Figure 3.4-12 Positioning by Navigation Satellite

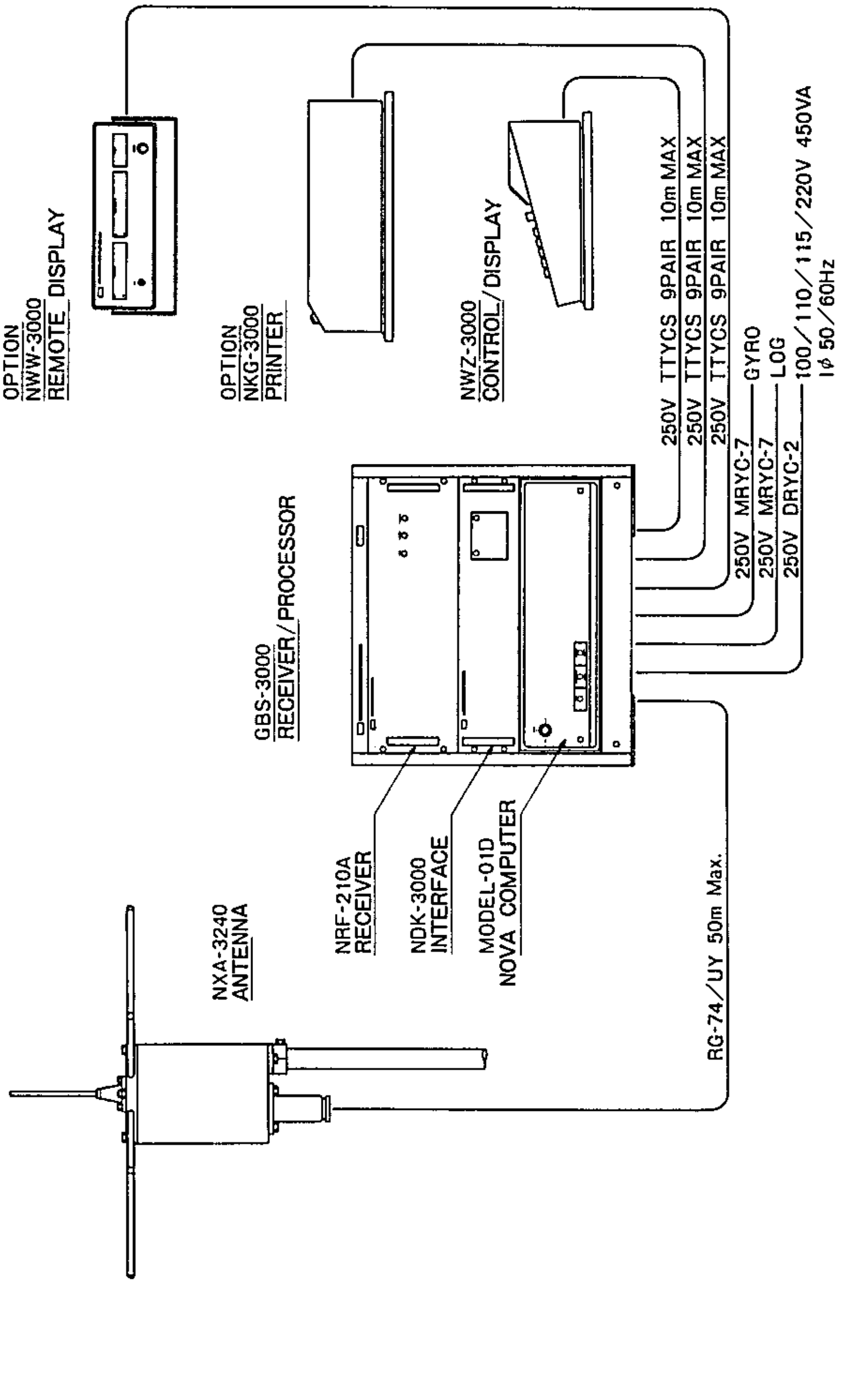


Figure 3.4-13 Composition of JLE-3000 Satellite Navigation Equipment

"HYDRO DIST" (Tellurometer Co.) is an equipment to measure a distance by making use of radio wave. Master and remote instruments which make up the equipment, are placed respectively at the fundamental and remote points, between which a distance is to be measured.

A continuous radio wave, having a frequency that lies in the band 2800 - 3200 MHz, is radiated from the Master antenna. This wave is frequency modulated by a pattern frequency of approximately 1.3 to 1.5 MHz. The modulated wave is received at the Remote station and is, in effect, reradiated back to the Master, where its time of travel over the double path is measured.

The Master instrument consists, therefore, of a transmitting device, a receiving device, and a timing device; the Remote instrument consists of a receiving device, a transmitting device, and a marking device, which puts a time mark on the wave before it is returned to the Master instrument.

The method of timing the wave is to make a phase comparison between the reference wave, which is derived in the Master unit, and the time mark from the Remote unit. This process is carried out by displaying the time mark as a bright spot on a circular trace on a cathod-ray tube; the angular position of the spot, relative to a zero mark, is a measure of the phase difference between the reference wave and the time mark. This phase difference is a measure of the transit time of the radio wave over the path. If the velocity of the wave is assumed to be known, the phase difference can be considered to be a direct measure of the distance between the Master and Remote instruments.

Technical data of "HYDRO DIST" are as follows;

Measuring Range (under normal conditions)		Nominally 40 Km maximum
Radio Telephone Link		Two -way communication between Master and Remote operators
Range of Carrier Frequencies		2800 - 3200 MHz
Nominal Radiated Power		100 mW
Pattern Frequencies	Master A	1498.468 KHz
	C	1483.483

	D	1348.621
	Remote A	-1499.468 KHz
	A	+1497.468
	C	1482.483
	D	1347.621
Imput Voltage		10.8 - 13 V D.C. or 24±10% D.C.

3.5 SURVEY RESULT

3.5.1 Bottom Topography

The whole survey area is extending on the shelf of southern part of South China Sea (or Borneo Sea) and water depths are less than 150 meters (or 82 fathoms). In such a shallow water, sea level variation due to tide, which was expected to be 2 or 3 meters (or 7 or 10 feet) can not be overlooked in sounding. The survey area was divided into the eight sub-areas and correction values of the sea level are determined for each sub-area according to the tidal data from the International Hydrographic Organization.

Sounding charts together with estimated contours in the off-shore portion are given in Figures 3.5-1(1) through 3.5-1(4): Sea bed profile along the selected route is shown in Figures 3.5-2 and 3.5-3. Soundings and contours in Cherating and Sematan shores are shown in Figures 3.5-4 and 5.

The off-shore portion is divided into five sub-portions according to their topographical features; Cherating slope, Flat shelf, Inter-islands area, Sarawak shelf and Sematan slope.

(a) Cherating slope (0 to 70 nm/0 to 130 Km)

This is a slope bottom from cherating shore to a depth of 70 meters (or 38 fathoms) and covers about 70nm (or 130 Km) along the selected route. The bottom becomes gradually deeper off-shore repeating small ups and downs. The bottom goes down in an average slope of 1:1000 to a depth of 45 meters (or 25 fathoms), thence in 1:3500 down to flat bottom of 70 meters (or 38 fathoms) in depth. The maximum partial slope in the small ups and downs is 1 : 8.

(b) Flat shelf (70 nm to 260 nm/130 Km to 476 Km)

After reaching the depth of 70 meters (or 38 fathoms), the route takes its way toward Natuna Island on a very flat bottom. The maximum depth of this area is 87 meters (or 47.5 fathoms). With approaching to the inter-islands area the bottom goes up gently to a depth of 65 m (or 35.5 fathoms).

(c) Inter-islands area (260 nm to 330 nm/480 Km to 610 Km)

This area has the most varied topography in the whole route. The route passes a couple of valley-like depressions in the south of Natuna Island. The maximum depth on the selected route is encountered in one of these depressions. The partial maximum slope in this area is 1 : 7.

(d) Sarawak shelf (330 nm to 420 nm/610 Km to 780 Km)

The bottom becomes flat again and gently goes shallower. As the bottom comes near to Sematan, weak undulations appear.

(e) Sematan slope (420 nm/780 Km to Sematan)

The flat bottom comes up to Sematan shore in a gentle slope of about 1:2400.

Sea bed Profiles of Cherating and Sematan shore portions are shown in Figure 3.5-3 together with sub-bottom layers. Slopes of the beach at Cherating and Sematan are 5.2° and 1.2° respectively.

Figure.3.5-2 BOTTOM PROFILE (Off Shore Portion)

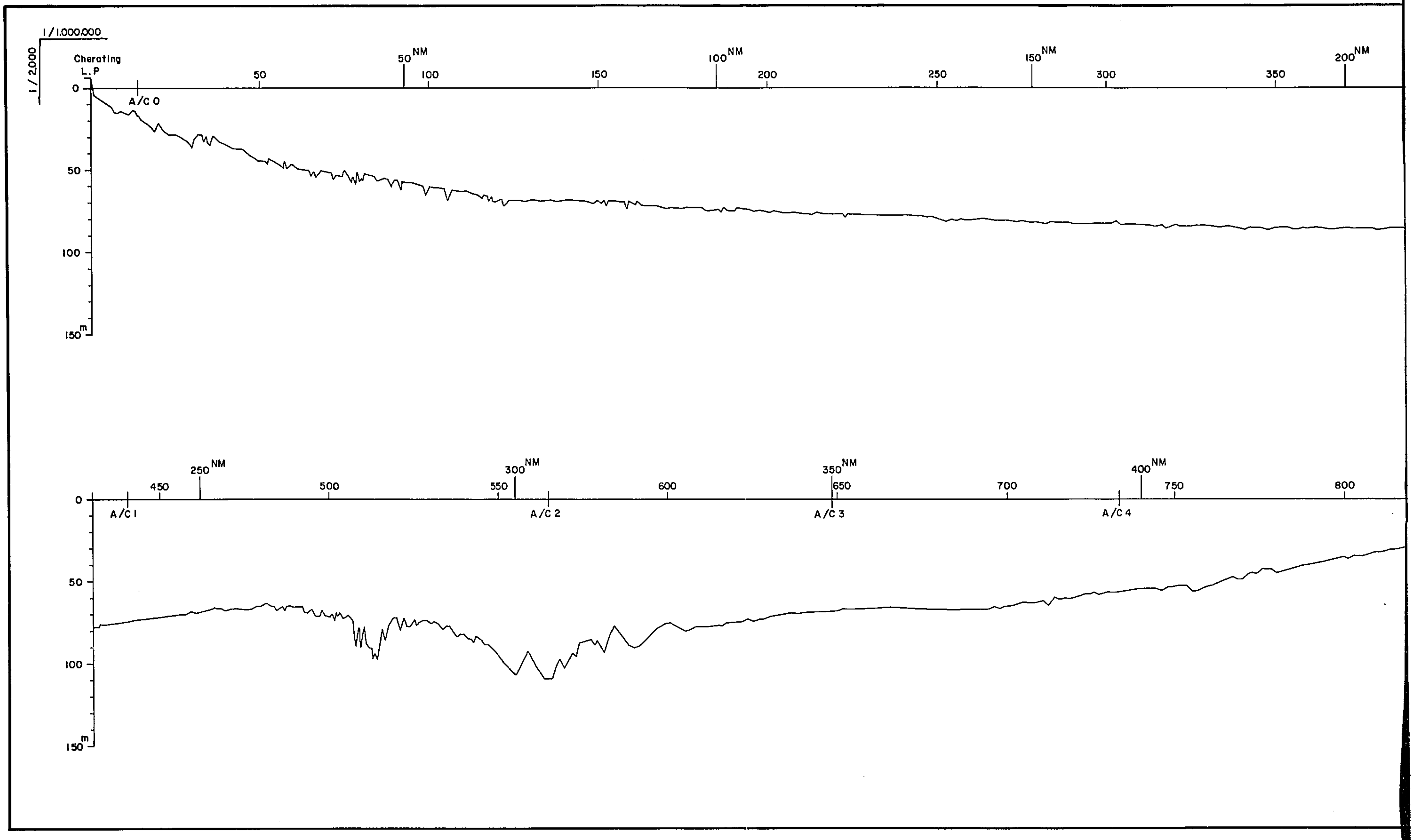


Figure.3.5-2 BOTTOM PROFILE (Off Shore Portion)

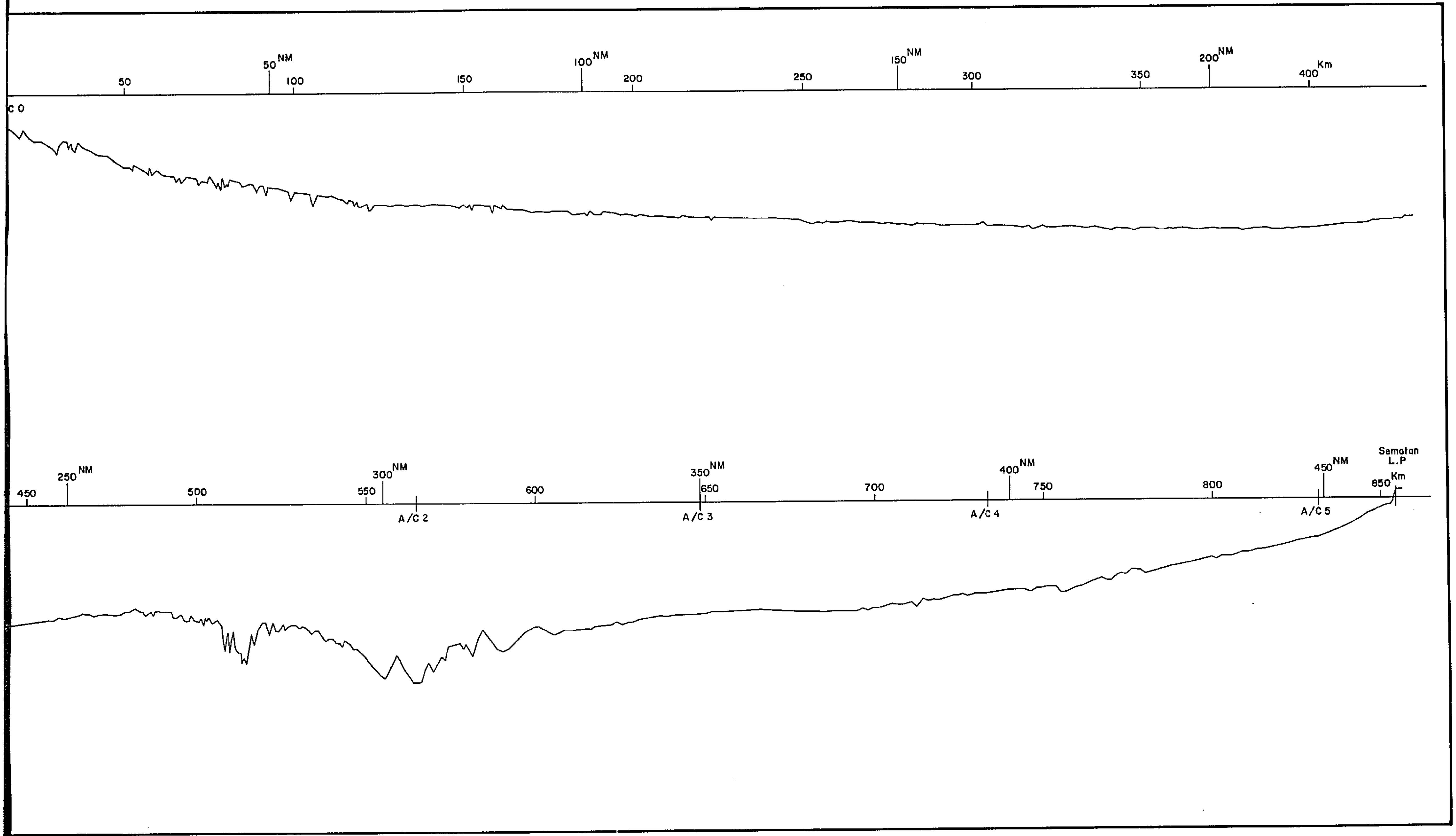


Figure.3.5-3 BOTTOM PROFILE AND SUB-BOTTOM LAYERS

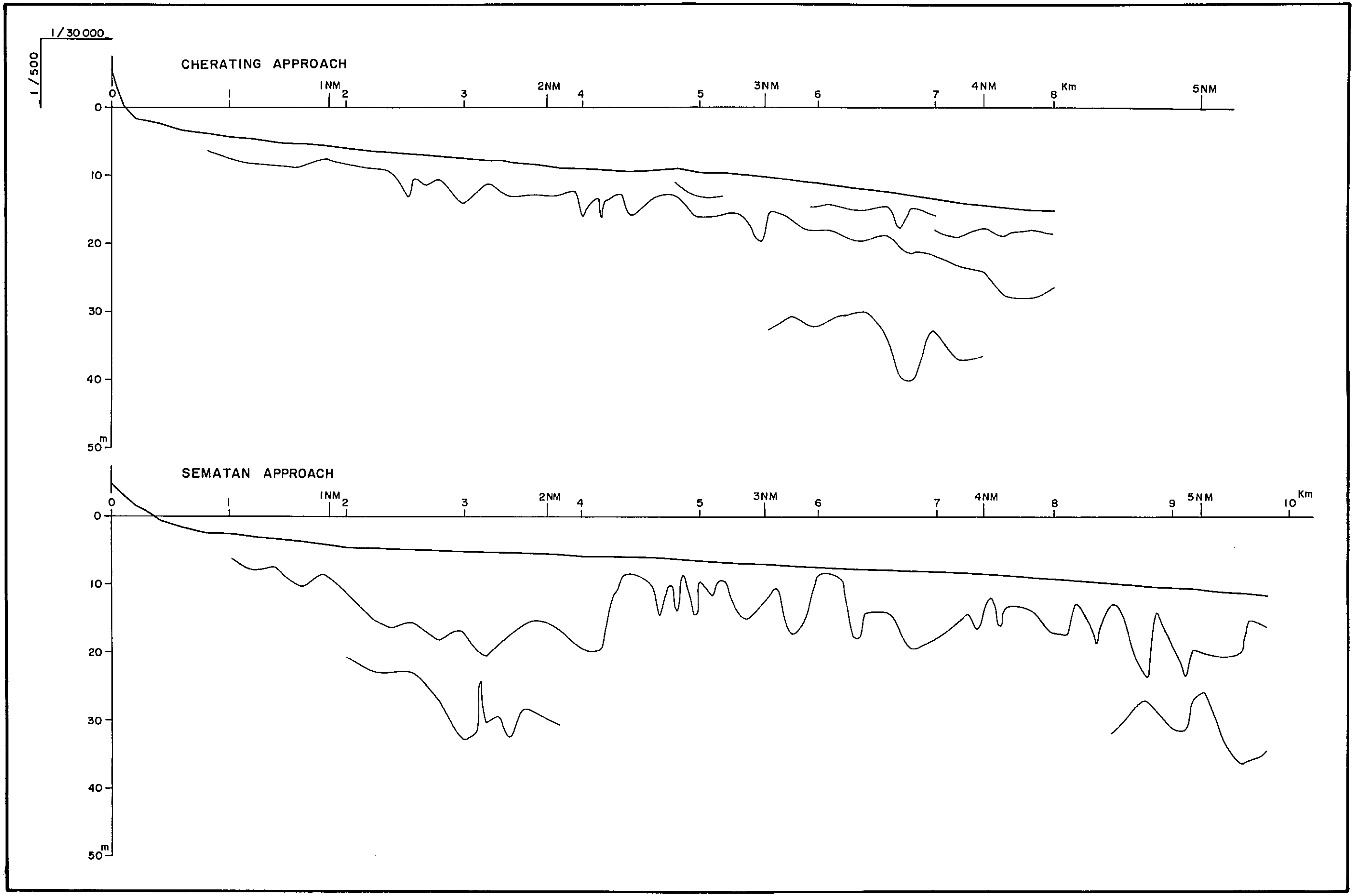


Figure.35-4 BATHYMETRIC AND CONTOUR CHART (CHERATING)

in metres

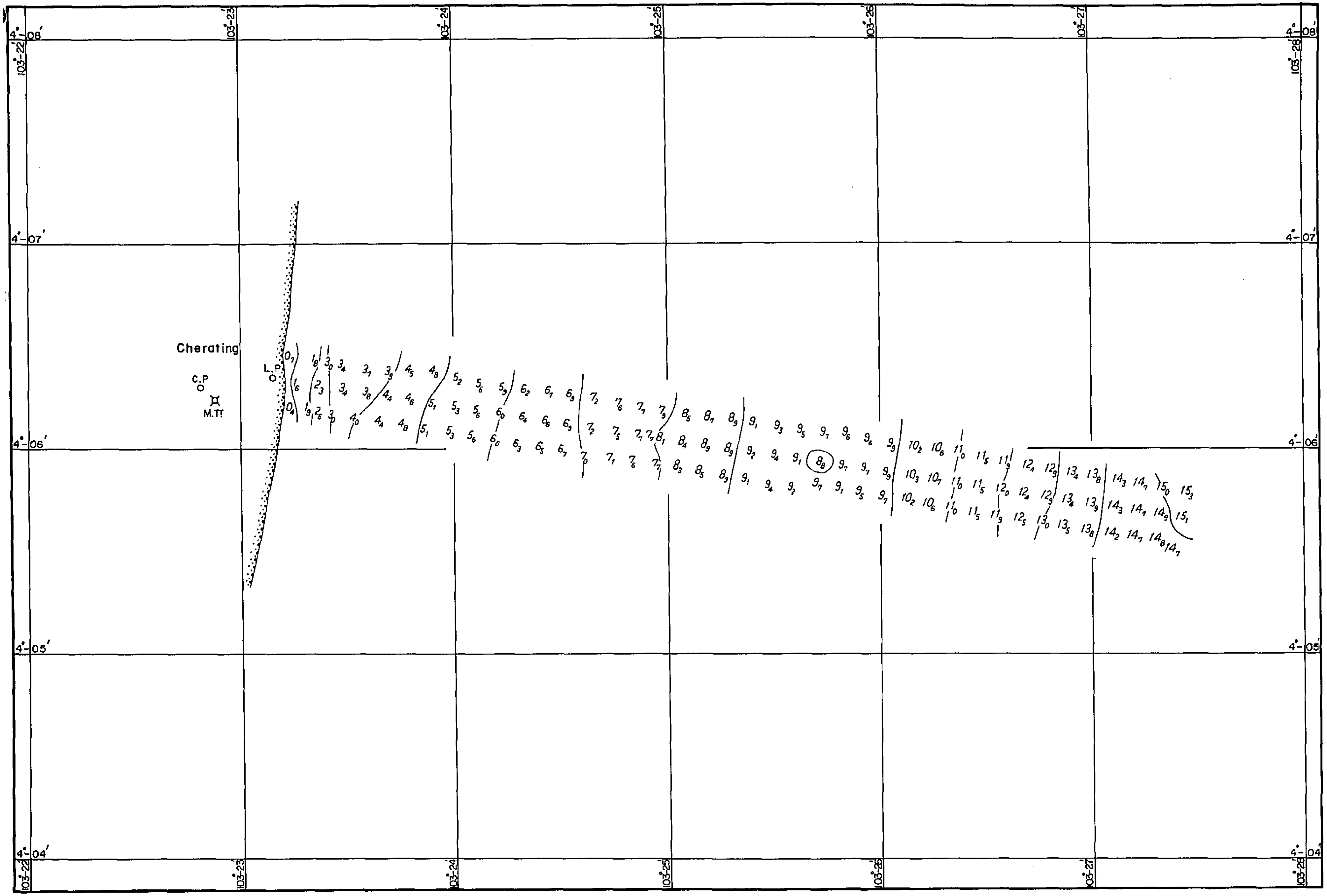
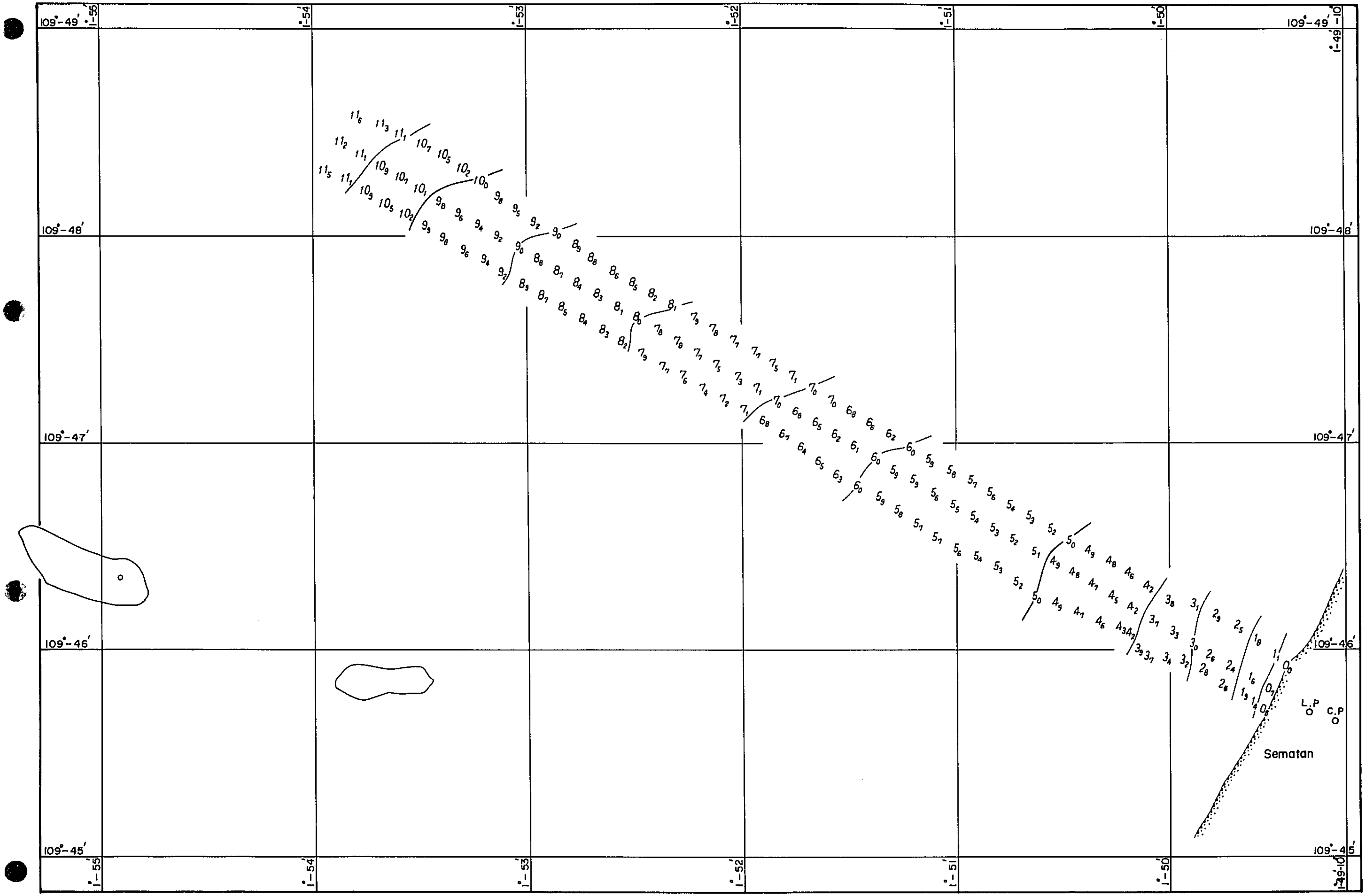


Figure.3.5-5 BATHYMETRIC AND CONTOUR CHART (SEMATAN)

in metres



3.5.2 Aspects of Bottom Surface

The result of bottom observation by SIDE SCAN SONAR is described below. The sonar fish was towed at 25 meters (or 82 feet) above the bottom surface covering the observation width of 250 meters (or 820 feet) on both sides of the sonar fish. Positions are given by distances along the route from Cherating in the description of the bottom aspects.

(a) From Cherating to 38 nm (or 70 Km) (Survey position 516 - refer to the survey track chart in Figure 3.3-1)

Many mottled patterns of 8 to 10 meters (or 26 to 33 feet) in diameter were observed in this area. These patterns seem to show partial existence of different kinds of sediment on the bottom surface (as sand patches in mud).

(b) From 38 nm to 92 nm (or 70 Km to 170 Km)

Some isolated shallow depressions of 4 to 7 meters (or 13 to 23 feet) were seen. They were distributed in the numbers of 2 to 7 per range of 2 x 0.5 Km^2 (or 2 x 0.3 $Mile^2$).

(c) From 92 nm to 270 nm (or 170 Km to 500 Km)

Some clusters of small shallow holes were recorded (Figure 3.5-6). Size of each small hole was about 2 meters (or 6.5 feet) at most.

(d) From 270 nm to 420 nm/500 Km to 780 Km (Survey position 27 - refer to Figure 3.3-1)

Isolated shallow depressions of 4 to 15 meters (or 13 to 50 feet) in diameter were observed very often. An example of them are shown in Figure 3.5-7. Ripple marks were also observed around survey position 101. They usually appear on the sandy bottom where bottom current exists.

In the vicinity of the survey position 153 between Natuna Island and Subi Besar, a ditch-like trace with a width of about 4 meters (or 13 feet) and a depression as much as 0.5 meters (or 1.6 feet) in depth was observed crossing the sonar coverage slantly in a distance of about

1.5 Kilometers (Figure 3.5-8). The record of the trace was similar to what had been found on the continental shelf in the East China Sea where trawling activities were frequent, and seems to have been made factiously by some bottom scratching instrument for fishing.

(e) From 420 nm to Sematan

Banded patterns with weak ups and downs appeared on the bottom (Figure 3.5-9). They are course and fine sediment sorted and accumulated alternatively from place to place by the action of water current near the bottom.

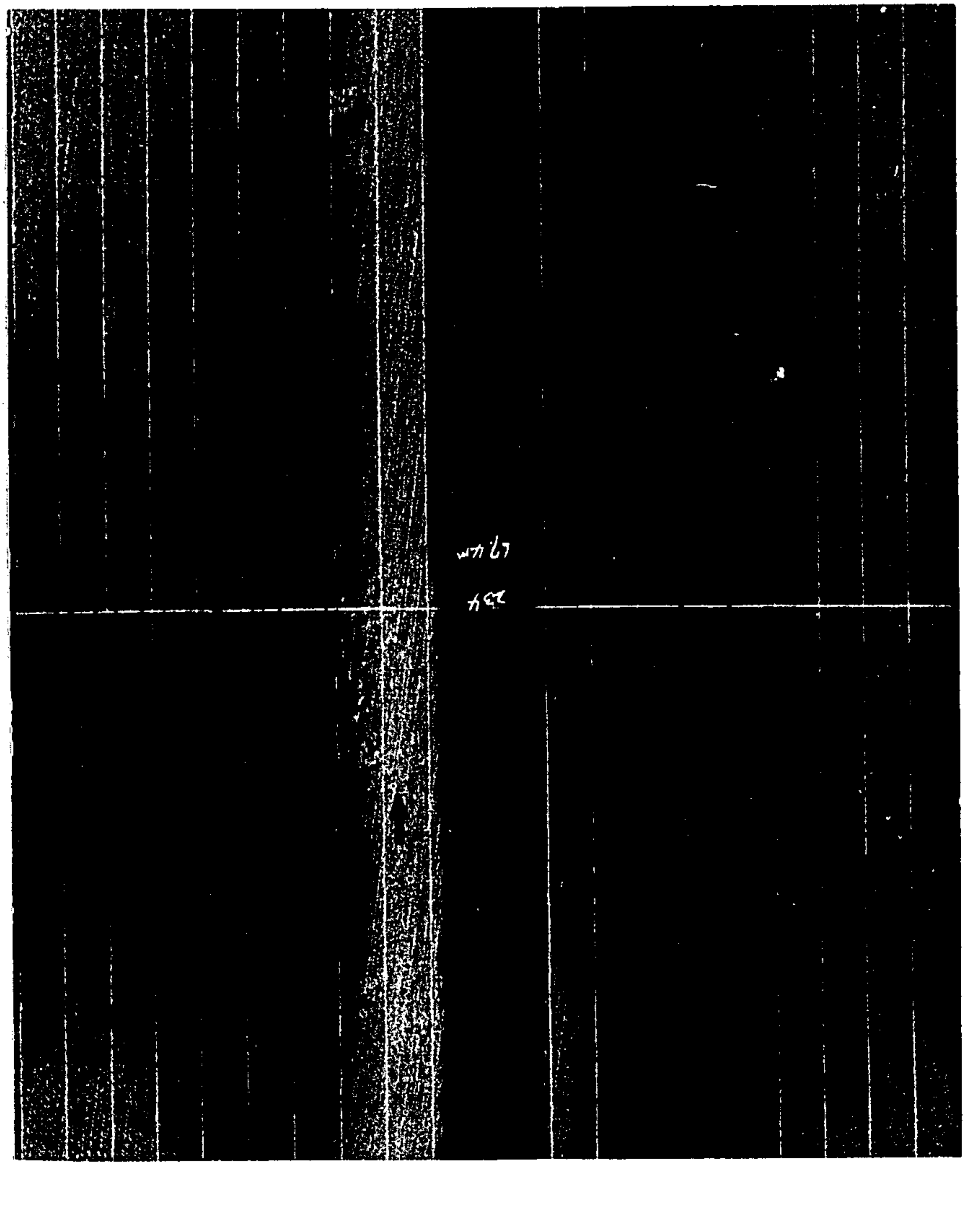


Figure 3.5-6 Recording by Side Scan Sonar

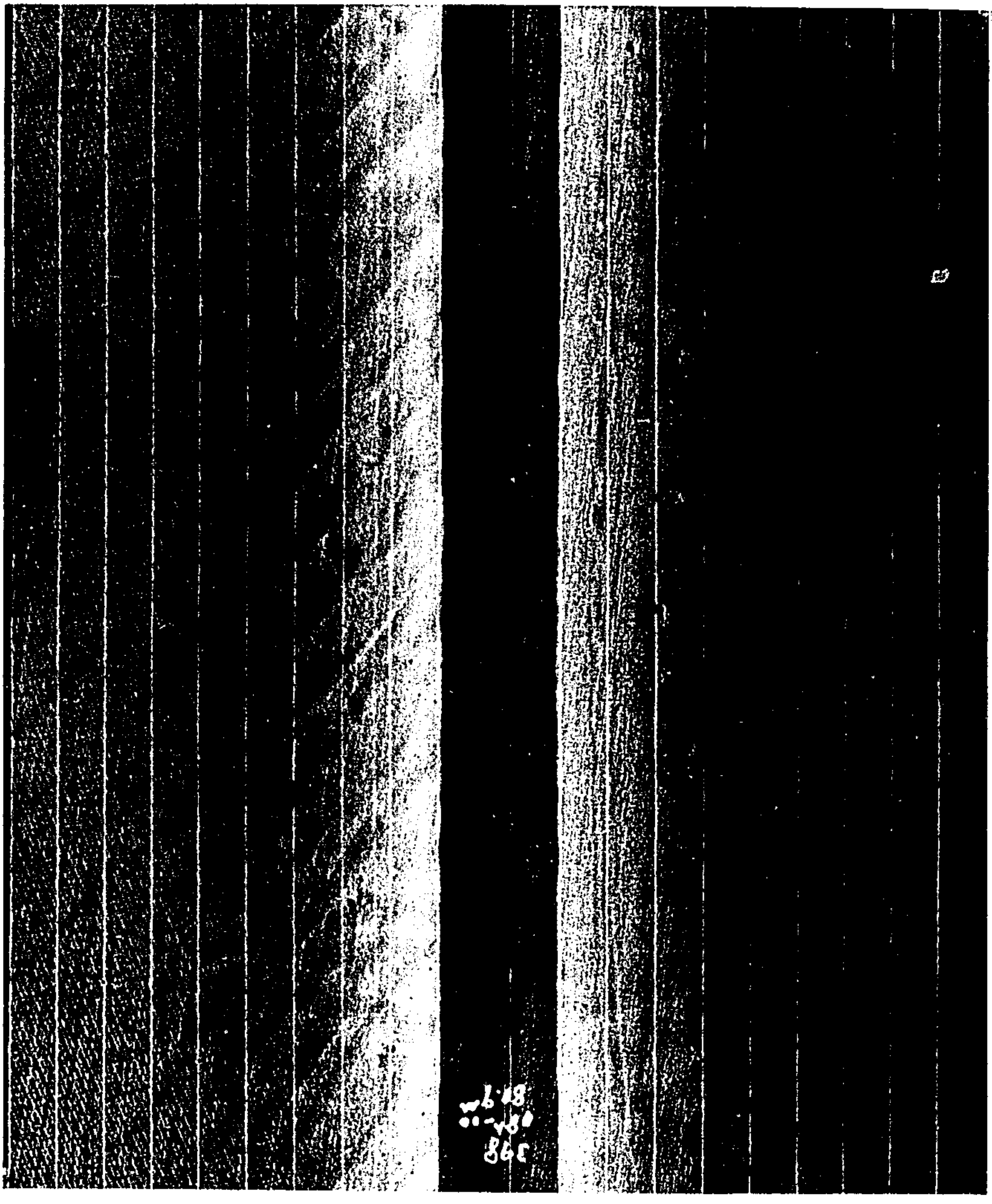


Figure 3.5-7 Recording by Side Scan Sonar

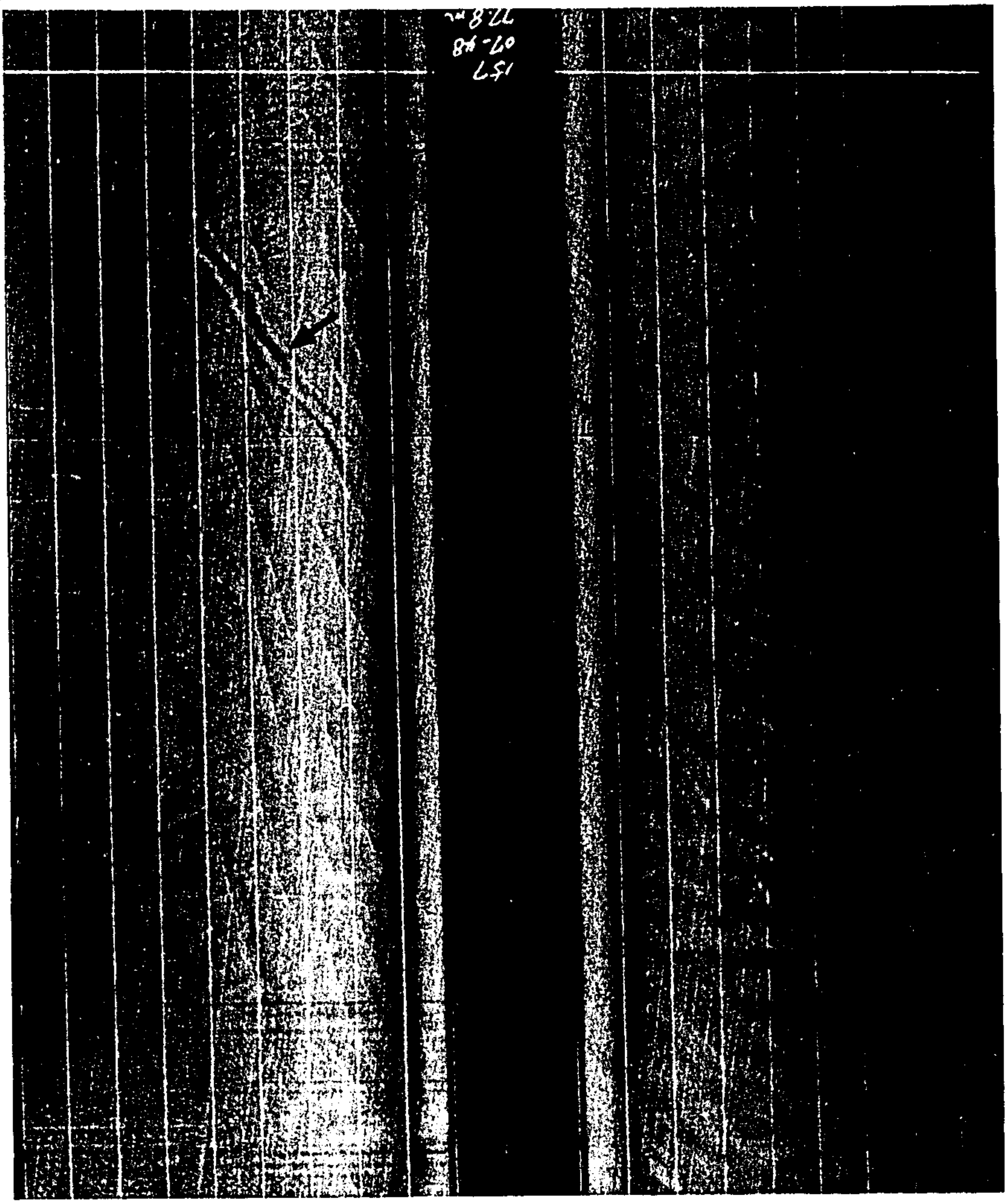


Figure 3.5-8 Recording by Side Scan Sonar

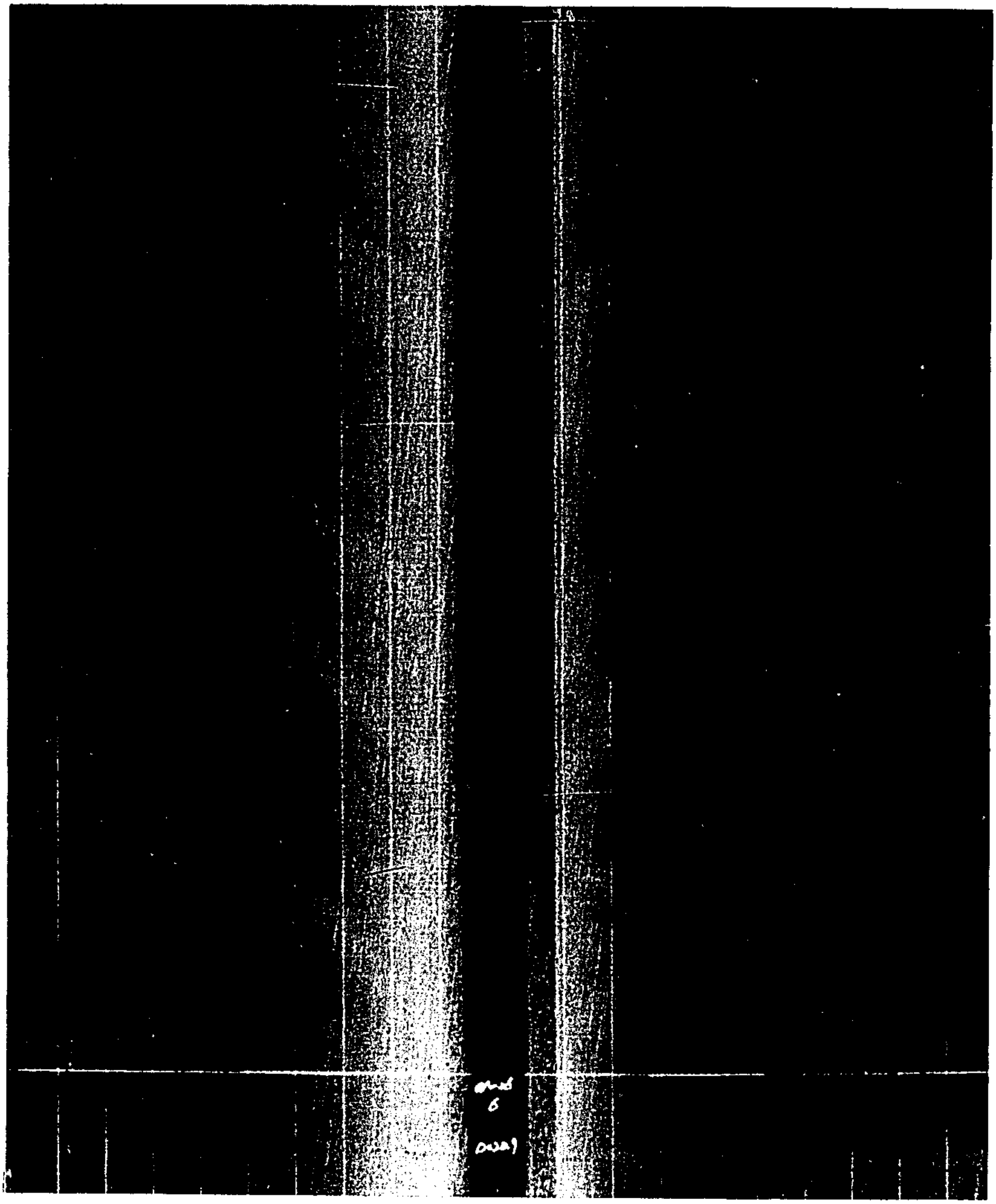


Figure 3.5-9 Recording by Side Scan Sonar

3.5.3 Bottom Sediment

Features of bottom sediment materials along the route is described from the results of bottom sampling, subbottom profiling and observation of the bottom surface by using SIDE SCAN SONAR. Bottom samples picked up in the survey are shown in Tables 3.5-1-a and -2-a, and their grain size distributions in Tables 3.5-1-b and 3.5-2-b. Positions are given in distances from Cherating.

(a) From Cherating to 38 nm (or 70 Km)

Approximate distributions of bottom materials in Cherating shore portion is shown in Figure 3.5-10. Coarse sand, medium to fine sand and mud distribute in a band parallel to the shore line. Bottom materials change from coarse to fine off-shore.

In the offing, the bottom consists of clay covered with sandy mud or muddy sand.

(b) 38 nm to 200nm (S.P.-321)/70 Km to 370 Km

Muddy sand covers clay in a thickness of 15 to 30 centimeters (or 6 inches to 1 foot). The clay is soft and grayish.

(c) 200 nm to 270 nm (S.P.-231)/370 Km to 500 Km

The bottom is muddy in a thickness of 15 to 20 centimeters (or 6 to 8 inches) with a clay layer beneath it.

The thickness of muddy surface sediment reaches about one meter at some places.

(d) 270 nm to 420 nm (S.P.-27)/500 Km to 780 Km

Sandy mud or mudy sand covers thinly (5 - 20 cm/2 - 8 in) the clay bottom. Sandy and muddy surfaces exist partially.

(e) 420 nm (780 Km) to Sematan

The clay bottom is covered with thin sand (about 10 cm/4 in. in thickness). An approximate distribution of bottom materials in the Sematan shore is shown in Figure 3.5-11.

Lower stratum of soft clay appears at some places in the shore portion.

TABLE 3.5-1-a SEA BOTTOM SAMPLING & TEMPERATURE MEASUREMENT

No.	Date	Time	POSITION Lat	POSITION Long	Depth (M)	TEMP - C Surface	TEMP - C Bottom	SM	BOTTOM Bottom Material	Core Length (CM)
1	15th Sept.,	11:37	4-03.17	103-52.37	46.0	28.3	25.65	PC	Sand (Upper) Clay (Lower)	15.5
2		15:23	4-00.73	104-10.97	55.0	28.8	23.90	S	Muddy Sand	-
3		19:18	3-58.23	104-40.17	69.9	28.6	23.20	PC	Muddy Sand	31.5
4		23:08	3-55.27	105-10.23	76.0	28.4	22.5	PC	Muddy Sand (Upper) Clay (Lower)	91
5	16th	03:00	3-53.10	105-40.34	80.4	28.5	22.2	PC	Mud	27
6		06:18	3-50.06	106-01.95	83.0	28.3	21.3	PC	Sandy Mud	90
7		09:13	3-46.91	106-23.44	86.0	28.4	20.6	PC	Sandy Mud	46
8		12:57	3-44.96	106-54.26	86.0	28.9	20.4	PC	Mud (Upper) Clay (Lower)	86
9	18th	06:58	3-42.49	107-08.00	83.0	28.5	20.4	PC	Mud	87
10		05:20	3-42.79	107-14.51	78.0	28.55	20.6	PC	Mud (Upper) Clay (Lower)	50
11		02:08	3-37.11	107-32.45	78.0	28.7	23.8	PC	Mud	95
12	17th	22:46	3-30.31	107-49.44	69.0	28.7	23.2	PC	Mud	53
13		20:55	3-27.50	107-56.20	95.0	28.65	22.4	PC	Muddy Sand (Upper) Clay (Lower)	23
14		17:00	3-18.25	108-18.73	100.0	28.95	19.95	PC	Muddy Sand (Upper) Clay (Lower)	62
15	19th	09:51	3-16.96	108-26.36	95.0	28.7	19.3	PC	Muddy Sand (Upper) Clay (Lower)	59
16		11:25	3-16.90	108-36.00	85.0	28.6	19.4	PC	Sand (Upper) Sandy Mud (Lower)	85
17		17:10	3-03.56	109-29.04	68.3	29.0	25.8	PC	Mud	20
18		19:18	2-55.34	109-42.89	59.6	28.9	28.1	PC	Sandy Mud (Upper) Clay (Lower)	26
19		21:36	2-41.54	109-47.83	59.0	28.9	28.5	PC	Muddy Sand	43
20		01:30	2-16.41	109-50.43	37.0	29.2	28.7	PC	Sand (Upper) Clay (Lower)	21

TABLE 3.5-2-a SEA BOTTOM SAMPLING & TEMPERATURE MEASUREMENT (CHERATING, SEMATAN)

C: Cherating Shore
S: Sematan Shore

No.	Date Time	POSITION		Depth (M)	TEMP - C		SM	BOTTOM	Core Length (CM)
		Lat	Long		Surface	Bottom		Bottom Material	
C-1	14th Sept., 15:15	4-05.66	103-27.42	15.1	28.7	28.5	PC	Sandy Mud	15
C-2	15:31	4-05.83	103-26.35	11.0	28.7	28.4	PC	Muddy Sand	32
C-3	15:43	4-06.00	103-25.28	8.8	28.9	28.6	PC	Sandy Mud	12
C-4	16:00	4-06.17	103-24.22	6.0	29.0	28.7	D	Coarse Sand	
C-5	16:20	4-06.29	103-23.47	3.4	29.1	29.1	D	Coarse Sand	
S-1	7th Sept., 10:40	1-53.72	109-48.20	10.7	29.6	29.3	D	Fine Sand	
S-2	10:49	1-53.38	109-48.24	10.0	29.8	29.3	D,PC	Fine Sand	6
S-3	11:15	1-53.12	109-47.83	9.1	30.1	29.4	D,PC	Fine Sand	4
S-4	11:39	1-52.59	109-47.60	8.0	29.6	29.35	D,PC	Fine Sand	7
S-5	12:31	1-51,74	109-47.29	7.1	29.8	29.3	D	Shell sand	
S-6	12:50	1-51.78	109-47.08	6.8	29.85	29.4	D,PC	Fine sand	
S-7	13:23	1-51.34	109-46.91	6.0	29.8	29.4	D	Fine sand	
S-8	13:46	1-50.72	109-46.34	5.0	30.0	29.5	D	Fine sand	
S-9	14:08	1-50.27	109-46.26	4.5	30.2	29.7	D	Fine sand	
S-10	14:32	1-49.67	109-45.85	1.9	30.0	29.7	D	Fine sand	

P.C. : Piston cover

D : Dredger

(Offshore No.4)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
250	2.0	0.1	0.1
177	2.5	0.2	0.3
125	3.0	0.3	0.6
88	3.5	0.4	1.0
63	4.0	1.1	2.1
44	4.5	0	2.1
32	5.0	8.8	10.9
21	5.6	3.3	14.2
13	6.2	69.9	84.1
9.6	6.7	5.8	89.9
6.8	7.2	1.3	91.2
3.4	8.2	2.3	93.5
3.4	8.2	6.5	100.0

Cumulative curve

$D(mm) = \frac{1}{2}\phi$

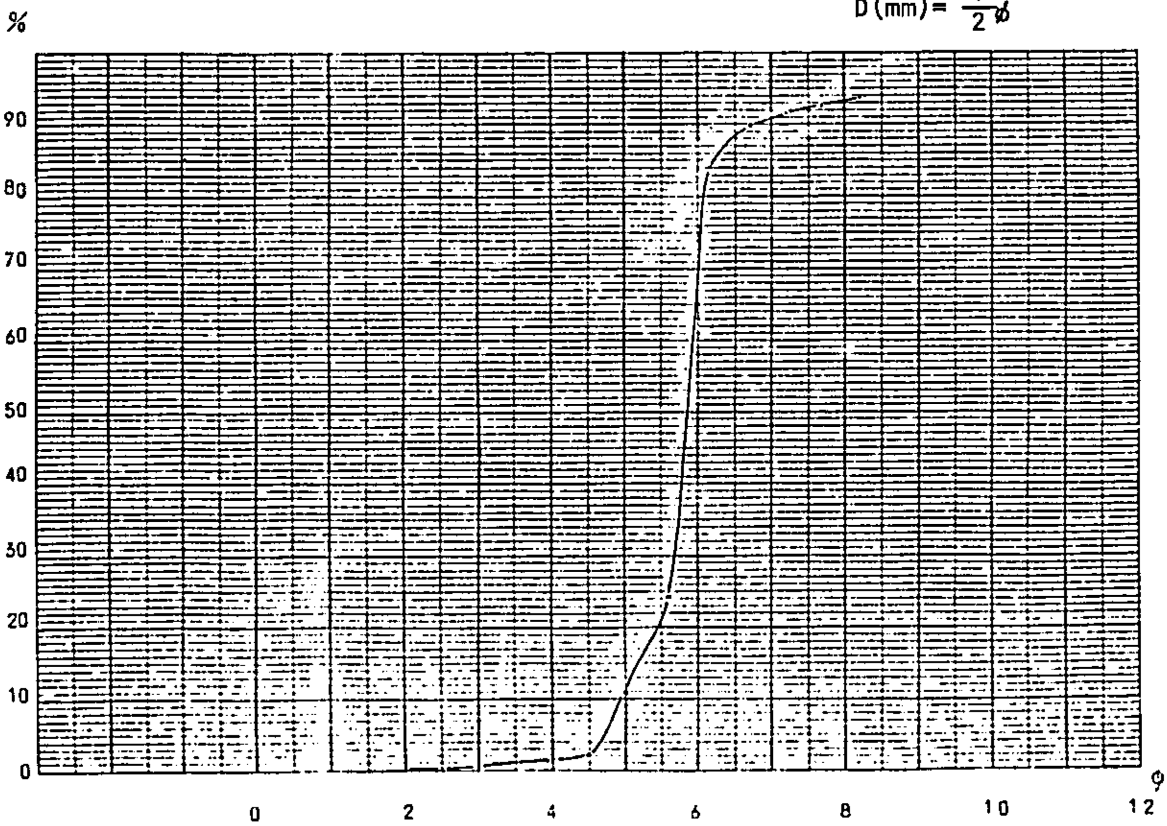


Figure 3.5-1-b(1) Results of Grain Size Analysis

(Offshore No.8)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
710	0.5	0.6	0.6
500	1.0	0.6	1.2
350	1.5	1.8	3.0
250	2.0	2.7	5.7
177	2.5	2.4	8.1
125	3.0	1.9	10.0
88	3.5	2.0	12.0
63	4.0	2.1	14.1
47	4.4	5.6	19.7
34	4.9	7.2	26.9
22	5.5	18.0	44.9
14	6.2	45.2	90.1
9.8	6.7	1.7	91.8
6.9	7.2	0	91.8
3.5	8.2	3.4	95.2
3.5	8.2	4.8	100.0

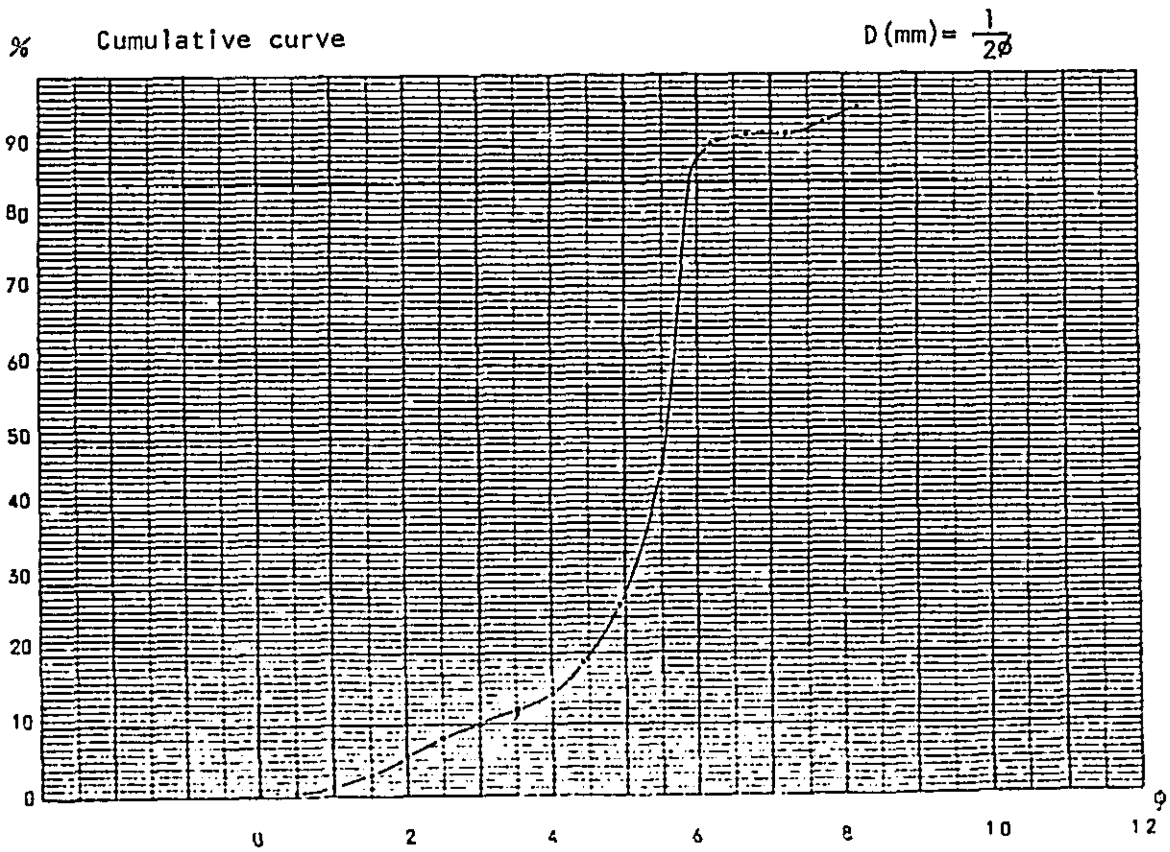


Figure 3.5-1-b(2) Results of Grain Size Analysis

(Offshore No.12)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
2000	- 1.0	1.5	1.5
1410	- 0.5	1.0	2.5
1000	± 0	0.5	3.0
710	0.5	0.3	3.3
500	1.0	0.7	4.0
350	1.5	1.9	5.9
250	2.0	3.2	9.1
177	2.5	3.1	12.2
125	3.0	2.8	15.0
88	3.5	1.8	16.8
63	4.0	1.4	18.2
48	4.4	0.5	18.7
34	4.9	0.7	19.4
22	5.5	6.7	26.1
13	6.2	25.6	51.7
9.6	6.7	33.6	85.3
7.0	7.2	4.4	89.7
3.5	8.1	2.3	92.0
3.5	8.1	8.0	100.0

Cumulative curve

$D(mm) = \frac{1}{2^{\phi}}$

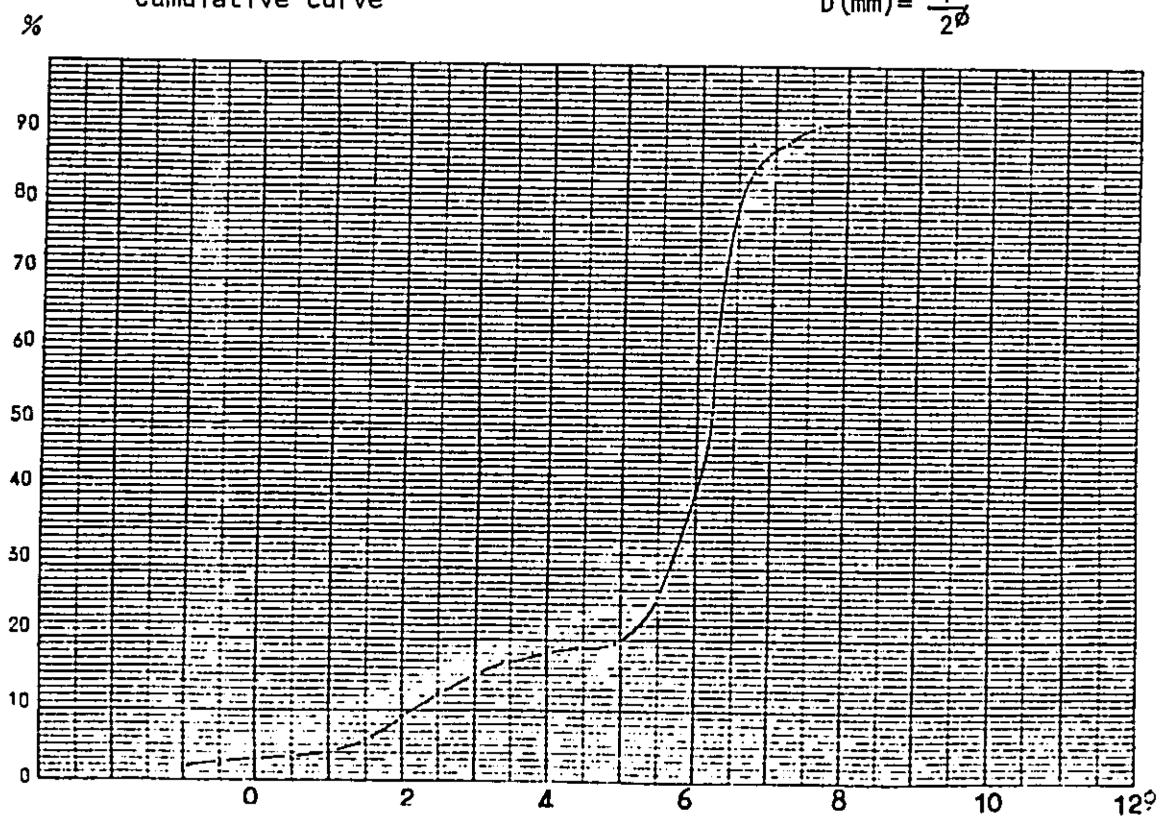


Figure 3.5-1-b(3) Results of Grain Size Analysis

(Offshore No.16)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
1000	± 0	0.2	0.2
710	0.5	0.6	0.8
500	1.0	0.9	1.7
350	1.5	2.5	4.2
250	2.0	5.6	9.8
177	2.5	10.3	20.1
125	3.0	11.5	31.6
88	3.5	8.6	40.2
63	4.0	6.5	46.7
49	4.4	3.2	49.9
35	4.8	4.4	54.3
23	5.5	11.3	65.6
13	6.2	16.4	82.0
9.6	6.7	5.8	87.8
6.8	7.2	2.5	90.3
3.4	8.2	0.9	91.2
3.4	8.2	8.8	100.0

Cumulative curve

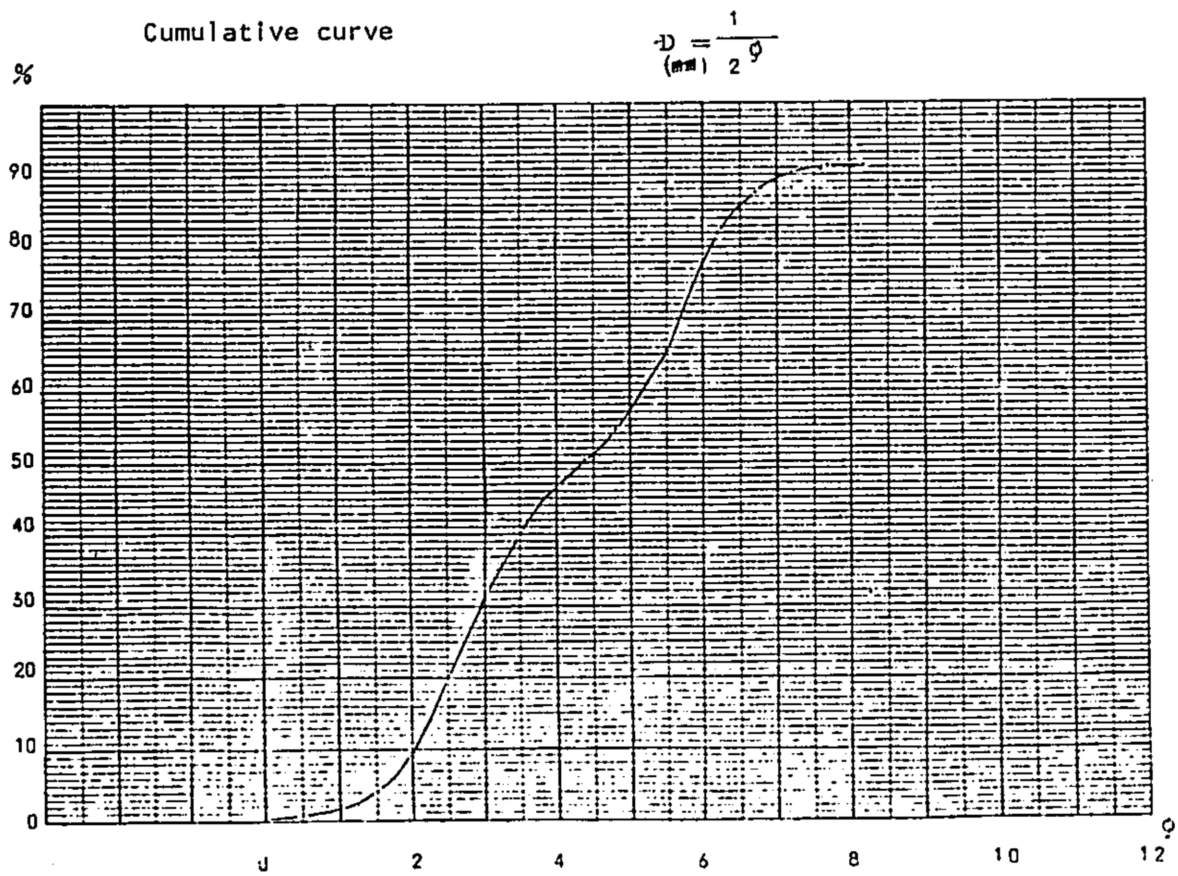


Figure 3.5-1-b(4) Results of Grain Size Analysis

(Offshore No.19)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
2000	- 1.0	0.7	0.7
1410	- 0.5	0.6	1.3
1000	± 0	1.0	2.3
710	0.5	1.5	3.8
500	1.0	2.0	5.8
350	1.5	4.1	9.9
250	2.0	6.1	16.0
177	2.5	7.2	23.2
125	3.0	7.5	30.7
88	3.5	5.4	36.1
63	4.0	3.8	39.9
49	4.4	2.4	42.3
35	4.8	4.1	46.4
23	5.5	18.9	65.3
14	6.2	23.6	88.9
9.6	6.7	1.1	90.0
6.8	7.2	0	90.0
3.4	8.2	1.9	91.9
3.4	8.2	8.1	100.0

Cumulative curve

$D_{(mm)} = \frac{1}{2^{\varphi}}$

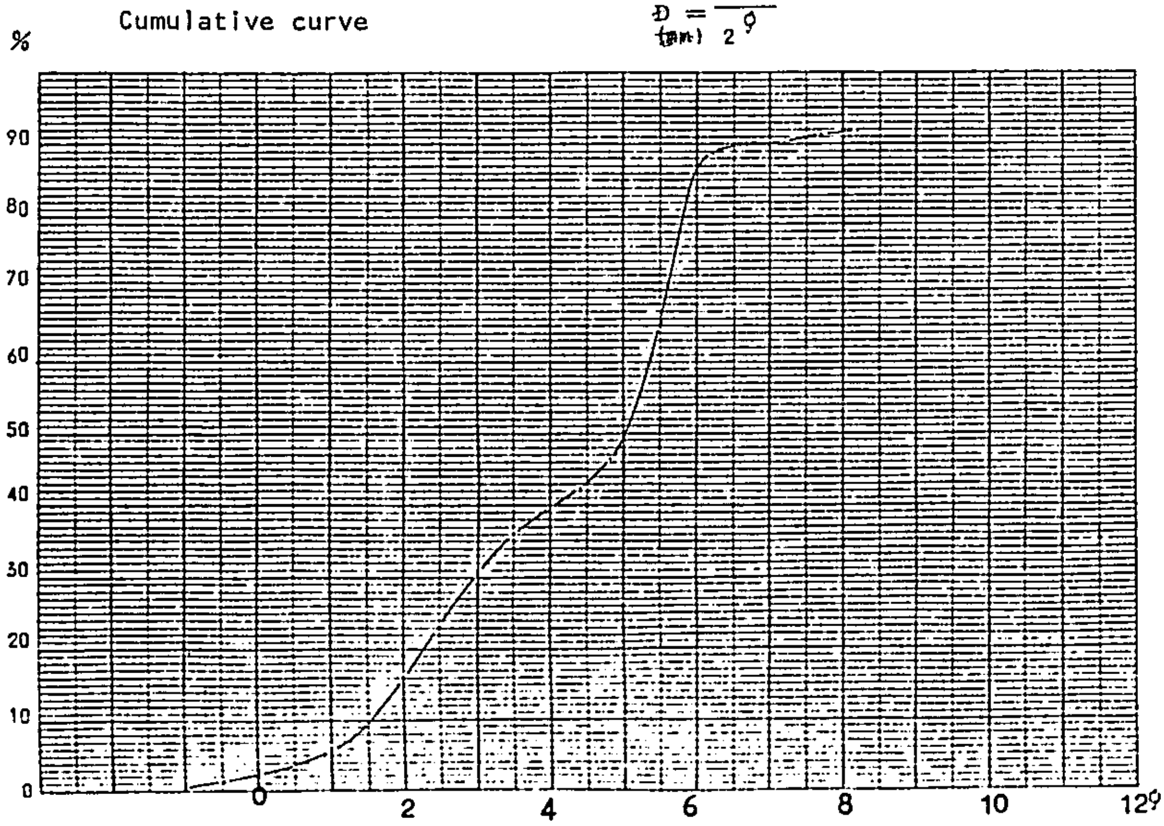


Figure 3.5-1-b(5) Results of Grain Size Analysis

(Cherating, No.C-2)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
710	0.5	0.8	0.8
500	1.0	0.4	1.2
350	1.5	1.8	3.0
250	2.0	2.2	5.2
177	2.5	3.0	8.2
125	3.0	3.4	11.6
88	3.5	3.9	16.5
63	4.0	21.9	38.4
52	4.3	33.2	71.6
38	4.7	17.7	89.3
24	5.4	3.7	93.0
14	6.2	1.3	94.3
9.8	6.7	0.7	95.0
5.0	7.2	0.3	95.3
3.5	8.2	0.3	95.6
3.5	8.2	4.4	100.0

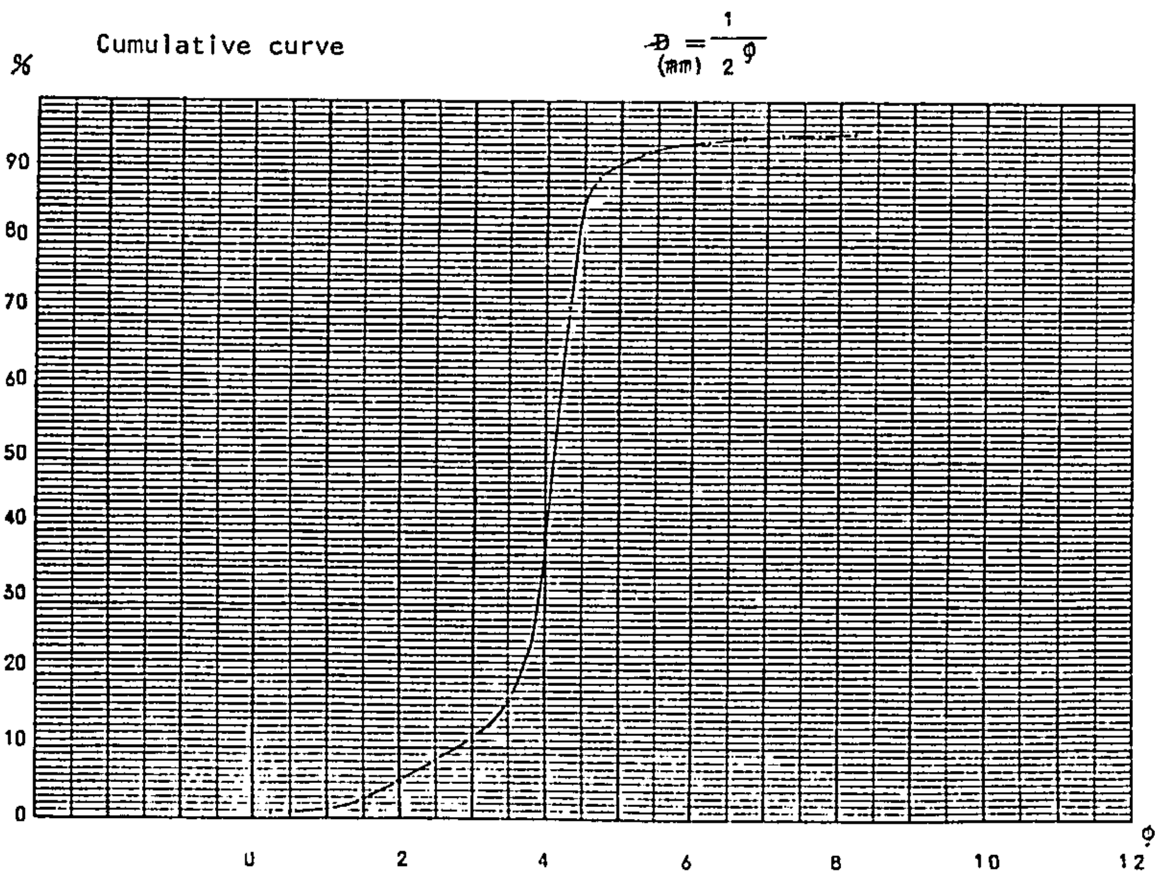


Figure 3.5-2-b(1) Results of Grain Size Analysis

(Cherating, No.C-4)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
2000	- 1.0	1.3	1.3
1410	- 0.5	3.0	4.3
1000	± 0	5.9	10.2
710	0.5	9.9	20.1
500	1.0	17.2	37.3
350	1.5	27.2	64.5
250	2.0	23.7	88.2
177	2.5	7.0	95.2
125	3.0	2.2	97.4
88	3.5	0.5	97.9
63	4.0	0.2	98.1
63	4.0	1.9	100.0

Cumulative curve

$$D_{(mm)} = \frac{1}{2^{\phi}}$$

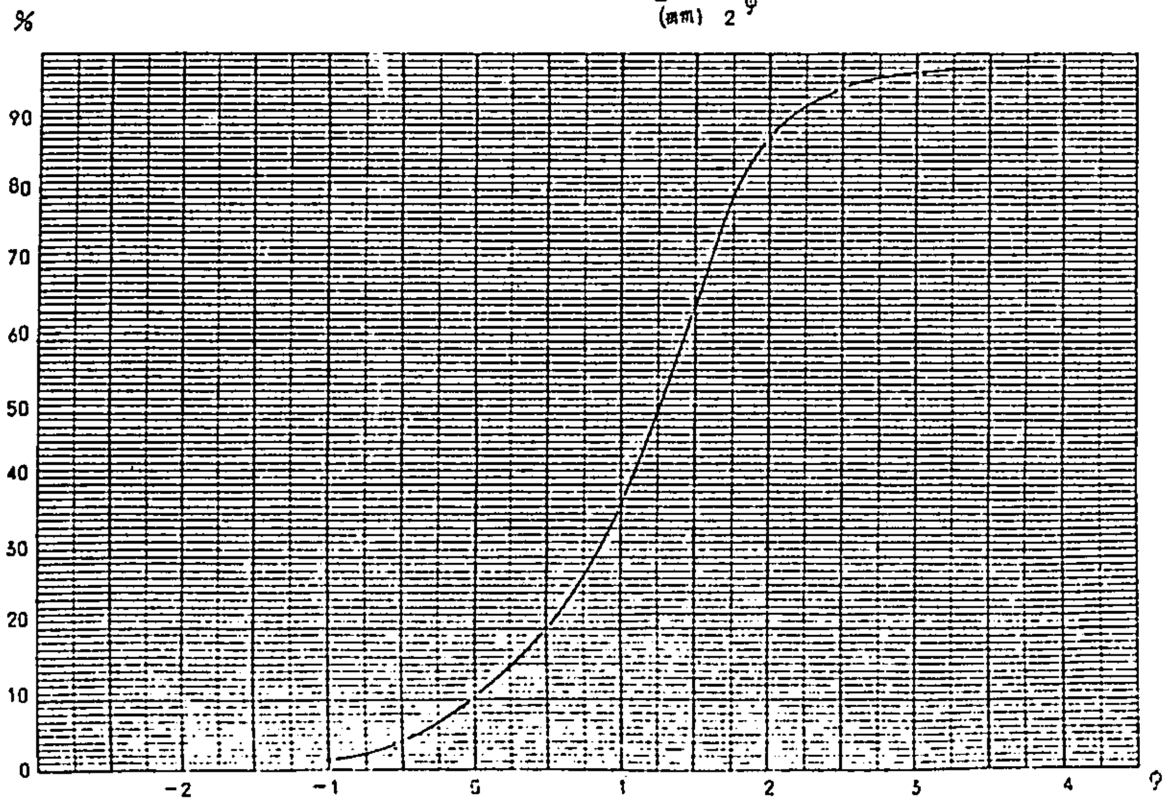


Figure 3.5-2-b(2) Results of Grain Size Analysis

(Cherating, No.C-5)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
2000	- 1.0	0.5	0.5
1410	- 0.5	0.3	0.8
1000	± 0	0.3	1.1
710	0.5	1.2	2.3
500	1.0	1.6	3.9
350	1.5	3.1	7.0
250	2.0	6.0	13.0
177	2.5	5.7	18.7
125	3.0	8.6	27.3
88	3.5	9.9	37.2
63	4.0	13.3	50.5
51	4.3	8.9	59.4
37	4.8	10.3	69.7
24	5.4	10.0	79.7
14	6.2	6.2	85.9
9.8	6.7	0.7	86.6
7.0	7.2	1.7	88.3
3.5	8.2	4.5	92.8
3.5	8.2	7.2	100.0

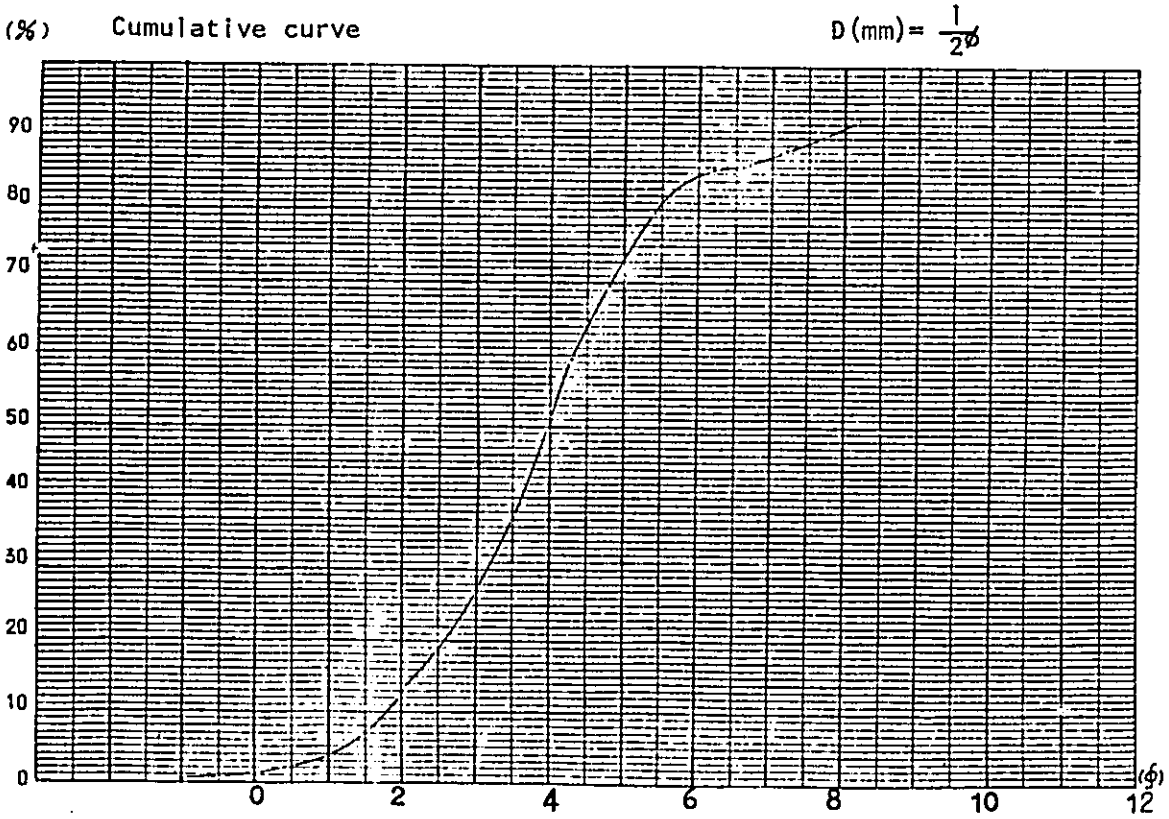


Figure 3.5-2-b(3) Results of Grain Size Analysis

(Sematan No.S-2)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
1000	± 0	0.5	0.5
710	0.5	0.2	0.7
500	1.0	0.3	1.0
350	1.5	2.1	3.1
250	2.0	3.1	6.2
177	2.5	3.2	9.4
125	3.0	5.5	14.9
88	3.5	12.2	27.1
63	4.0	34.5	61.6
52	4.3	15.5	77.1
37	4.8	5.6	82.7
23	5.4	4.7	87.4
14	6.2	3.0	90.4
9.7	6.7	2.0	92.4
6.8	7.2	0.6	93.0
3.4	8.2	0.7	93.7
3.4	8.2	6.3	100.0

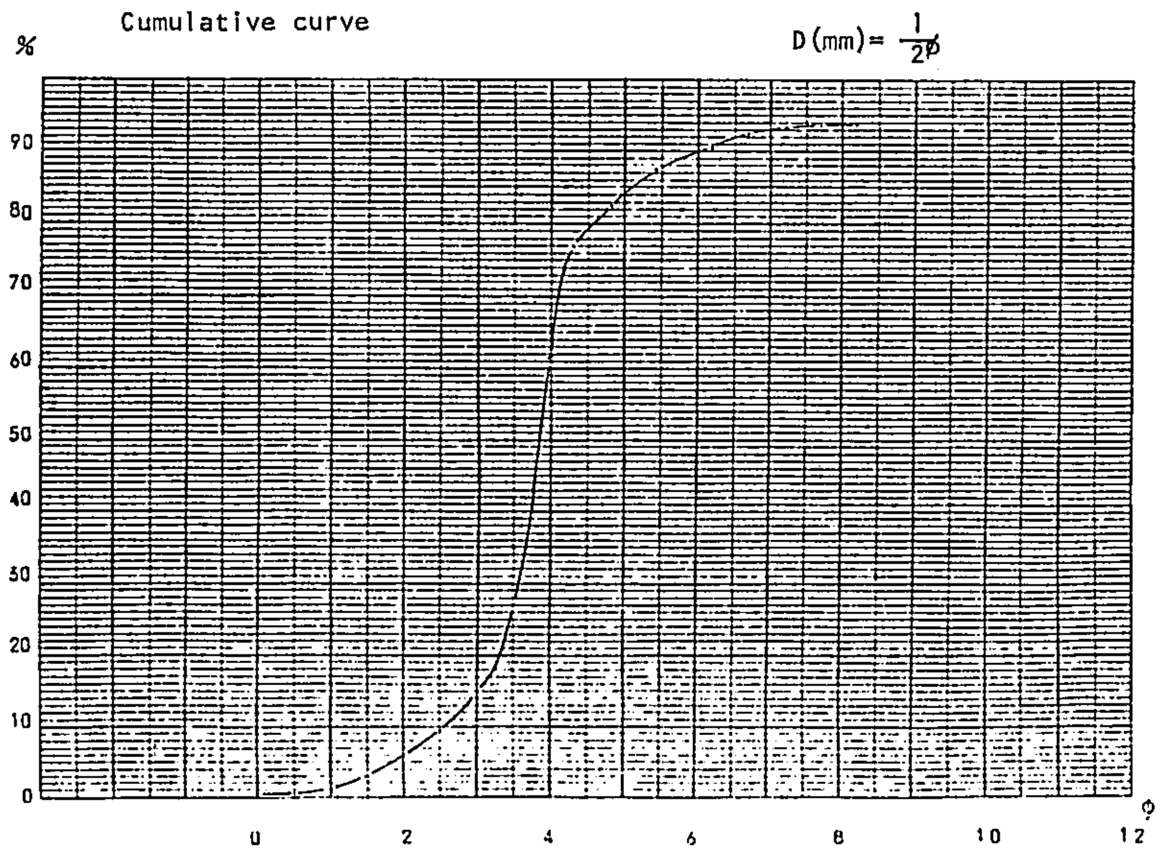


Figure 3.5-2-b(4) Results of Grain Size Analysis

(Sematan, No.S-8)

Grain Size		Weight (%)	Cumulative (%)
μ (micron)			
2000	- 1.0	0.4	0.4
1410	- 0.5	0.4	0.8
1000	± 0	1.3	2.1
710	0.5	1.8	3.9
500	1.0	1.7	5.6
350	1.5	1.9	7.5
250	2.0	3.9	11.4
177	2.5	4.4	15.8
125	3.0	8.2	24.0
88	3.	15.5	39.5
63	4.0	35.0	74.5
52	4.3	8.5	83.0
37	4.8	4.5	87.5
23	5.4	2.5	90.0
13	6.2	0.3	90.3
9.5	6.7	0	90.3
6.7	7.2	0	90.3
3.4	8.2	3.0	93.3

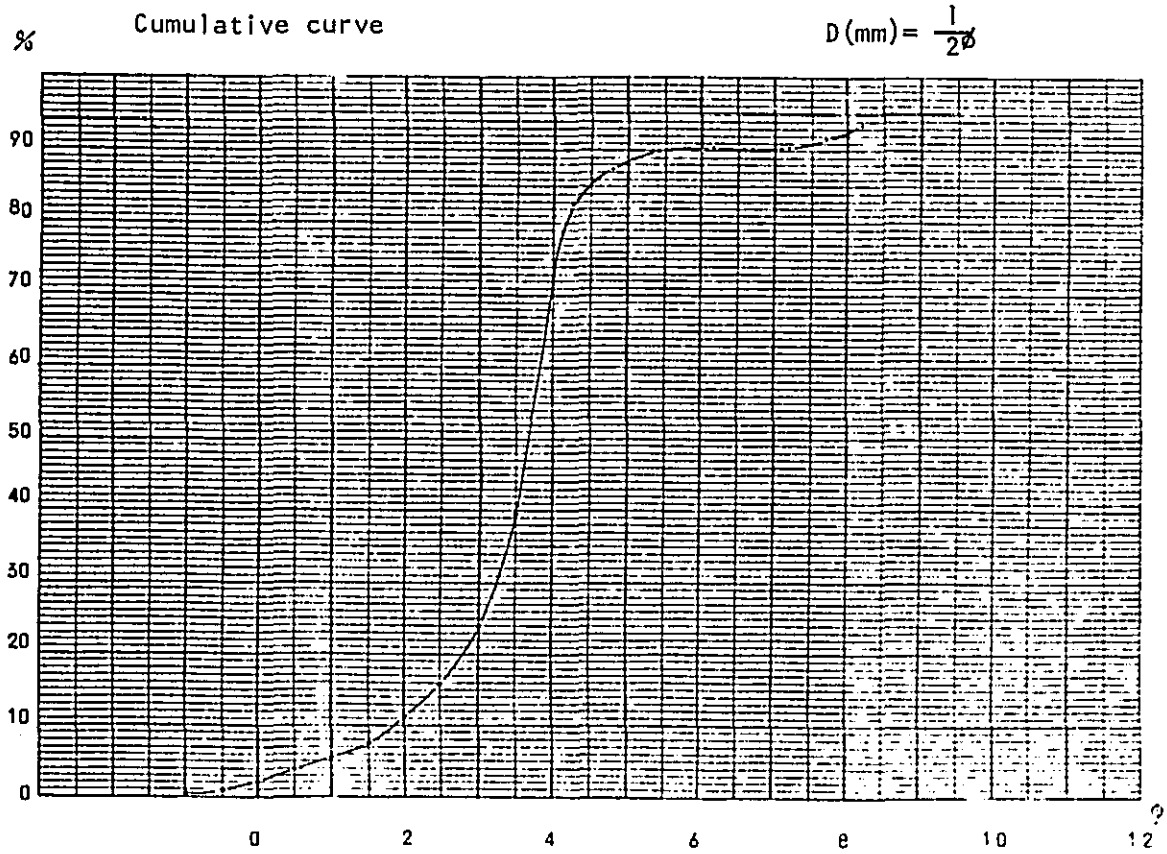


Figure 3.5-2-b(5) Results of Grain Size Analysis

Figure 3.5-10 Bottom Materials in Cherating Shore

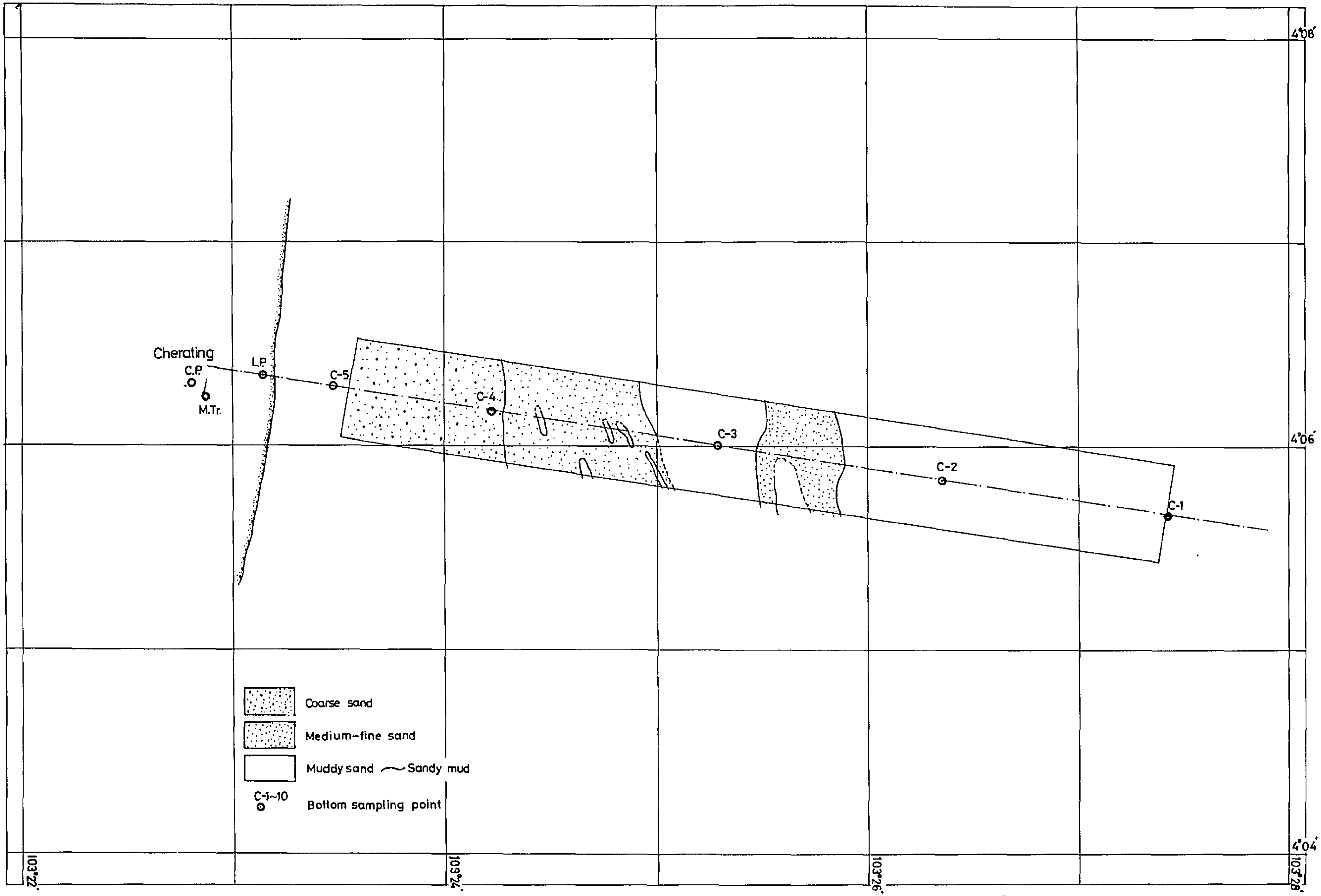
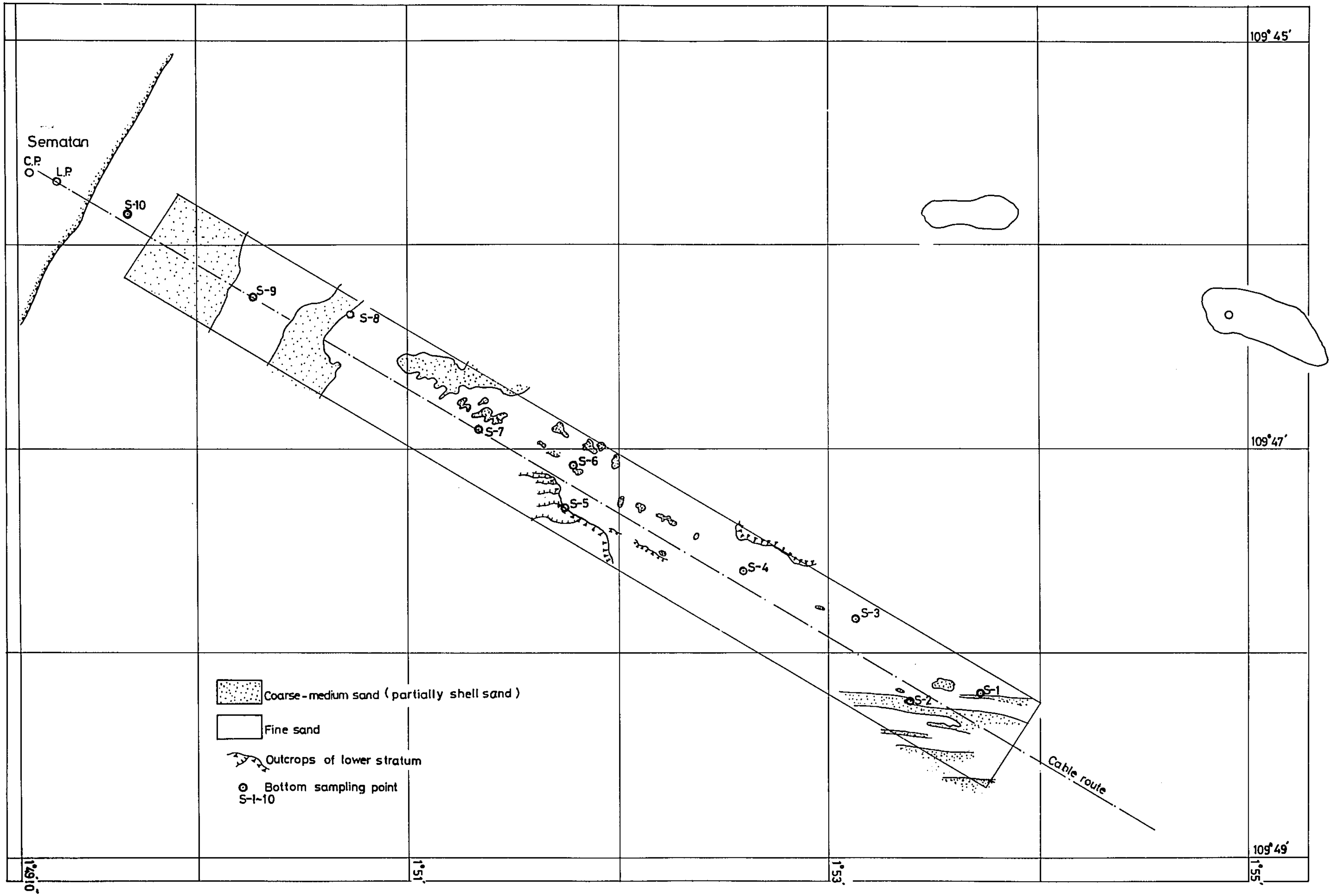


Figure 3.5-11 Bottom Materials in Sematan Shore



3.5.4 Subbottom Structure

The records of subbottom profiling were analized and the results are shown in Figures 3.5-3 and 3.5-12. Subbottom layes are classified into the following four types according to their reflection pattern or continuity.

(1) A1 layer

This is a layer forming the present sea bottom and has a good continuity. In many cases, it appears on the record as an apparent layer or indistinct layer pattern. It gives, at some places on the route, acoustically transparent pattern as shown in Figure 3.5-13.

(2) A2 layer

This is a layer accumulated in a valley or depression of a lower stratum. It varies in thickness and not continuous. It appears in various patterns on the record, and cannot be well discriminated from A1 layer in some cases (Figure 3.5-14).

(3) B layer

This lies beneath A1 and A2 layers and is in unconformity to them. The surface of the layer shows distinct reflection on the record and incorporates another continuous multi-layer pattern (Figure 3.5-15).

(4) C layer

This layer exists adjacent to both A and B, and has many ups and downs on its surface. It gives strong reflection on the record and shows no layer like pattern (Figure 3.5-16).

A1 layer is at the surface of the sea bottom, and consists of clay or mud covered with thin sandy mud or muddy sand. The thickness of A1 is mostly about 10 meters (or 33 feet), but sometimes will be 2 meters (or 7 feet) at such places as 320 nm (or 590 Km) from Cherating and around Natuna. A2 layer is a sediment accumulated in the valley or depression on the surface of B layer and does not appear on the sea bottom surface. It seems to be unsolidified sediment which consist of mud or clay.

B layer forms depressions on its surface and is supposed to be solidified alternative layers of sand and mud. This layer also does not appear on the sea bottom surface but comes up nearer to it around Natuna.

From the position 280 nm/520 Km (from Cherating) toward Sematan, C layer comes up repeating ups and downs and reaches several meters below the bottom surface at 318 nm (590 Km) from Cherating. According to the reflection pattern, C layer seems to consist of hard igneous rocks which forms Natuna Ridge extending from Sematan toward Natuna Island.

Figure. 3.5-12 SUB - BOTTOM PROFILE (Off Shore Portion)

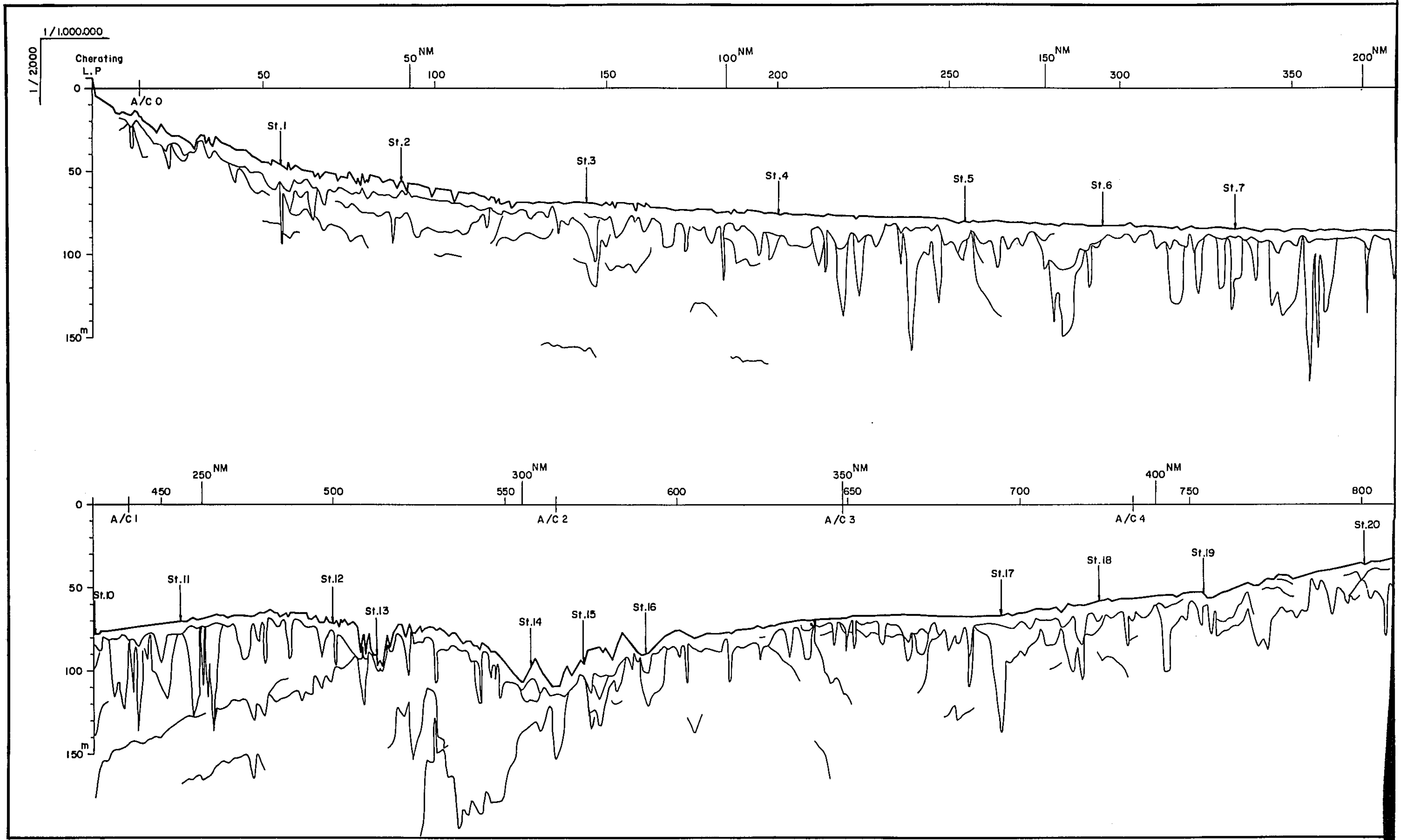
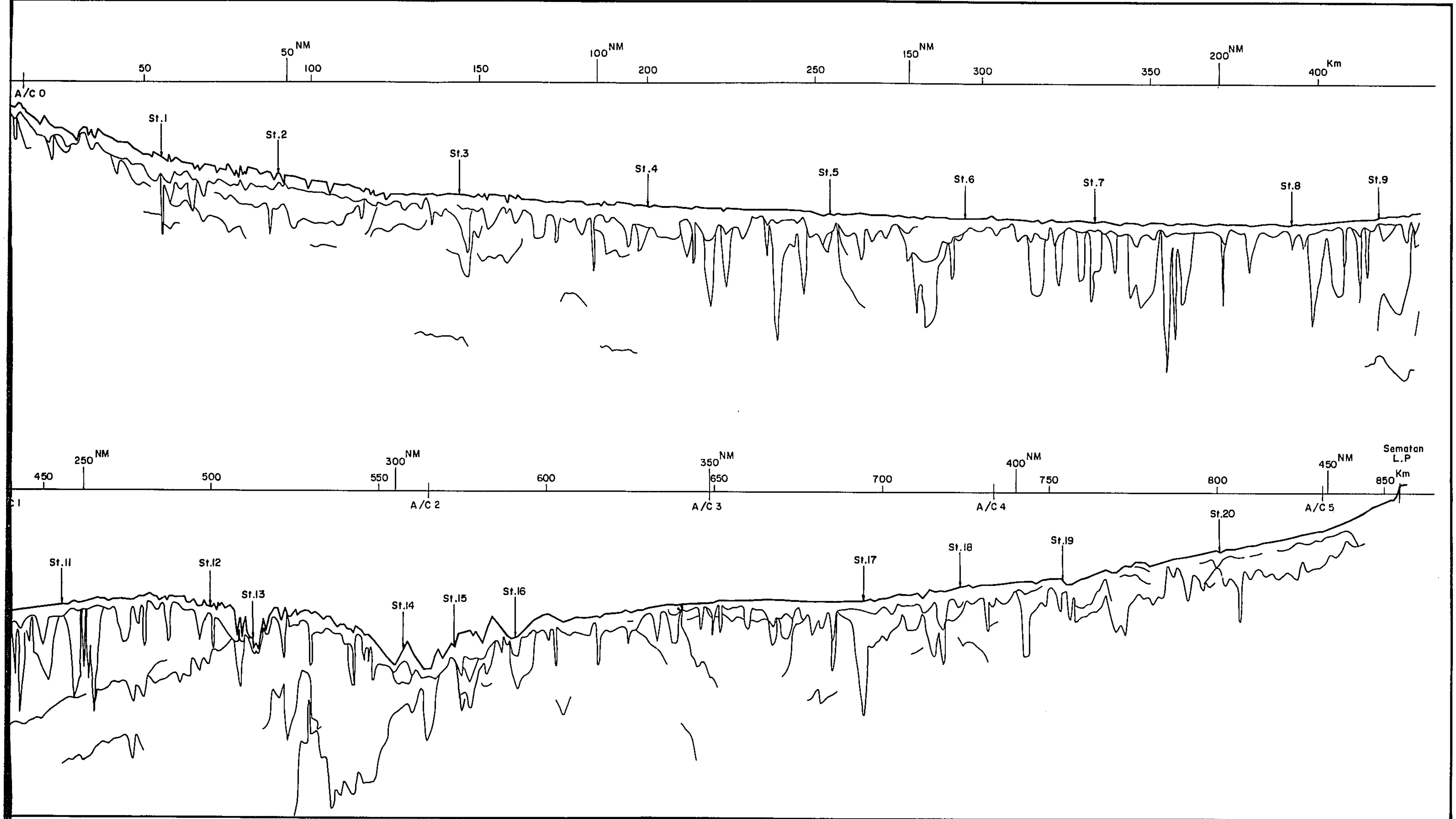


Figure. 3.5-12 SUB - BOTTOM PROFILE (Off Shore Portion)



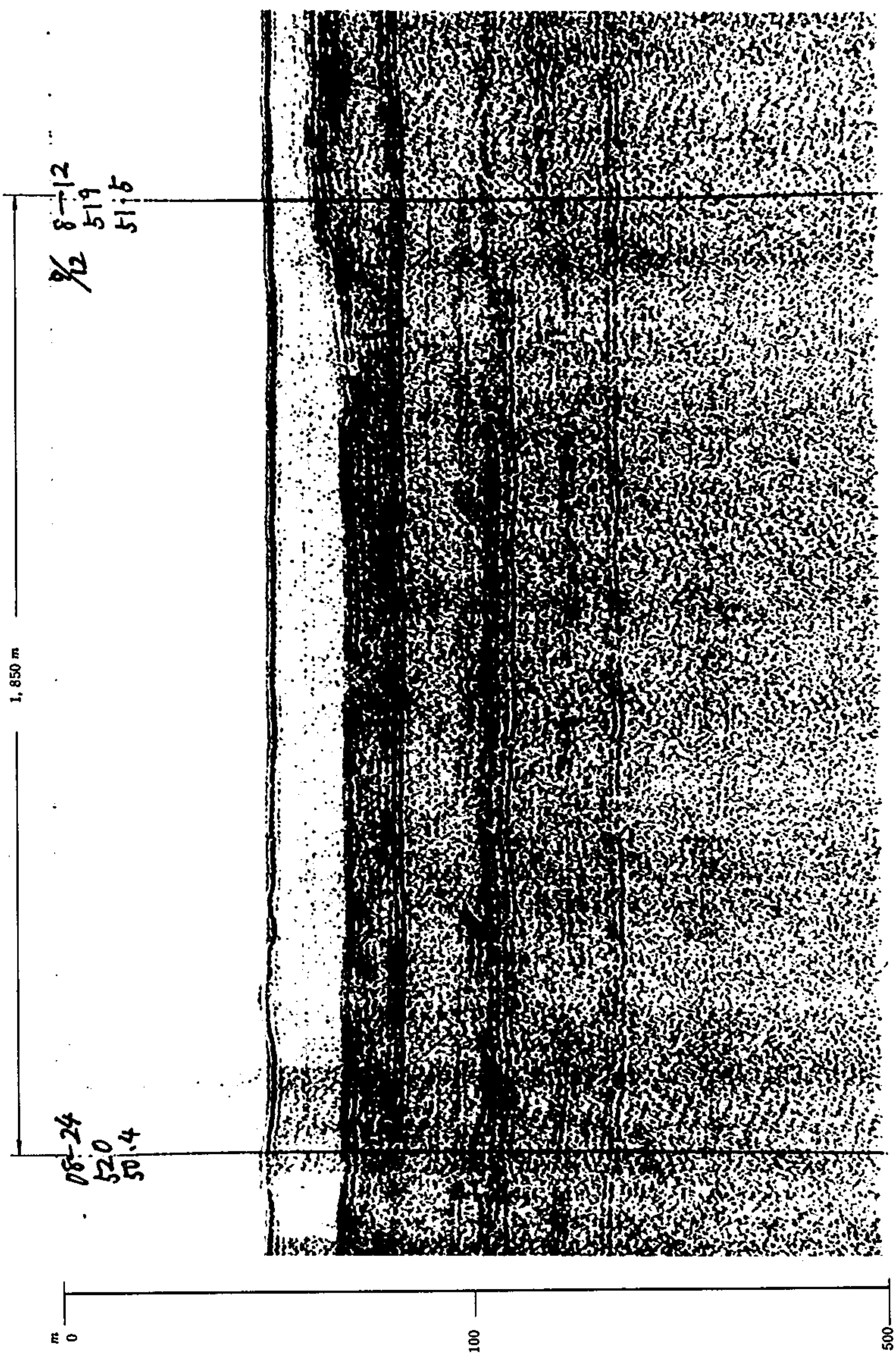


Figure 3.5-13 Record of Subbottom Profiling

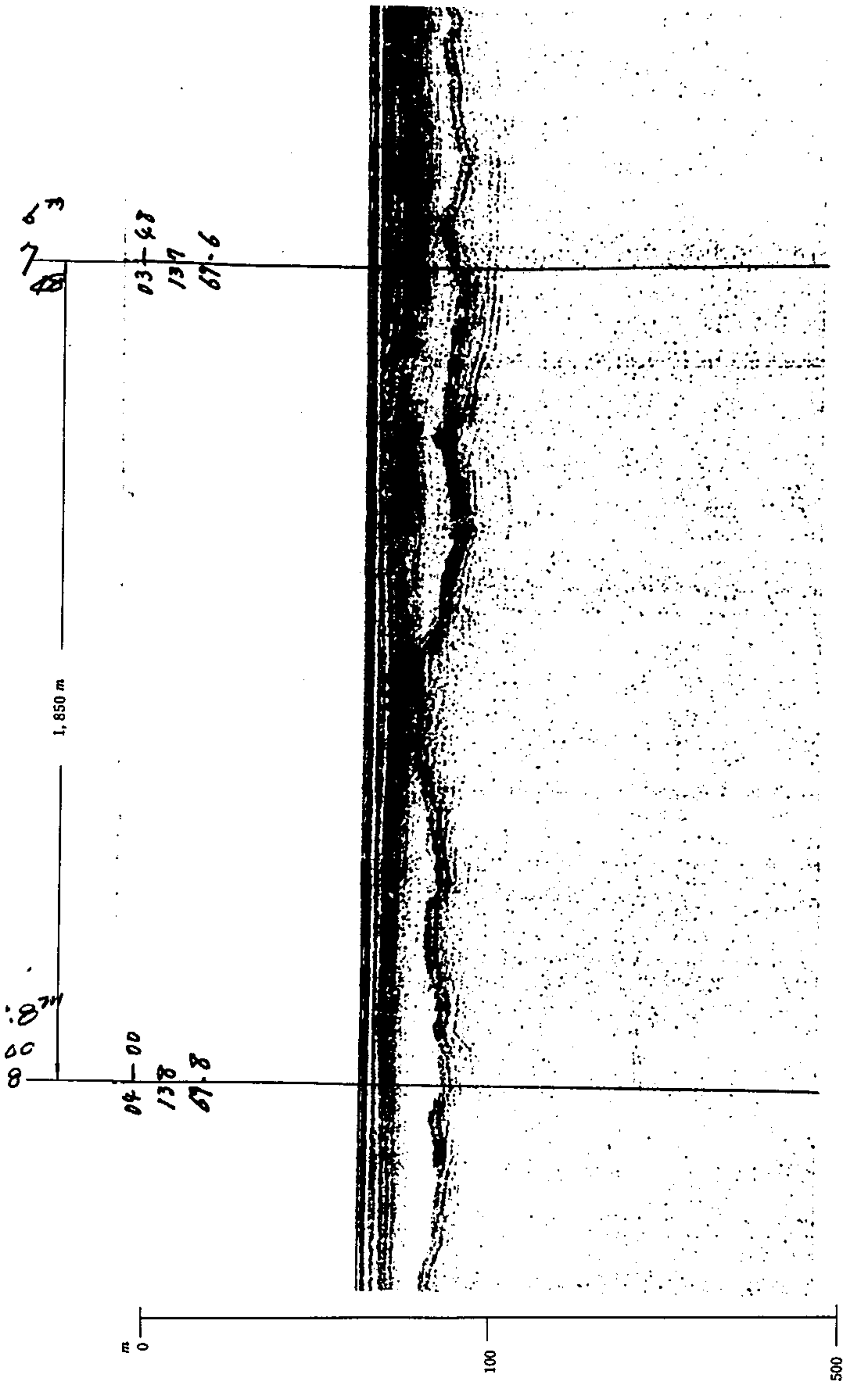


Figure 3.5-14 Record of Subbottom Profiling

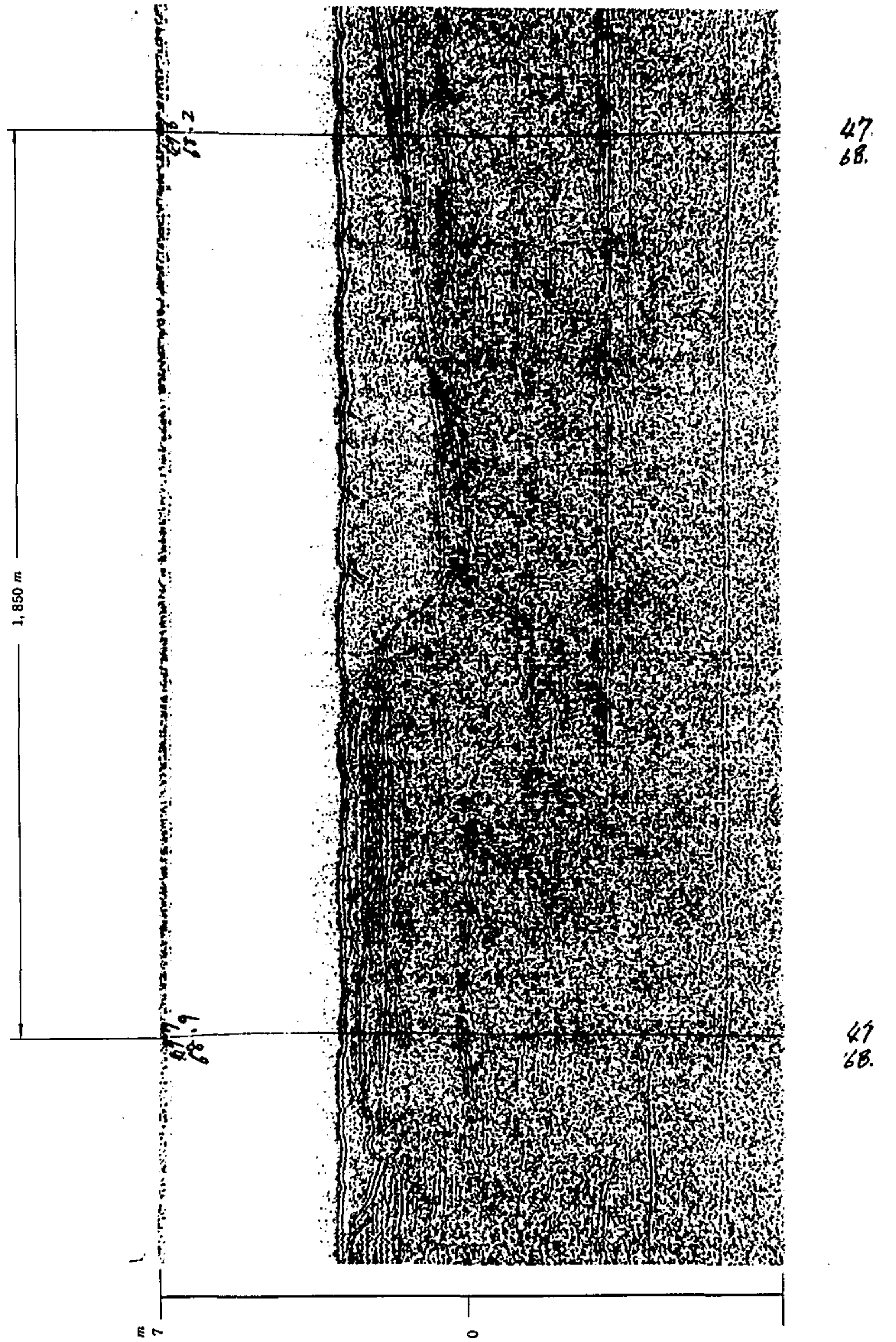


Figure 3.5-15 Record of Subbottom Profiling

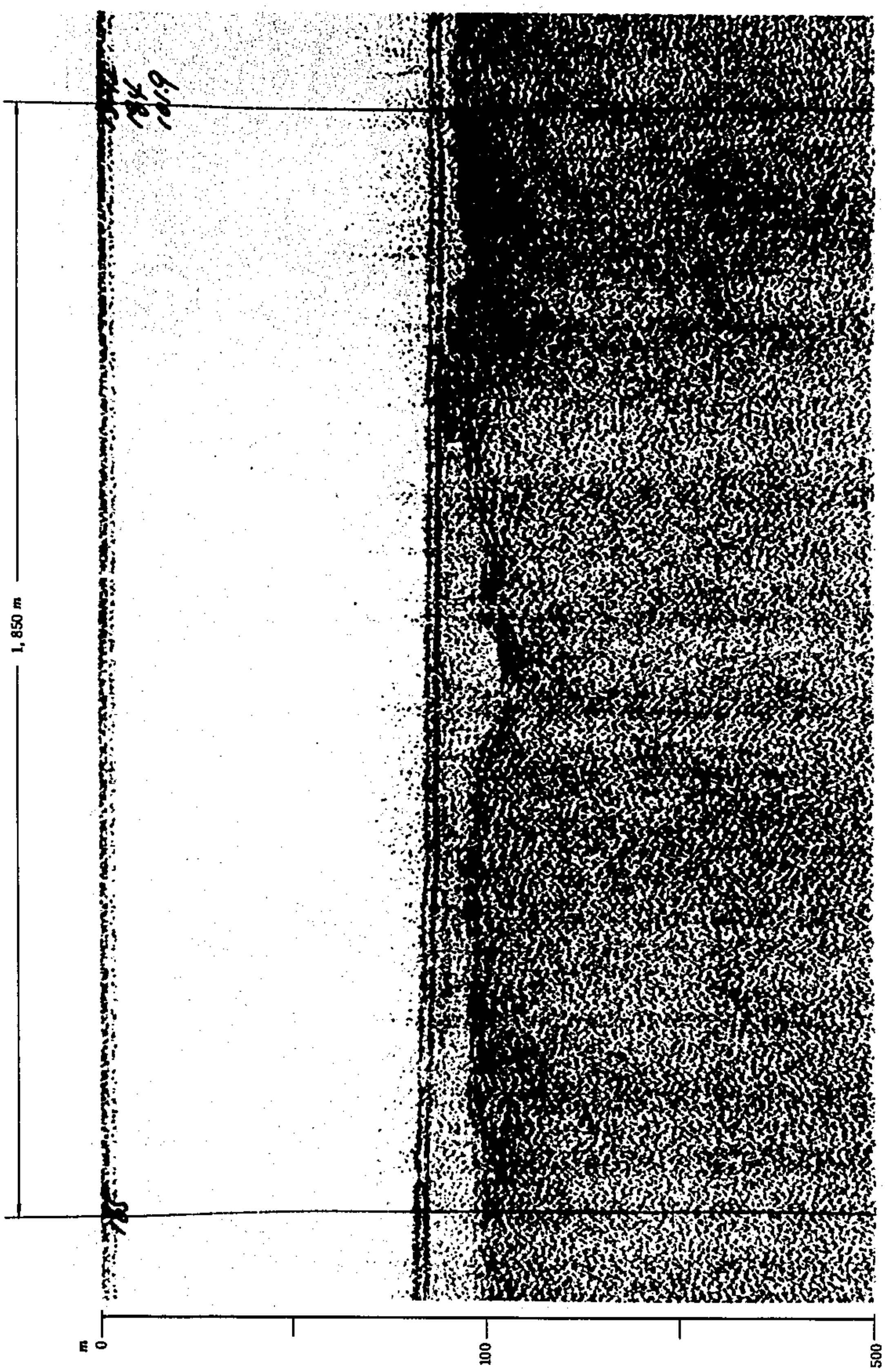


Figure 3.5-16 Record of Subbottom Profiling

3.5.5 Water Temperature

Bottom water temperature was observed by using mainly the electric thermometer at same positions as bottom sampling was made.

Surface and bottom temperatures at positions along the main survey track are given in Tables 3.5-1 and -2. In the shore portion, water was almost isothermal. In the off-shore portion, there was a considerable difference in temperature between surface and bottom water layers.

Remarkable thermocline was observed in the water depth of 50 to 70 meters (or 27 to 38 fathoms) and XBT was used to confirm it. Temperature records by XBT are shown in Figure 3.5-17.

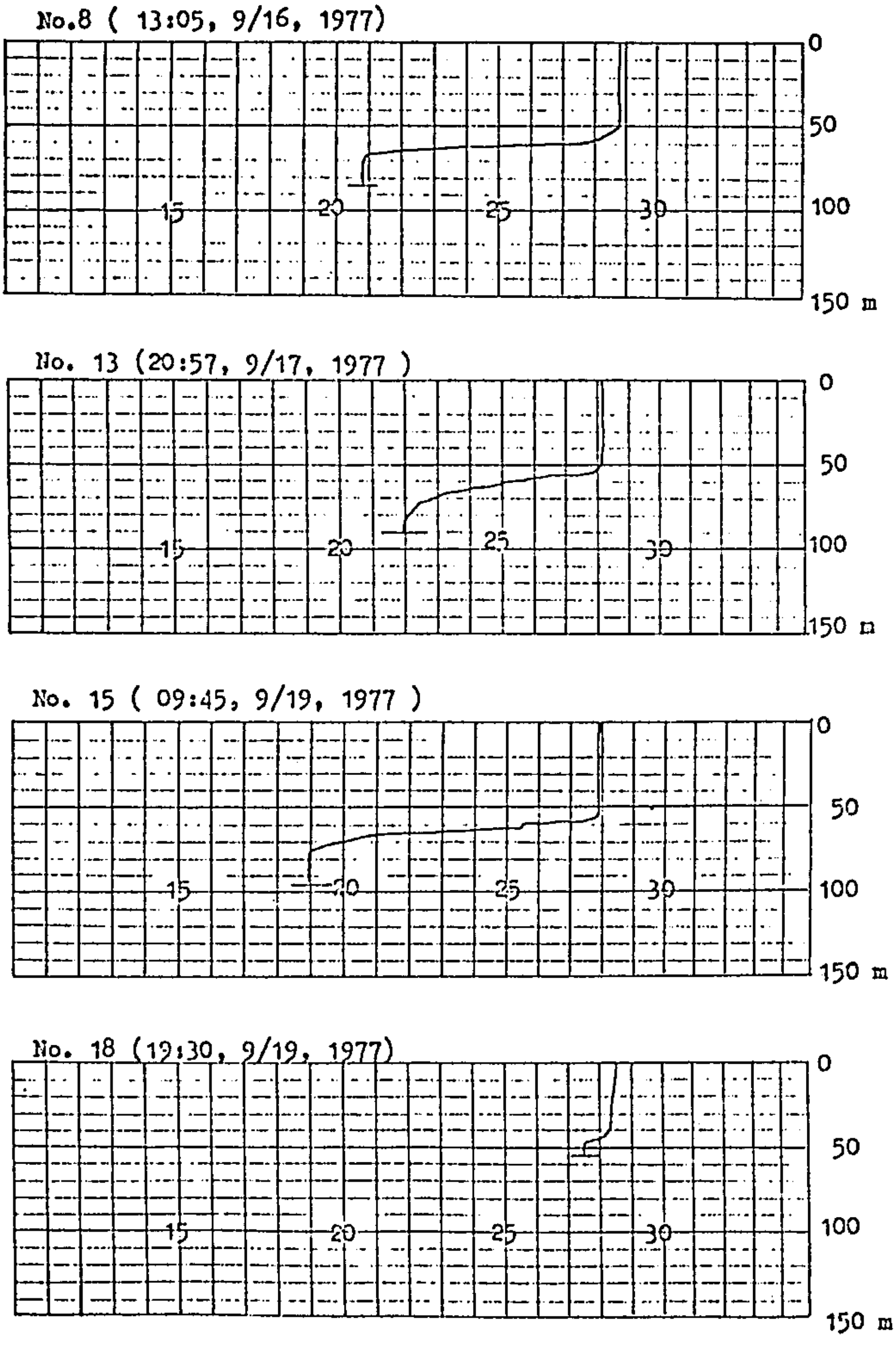


Figure 3.5-17 Vertical Distribution of Water Temperature (in °C) Measured by XBT at 4 stations

3.5.6 Current

Ono-type Current Meters were placed in a depth of five meters below the sea surface and current direction and velocity were recorded for about 25 hours at positions:

4°05.8'N/103°26.0'E (Cherating shore - 13 to 14 September)
3°43.2'N/107°04.3'E (Off-shore portion/ST-1 - 16 to 18th September)
3°17.2'N/108°22.6'E (Off-shore portion/ST-2 - 17 to 19th September)
1°54.4'N/109°48.4'E (Sematan shore - 6 to 7th September)

The current data obtained on the records were compiled into the forms as follows:

(1) Vector diograms of current (Figures 3.5-18 and -19)
(2) Current curves of N and E components (Figure 3.5-20)
(3) Harmonic constants from one day recording (Table 3.5-3)
(4) Computed current curves (Fugure 3.5-21)
(5) Current ellipses (Figure 3.5-22)

The vector diagrams of current show that:

(i) In Cherating shore
Current in the direction of NNE was dominant and the reverse current (SSW) was weak. The strongest current observed was 19°-0.74 kts (0.38 m/sec)

(ii) At ST-1 (West of Natuna Island - refer to Figure 3.3-1)
Current in the direction of E or W was dominant.
The strongest current observed in each direction was 72°-0.68 kts (0.35 m/sec) and 251°-0.49 kts (0.25 m/sec).

(iii) At ST-2 (South of Natuna Island - refer to Figure 3.3-1)
Current in the direction of SW was dominant.
The strongest current observed was 225°-1.07 kts (0.55 m/sec).

(iv) In Sematan shore
Current in the direction of NNW or SSE was dominant.
The strongest current observed in each direction was 330°-0.4 kts (or 0.21 m/sec) and 158°-0.45 kts (or 0.23 m/sec).

From the current curves or the hamonic constants, existence of current variations of approximately half a day period can be seen. The maximum current strength of this component varies from 0.15 to 0.25 m/sec (0.3 to 0.5 knots) according to the observed positon.

Tidal current of one day period also existed at all observational points. The maximum current speed of one day period component was 0.1 knots in Cherating shore, 0.27 kts at ST_1 and ST_2, and 0.16 knots in Sematan shore.

At positions off Cherating and Sematan, flood current flows coastwise toward the south and ebb current toward the north. At ST-1 (west of Natuna Island), strongest current flows westward at high water and eastward at low water, while at ST-2 (south of Natuna), current flows toward the west or south west all day long due to the existance of strong constant westerly current, and the maximum current speed appeared at high tide and minimum one at low tide. Daily mean (non tidal) current was 0.23 knots (or 0.12 m/sec) northerly, 0.18 knots (or 0.09 m/sex) south-easterly, 0.7 knots (or 0.36 m/sec) to the south south west (as shown in Figure 3.5-23).

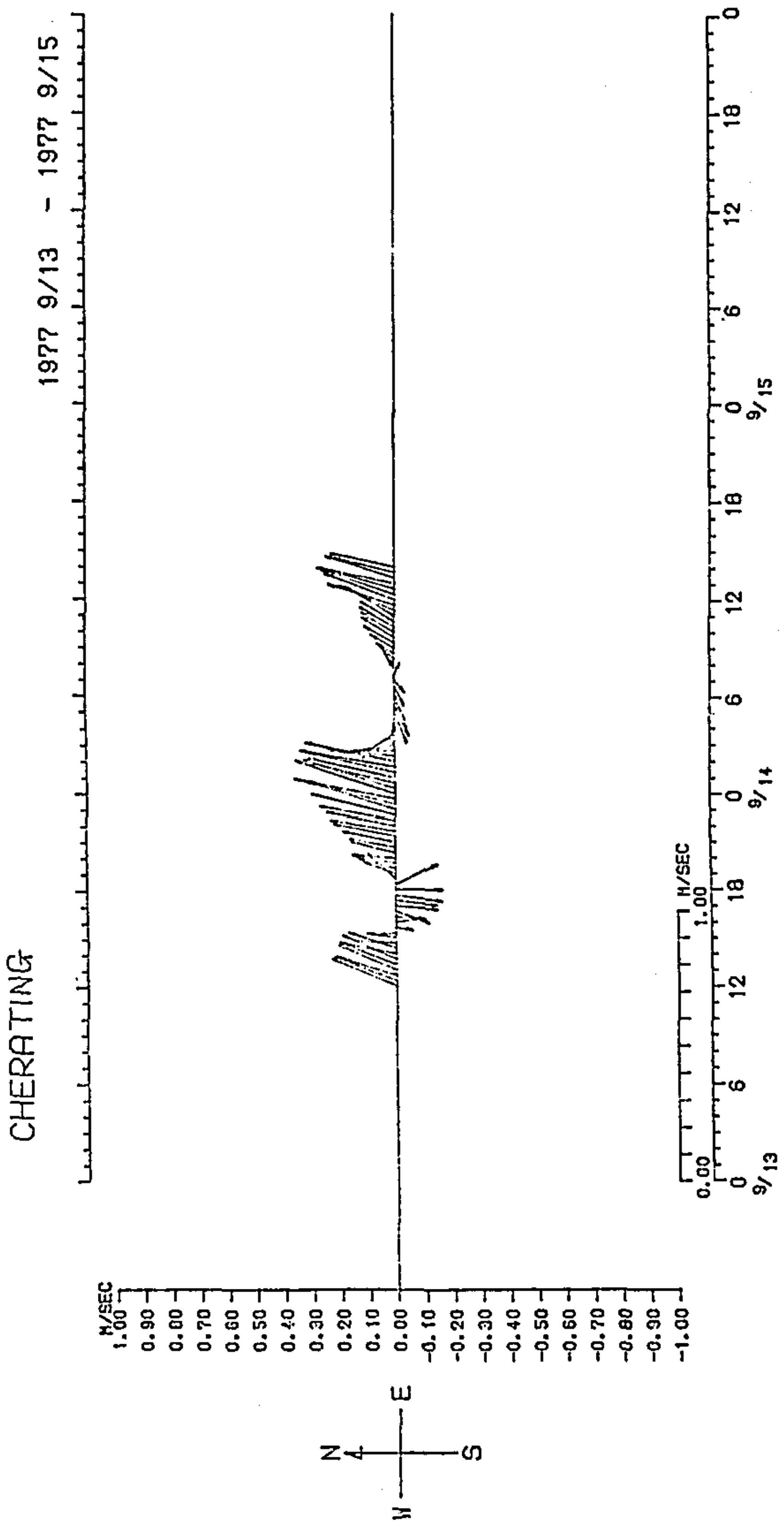


Figure 3.5-18(1) Cherating Vector Diagram of Current

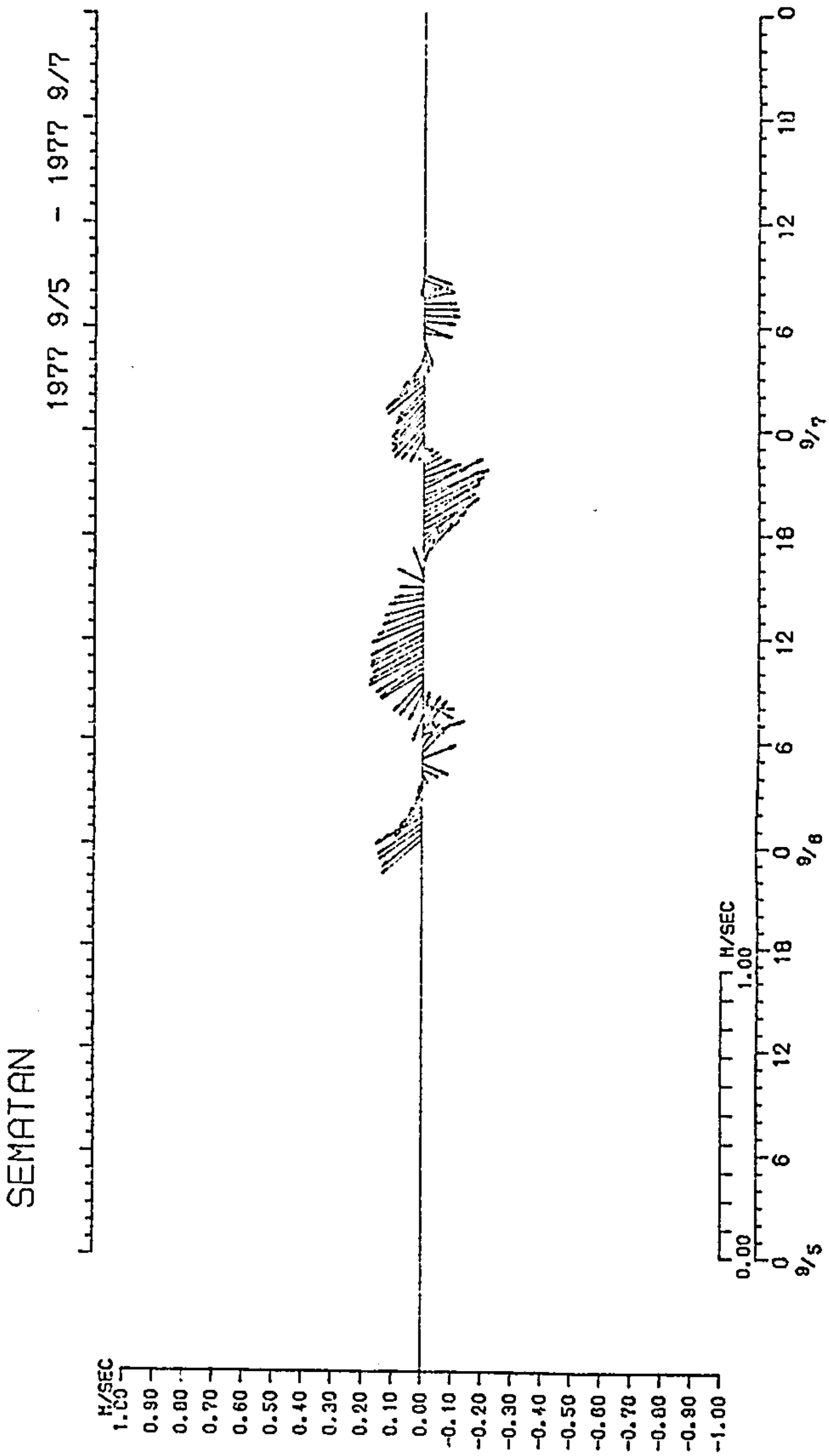


Figure 3.5-18(2) Sematan Vector Diagram of Current

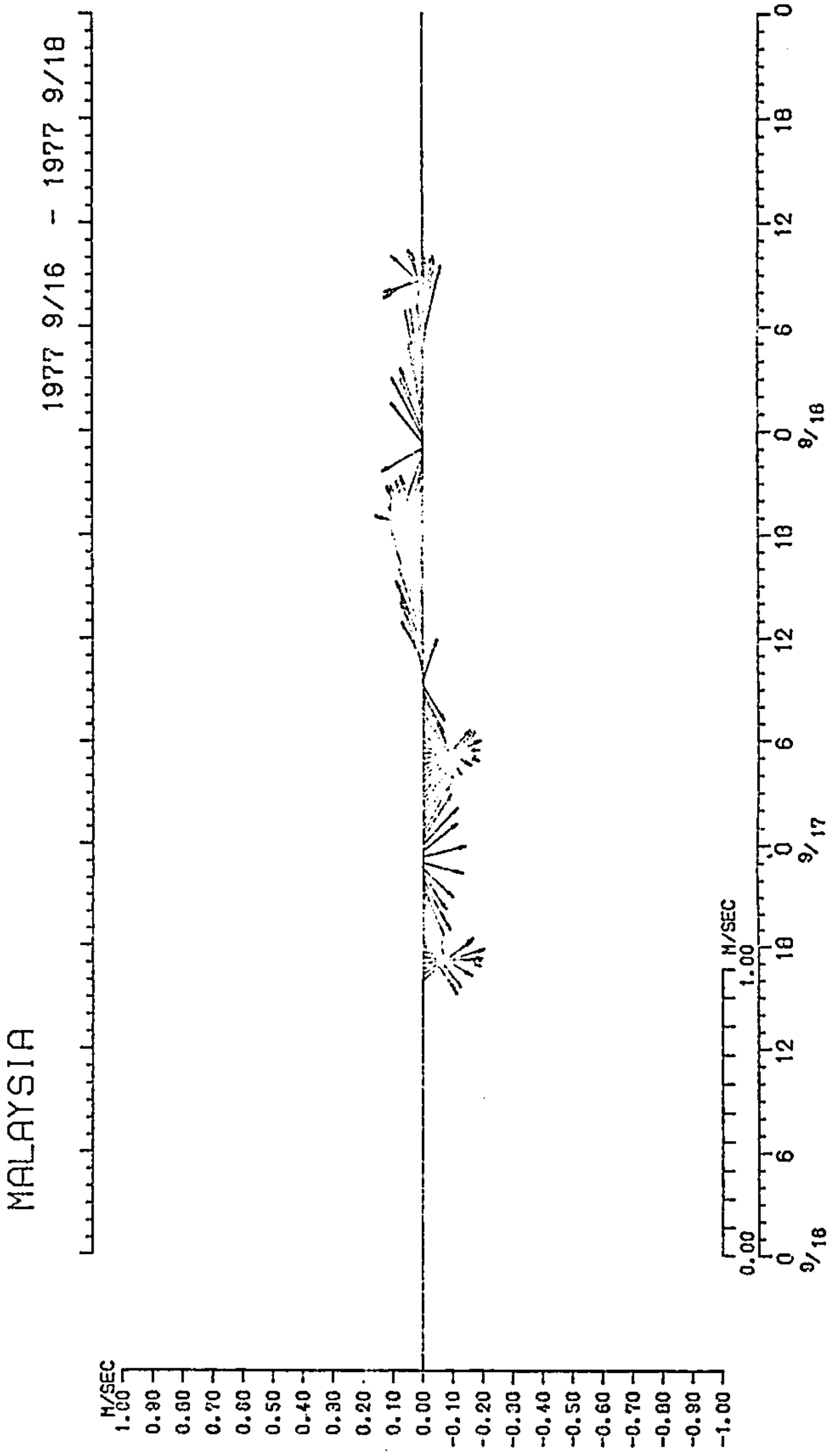


Figure 3.5-19(1) West of Natuna Island Vector Diagram of Current

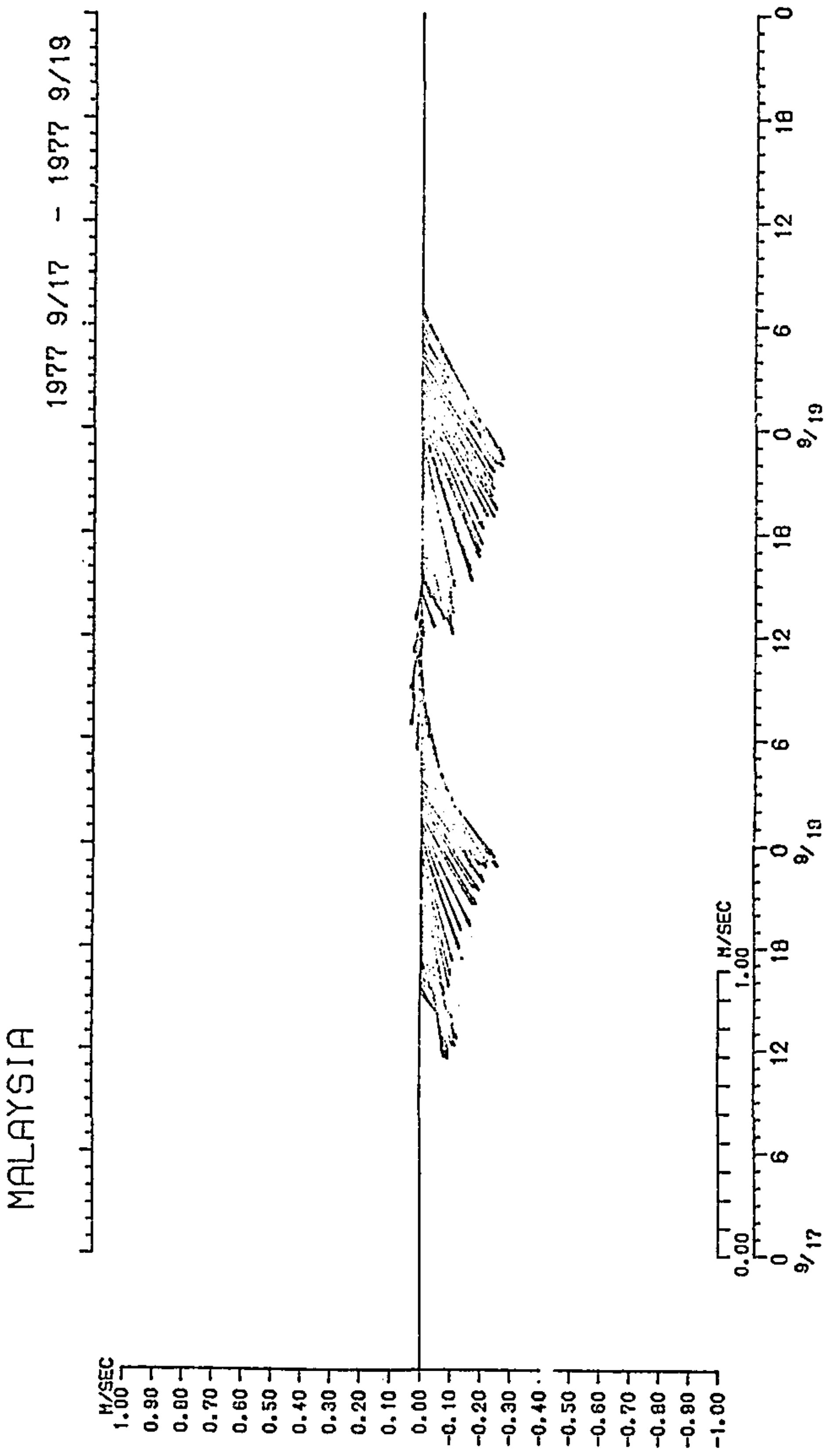


Figure 3.5-19(2) South of Natuna, Vector Diagram of Current

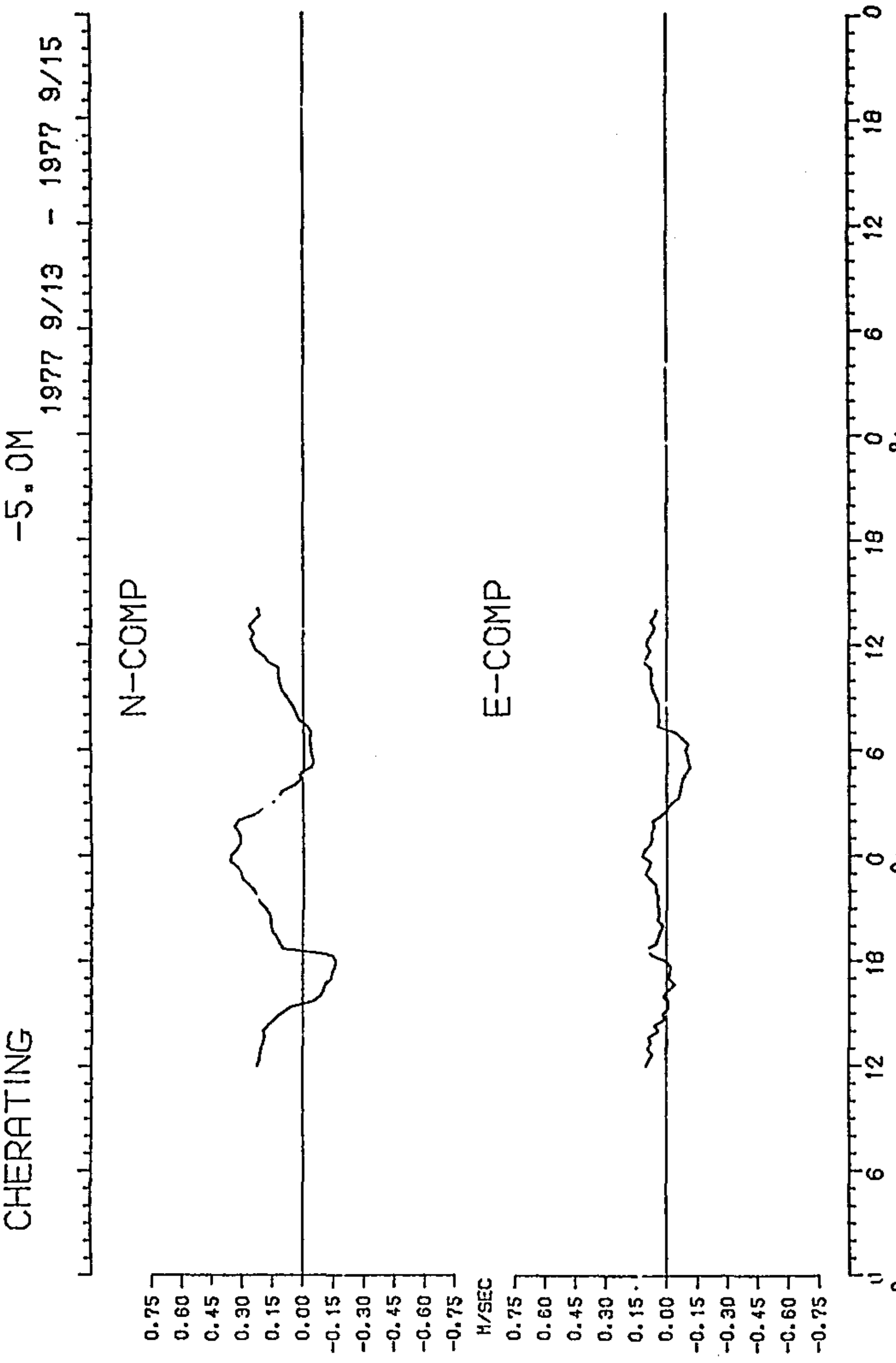


Figure 3.5-20(1) Velocity Curve of N and E-Component

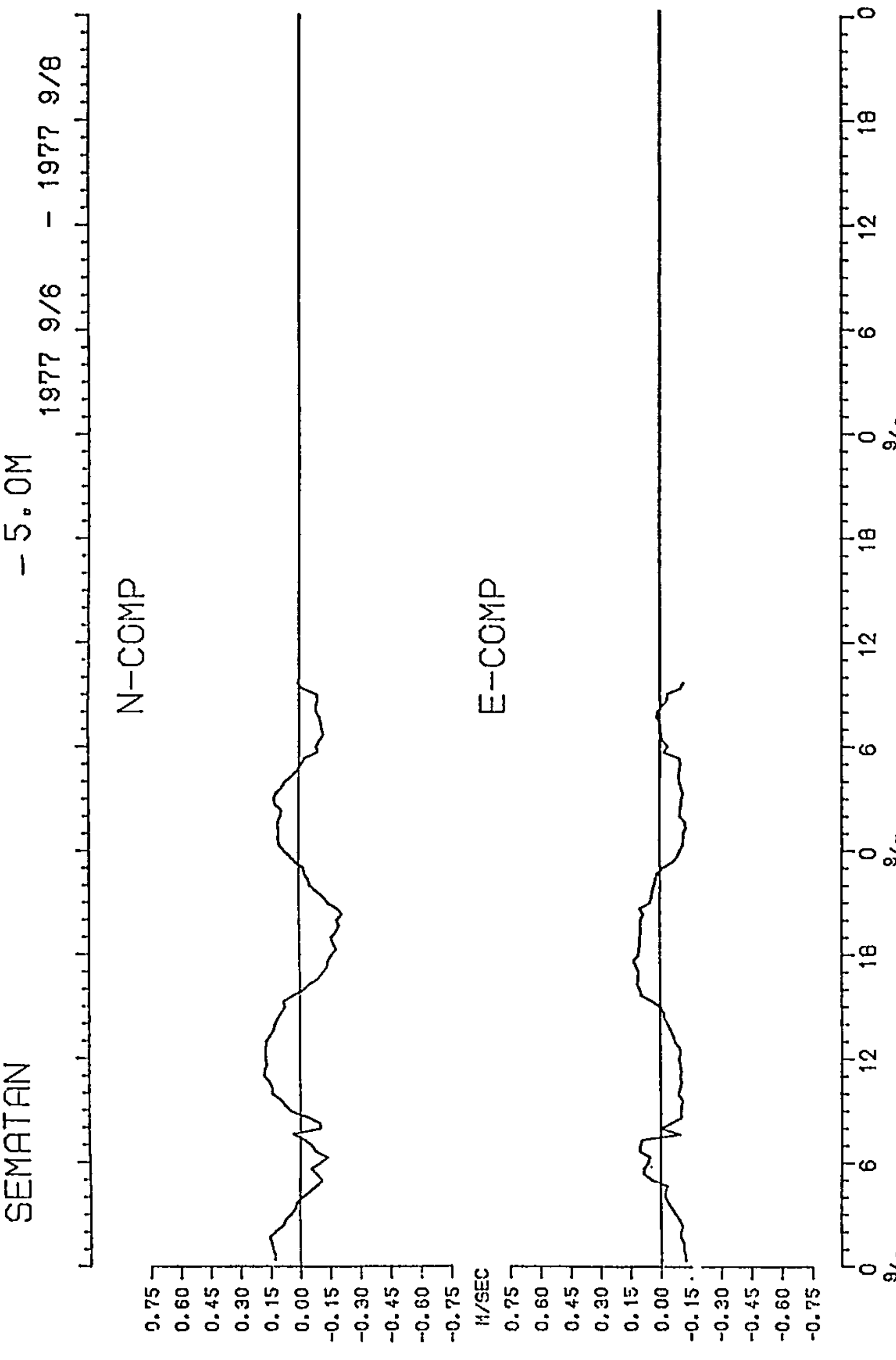


Figure 3.5-20(2) Velocity Curve of N and E-Component

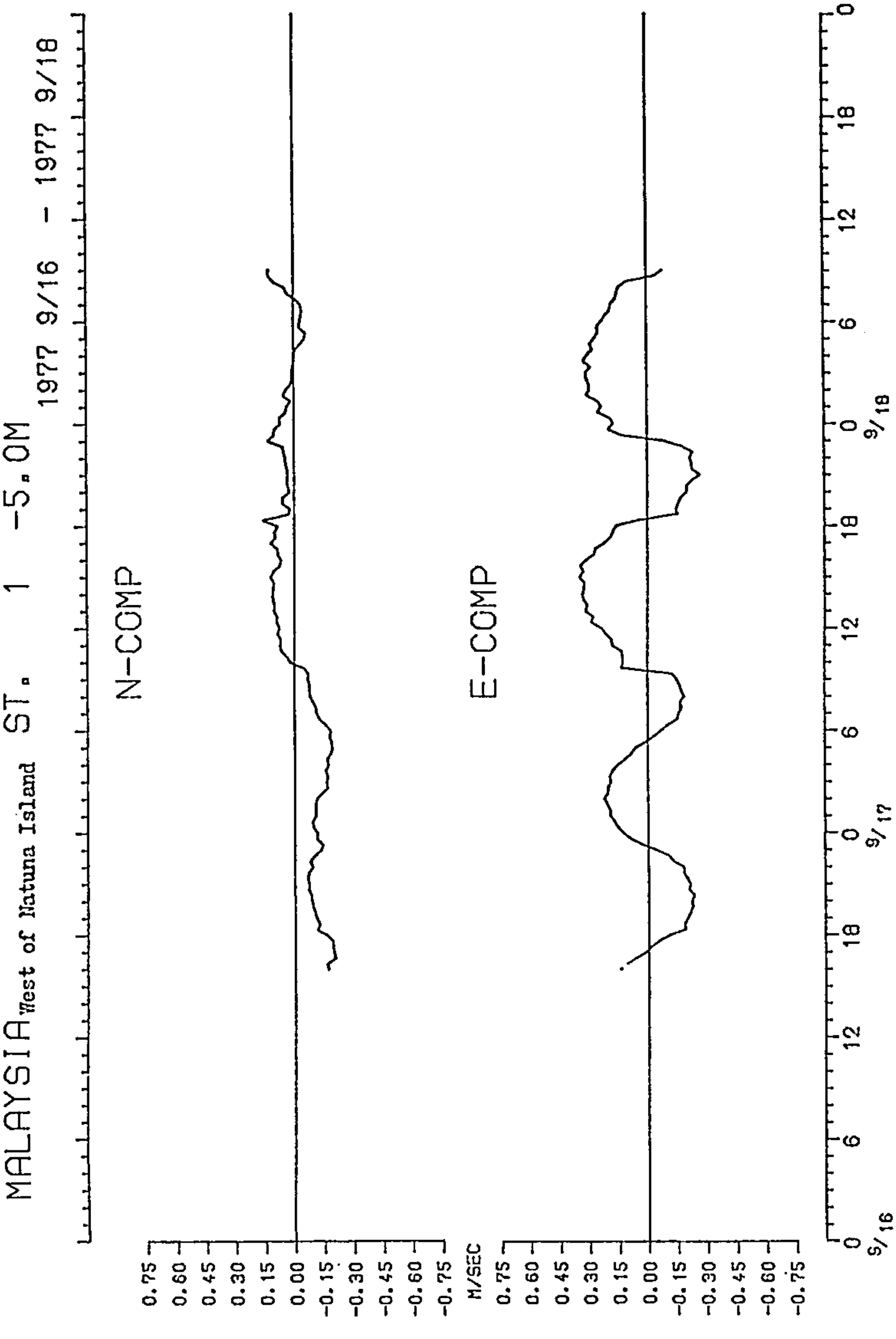


Figure 3.5-20(3) Velocity Curve of N and E-Component

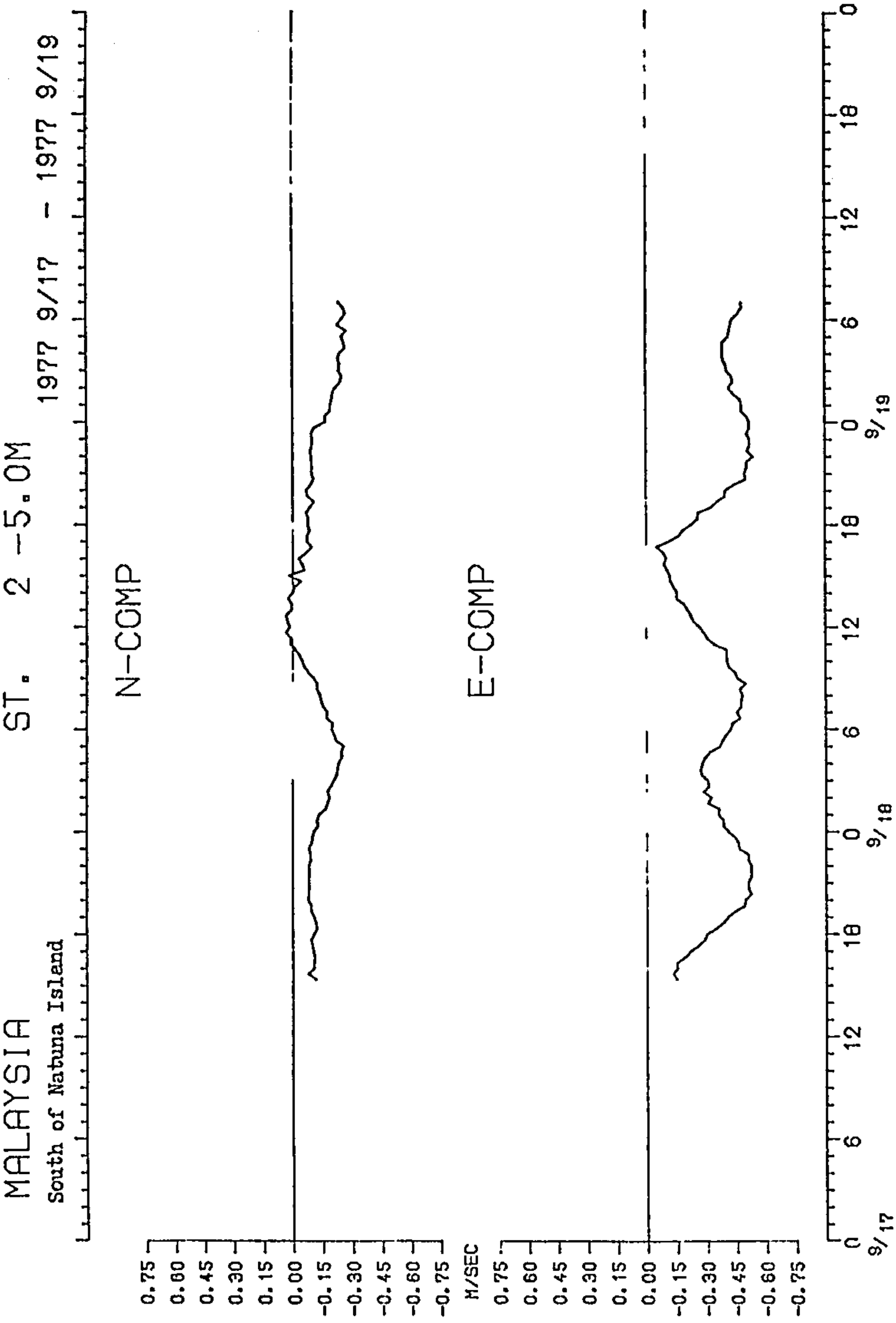


Figure 3.5-20(4) Velocity Curve of E and N-Component

Table 3.5-3 Analysis of Tidal Current for 25 Hours

Area ; Cherating Station; 103 26 00 E, 4 05 48 N
Layer; -5.0 m
Epock; 12h-00m, 13 Sept., 1977 Transit; 13h-10m, 14 Sept.,

Ellipse of Tidal Current

	M1			M2			M4			CONST.		
	DIR	V1	K1	DIR	V2	K2	DIR	V4	K4	DIR	V0	M1/M2
L	342	0.059	180	20	0.190	331	26	0.048	62	12	0.124	0.310
S	72	0.025	90	110	0.023	241	116	0.012	332			

Area ; Sematan Station; 109 48 16 E, 1 54 16 N
Layer; -5.0 m
Epock; 01-00m, 6 Sept., 1977 Transit; 06h-16m, 6 Sept.,

Ellipse of Tidal Current

	M1			M2			M4			CONST.		
	DIR	V1	K1	DIR	V2	K2	DIR	V4	K4	DIR	V0	M1/M2
L	321	0.084	20	327	0.174	184	293	0.011	114	294	0.011	0.482
S	51	0.031	110	57	0.022	274	23	0.001	24			

Area ; West of Natuna Island (St.1) Station; 107 04 18 E, 3 43 12 N
Layer; -5.0 m
Epock; 16h-00m, 16 Sept., 1977 Transit; 15h-31m, 17 Sept.,

Ellipse of Tidal Current

	M1			M2			M4			CONST.		
	DIR	V1	K1	DIR	V2	K2	DIR	V4	K4	DIR	V0	M1/M2
L	43	0.139	321	78	0.247	321	322	0.032	295	139	0.086	0.562
S	133	0.025	231	168	0.062	51	52	0.024	25			

Area ; South of Natuna Island (St. 2) Station; 108 22 18 E, 3 17 12 N
Layer; -5.0 m
Epock; 16h-00m, 17 Sept., 1977 Transit; 16h-23m, 18 Sept.,

Ellipse of Tidal Current

	M1			M2			M4			CONST.		
	DIR	V1	K1	DIR	V2	K2	DIR	V4	K4	DIR	V0	M1/M2
L	52	0.135	336	279	0.152	153	279	0.018	200	253	0.358	0.888
S	142	0.009	246	9	0.058	243	9	0.002	110			

M1 ; Diurnal tidal current
M2 ; Semi-diurnal tidal current
M4 ; Quarter-diurnal tidal current
CONST. ; Daily mean current (Non-tidal current)
L ; Major axis of current ellipse
S ; Minor axis of current ellipse
DIR ; Direction (Degree)
V ; Amplitude of tidal current speed (m/sec)
K ; Phase lag refered to the transit of the moon (Degree)

CHERATING

-5.0M 1977 9/13 - 9/14

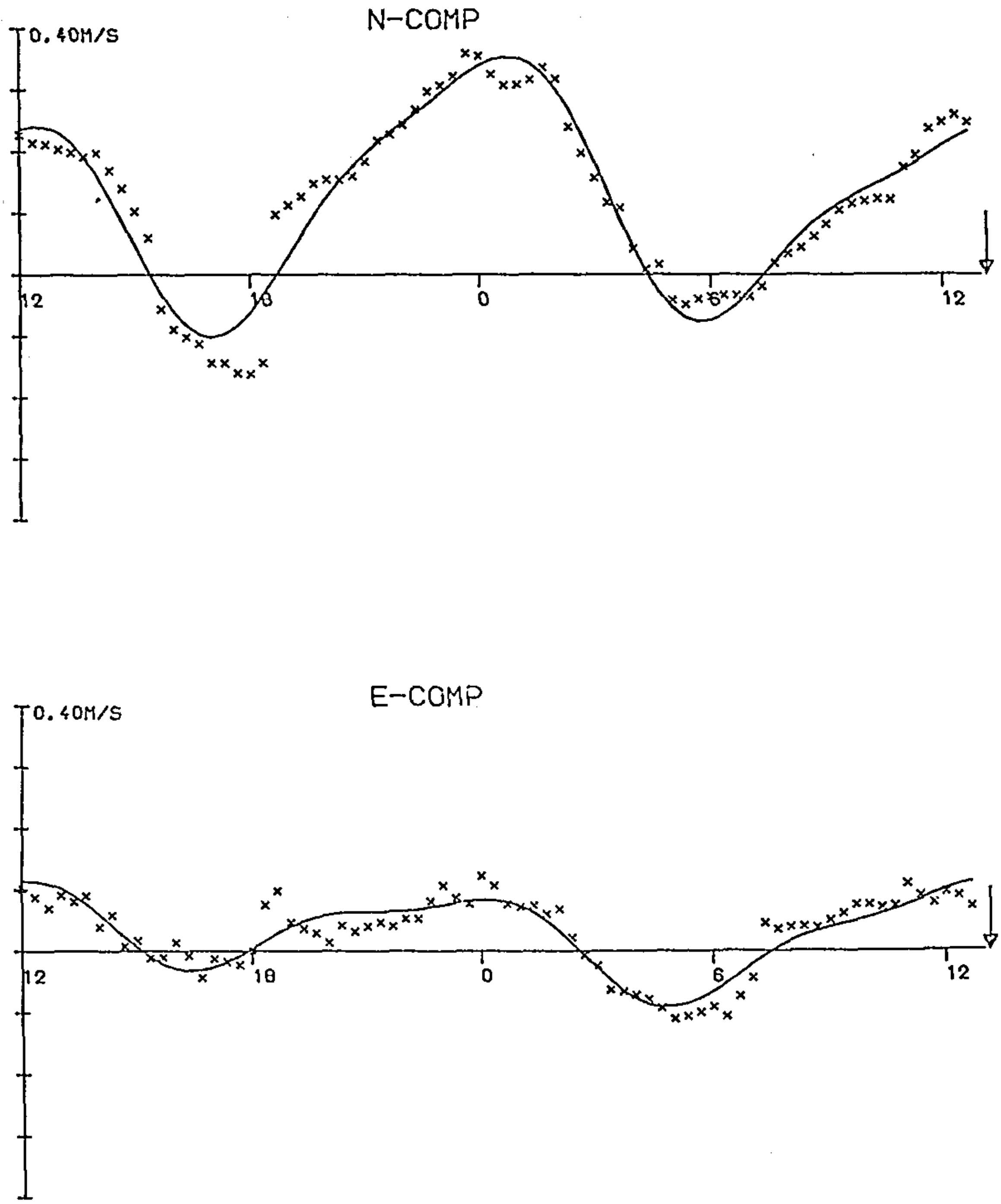


Figure 3.5-21(1) Velocity Curve from 25 Hours Harmonic Analysis
x ----- Observed Value

SEMATAN

— 5.0M 1977 9/6 - 9/7

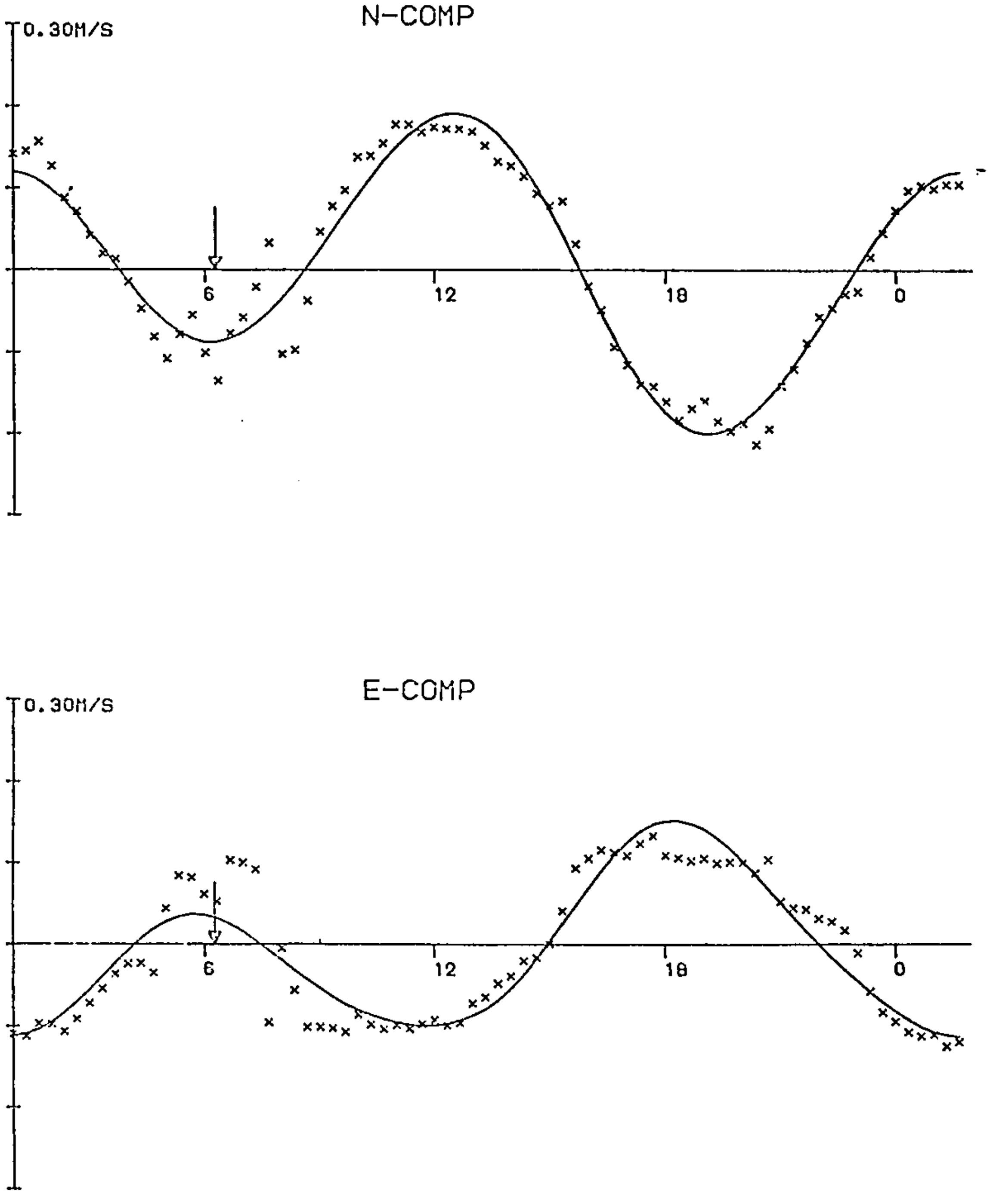
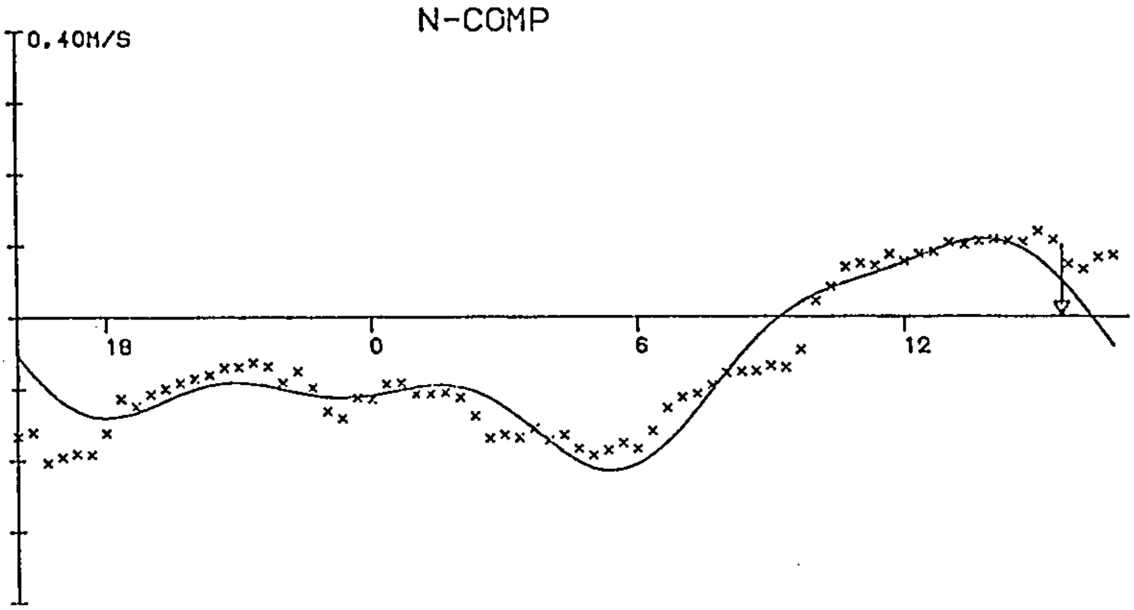


Figure 3.5-21(2) Velocity Curve from 25 Hour Harmonic Analysis
x ----- Observed Value

MALAYSIA

West of Natuna Island
ST; 1 -5.0M 1977 9/16 - 9/17



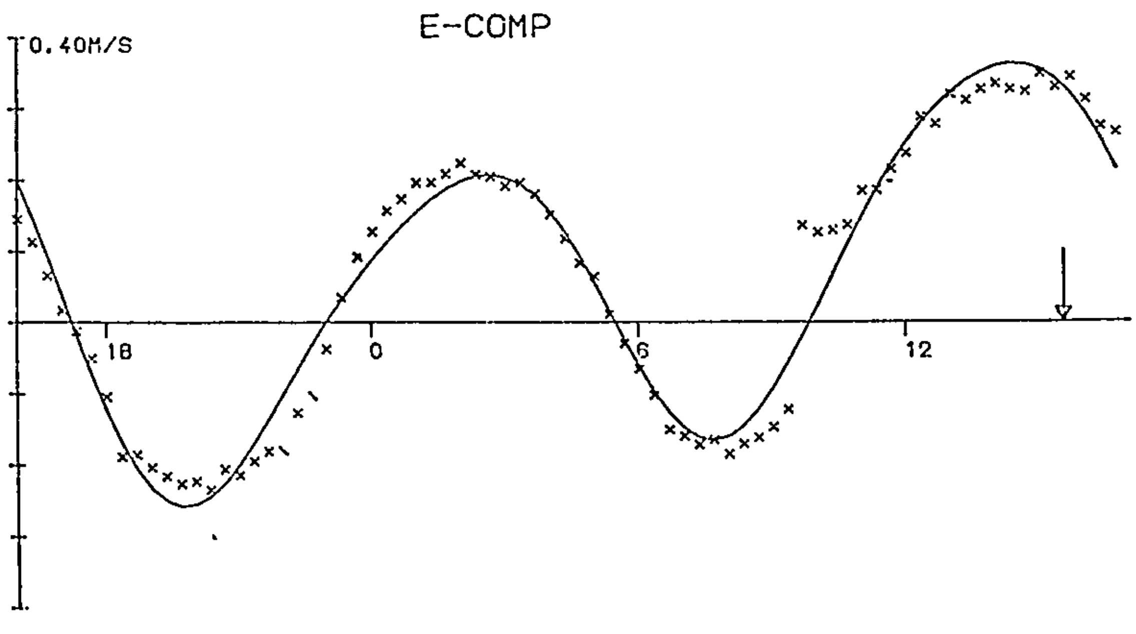


Figure 3.5-21(3) Velocity Curve from 25 Hours Harmonic Analysis
x ----- Observed Value

MALAYSIA

South of Natuna Island

ST; 2 — 5.0M 1977 9/17 - 9/18

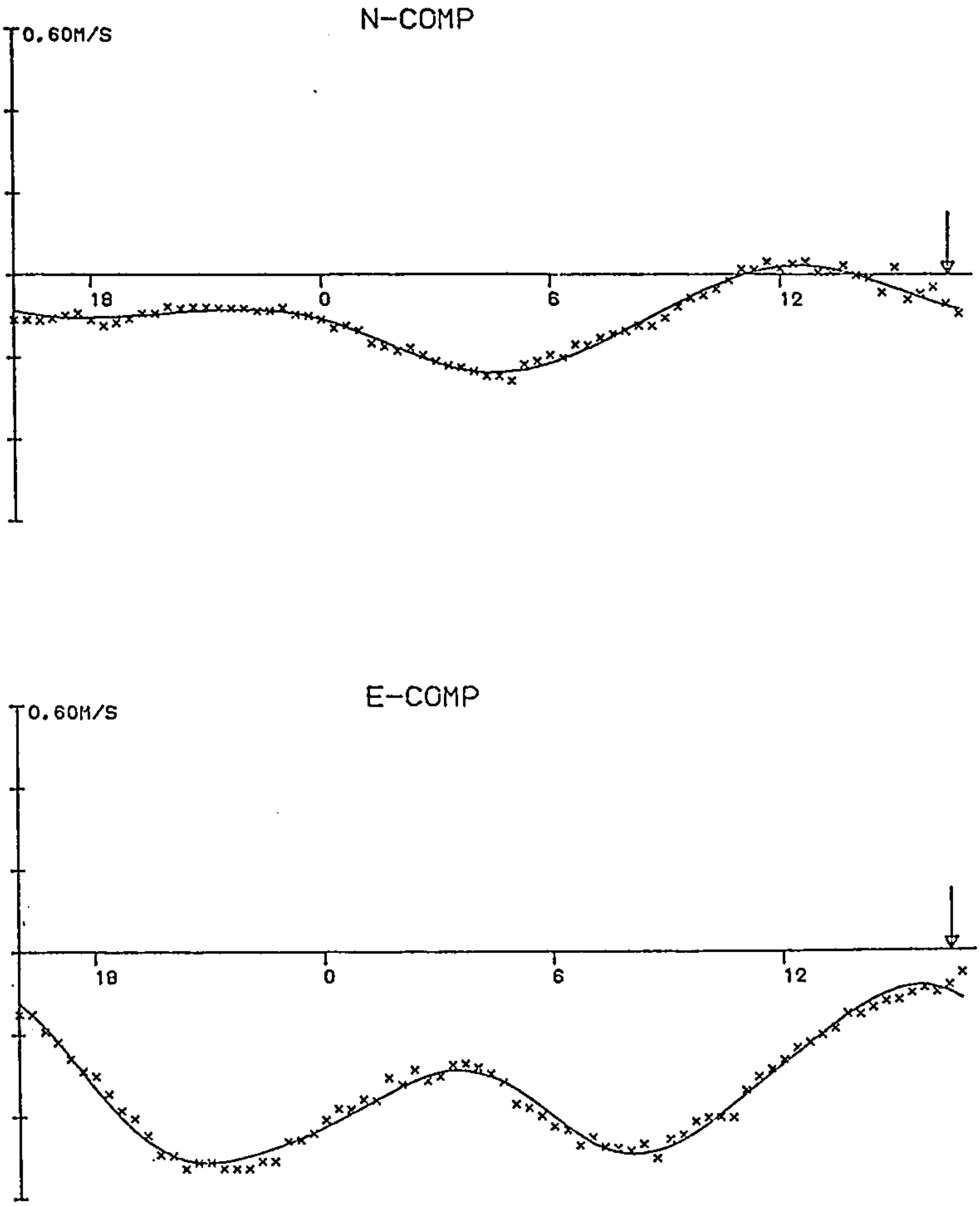


Figure 3.5-21(4) Velocity Curve from 25 Hours Harmonic Analysis
x ----- Observed Value

CHERATING

-5.0M 1977 9/13 - 9/14

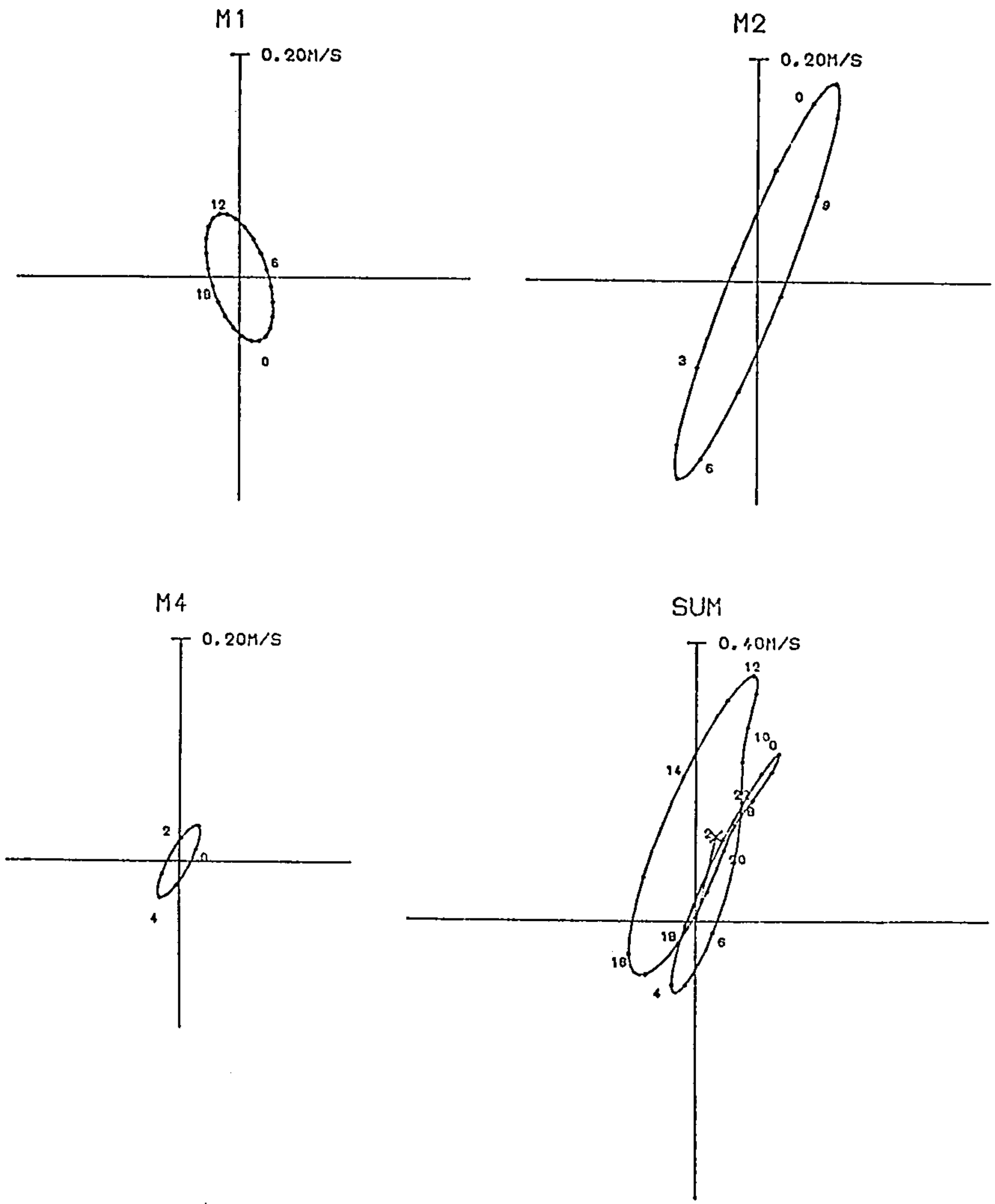


Figure 3.5-22(1) Current Ellipses

SEMATAN

— 5.0M 1977 9/6 - 9/7

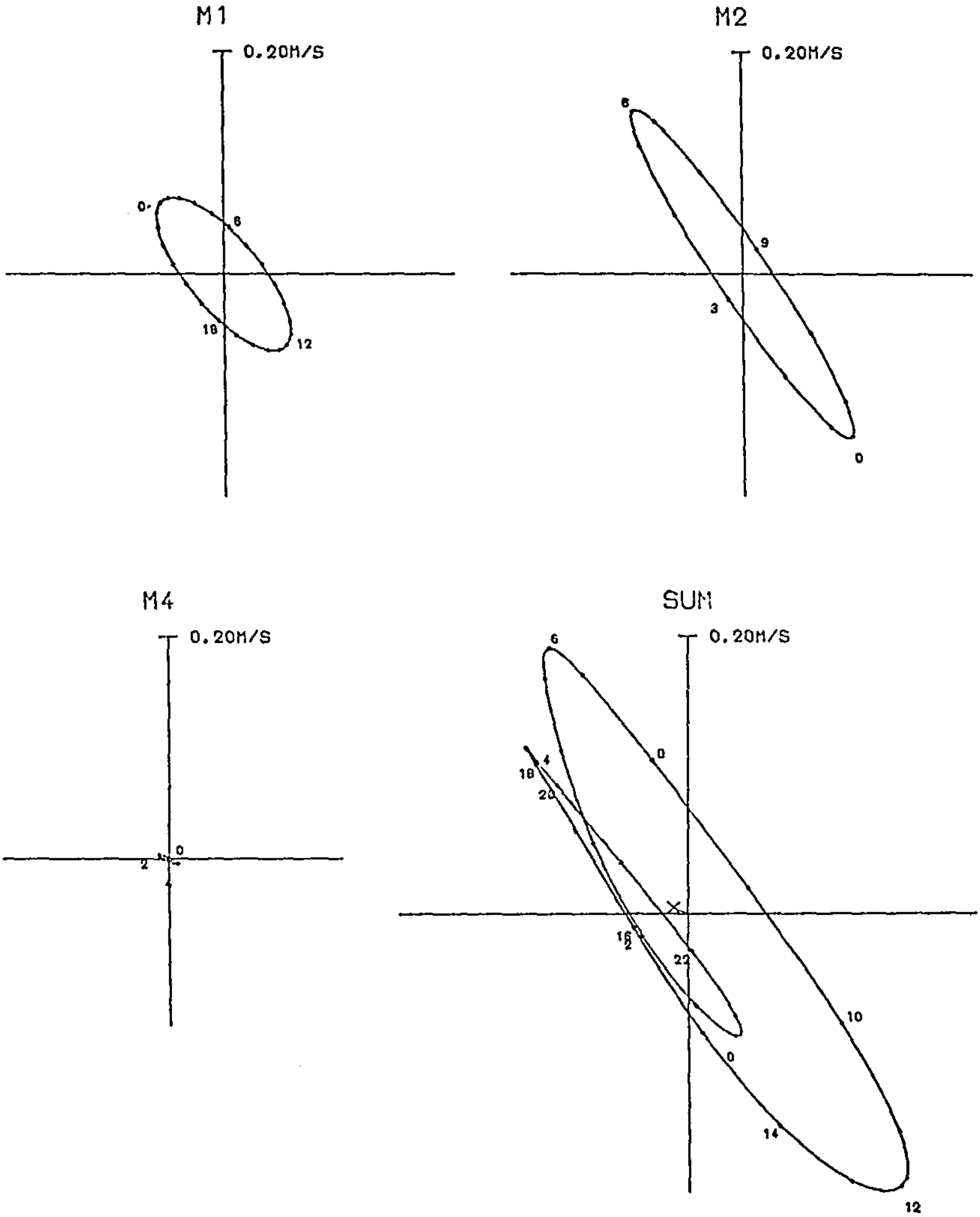


Figure 3.5-22(2) Current Ellipses

MALAYSIA

West of Natuna Island

ST; 1 -5.0M 1977 9/16 - 9/17

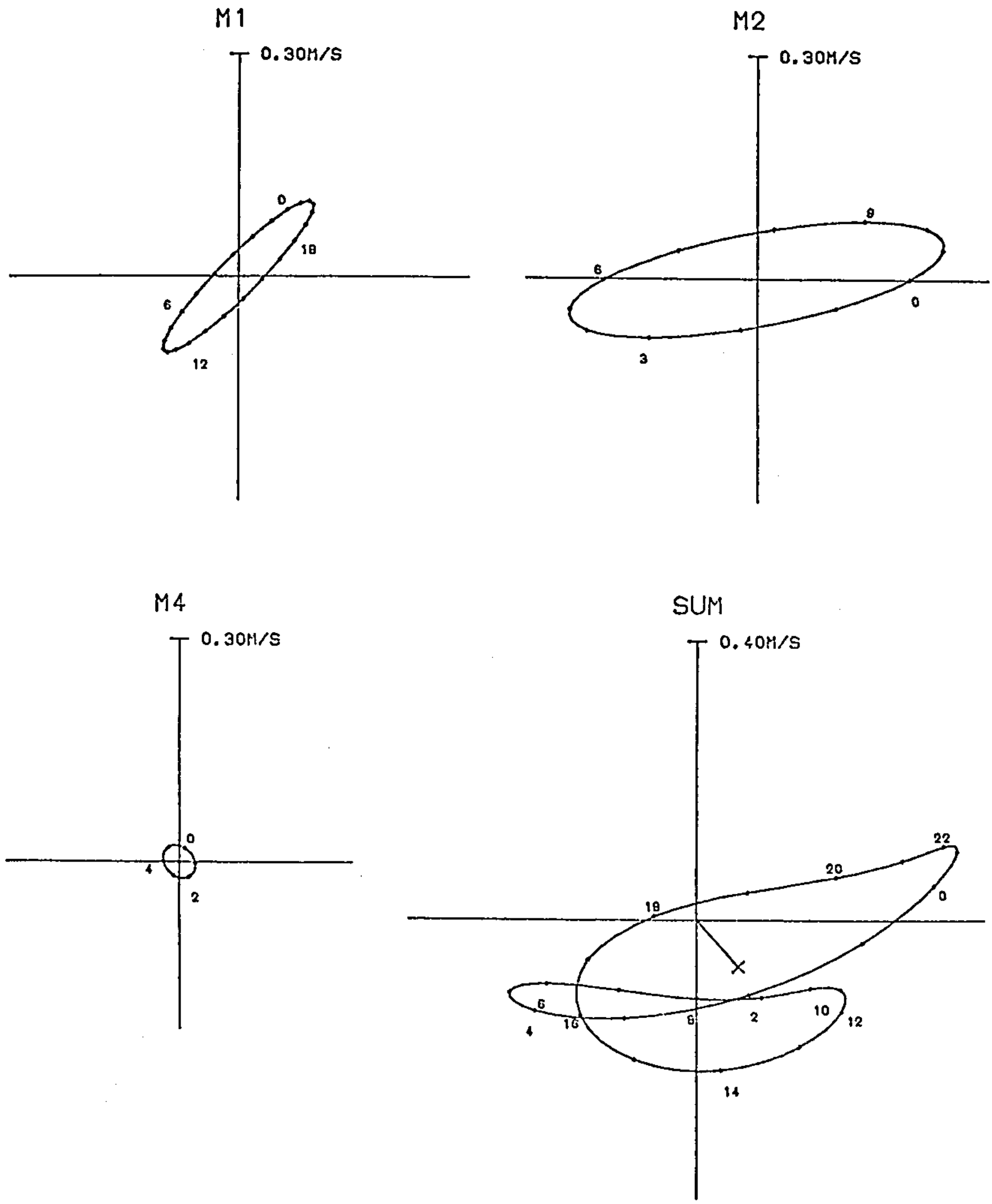


Figure 3.5-22(3) Current Ellipses

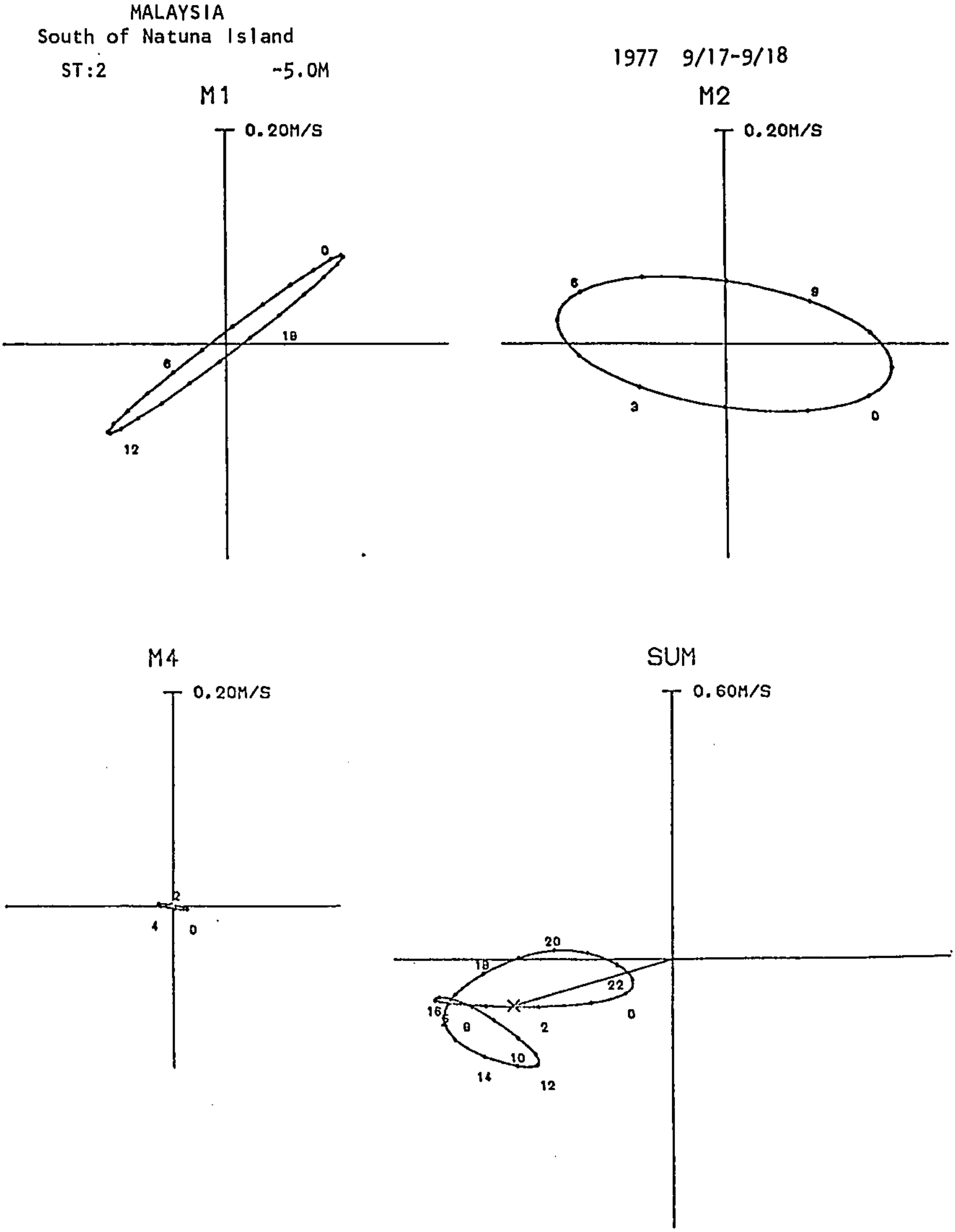


Figure 3.5-22(4) Current Ellipses

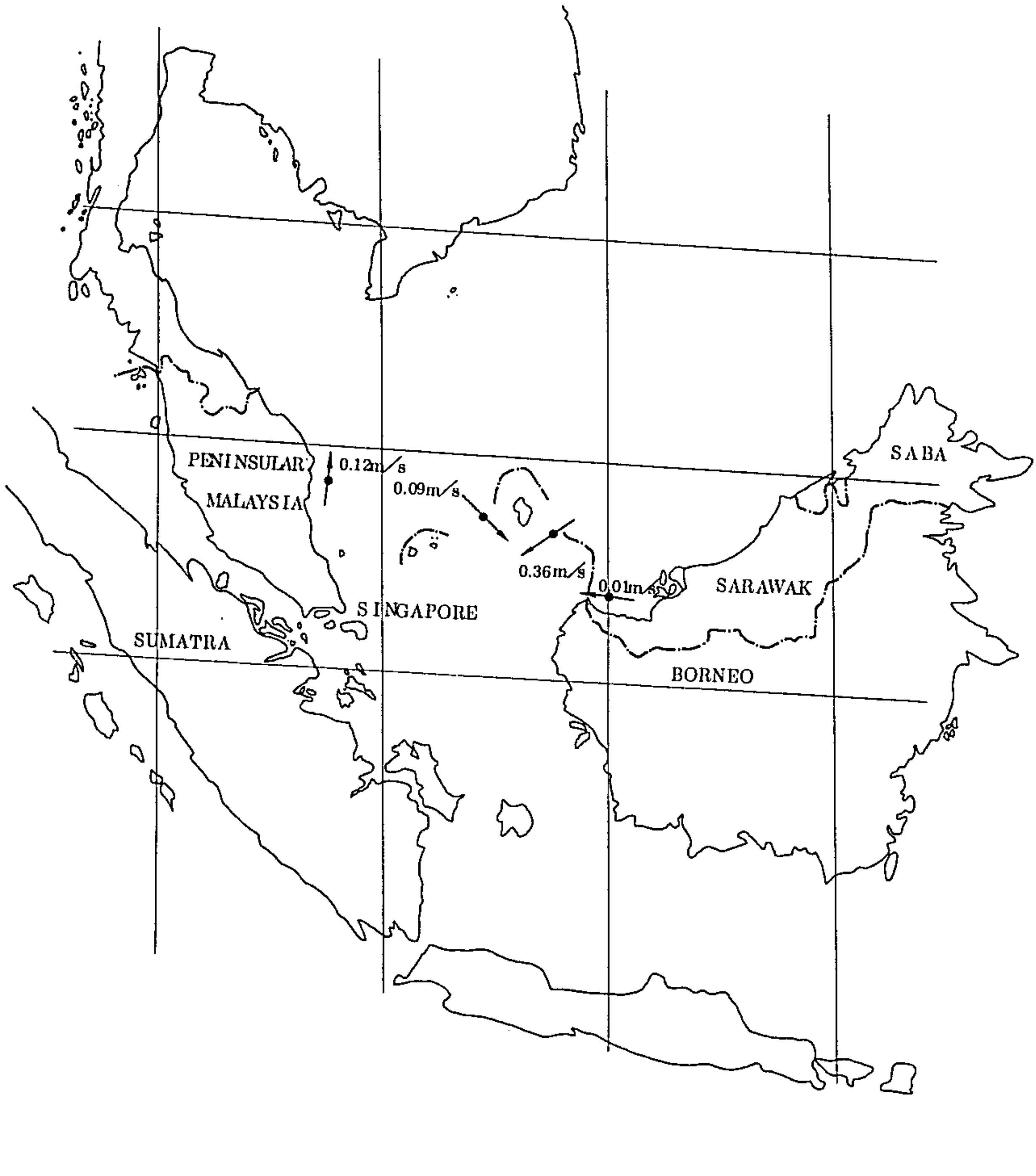


Figure 3.5-23   25 Hours Mean Currents

3.5.7 Landing Sites

The results of survey in the land portion at Cherating and Sematan are shown in Figures 3.5-24 and -25.

Both land portions are very flat and have soils which can be easily excavated. The ground level is about 5.5 meters (or 18 feet) higher than the mean water level at Cherating and 6 to 7 meters (or 20 to 23 feet) at Sematan.

The route directions relative to unmovable targets from the landing point are shown in Figures 3.5-26 and -27.

Figure 3. 5—24 LAND CABLE ROUTE CHERATING

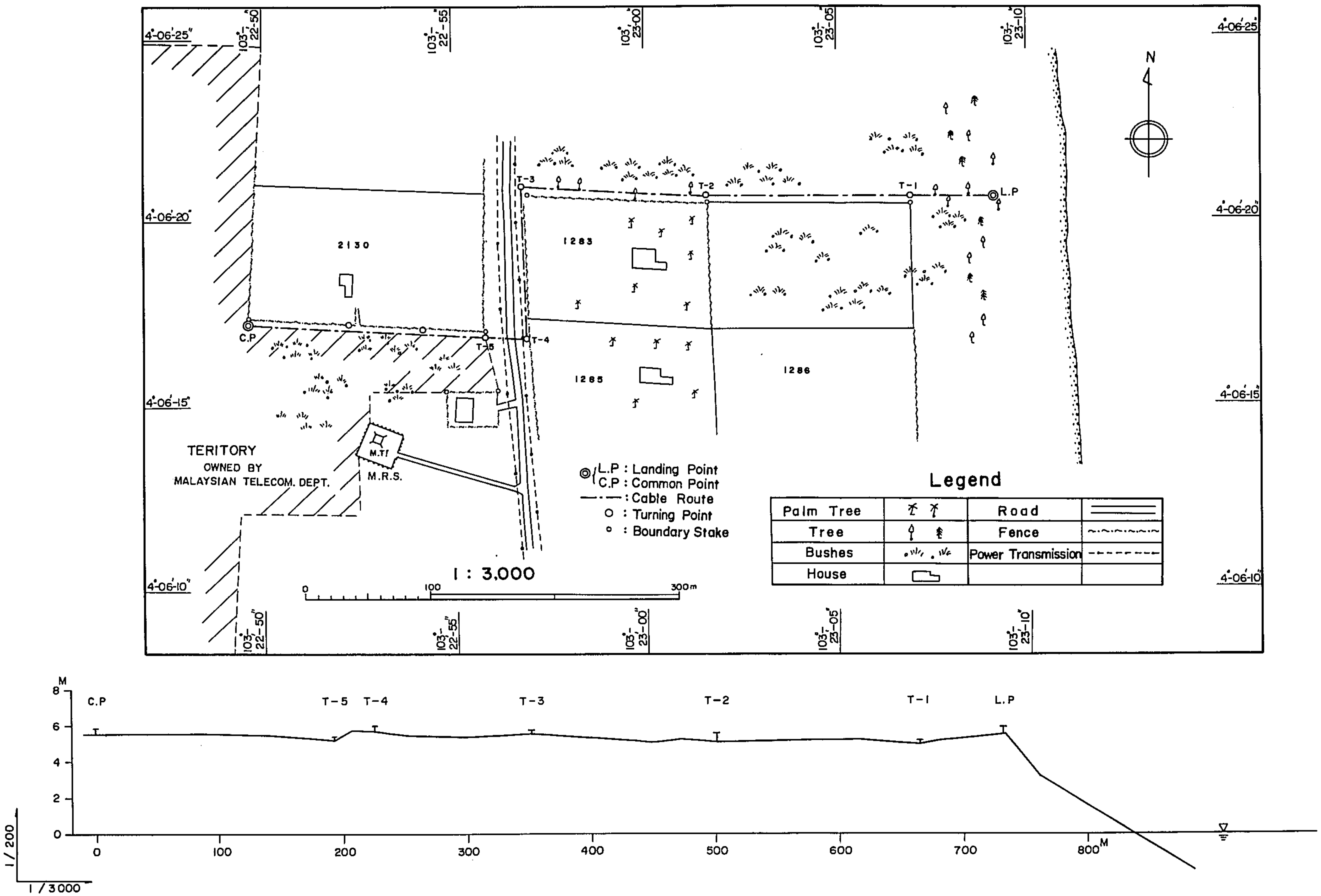
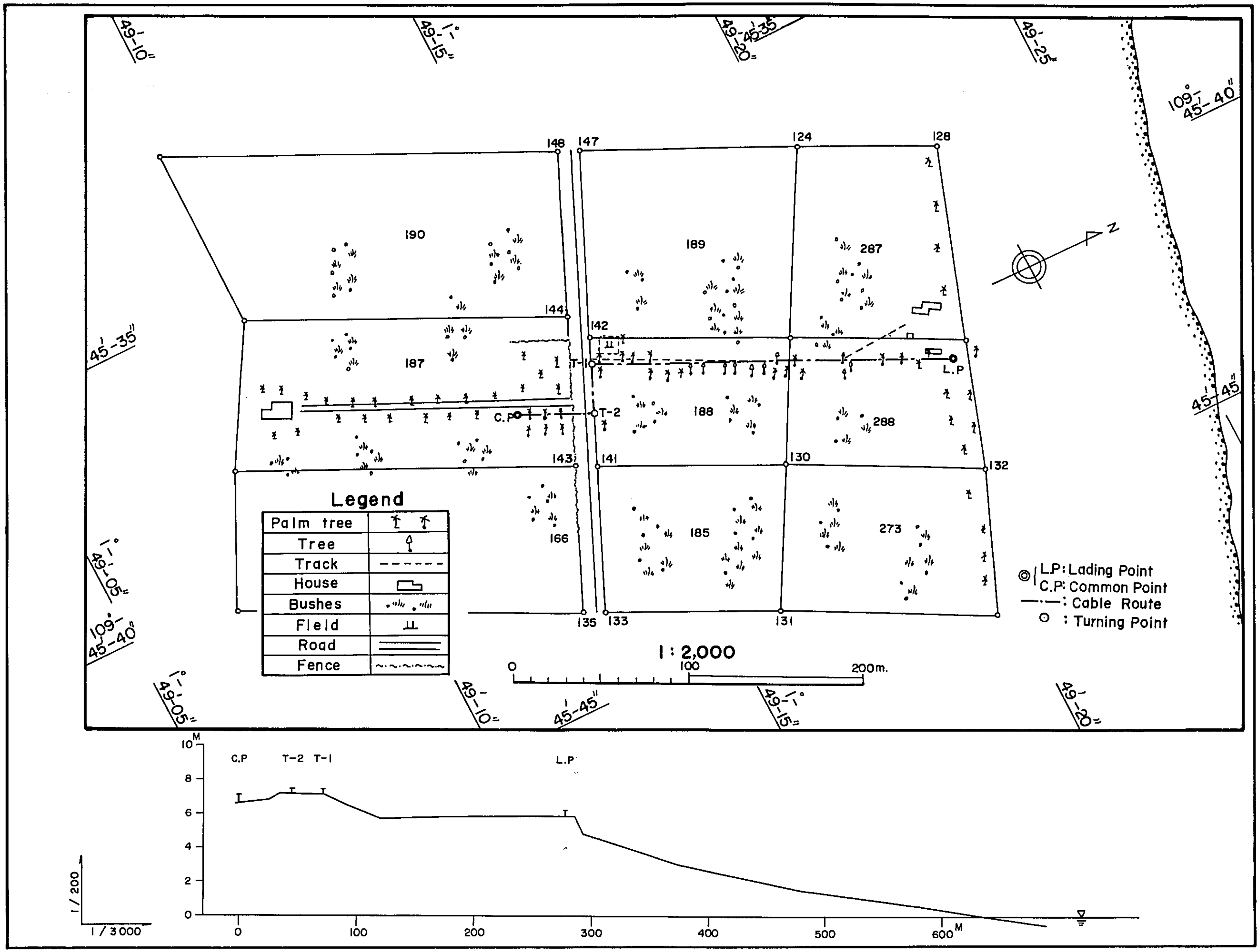


Figure 3. 5—25 LAND CABLE ROUTE SEMATAN



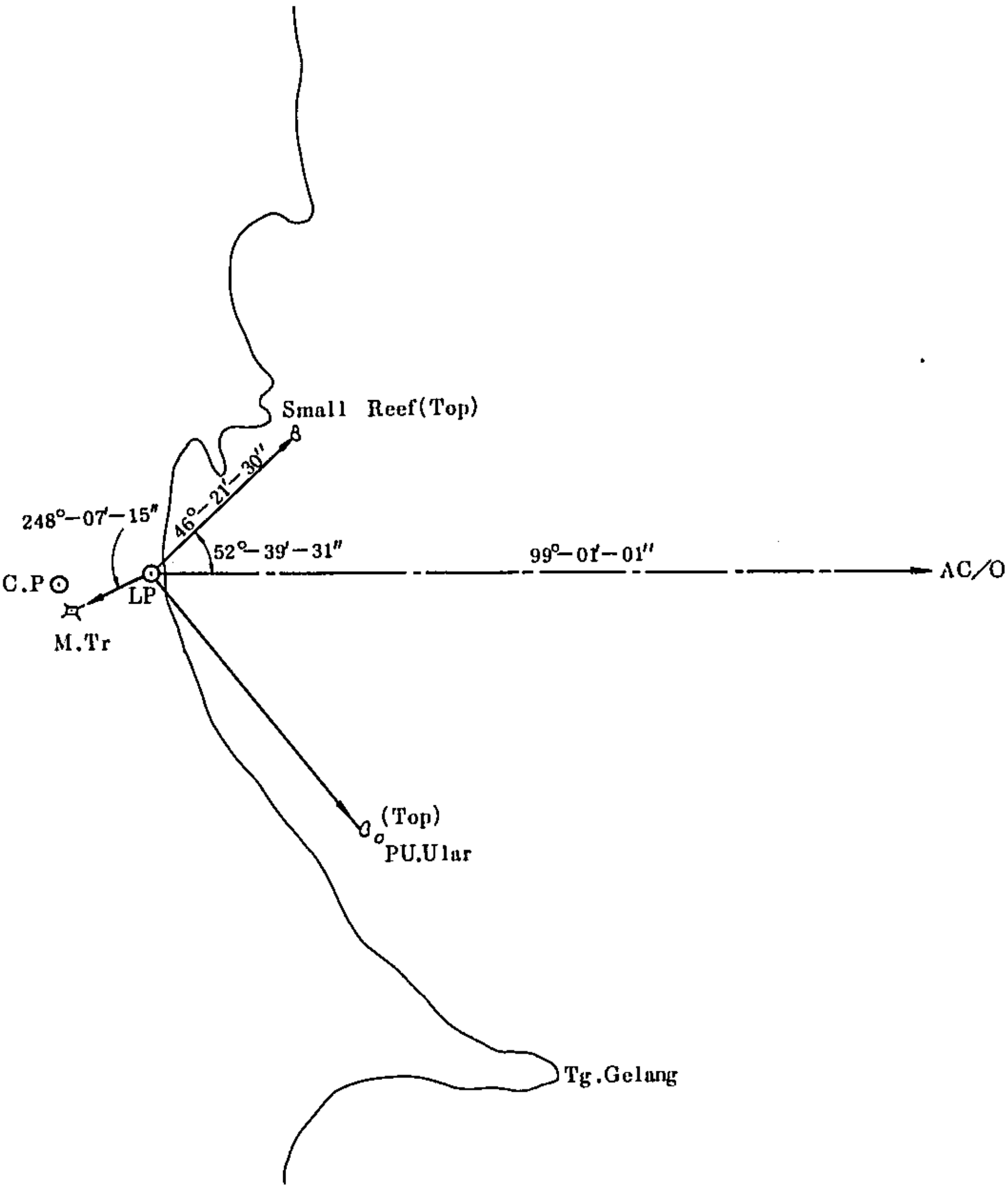


Figure 3.5-26 Bearings of Cable Route in Cherating

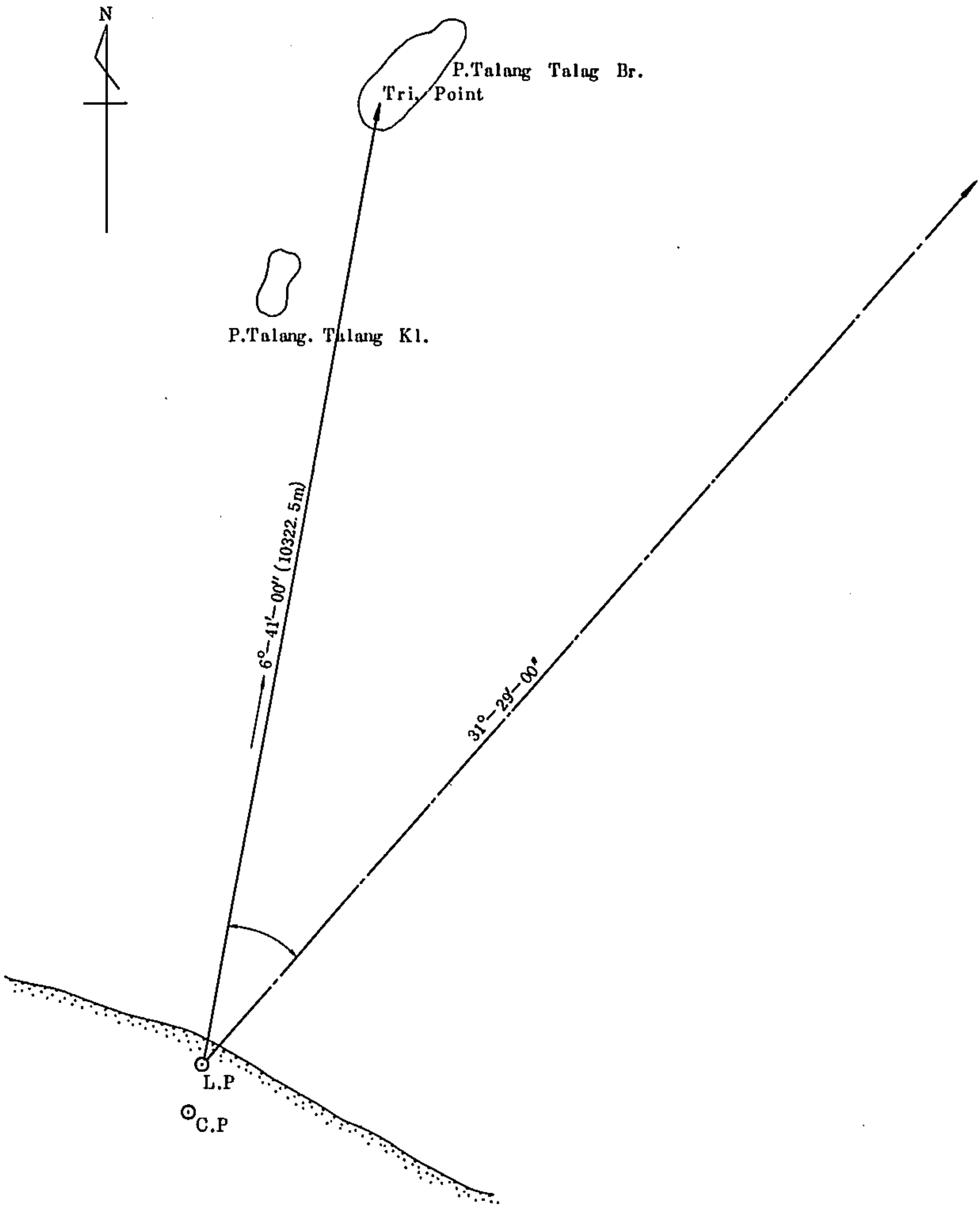


Figure 3.5-27 Bearing of Cable Route in Semata

3.6 DISCUSSION AND CONCLUSION

3.6.1 Geological Aspects

The survey area lies in the northern part of Sunda Shelf. The shelf is said to to be the largest peneplain on the earth which was submerged in the latter period of the Quaternary Pleistocene. The sea bottom enclosed by Indochina Penisula, Malay Peninsula and Borneo Island are divided into four areas of Gulf of Thailand Basin, Natuna Ridge, Brunei Basin and Singapore platform according to bottom topography and geological structure. ("Stractural Framework of Sunda Shelf" - by Zbi Ben-Anraham and K.O. Emery). The thickness of the bottom sediment is mostly 0.5 to 2.0 kilometers in those areas. As the subbottom sounding in the route survey was made with the object of investigation of subbottom structure near the bottom surface, a part of bed rock was observed only on Natuna Ridge.

According to "Marine Geology" (1950) by H. Kuenen, there are many sea valleys on Sunda Shelf and their connections to estuaries of existing rivers on land show that they are remains of reviers which were made in the time of the glacial period when the sea level was lower than that of at present. The main rias called "Sunda River" extends northerly on the bottom between Malay Peninsula and Borneo.

It passes between Natuna Island and Subi Besar where depressions of the sea bottom were observed by sounding in the route survey.

3.6.2 Proposed Cable Laying Route and Required Cable Length

From the result of the route survey, the main survey track can be proposed as a suitable route for laying the Kuantan-Kuching submarine cable system. The proposed route is given in Table 3.6-1 with the positions of course alteration points from the cable terminal site in Cherating through to that in Sematan. It is shown also in Figure 3.6-1.

The route distance amounts to 461.83 nautical miles (or 855.31 km) including land portions at Cherating and Sematan.

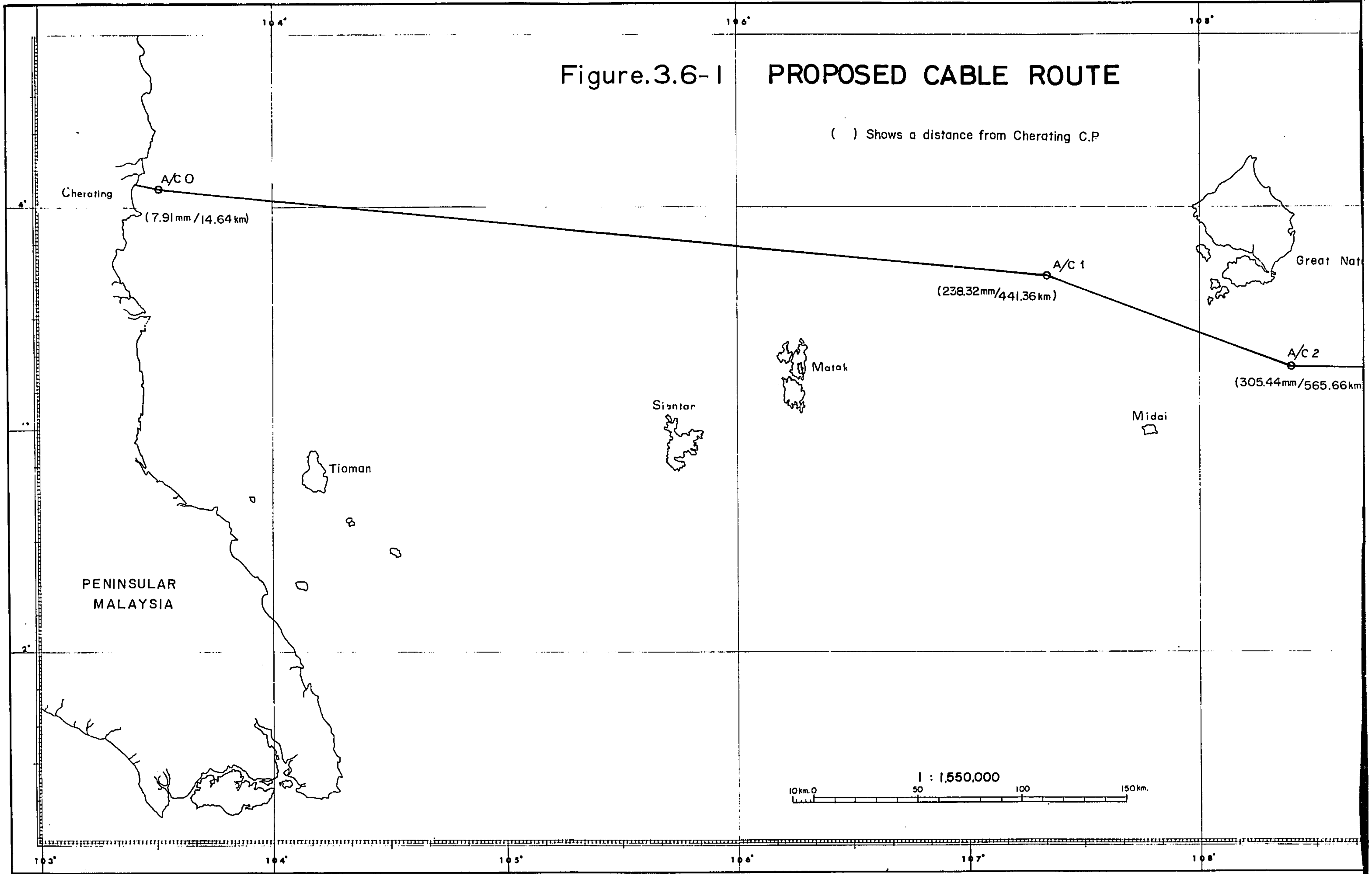
In view of the sea bed profile along the main survey track and the bottom sediment on it, 466.5 nautical miles, by adding 1% to the route distance, would be enough as a cable length required for the proposed route.

Table 3.6-1 CABLE ROUTE LENGTH

		POSITION		DISTANCE		REMARKS
				K.M.	N.M.	
Cherating	C.P.	4°-06.29'	103°-22.83'	0.73	0.40	
"	L.P.	4°-0.34'	103°-23.15'	13.91	7.51	
	A/C 0	4°-05.16'	103°-30.58'	426.72	230.41	
	A/C 1	3°-42.25'	107°-20.00'	124.30	67.12	
	A/C 2	3°-17.00'	108°-22.25'	83.81	45.25	
	A/C 3	3°-16.50'	109°-07.50'	84.55	45.65	
	A/C 4	2°-53.00'	109°-46.70'	98.16	53.00	
	A/C 5	2°-00.00'	109°-52.00'	22.85	12.34	
Sematan	L.P.	1°-49.35'	109°-45.70'	0.28	0.15	
	C.P.	1°-49.21'	109°-45.65'			
TOTAL				855.31	461.83	

(1 n.m. = 1.852 Km)

Figure.3.6-1 PROPOSED CABLE ROUTE



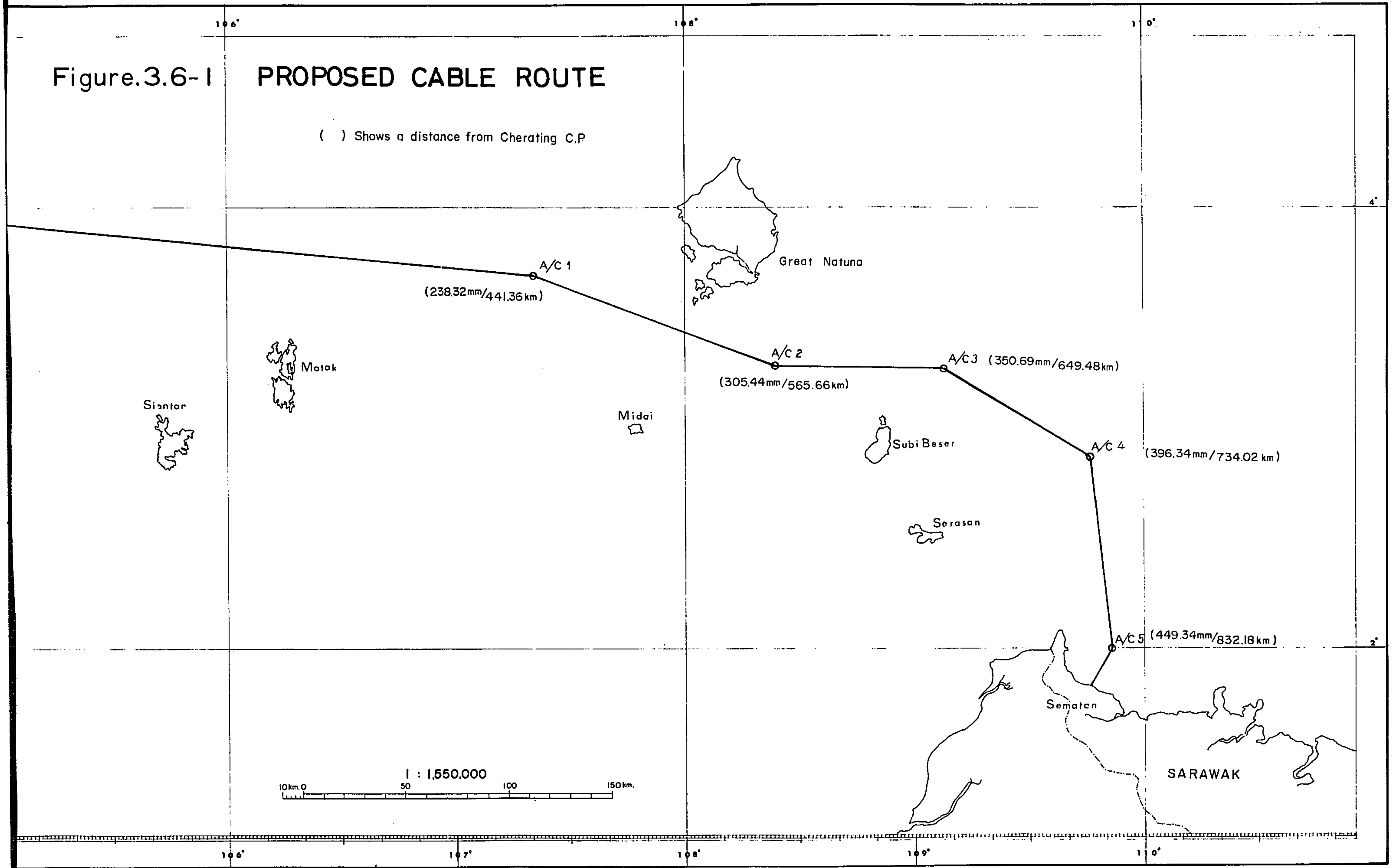


Figure. 3.6-1 PROPOSED CABLE ROUTE
( ) Shows a distance from Cherating C.P
106°
108°
110°
4°
2°
107°
109°
Great Natuna
A/C 1
(238.32mm/441.36km)
Matak
Siantar
Midai
A/C 2
(305.44mm/565.66km)
A/C 3 (350.69mm/649.48km)
Subi Beser
A/C 4
(396.34mm/734.02km)
Serasan
A/C 5 (449.34mm/832.18km)
Sematan
SARAWAK
1 : 1,550,000
10km. 0
50
100
150km.

3.6.3 Estimated Bottom Temperature Variation

Bottom temperature variation was estimated by analizing the temperature data in the relevant area which were compiled at Japan Oceanographic Data Center from temperatures observed so far. The range of water temperature variation corresponding to the sea depth is shown in Figure 3.6-2 together with temperatures observed in the route survey.

The sea current which flows diversely corresponding to the seasonal wind (refer to "Currents in the South China, Java, Celebes and Sulu Seas" (1945) Published by the Hydrographic Office, United States Navy) dominates the temperature variation in the cable route area.

Some times bottoms in the same depth at different places on the route may have different temperatures, but the estimated range of temperature variation may be applied to all over the route.

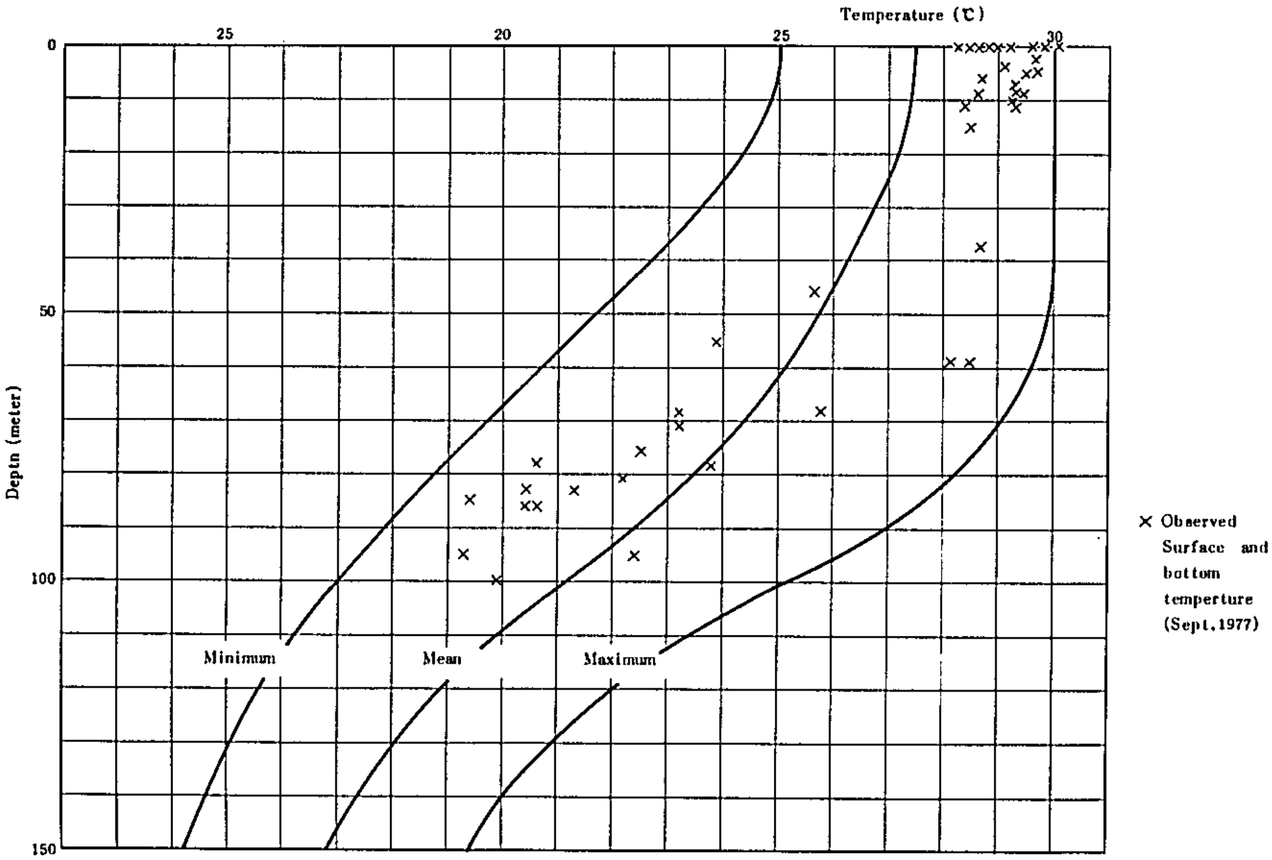


Figure 3.6-2 Temperature Variation on Kuantan-Kuching Cable Route

3.6.4 Seasonal Current

Monthly current in the South China Sea is shown in "Currents in the South China, Java, Celebes and Sulu Seas" (1945) published by the Hydrographic Office U.S. Navy. (H.O. No.236)

The current is principally affected by the monsoons and transitional winds in the area.

According to the paper (H.O. PUB. No.236), current flows from South China Sea into Java Sea with a speed of 0.5 - 1.5 knots off Cherating and 0.4 - 1.2 knots off Sematan in January to March.

In April, current flows counter-clock wise in the south part of the South China Sea with southerly current of 0.48 - 0.8 knots off Cherating and westerly current of 0.2 - 0.5 knots in the inter-islands area and off Sematan. From May to August, current flows from Java Sea into the South China Sea in a speed 0.4 - 1.5 knots off Cherating and 0.2 - 1.0 knots off Sematan. In September, current flows clock-wise with a center of circulation at inter-islands area. Northerly current of 0.5 - 1.5 appears off Cherating and easterly current of 0.4 - 0.6 off Sematan.

From October to November, current flows clock-wise with a circulation center in the north of Borneo.

Southerly current of 0.4 - 0.8 knots flows off Cherating easterly current of 0.2 - 0.4 in the inter-island area and off Sematan.
In December, stronger southerly current of 0.5 - 1.5 knot becomes dominant between Cherating and Natuna Island and easterly current of 0.5 - 1.0 flows between Natuna and Sematan.

The mean current observed in the survey of September well matches to the above current descriptions.

From the tidal current data obtained in the survey and tidal level informations, tidal current hodographes in the four seasons are made. They are shown in Figures 3.6-3(1) through -3(4). This may be useful in estimating daily current changes in any season.

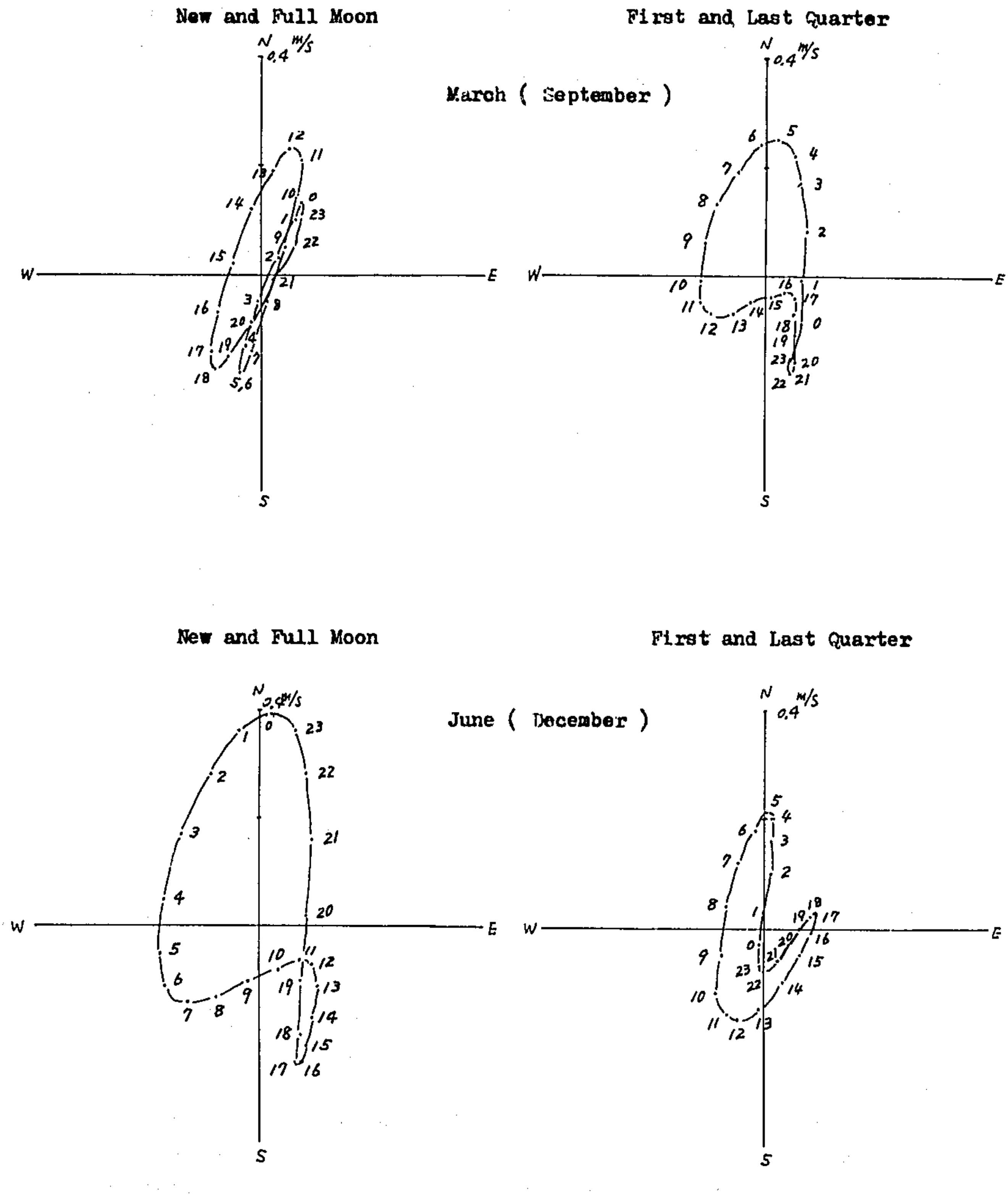


Figure 3.6-3(1) Tidal Current Hodographs in a year Cherating Shore

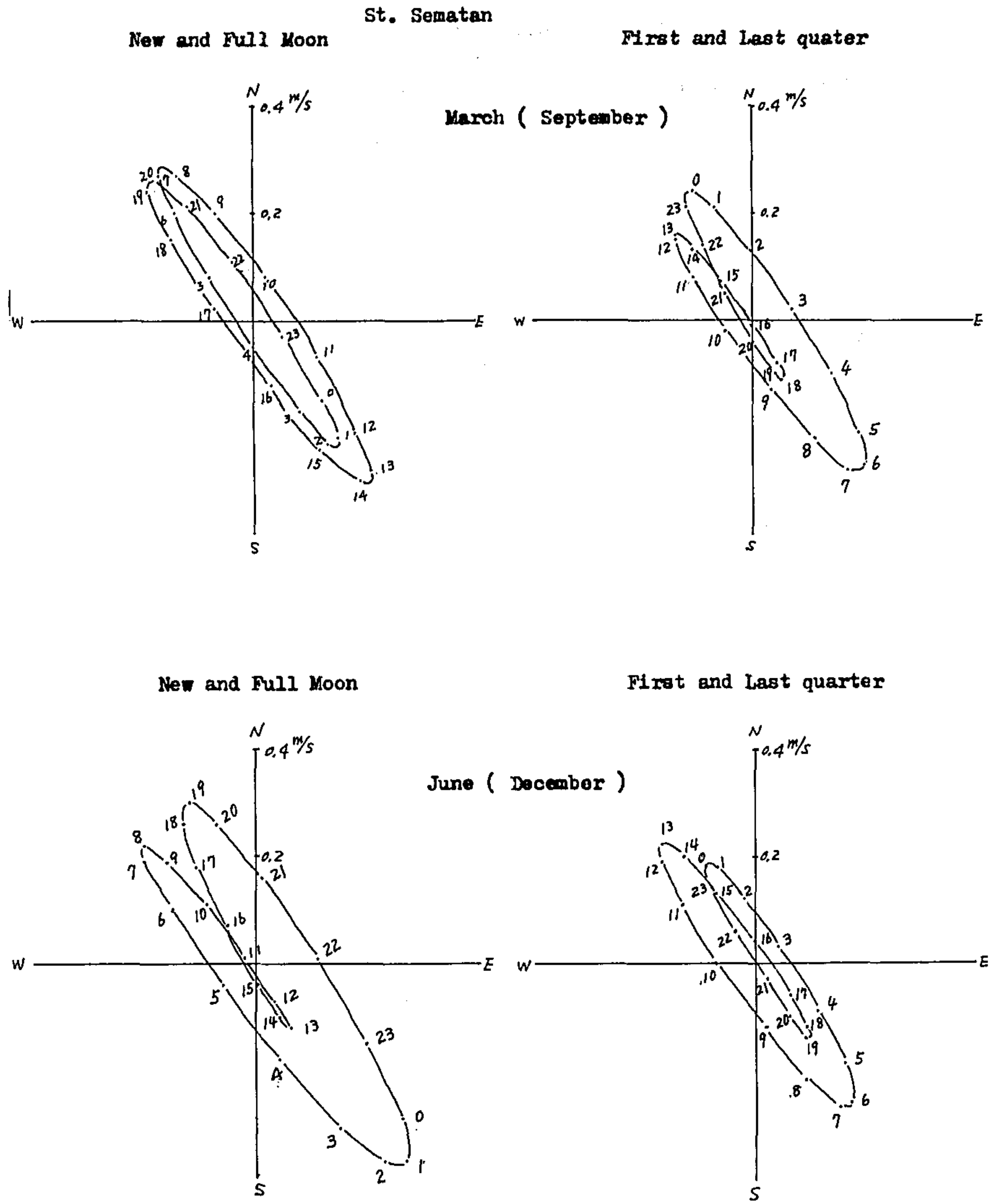


Figure 3.6-3(2) Tidal Current Hodographs in a year Sematan Shore

West of Natuna Island (St. 1)

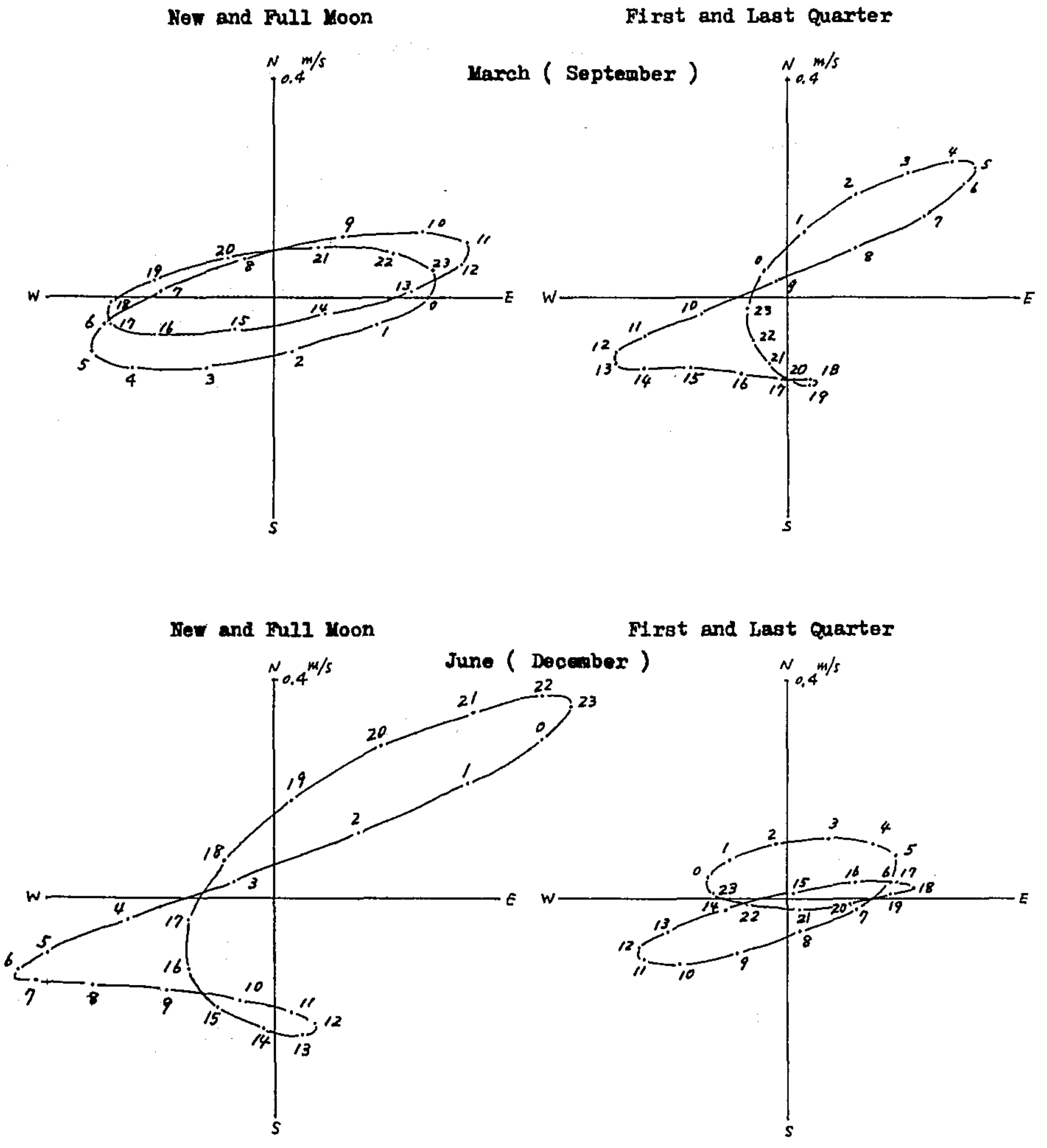


Figure 3.6-3(3) Tidal Current Hodographs in a year
West of Natuna Island (St. 1)

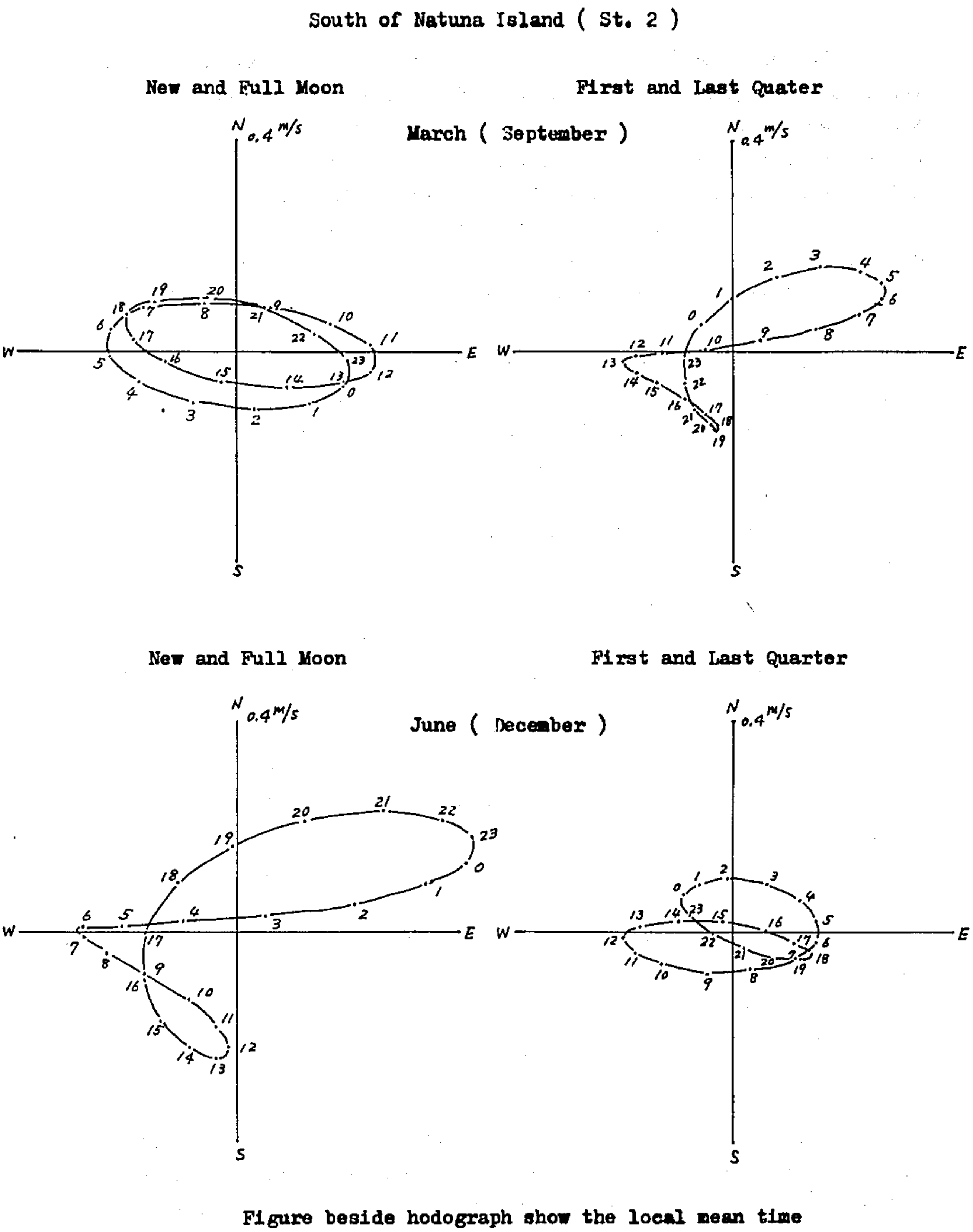


Figure 3.6-3(4) Tidal Current Hodographs in a year South of Natuna Island (St. 2)

3.6.5 Precautions against Cable Damage

The east coast of Peninsular Malaysia, the inter-islands area and the coast of Sarawak are known as good fishing grounds in the South China Sea (reter to 3.6.7). Trawling is made in these areas by using fishing crafts and instrument, becoming larger year by year. A trace on the bottom which seemed to have been caused by some fishing instrument, was observed in the survey area between Natuna Island and Subi Besar, where the sea depth was approximately 78 meters. Most of the submarine cable failures in the world have been caused by fishing activities as shown in Table 3.6-2.

In consideration of the sea depths and bottom conditions in the cable laying area, no places can be said to be free from cable damage due to fishing activities on the bottom. Some relevant precaution against possible cable damage should be taken over the whole cable route.

The armour wire applied to cable may be effective for the protection of cable to some extent, but sometimes even armoured cable were broken by fishing instrument dragged on the bottom surface. Armoures cable in the South China Sea have reportedly been damaged twice by trawling in the waters, of 93 and 26 meters (or 51 and 14 fathoms) in depth, off Hong Kong in 1966 and 1975.

Another precaution against cable damage can be achieved by burying cable under the sea bottom. This method proved by actual performances in the world to be much more successful in protecting cable. Examples of buried submarine telephone cable are shown in Table 3.6-3.

In view of the bottom conditions on the selected route which enable easy plowing of the bottom, burying cable under the sea bottom is recommended as an adequate precaution against possible cable damage for the purpose of maintaining the reliability of telecommunication service through a high capacity cable.

The proposed cable route crosses SEACOM (Singapore - Kota Kinabalu cable) around 3° - 48.50' N/ 106° - 11.30'E and the planned Singapore - Philippine cable around 3° - 50.8' N/ 105° - 47.2' E. Cable buring cannot be applied in the portion covering five or six nautical miles on the route with the cross point in the middle point of it.

Armoured cable should be prepared for such cable crossing areas.

3.6.6 Some Requirements for Cable Laying

From the survey results, some requirements are suggested here for cable laying on the selected route including the land portion.

(1) A shore approaching limit of a cable ship is normally 10 meters in depth of water. The distance from the beach to 10 meter contour is 4.5 nautical miles at Cerating and 8.3 nautical miles at Sematan. Therefore some flat bottom ship may be needed for landing and laying submarine cable in Cherating and Sematan shores.

(2) In case the cable is to be buried, final splice should be made at a place where the sea depth is less than 30 meters and the laid cable may be easily jetted into the bottom by divers.

(3) Beach splice should be made at a place about one hundred meters inlandward from the landing point.

(4) Cable should be buried more than 1.5 meters below the ground surface in the land portion and more than 2.0 meters at the beach.

(5) At the road crossing of the land route, cable should be protected by an iron pipe fixed in concrete.

TABLE 3.6-2 ANALIZED SUBMARINE CABLE FAILURES IN THE PERIOD OF SEPTEMBER 1953 TO NOVEMBER 1964

From "Analizing Failures of Ocean Communication Cables" by A.J. MUNITZ, BTS Technical Pub. 5203

	Cause of Fa-lure	Percentage of Total (252 cases)
1.	Trawlers and ships' anchors	44.0 %
2.	Biological & chemical damage	4.0 %
3.	Corrosion and chafe damage	27.0 %
4.	Earthquake related damage	1.6 %
5.	Iceberg damage	1.6 %
6.	Undamaged cable from re-routing and preventative maintenance	8.3 %
7.	Miscellaneous failures (Tension, twist, crush, electrical faults etc)	13.5 %
		100.0 %

TABLE 3.6-3 BURIED SUBMARINE CABLE IN THE WORLD

From IEEE transactions Communication Technology
vol. COM-19, No.6 Dec. 1971/
Electrical communications vol.49, No.4 1974/
Bell laboratory Record Sep. 1976/
ITU Telecommunication Journal Jul. 1977

System Designation	Time	Buried Distance (in Km)	Sea Depth (in meters)
TAT - 4	Jul. 1967	68	54 - 152
TAT - 3	Jul. 1967	88	42 - 134
SF - Florida	Apr.-May. 1968	68	16 - 40
TAT - 5	Jul. 1969	164	18 - 540
TAT - 5	Aug. 1969	53	22 - 558
MAT - 1 (Spain)	Aug. 1969	20	40 - 600
MAT - 1 (Italy)	Sep. 1969	28	16 - 600
CANTAT - 2 (Canada)	Nov. 1973	222	up to 550
CANTAT - 2 (U.K.)	Apr. 1973	unknown	up to 550
TAT - 6 (Rhode Island)	Aug. 1975	176	up to 180
TAT - 6 (France	Oct. 1975	176	up to 180
Japan - China	Apr.-Jul. 1976	680	up to 200

3.6.7 Fishing Activities

Main fishing ports are at Kuala Besut, Chendering, Kuantan and Kuala Sedili along the east coast of Peninsular Malaysia, at Kuching, Bintulu and Mili in Sarawak, and at Kudat, Kota Kinabalu, Sandakan and Tuwau in Sabah. The number of fishing vessels amounts to 6,800 in the east coast of Peninsular Malaysia and 9,440 in Sabah/Sarawak. They are mostly of the type with 10 - 30 HP inboard engines and the largest ones are of 100 - 120 HP.

Trawling by using otter board, purse seining, drift-netting are carried out coastwise within 30 nautical miles off-shore. Trap fishing is made also around Natuna Island by fishermen from Kamaman.
Trawling by larger vessels from foreign countries is made outside 30 nautical miles off-shore and Malaysian trawling area is planned to be expanded beyond 30 nautical miles off-shore with the increased number of larger fishing vessels.

4 SYSTEM DESIGN

4. SYSTEM DESIGN

4.1 Requirements

4.1.1 General

The Kuantan-Kuching Submarine Cable System will be completed by purchasing the submarine cable system and constructing the terminal stations at which the cable system will be terminated and extended to the back haul systems.

The general requirements for the submarine cable system is summarized, at first, in this section taking into account the results of the ocean survey stated in section 3. Then the technical specification of the submarine cable system is related which could satisfy the requirements and with which Malaysian Government could request for tenderers proposal.

Lastly the basic requirements for the cable terminal stations are recommended as the reference for Malaysian Government to design them.

4.1.2 General Requirement and Technical Specification

Taking into account the result of the ocean survey the general requirement for the cable system is summarized as follows:

(1) The capacity shall be not less than 1,200 voice grade circuits (4 kHz).

(2) Completion of the system construction shall be by the end of 1979.

(3) The system performance shall be compatible with CCITT Standards for international telephone circuits.

(4) The terminal stations should be built in sites of Cherating and of Sematan. These were proposed by (Malasian) Telecommunication Department and proved to be suitable by the survey results.

(5) The route length will be 855.3 km (461.8 nm).

(6) The necessary cable slack will be 1%, therefore the cable length will be about 864 km (466.5 nm).

(7) The cable system shall be protected from fishing trawlers.

(8) The cable system shall maintain transmission quality under large seasonal and daily changes of bottom temperature up to $\pm$ 4.4 degrees in centigrade.

Based upon these requirements, the technical specification is engineered as shown in Appendix 2 which could be used for procurement for the submarine cable system.

The technical specification is intended to cover the whole submarine cable system between the interface points S and S' as defined in CCITT Recommendation G 371, and to includes such works as laying submarine cable, installation of terminal equipment, training of maintenance officers, etc., but excludes such civil works as ducting and laying cable between shore and landing station.

Such items as the condition of buildings, back haul systems, primary power for all equipment in the terminal stations are not specified in the technical specification. They would better be decided by Malaysian authorities concerned taking into account those basic requirements stated in Sub-section 4.1.3.

4.1.3 Basic Requirements for Cable Landing Stations

Considering the results of the cable route survey, usual performance of terminal equipments, general way of maintenance, etc., following requirements will be recommended for both cable landing stations only from the stand point of submarine cable system construction.

(1) Rooms Required: They should have terminal equipment room, power room, engine room, store, office rooms (station manager's room, etc.), toilet, shower room, kitchen, air-conditioning equipment room, etc.
Existing examples of floor arrangement in a cable landing station are shown in Fig. 4-1and 4-2.

(2) Floor Height: Floors of their rooms except engine room should be enough high above the ground to prevent influence of flood.
A limited space for engine room, considering the heaviness of engines and the vibration and noise, would be preferably allocated on the ground with water tight construction.

(3) Air Conditioning: With the air conditioning equipment operating normally, the temperature and humidity should be restricted to 24 ± 2°C, 55 ± 10% respectively.

(4) Capacity of Primary Power: The capacity of primary power should be decided according mainly to the power for air conditioning and lighting.

The power of 3 kVA via battery/rectifier arrangement and 4 kVA AC220V will be enough for equipment specified in the technical specification. Providing against primary power failure generators are recommended in the engine room with enough capacity for the whole load of the station.

(5) The space more than 60 square meters will be usually required for equipment specified in the specification. A typical layout of terminal equipment is shown in Fig. 4-3.

(6) The strength of wall and ceiling of the equipment room should be large enough to fix and suspend the equipment.

(7) Floor of the equipment room and engine room should be strong enough to endure load of 740 kg and 3,000 kg per square meters (or 150 and 614 lb/ft^2) respectively.

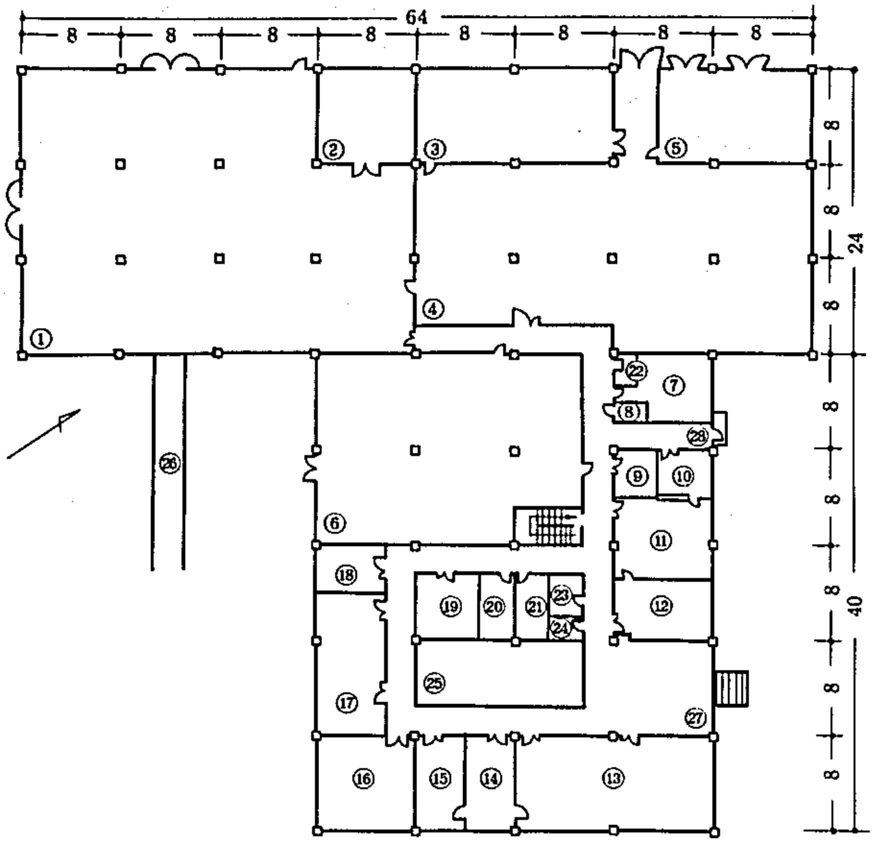
(8) The height of the ceiling of the equipment room should be more than 3.6 meters to install the structures and cable racks.

(9) The transmission equipment room should have the entry for sea cable and PFE cable through the floor. The construction of the entry should allow the bending radius of entering cable more than 1.5 meters. An example is shown in Fig. 4-4.

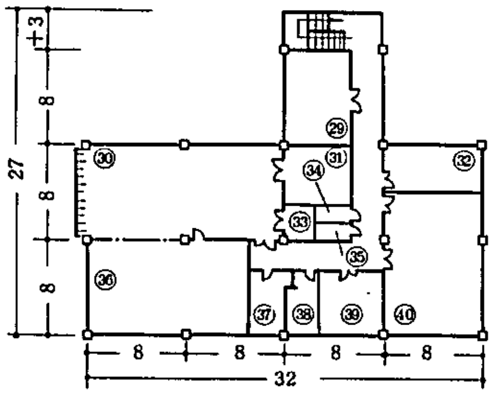
(10) The equipment of back haul system should be preferably allocated near the transmission equipment of submarine cable system in the same room.

(11) The material of floor and wall in the battery room, in general, should be of acid proof.

(12) Power points and lighting should be adequately provided in each room.



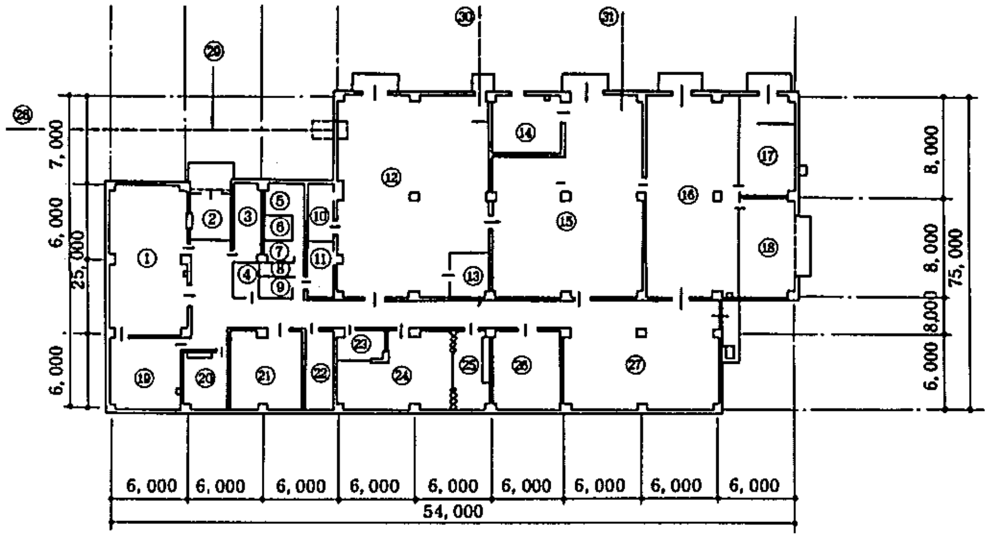
Ist Floor



Ground Floor

1 Carrier Terminal Room (704 m^2)
2 Power Feeding Equipment Room
3 Battery Room
4 Power Plant Room
5 Engine Room
6 Air-conditioning Equipment Room
7 Bed Room
8 Storage
9 Locker Room (men's)
10 Pantry
11 Dining Room
12 Lounge
13 Office
14 Station Manager's Office
15 Reception Room
16 Reception Room
17 Conference Room
18 Storage
19 Library
20 Shower Room
21 Toilet (men's)
22 Toilet (men's)
23 Toilet (women's)
24 Locker Room (women's)
25 Courtyard
26 Submarine Cable Entrance
27 Entrance
28 Service Entrance
29 Pump Room
30 Garage
31 Propane Gas Cylinder Room
32 Work Shop
33 Storage
34 Storage
35 Dark Room
36 Storage
37 Toilet (men's)
38 Toilet (women's)
39 Janitor Room
40 Storage

Fig. 4-1 An Existing Example of Floor Arrangement in a Cable Landing Station for four Submarine Cable Systems



1 Office
2 Hall
3 Janitor Room
4 Dark Room
5 Toilet (men's)
6 Toilet (women's)
7 Shower Room
8 Locker Room (womens's)
9 Locker Room (men's)
10 Storage (A)
11 Storage (B)
12 Carrier Terminal Room
13 Power Feeding Equipment
14 Battery Room
15 Power Plant Room
16 Air Conditioning Equipment Room
17 Boiler Room
18 Storage
19 Station Manager's Office
20 Reception Room
21 Conference Room
22 Bed Room
23 Pantry
24 Dining Room
25 Lounge
26 Air Conditioning Equipment Room (for Office Rooms)
27 Engine Room
28 Submarine Cable Entrance
29 Entrance
30 Coaxial Cable Entrance
31 Power Cable Entrance

Fig. 4-2 An Existing Example of Floor Arrangement in a Cable Landing Station for Single Submarine Cable System

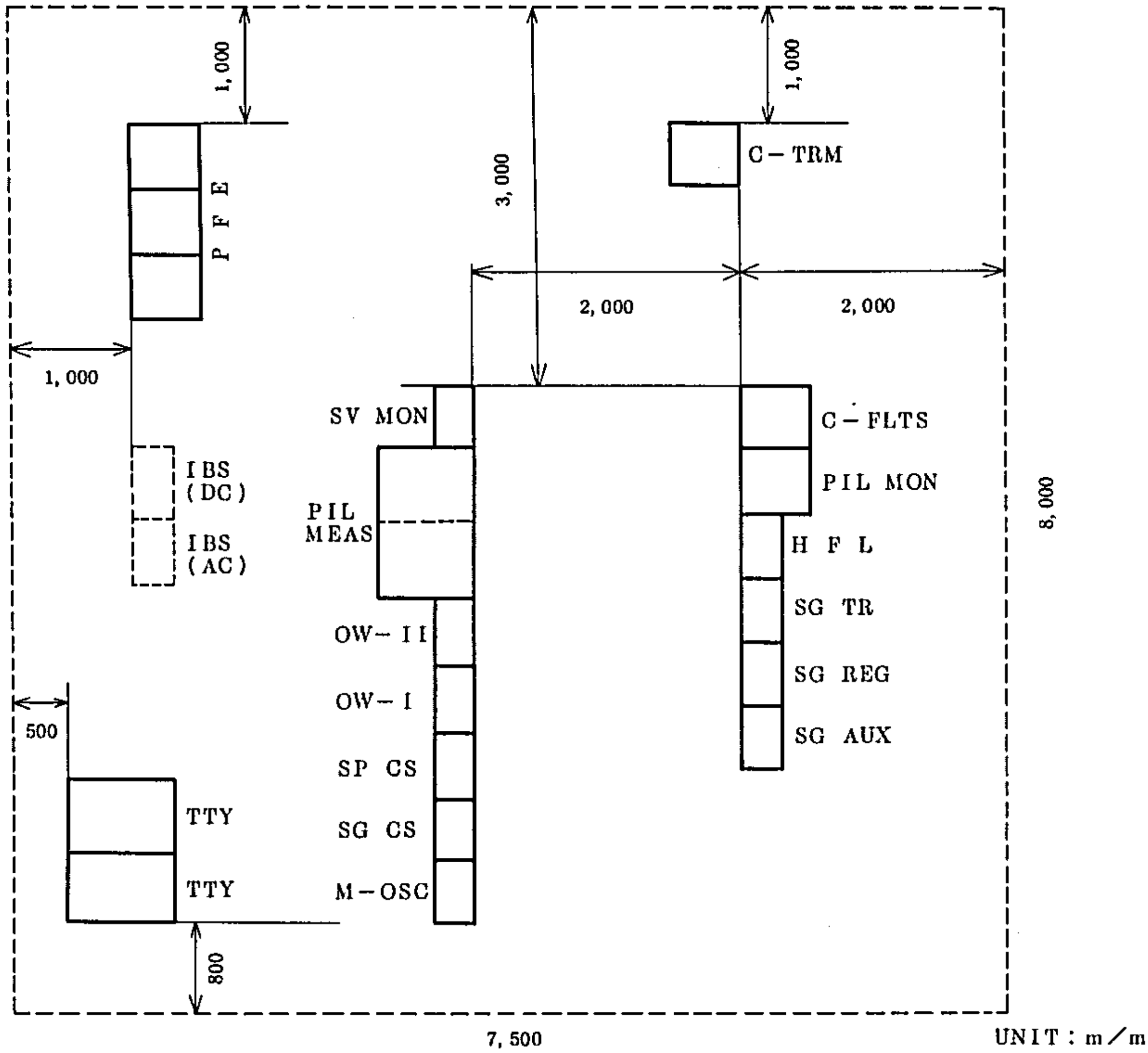


Fig. 4-3 Typical Layout of Terminal Equipment

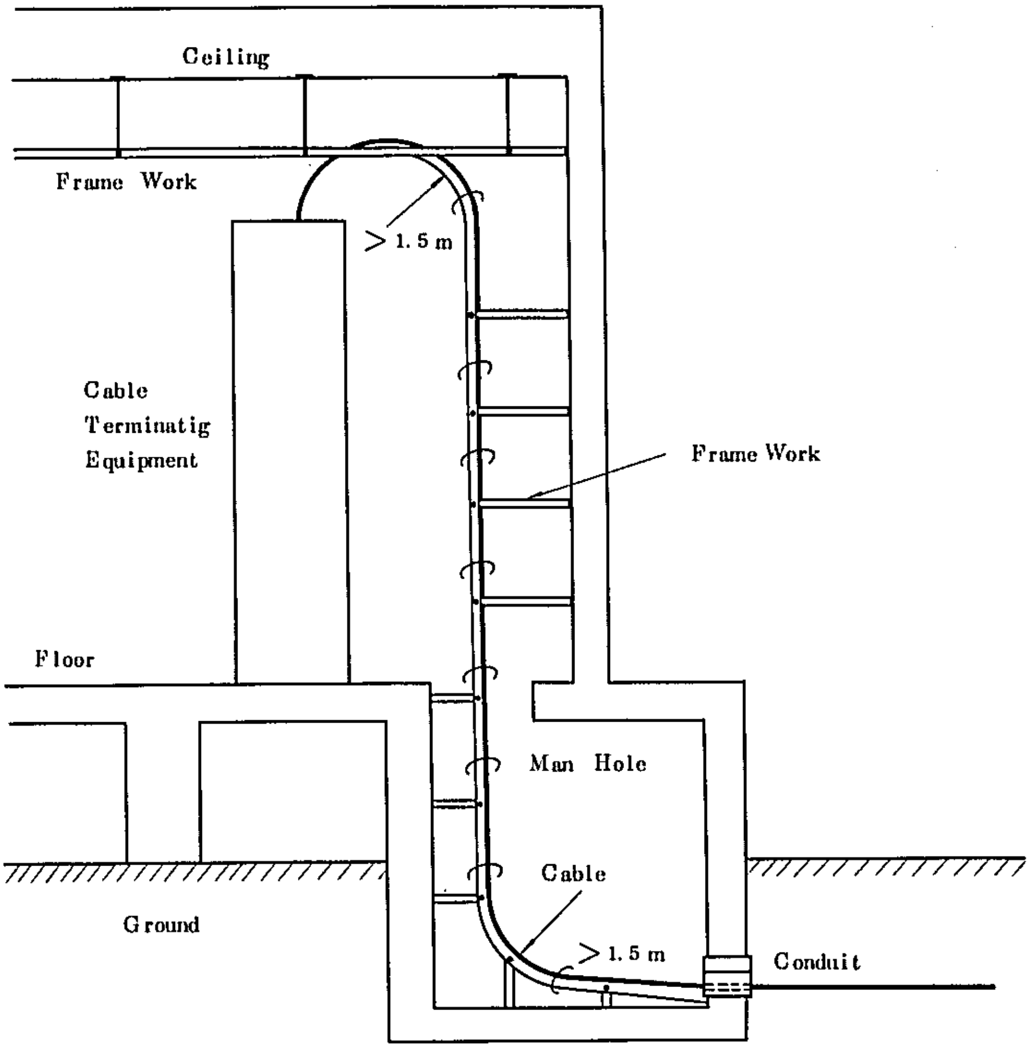


Fig. 4-4 Typical Construction of Cable Entry

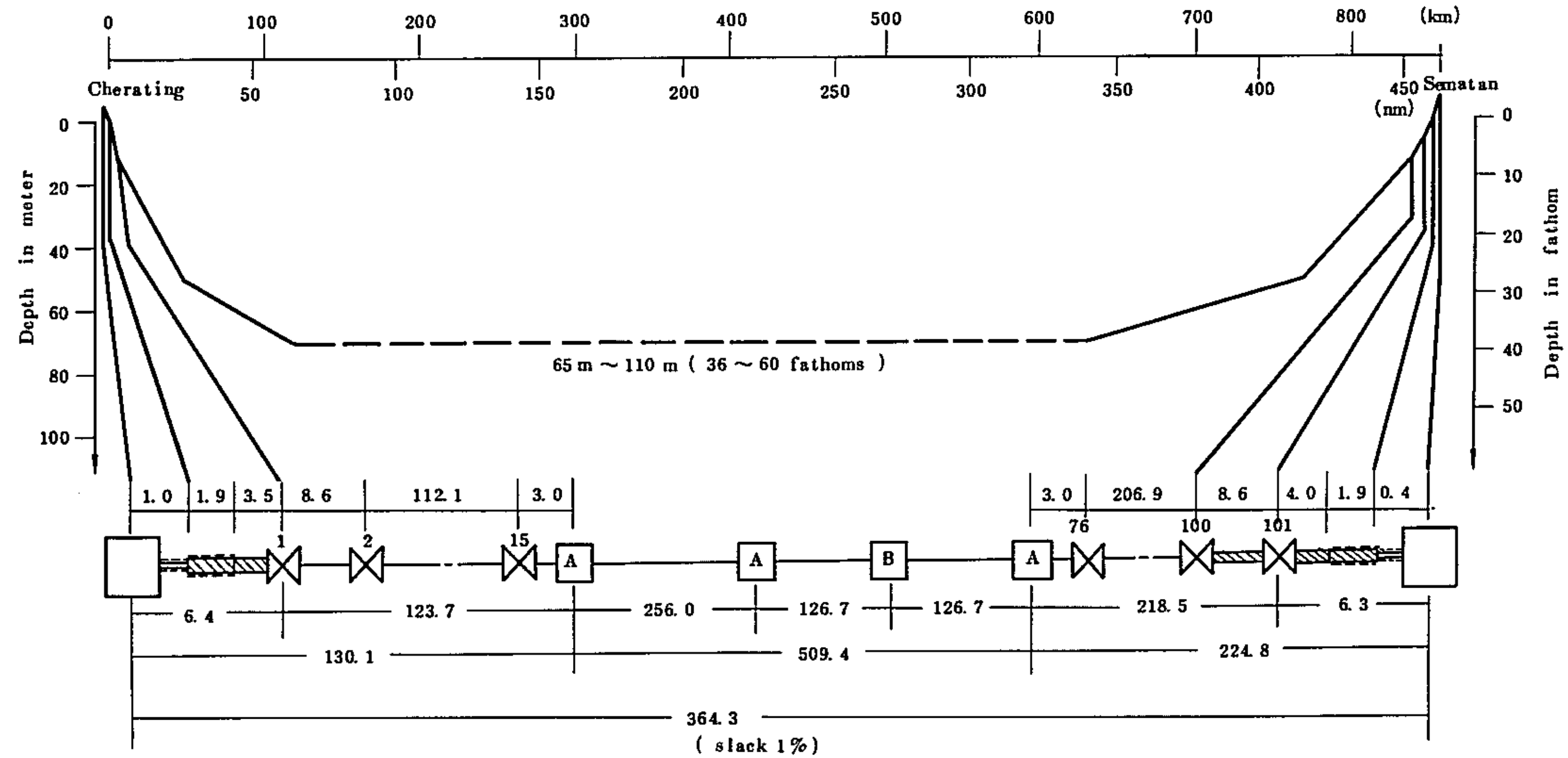
4.2 Recommendable examples of system configuration and Time Schedule of Construction

Here are presented two recommendable examples of system configuration which could fulfil the requirements stated in the preceding section as shown in Fig. 4-5 and Fig. 4-6, and the time schedule of construction of these system in Fig. 4-7. These two plans are both drawn upon the basis of Japanese CS-12M system which has been developed by KDD but could be modified according to the additional requirements given by Malysian Authorities and to the advise of Tenderers.

The distinctive features of them are as follows:

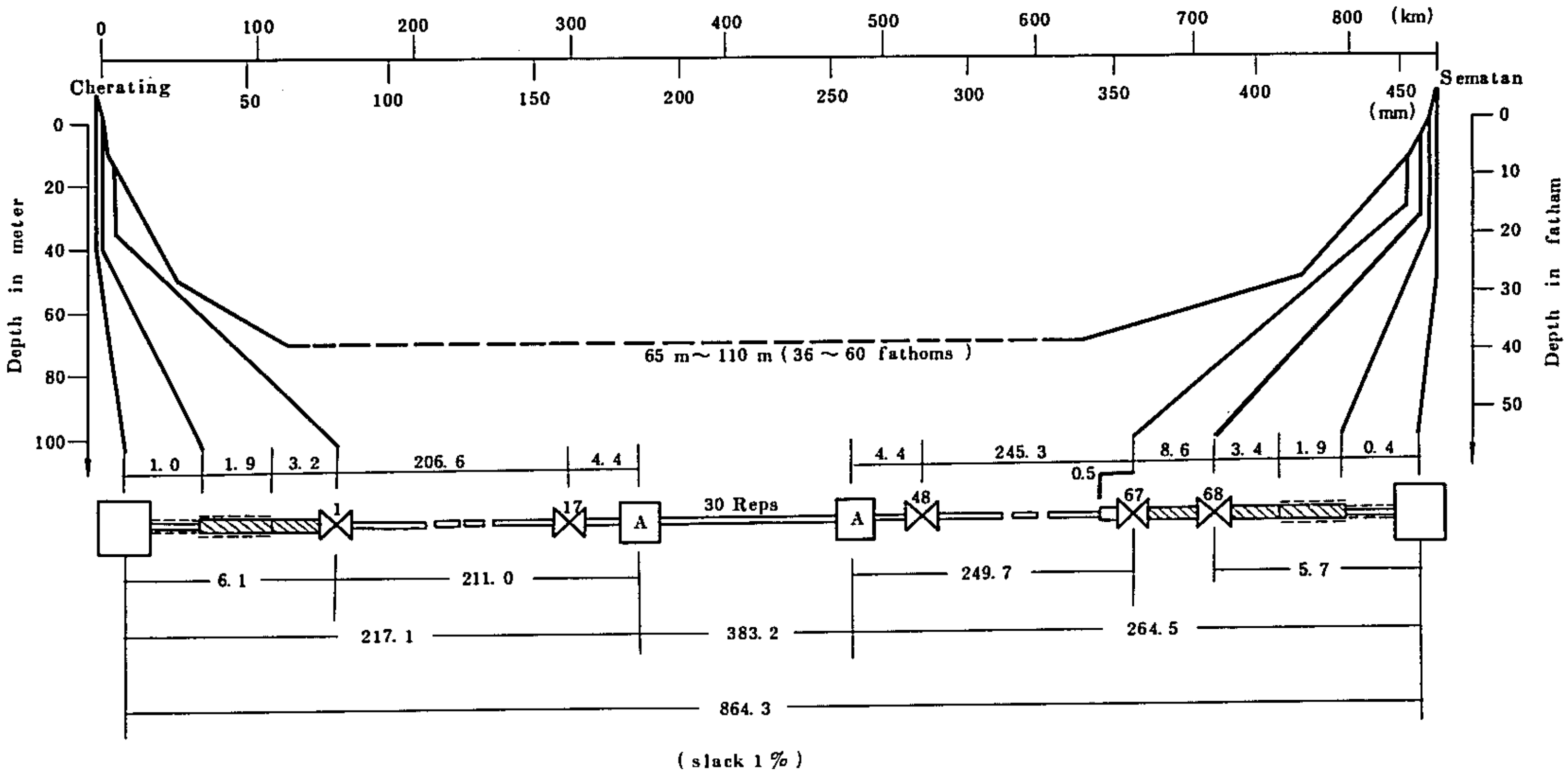
(1) Plan A: Against fishing trawlers armoured cable with heavy gauge wire is applied. The size of cable core is one inch in diameter giving more loss to signal than that of Plan B. So the repeaters used should have so called T-AGC (Thermal Automatic Gain Controle) facility.

(2) Plan B: The cable system would be protected by cable burying under the sea bed. The cable to be mainly used is so called 1.5 inches armourless type with less attenuation which enables to decrease the number of repeaters to two thirds of Plan A. This small total loss of cable in addition to the fact that temperature variation of cable is lessened by burying it will give the possibility of use of the fixed gain repeaters.



Repeater		101
Equalizer		4
Cable		
(double armoured, screened symbol)	Double Armoured 1 inch (screened), 6 / 8	3.8 Km
(double armoured symbol)	Double Armoured 1 inch, 6 / 8	16.1
(single line symbol)	Single Armoured 1 inch, 8	843.0
(double line symbol)	Single Armoured 1 inch (screened), 6	1.4

Fig. 4-5 Plan A (Protection by Armouring)

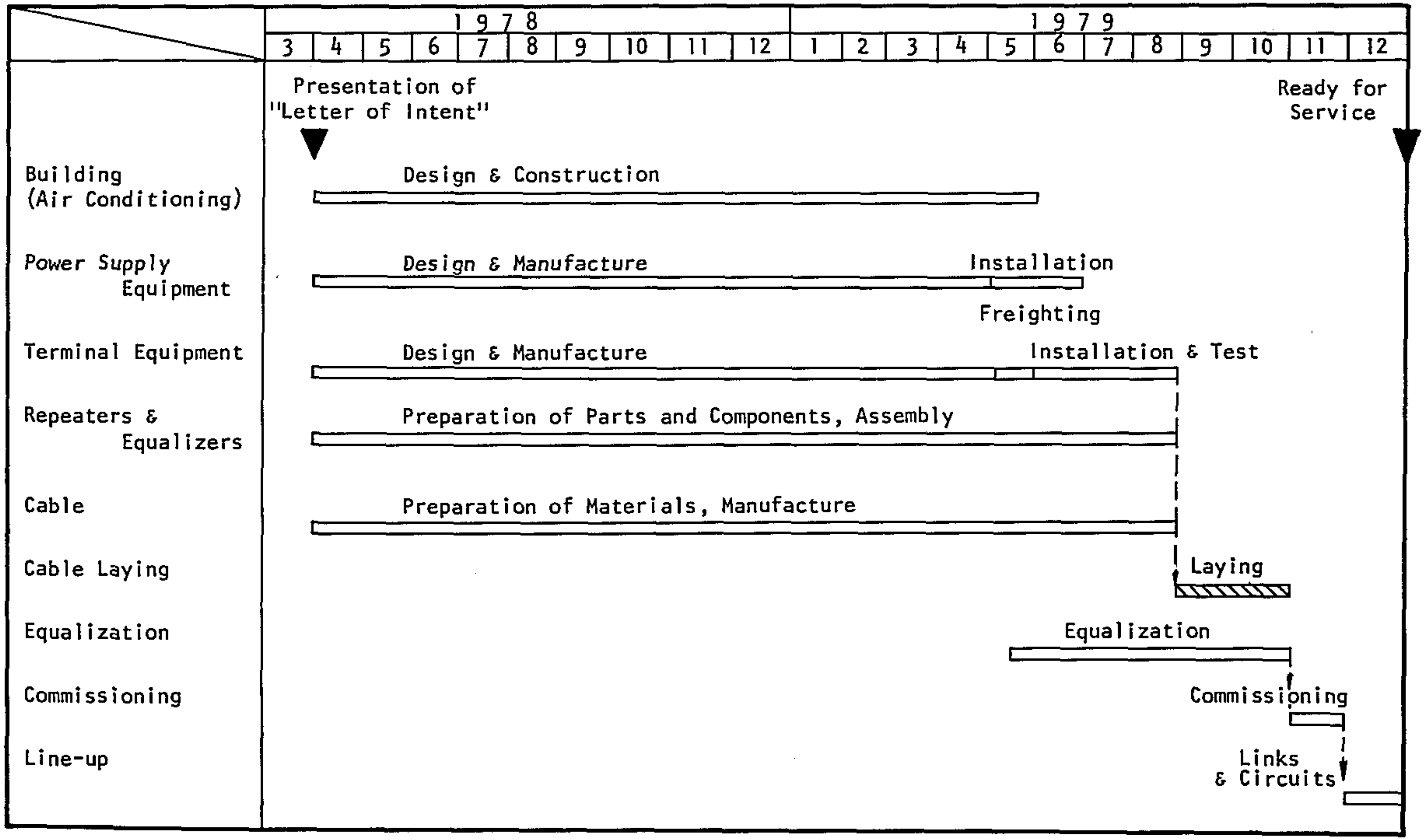


Repeater	68	
Equalizer	2	
Cable		
Double Armoured 1 inch (screened), 6 / 8	3.8	km
Double Armoured 1 inch , 6 / 8	15.2	
Single Armoured 1 inch (screened), 6	1.4	
Single Armoured 1.5 inches , 6	2.5	(note)
Armourless 1.5 inches	841.4	

note: Used for protection of parts remaining unburied for intermission of laying

Fig. 4-6 Plan B (Protection by Burying)

Fig. 4-7 Time Schedule of Construction



5 COST ESTIMATE AND ECONOMIC EVALUATION

5. COST ESTIMATE AND ECONOMIC EVALUATION

5.1 General

It is generally difficult to make an exact evaluation on the national benefits brought by the construction of the cable system when considering such kinds of benefits as its effect on the national unity, education, enjoy of information itself, etc. In accordance with usual way of this kind of study, however, the earning of charge for telephone calls which are to be conveyed by this submarine cable system is considered as a quantitative measure for the benefits brought about by this communication media itself.

On the other hand, the whole cost for telephone calls to be compared with the benefit should involve, in addition to Construction Expenses of the cable system itself, those of buildings for terminal stations, back haul micro wave systems, additional switches to fulfil the accelatedly increasing demand, etc. In this Report, however, only the construction expenses are presented in sub-section 5.2 and other items are considered as a part of contribution to operation cost when economic evaluation is carried out in sub-section 5.3.

5.2 Construction Expenses

Construction expenses are estimated on the two recommendable examples of system configuration under the following conditions:

(1) Construction will be carried out by the Contractor to be who will be responsible to items specified in the technical specification.

(2) Construction is scheduled to complete by the end of 1979.

(3) The price has been estimated on the basis of prices for Okinawa-Luzon segment of OLUHO Cable.

(4) Yen to M$ Exchange rate has been adopted as
1 M$ = 120 Yen

(5) No tax are applied on goods imported into Malaysia.

The result of estimation of Construction Expenses is shown in Table 5-1.

5.3 Economic Evaluation of Kuantan - Kuching Submarine Cable System

The economic evaluation has been made on the more expensive example recommended as plan A in sub-sec. 5.2 over a period of 20 years after construction and the internal rate of return (IRR) is applied as the evaluation measure.

(1) Benefit

Earnings by telephone charge have been estimated by multiplying the number of circuits to be used by earnings per a circuit, assuming the following conditions:

(a) The number of circuits to be used is estimated as shown in Table 5-2.

(b) Earnings to be obtained with a circuit has been estimated using following parameters which are deduced from the actual data of 1976; occupation time per circuit 14,680 min
average charge per minute 4.17 M$.

The result is shown in the 5th column of the Table 5-3 as "Benefit (B)".

(2) Cost

Cost for telephone calls carried by the system consists of construction expenses and operation cost as previously mentioned. Operation cost can be divided into two large categories, "Maintenance Cost" and "Administration and Operation Cost".

The former includes the operation cost of the cable terminal stations and a share of maintenance cost of the cable repair ship. The latter is all other expense which could be considered to contribute to carrying out telephone service, such as contribution of exchange switches and their operators, subscribers lines, administration, etc.

"Construction Expenses" and "Operation Cost" are presented in the column 2 and 3 respectively, and the sum of them in the column 4 as "Total Cost (C)".

The result of the evaluation indicates that IRR would be 13.8 %. These figures could mean that this submarine cable system construction project is feasible from the economical stand point.

Table 5-1 Construction Expense of Kuantan - Kuching Submarine Cable System

unit 1000 MS

	Plan A Cable Protection with Armour	Plan B Cable Protection by Burying
1. Terminal Equipment and installation (CIF) (including power feeding equipment earth system)	9,275	9,275
2. Submersible Plant (FOB)		
Cable	35,817	19,025
Coupling	3,017	2,050
Repeater	18,817	12,725
Equalizer	1,025	517
3. Cable Laying (including transportation, cable landing with small vessels, insurance etc.)	9,808	13,300
4. Engineering	833	1,250
Total	78,592	58,142

note 1) Exchange Rate is 1 M$/120 yen.

2) The cost of plan B is 26 % less than that of plan A.

Table 5-2 Estimated Number of Circuits Provided by the Cable System

Fiscal Year	Rate of Annual Growth (%)	Total Circuits Demand	Circuits to be Provided by Tropo, Satellite and SEACOM	Circuits to be Provided by the Cable
1979	60(note 2)	198	198(note 1)	0
80	20	317	150(note 3)	167
81	20	380	150	230
82	20	456	150	306
83	15	547	150	397
84	15	630	150	480
85	15	724	150	574
86	15	833	150	683
87	15	957	150	807
88	15	1101	150	951
89	15	1266	150	1116
90		1456	256	1200
91				1200
92				1200
93				1200
94				1200
95				1200
96				1200
97				1200
98				1200
99				1200

note 1 : Consisting of 48 circuits of troposcatter, 132 circuits of satellite and 18 circuits of SEACOM.

note 2 : The effect of introduction of STD is taken into account by 40 %.

note 3 : 48 circuits of troposcatter will get out of service.

Table 5-3 Internal Rate of Return of the Project

Fiscal Year	Construction Expense	Operation Cost	Total Cost (C)	Benefit (B)	(B) - (C)	13 % Discount	14 % Discount
1979	78,592		78,592		78,592	88,809	89,595
* 1980		26,272	26,272	10,224	16,048	16,048	16,048
1981		26,272	26,272	14,080	12,192	10,789	10,695
1982		26,272	26,272	18,732	7,540	5,905	5,802
1983		26,272	26,272	24,303	1,969	1,365	1,329
1984		26,272	26,272	29,383	3,111	1,908	1,842
1985		26,272	26,272	35,140	8,868	4,814	4,606
1986		26,272	26,272	41,810	15,538	7,463	7,079
1987		26,272	26,272	49,401	23,129	9,831	9,243
1988		26,272	26,272	58,216	31,944	12,016	11,198
1989		26,272	26,272	68,317	42,045	13,996	12,929
1990		26,272	26,272	73,459	47,187	13,901	11,341
1991		26,272	26,272	73,459	47,187	12,302	11,165
1992		26,272	26,272	73,459	47,187	10,886	9,794
1993		26,272	26,272	73,459	47,187	9,634	8,591
1994		26,272	26,272	73,459	47,187	8,526	7,536
1995		26,272	26,272	73,459	47,187	7,545	6,611
1996		26,272	26,272	73,459	47,187	6,677	5,799
1997		26,272	26,272	73,459	47,187	5,909	5.087
1998		26,272	26,272	73,459	47,187	5,229	4,462
1999		26,272	26,272	73,459	47,187	4,627	3,914
Total	78,592	525,440	604,032	1,084,196	480,164	12,348	2,272

$$IRR = 13 + \frac{12,348}{12,348 + 2,272} = 13.8$$

* Reference Year

APPENDIX

REPORT OF MEETINGS ON THE SCOPE OF WORK FOR THE ROUTE SURVEY OF SUBMARINE CABLE BETWEEN KUANTAN AND KUCHING IN MALAYSIA

Report of Meetings on the Scope of Work for the Route Survey of Submarine Cable between Kuantan and Kuching in Malaysia

At the request of the Government of Malaysia for a technical/aid to carry out a survey of submarine cable route between Kuantan and Kuching, the Government of Japan, through Japan International Cooperation Agency (JICA), sent a preliminary survey team headed by Mr. Mitsugi Iijima, Counsellar of Telecommunications, Ministry of Posts and Telecommunications, to discuss the Scope of Work to be undertaken by the Government of Japan on the requirement for the survey of the cable route.

Three meetings were held between the Japanese Delegation and the Malaysian Officials. They were held at the following venues:

July 18th, 1977 at Telecommunications Headquarters
July 21st, 1977)
) at the Economic Planning Department
July 29th, 1977)

The lists of delegates attending the above meetings appeared in Annexes A, B and C.

The meetings at the Economic Planning Department formulated and agreed on the Scope and objective of the Survey and Study as appeared in Annex D.

The Government of Malaysia was unable to provide a survey ship and requested the Government of Japan to provide a Survey ship such as KDD Maru or the Kuroshio Maru. The Japanese Delegation agreed to consider the provision of a survey ship from Japan. It has also agreed that the ocean survey team shall compose of 2-3 Malaysian officers in addition to the Japanese team. The proposed route for the survey appeared as Annex E.

At the request of Malaysian officials, the Japanese Delegation agreed to submit an interim report of the survey to the Government of Malaysia within two weeks after the ocean survey. The interim report would contain items as appeared in Annex D.

The Draft of Final Report of the survey and study would be submitted to the Government of Malaysia for comments and discussion after which the Final Report would be prepared and presented to the Government of Malaysia. The report would contain item as appeared in Annex D.

It was indicated to the Japanese Delegation that Indonesian Officials would not be required on board the survey ship as the Indonesian Authority would be kept informed of the period and location of the survey.

Kuala Lumpur, July 30th, 1977.

....	....
GOH KHEN WAH	MITSUGI IIJIMA
Director of Telecommunications	Counsellor of Telecommunications
Telecommunications Headquarters	Ministry of Posts & Telecommunications
Kuala Lumpur	Japan

ANNEX A

THE KUANTAN-KUCHING SUBMARINE CABLE

PRELIMINARY SURVEY MEETING

TELECOMMUNICATIONS HEADQUARTERS, KUALA LUMPUR, JULY 18TH, 1977

LIST OF DELEGATES

JAPAN

1. Mitsugi Iijima (Leader)
   Ministry of Posts and Telecommunications

2. Kazunaga Matsuda
   Deputy Manager of Engineering Dept., KDD

3. Taisuke Kitamura
   KDD

4. Atsuo Ebata
   KDD

5. Toru Sampei
   Ministry of Posts and Telecommunications

6. Akio Itoh
   Japan International Cooperation Agency (JICA)

7. Tooru Kasai
   JICA (Kuala Lumpur)

MALAYSIA

1. I.O. Merican
   Deputy Director General of Telecommunications

2. Goh Khen Wah
   Director of Telecommunications

3. Mohamed Ali Yusoff
   Controller of Telecommunications

ANNEX B

THE KUANTAN-KUCHING SUBMARINE CABLE

PRELIMINARY SURVEY MEETING

ECONOMIC PLANNING DEPARTMENT, KUALA LUMPUR, JULY 21ST, 1977

LIST OF DELEGATES

JAPAN

1. Mitsugi Iijima (Leader)
   Ministry of Posts and
   Telecommunications

2. Kazunaga Matsuda
   Deputy Manager of
   Engineering Dept.
   KDD

3. Taisuke Kitamura
   KDD

4. Atsuo Ebata
   KDD

5. Toru Sampei
   Ministry of Posts and
   Telecommunications

6. Akio Itoh
   Japan International Cooperation
   Agency (JICA)

7. Tooru Kasai
   JICA (Kuala Lumpur)

MALAYSIA

1. Bashah Nordin
   Economic Planning Department

2. Zulkifli Hassan
   Economic Planning Department

3. Phang Pin Suan
   Economic Planning Department

4. Rosmah bt Hj Jentera
   Economic Planning Department

5. Zubir bin Abdul Aziz
   Economic Planning Department

6. Mohd Radzi Hj Mansur
   Ministry of Communications

7. Mohamed Ali Yusoff
   Telecommunications Department

ANNEX C

THE KUANTAN-KUCHING SUBMARINE CABLE

PRELIMINARY SURVEY MEETING

ECONOMIC PLANNING DEPARTMENT, KUALA LUMPUR, JULY 29TH, 1977

LIST OF DELEGATES

JAPAN

1. Mitsugi Iijima (Leader)
   Ministry of Posts and
   Telecommunications

2. Kazunaga Matsuda
   Deputy Manager of Engineering
   Dept., KDD

3. Akio Itoh
   Coordinator (JICA)

4. Tooru Kasai
   JICA (Kuala Lumpur)

MALAYSIA

1. Bashah Nordin
   Economic Planning Department

2. Zulkifli Hassan
   Economic Planning Department

3. Zubir bin Abdul Aziz
   Economic Planning Department

4. Phang Pin Suan
   Economic Planning Department

5. Mohd Radzi Haji Mansur
   Ministry of Communications

6. Mohamed Ali Yusoff
   Telecommunications Department

ANNEX D

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY AND ROUTE SURVEY

OF

THE KUANTAN-KUCHING SUBMARINE CABLE PROJECT

IN

MALAYSIA

I. Introduction

Inresponse to the request of the Government of Malaysia, the Government of Japan has decided to conduct a study of the Kuantan-Kuching Submarine Cable Project in accordance with laws and requlations in force in Japan.

Based on this decision, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, will carry out the study.

The present document sets forth the scope of work in regard to the above mentioned study which is to be carried out in close cooperation with the Government of Malaysia and authorities concerned.

II. Objective of the Study

The study aims to determine the feasibility of the Kuantan-Kuching Submarine Cable Project in Malaysia and to identify the most feasible route for the purpose of laying a submarine cable.

III. Outline of the Study

The study will be carried out in the following manners.

1. Preliminary Study
   1) Agreement on scope of work
   2) To obtain the preliminary data on the Kuantan-Kuching Submarine Cable Project
      traffic demand and system capacity
      type of service
      connection with land line
      cable landing sites
      ocean survey route, etc.
   3) Survey of cable landing sites
      collection of informations about cable landing sites
      confirmation of the actual conditions of the sites by observation
   4) Preparation of route survey
      collection of existing oceanographic and meteorological data
      collection of informations about sea activities in the area where the cable is to be laid

study on ocean survey ship, survey items, survey period, composition of survey team, base port of the ship, etc.

2. Ocean survey

The following survey will be carried out on the shortest possible route between Kuching and Kuantan.

1) Deep water survey
bottom topography, nature and thickness of the bottom sediment, bottom temperature, existence of obstacles on the bottom surface, current condition, etc.

2) Shallow water and shore survey
bottom topography, nature and thickness of the bottom sediment, bottom temperature, existence of obstacles on the bottom surface, current, sea level variation etc.

3) Land survey
topography, level, soil material, etc.

IV. Report

1. Preparation of report
The JICA will prepare and submit 20 copies of the following reports in English to the Government of Malaysia.

1) Interim report
Within about two weeks after the completion of the ocean survey.

2) Draft final report
Within about two months after the completion of the ocean survey. The Government of Malaysia is requested to provide the JICA with its comments within two weeks after the receipt of the draft final report from JICA.

3) Final report
Within one and half months after receiving the comments from the Government of Malaysia.

2. Contents of Report
The report will contain the following items.

1) Interim Report
a. Proposed cable route and its sea bed profile

b. Cable length required for the route

c. Descriptions on route conditions

d. Seabed topography

e. Nature and thickness of seabed sediment

f. Seabed temperature

2) Draft Final and Final Report

a. Configuration and specification of the submarine cable system and requirements for its installation

b. Interface condition with land line

c. Result of route survey

d. Basic requirements of cable landing stations (e.g. building, power supply, airconditioning, etc.)

e. Cost estimate

f. Schedule of construction

g. Economic Evaluation

V. Undertaking of the Government of Malaysia

1) To provide the team with data and information necessary for the study

2) To exempt the team from the taxes and duties on the material equipment connected with the survey and personal effects brought into Malaysia by the team

3) To assign the official counterparts during the field survey

4) To make necessary arrangements for the team to bring out the data and materials concerning the study into Japan

5) To grant necessary approvals for the implementation of the ocean survey in the territorial waters and where the survey falls within Indonesian waters, to obtain the necessary clearance from the Indonesian authority.

6) To give necessary notice to fishermen where possible in the survey area, of the implementation of survey and to take appropriate measures so that the survey work may be carried out without any hindrance

VI. Undertaking of the Government of Japan

To transfer the knowledge to the official counterparts during the field survey and to import the knowledge of the study and the survey to the Government of Malaysia.

VII. Schedule of study

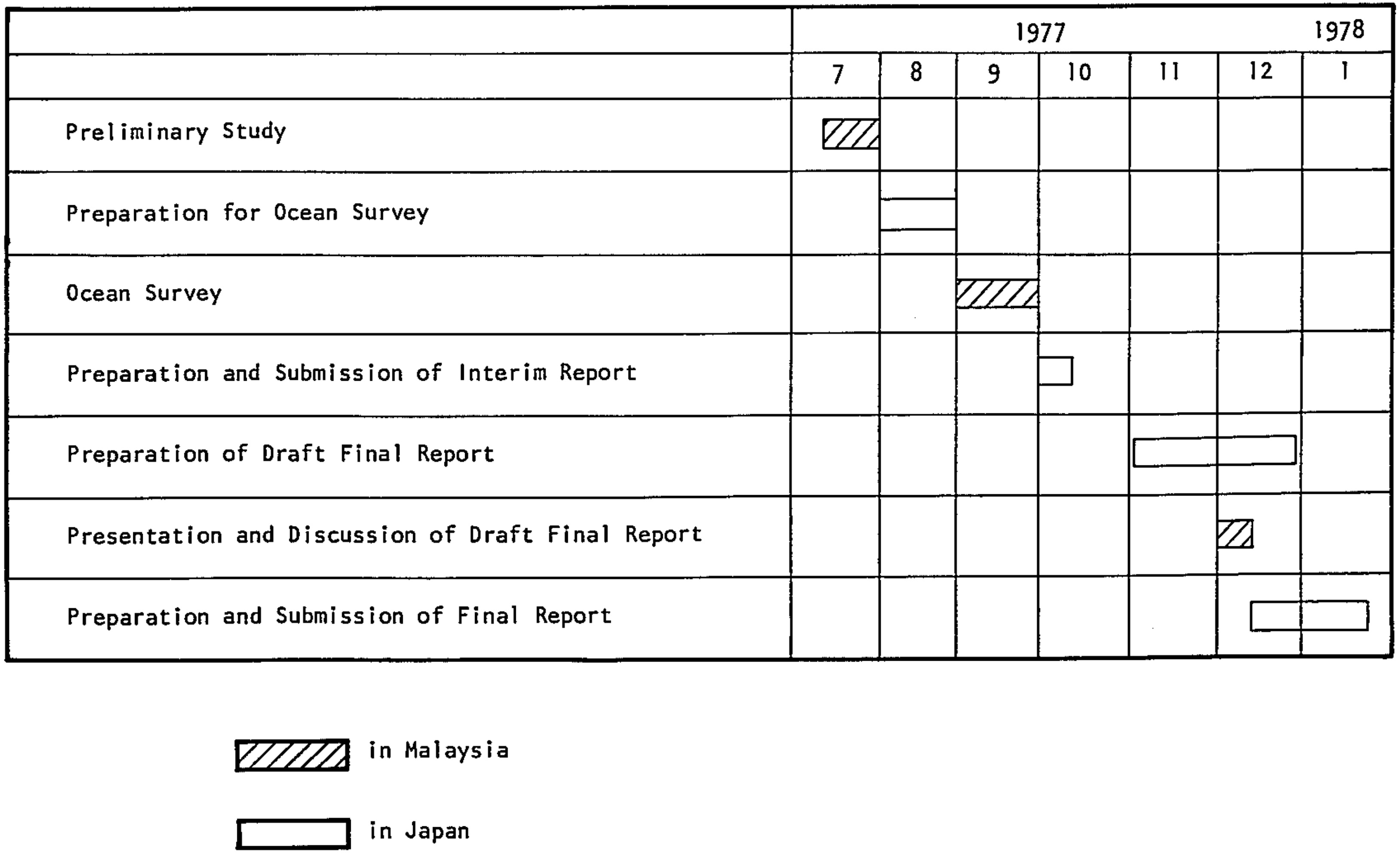
Refer to attached paper

VII. Survey information request

Refer to attached paper

Annex-1

SCHEDULE OF STUDY



Annex-2

Survey Information Request

Please be so kind as to prepare the following informations, if available prior to arrival of the Mission:

1 General information

1-1 Estimate of telecommunication service demand between Peninsular Malysia, Sabah and Sarawak during the period of about 20 years of planned submarine cable

1-2 The number of circuits (voice grade) which are and will be provided by other telecommunication media between Peninsular Malaysia, Sabah and Sarawak other than this planned cable system

2 Information for determining the ocean survey route if available

2-1 Existing oceanographic data
Water depths (navigation or sounding chart)
Nature of bottom material
Water temperature
Sea level variation by tide, wind and wave conditions

2-2 Informations about ship anchoring, fishing activity (especially trawling), under water resource development and any other sea activities in the survey area that may be hazardous to the submarine cable to be laid

3 Information for the ocean survey work

3-1 Maps and data of such fundamental points for positioning as triangulation points around the proposed landing shore

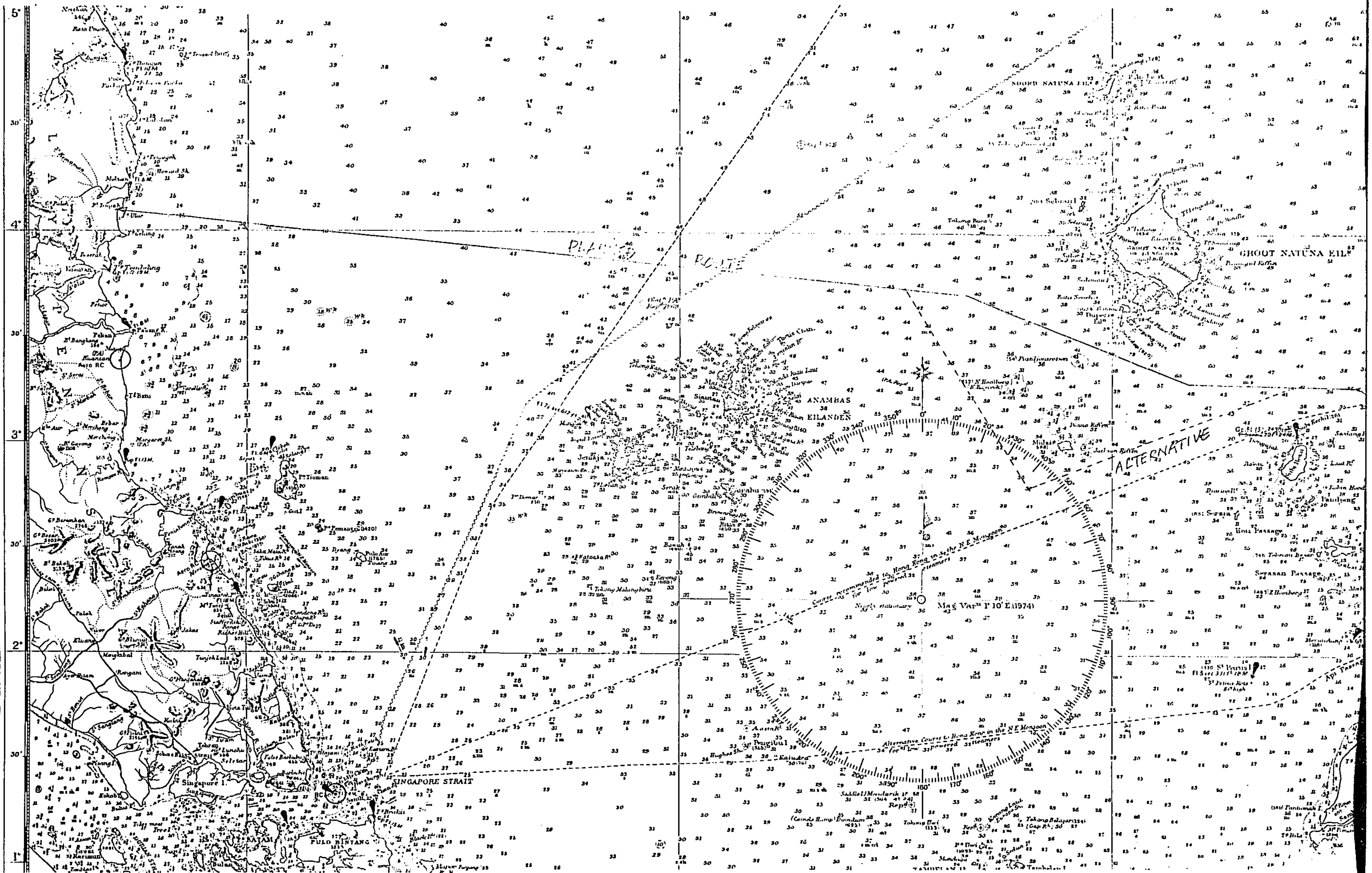
3-2 Dimensions and powers of ships which seem to be available for making the planned ocean survey.

3-3 Existence of any sea activities that may interfere with the ocean survey work such as shore fishing net

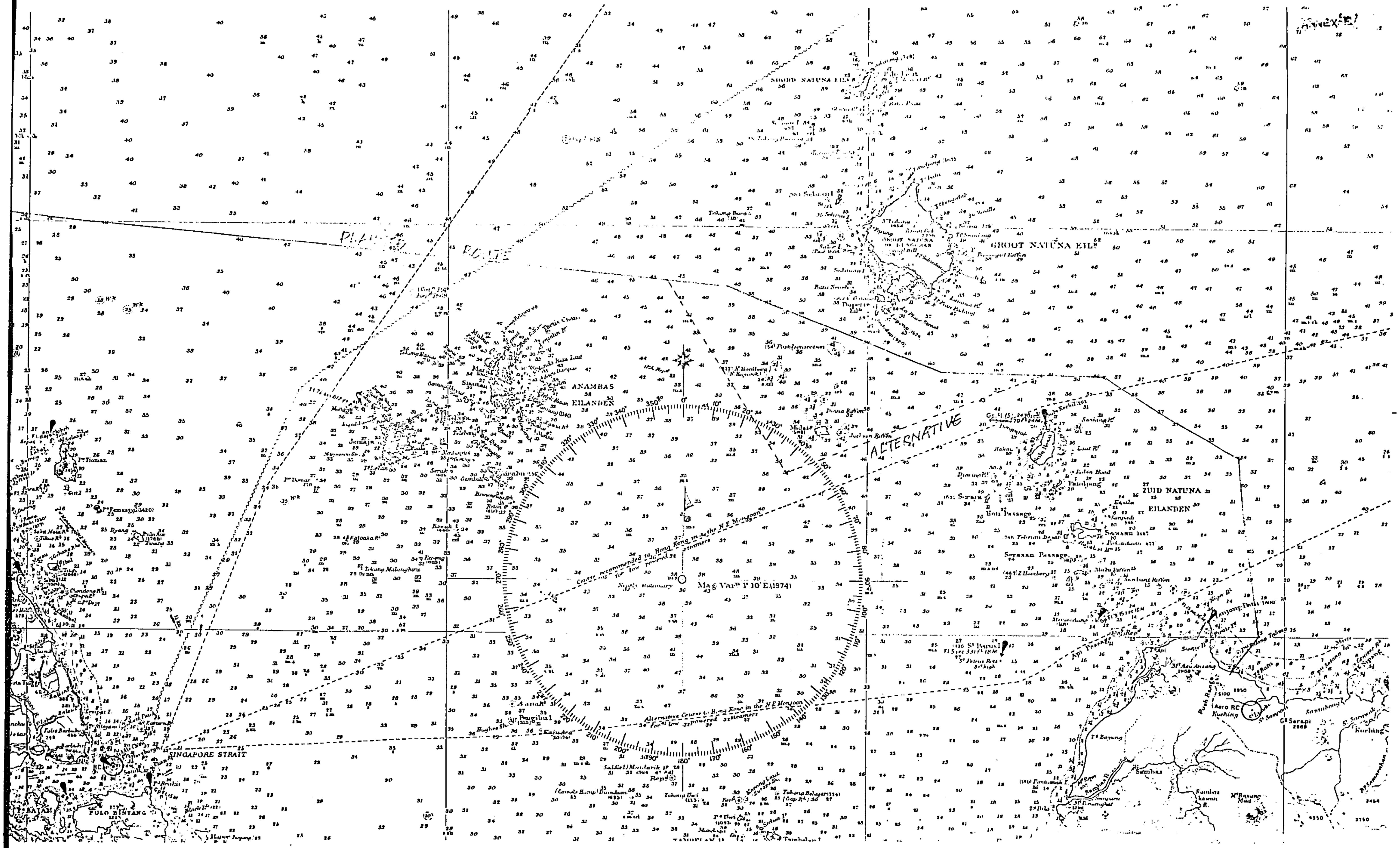
4 Information of the proposed landing sites

4-1 Variation of shore line at the proposed cable landing sites

4-2 Weather, detailed geographical features, availability of electricity and water at the proposed landing sites and future development plan at the area, if any



5°
4°
3°
2°
1°
ANAMBAS
EILANDEN
GROOT NATUNA EILD
ALTERNATIVE
Course recommended to Hong Kong in the N.E. Monsoon for low powered steamers
Alternative Course to Hong Kong in the N.E. Monsoon for low powered steamers
Mag Varn 1° 10' E (1974)
SINGAPORE STRAIT
Singapore I.
PULO BINTANG
Kuantan
Tioman


ANNEX 'B'
PLANNED ROUTE
ALTERNATIVE
GROOT NATUNA EILD
ANAMBAS EILANDEN
ZUID NATUNA EILANDEN
Mag Var 1°10'E (1974)
Course recommended to Hong Kong in the N.E. Monsoon for low powered steamers
Alternative Course to Hong Kong in the N.E. Monsoon for low powered steamers
SINGAPORE STRAIT
FULO BINTANG
Api Passage
Serasan Passage
Kuching
Sambas

APPENDIX-2

KUANTAN - KUCHING SUBMARINE CABLE SYSTEM

TECHNICAL SPECIFICATION

JAPAN INTERNATIONAL COOPERATION AGENCY

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DETAILS OF THE TERMINAL STATIONS

1. GENERAL

1.1. Introduction

This technical specification relates to the provision of a wideband submarine coaxial cable system, which will connect Peninsular Malysia with Sabah/Sarawak.

The system will be constructed between Cherating in Peninsular Malysia and Sematan in Sarawak.

1.2. Application

1.2.1. General

This technical specification shall be read in conjuction with the accompanying (conditions of Contract).

The attention of the Tenderer is also drawn to Appendices 1 and 2 of this document, which provide details of the individual terminal stations and provisional cable-route temperature information respectively.

1.3. Description of System

1.3.1. General

The system shall be capable of providing, over a single submarine coaxial cable, a minimum of 1200 (4 kHz bandwidth) telephone circuits. These circuits may comprise either the CCITT recommended channels of nominal 4 kHz or 3 kHz bandwidth. The system shall meet the required performance when full loaded with 4 kHz circuits, with 3 kHz circuits, or with some supergroups full equipped with 4 kHz circuits and the remainder fully equipped with 3 kHz circuits.

1.3.2. Compatibility with CCITT Standards

The system will form part of the international telephone network. The performance of the equipment offered must therefore be of a sufficient standard to enable the CCITT recommendations for international telephone circuits to be realized, unless stated to the contrary in this specification.

1.3.3. Locations

The locations of the terminal buildings are detailed in Appendix 1. The terminal buildings will be permanently attended by technical maintenance staff.

1.3.4. Direction of Frequency Band Transmission

The submarine cable system shall be worked on an equivalent 4-wire basis by the transmission of the low frequency band in one direction (from 'A' terminal station to'B' terminal station), and the high frequency band in the opposite direction (from 'B' to 'A').

The terminal station in Cherating is designed as 'A', and that in Sematan as 'B'.

The power feeding equipment at the 'A' terminal shall feed a positive polarity to the cable system and that at the 'B' terminal a negative.

1.3.5. Interface Arrangements

The interface of the system with inland systems shall be the CCITT recommended interface points S and S' as defined in their recommendation G371. These points shall be on the supergroup distribution frame in each terminal, as shown in Figure 1, which is a simplified block schematic of a terminal configuration.

1.3.6. Supergroup Facilities

The provision of supergroup pilot equipment and supergroup regulating equipment are left to the discretion of the Tenderer, subject to the prior approval of the Purchaser.

1.3.7. Duplicated Transmission Paths

Where the transmission path contains active units, the failure of which would cause the loss of more than one supergroup, then the path shall be fully duplicated with automatic changeover.

1.3.8. Redundancy of Power Feeding Equipment

The power feeding equipment at each terminal will have redundancy such that failure of an individual power unit will not result in the loss of the power feeding facilities from that terminal or degradation of the system performance.

1.4. Equipment and Services to be provided by the Contractor

1.4.1. Supply of Cable and Equipment

The Contractor will be responsible for the supply of the land and submarine cable together with all integral equipment such as repeaters and equalizers, and the terminal equipment as detailed in this specification.

1.4.2. Special Services

Services such as engineering, planning and commissioning of the system shall be required from the Contractor, and these are specified in section 4.

1.4.3. Installation

The Contractor shall be requested by the Purchaser, to install all of the terminal equipment and the submersible plant.

1.4.4. Service and Equipment Excluded

All civil works, land cable laying and multiplex equipment inland of the CCITT interface points S and S' (refer Figure 1) are specifically excluded from this contract.

Primary power and no break arrangements as specified in sub-section 5.9.1. are also excluded.

1.5. System Reliability

1.5.1. Aim

In conformity with normal ocean cable standards, it is of primary importance that a high standard of reliability for the system shall be achieved, with the objective of providing continuous, fault-free service for a minimum period of 25 years.

1.5.2. General Reliability

The reliability of the system as a whole, and the submersible plant in particular, shall be started by the Tenderer, and this statement shall be supported by m.t.b.f. and possibly other reliability calculations.

1.5.3. Protection of Submersible Plant

The cable system shall be protected against fishing trawler by means of armouring or burying (refer section 2.1)

1.5.4. Technology Reference

The Purchaser emphasizes that his preference will be towards technology already proven in practice, and on which a considerable body of data and experience has already been amassed.

1.6. Design Information

1.6.1. General

The design of Submersible Plant and Equipment must be to this specification, and the successful Tenderer may be required to supply a prototype or laboratory model sufficient to demonstrate that the requirements of this specification are covered.

All details of design not covered in this or other relevant specifications will be left to the discretion of the Contractor, subject to the prior approval by the Purchaser.

1.6.2. Special Design

Where the requirements of this specification will result in the need for items to be specially designed, the Tenderer shall state this in his tender.

1.6.3. Design Constraints

The design objectives detailed in this technical specification shall be met under all working conditions covered in the specification.

1.7. Technical Information and Literature

1.7.1. Submission of Documents

1.7.1.1. Documents for approval

The Contractor shall submit to the Purchaser for his approval, before commencement of manufacturing, the following documents:

a) separate handbooks of each type of terminal equipment.

b) factory test specifications covering the permissible performance limits of individual equipments.

c) drawings of the submersible plant and equipment to cover the following details:

   i) General Information
   ii) Assembly
   iii) Wiring
   iv) Signwriting/Engraving
   v) Schematic

d) recommended maintenance routines.

1.7.1.2. Other documents

a) plan of work
Within three months of the contract being placed, the Contractor shall submit a detailed plan of work including manufacture, delivery and installation work, showing all majour items and their places of manufacture.

b) progress reports
The Contractor shall render periodical progress reports to the Customer in order to monitor the achievements of the Contractor according to the above plan of work.

c) installation reports
Within three months of the Ready for Service date, the Contractor shall deliver following reports,

In-station Test Report
Laying Report
Comissioning Test Report

1.7.2. Supply for First-Off Equipment

Sets of handbooks and drawings (whether approved or not) shall be supplied with the first off equipment for each terminal station and laying vessel. Drawings which have not been approved by the Purchaser shall be marked 'Provisional'.

1.7.3. Final Versions of Documents

Approved final versions of handbooks and drawings shall be supplied by the Contractor not later than 6 months after acceptance of the equipment.

1.7.4. Test and Data Sheets

The Contractor shall supply sets of completed factory tests sheets for each item of submersible plant and equipment. In the case of submersible plant, factory data sheets (mechanical and electrical) shall be supplied to the laying or freight ship before the plant arrives onboard.

1.7.5. Quantities of Documents

The quantities of handbooks, drawings and test sheets listed above under sub-sections 1.7.1. to 1.7.4. inclusive, to be supplied will be subject to agreement between the Purchaser and the Contractor.

1.8. Safety of Personnel

1.8.1. High Voltage Protection

In the design of the equipment, special emphasis shall be placed on safeguarding personnel from high voltages.

1.8.2. Earthing

The outside of all cabinets and racks and the chassis of all enclosed components, motor or generator frames and all external parts, meter cases, control shafts and knobs shall be securely earthed.

1.8.3. Voltage Segregation

No terminal strip shall contain both hazardous and non-hazardous voltages.

1.8.4. Terminal Strip Protection

All terminal strips containing hazardous voltages shall be equipped with covers. The design of the covers shall be such that sufficient mechanical rigidity and clearance is provided to prevent short circuits and other failures.

1.8.5. Warning Notices

The covers of all panels which will be connected to a.c. mains, or to d.c. voltages in excess of 400 volts shall have a warning notice in a conspicuous position on the front face of the panel. The notice should read-DANGER: HIGH VOLTAGE, and shall be in red characters on a white background.

1.8.6. Connector Withdrawal

Normal withdrawal of a connector shall not enable accidental access to hazardous voltage.

1.8.7. Earthing Devices

Earthing device shall be provided where voltages in excess of 400 volts can remain stored in the equipment after access has been gained. These devices shall be permanently connected to the earthed equipment rack or cabinet, and held in clips when not in use.

1.9. Inspection and Quality Assurance

1.9.1. General Procedures

The Tenderer shall supply sufficient details of his quality assurance and inspection procedures to enable the Purchaser to assess these procedures to his satisfaction.

1.9.2. Factory Test Procedures

The Contractor shall supply copies of his factory test procedures in accordance with sub-section 1.7.1.(b). Part of the factory acceptance testing procedure shall involve testing the equipments back-to-back.

1.9.3. Testing and Equalization Procedures

The Tenderer shall provide full details of the testing and equalization procedures to be employed from the time of completion of manufacture of cables and repeaters to the completion of laying.

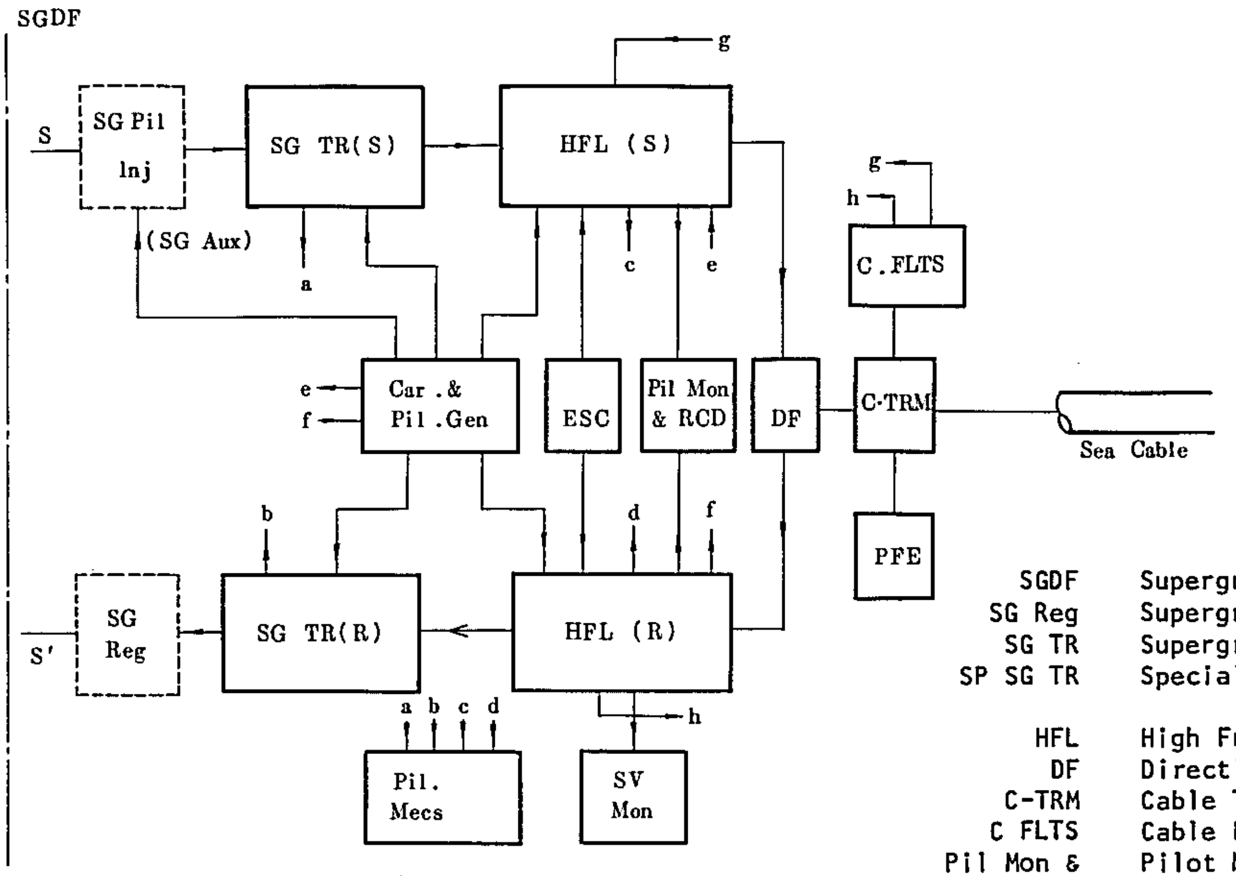
1.9.4. Demonstration

The Cnotractor will be required to demonstrate to the satisfaction of the Project Controller that the person responsible for on-board equalizing of the system is adequately qualified to perform the task.

1.9.5. Acceptance Test

The tenderer shall propose the detailed test procedures. The tests comprise such tests necessary to line up the overall system, to show that all the defined parameters and facilities specified in other sections in this Specification have been met and to indicate confidence in continuous satisfactory operation of the overall system.

Within seven days of receipt of the complete test results from the Contractor, the Perchaser will advise the Contractor of their acceptance or rejection, in accordance with the procedure detailed in the contract.



BASIC TERMINAL CONFIGURATION

ABBREVIATIONS

SGDF	Supergroup Distribution Frame
SG Reg	Supergroup Regulating Equipment
SG TR	Supergroup Translating Equipment
SP SG TR	Special Supergroup Translating Equipment
HFL	High Frequency Line Equipment
DF	Directional Filter
C-TRM	Cable Terminating Equipment
C FLTS	Cable Fault Localization Test Set
Pil Mon & RCD	Pilot Monitoring and Recorder Equipment
ESC	Engineering Service Circuit Equipment
Car. & Pil. Gen.	Carrier and Pilot Generating Equipment
SV Mon.	Supervisory Tone Monitoring Equipment
Pil. Meas.	Pilot Measuring Equipment
SG Pil. Inj.	Supergroup Pilot Injector
PFE	Power Feeding Equipment
-----------	Optional

2. SEA-CABLE AND COUPLING

2.1. Submarine Cable Quantities

A provisional list of the quantities of each cable type, required for the sea sections Cherating and Sematan is given in Tables 1 and 2 below. Tenderer is invited to quote for all or any part of Tables 1 and 2 which are alternative proposals for non-burying and for burying.
A cable nautical mile is defined as 1852 meters.

Table 1

Cable Type	Diam of Armour Wires (mm)	Total length (km) (incl. spare)
Double Armoured, type AB (screened)	8 over 6	4.3
Double Armoured, type AB	8 over 6	16.7
Single Armoured, type A	8	868.8
Single Armoured, type B (screened)	6	1.7

Table 2

Cable Tupe	Diam of Armour Wires (mm)	Total length (km) (incl. spare)
Double Armoured, type AB (screened)	8 over 6	4.3
Double Armoured, type AB	8 over 6	15.8
Single Armoured, type B (screened)	6	1.7
Single Armoured, type C (Deep Sea Lightweight)	8	15.4
Deep Sea Lightweight (1.5')	-	867.2

2.2. Modification of Cable Quantity

Final quantities will be established after modification with respect to the installation method which will be proposed by the Contractor and approved by the Purchaser.

2.3. Design Requirements - Lightweight Cable

2.3.1. Steel Central Strength Member

The central strength member shall consist of high tensile stranded steel wires formed in layers and constructed so as to minimize torsional effects.

2.3.2. Inner Conductor

The inner conductor shall be a copper tape applied longitudinally to the central strength member to form a tight fitting tube. The butting edges shall be continuously welded.

2.3.3. Dielectric

The material used for the dielectric shall be polythene. The central strength member and inner conductor assembly shall be homogeneously covered by the polythene dielectric in one continuous extrusion process.

2.3.4. Outer Conductor

The outer conductor shall comprise a copper or aluminium tape formed longitudinally and tightly around the core, with the overlapping tape edges parallel to the axis of the cable.

2.3.5. Outer Sheath

The outer sheath shall be formed of polythene of a harder grade than that used for the dielectric. In the case of specially protected lightweight cable, the nominal radial thickness of the outer sheath shall be increased to a minimum thickness equivalent to twice the radial thickness of the sheath of the standard lightweight cable.

2.4. Design Requirements - Armoured Cable

2.4.1. Compatibility

The basic design features of the inner conductor assembly, dielectric and outer conductor will be open to proposal by the Tenderer, but the electrical characteristics shall be compatible with the lightweight cable and the repeater and equalizer to be offered.

2.4.2. Inner Serving or Bedding

The taped coaxial or polythene sheathed cable shall be served with a layer or layers of proofed jute yarn or other material approved by the Purchaser to form a satisfactory bedding for the armour.

2.4.3. Armouring

The armouring shall comprise helically-wound galvanized mild-steel wires of number and gauge near or equivalent to that stated in Tables 1 and 2 above. The wires shall be coated with a tar or bitumen compound or other material approved by the Purchaser and applied in a compact even layer with a left-hand lay.

2.4.4. Intermediate or Outer Serving

The intermediate and outer serving of double armoured cable, or the outer serving of single armoured cable, shall consist of two layers of three-ply proofed jute yarn or other materials approved by the Purchaser, with coatings of bituminous compound, tar or other approved compound applied under and over each layer.

2.5. Design Requirements - General

2.5.1. Cable Bending Radius

All submarine cable types shall have sufficient flexibility to enable them to withstand bending to:

(i) a minimum radius of 1 meter and 30 reverse bends for aluminium outer conductors or
(ii) a minimum radius of 1.4 meters and 50 reverse bends for copper outer conductors

without sustaining either mechanical damage or deterioration of electrical performance.

2.5.2. Cable Joints

The method used for making an inner conductor assembly joint in lightweight cable shall be such, that the strength of the jointed cable is not less than the design tensile strength of the cable.

2.5.3. Cable Markers

Cable markers shall be applied to the cable as may be required by the Purchaser. In general, mile marks, accurate to ± 1 %, will be required at intervals of one nautical mile (1852 meter) from the top end of each cable section stowed in the tanks of the laying vessel, and repeater warning mark at one nautical mile and 0.5 nautical miles from the bottom end of each section. Any factory-made joints in the strength member and inner conductor of the cable section must also be marked.

2.6. Information to be Supplied by Tenderer

The Tenderer shall provide as part of his offer a complete description, both electrical and mechanical as appropriate, for each type of cable, each type of cable joint and each type of cable termination or cable coupling. Such descriptions shall include, but shall not necessarily be restricted to, the following.

2.6.1. Strength Member and Inner Conductor

(a) The number, diameter and formation of the wires in the strength member of the lightweight cable together with its total tensile strength.
(b) The nominal value and the tolerance limits of the diameter, and the conductivity of the inner conductor.
(c) The limit of adhesion between the inner conductor and the strength member or the penetration depth of inner conductor between the individual steel strand of the lightweight cable.
(d) Mean wall thickness of the inner conductor.

2.6.2. Dielectric

(a) The nominal values and the tolerance limits of the dielectric constant and dissipation factor.
(b) The degree of freedom from voids and impurities after extrusion.
(c) The nominal value and tolerance limits of the diameter.
(d) The tolerances permitted during manufacture for elipticity of the dielectric and concentricity of the inner conductor within the dielectric, together with information on the process control used during manufacture to maintain these tolerances.
(e) The limit of adhesion between the inner conductor and the dielectric of the lightweight cable.

2.6.3. Outer Conductor

(a) The material and the nominal value and the tolerance limits of conductivity.

(b) The nominal thickness.

(c) The limit of adhesion between the dielectric and the outer conductor of the lightweight cable.

2.6.4. Lightweight Cable Outer Sheathing

(a) The nominal thickness and type of polythene to be used.

(b) The limit of adhesion between the outer conductor and the outer sheathing.

(c) The nominal thickness and type of polythene to be used in the case of the specially protected lightweight cable.

(d) Stress crack resistance of high-density polythene.

2.6.5. Screening and Sheathing of Armoured Cable

(a) The material and the nominal thickness of sheathing cver the outer conductor.

(b) The limit of adhesion between the outer conductor and the sheathing.

(c) The construction and method of application of the electromagnetic screen.

(d) The material and nominal thickness of the screen.

(e) The material and nominal thickness of the outer Sheathing of the screened cable.

2.6.6. Serving and Armouring of Armoured Cable

(a) The nature of the raw material and the type of preserving treatment of the servings.

(b) The method of application and the overall diameter of the inner serving.

(c) The material, diameter, number and length of lay of the armour wires and the nature of the tar or bitumen or other coating of the wires.

(d) The diameter over the armour wires.

(e) The method of application and the diameter over the outer servings.

2.6.7. Complete Cable

(a) The nominal value and limits of tolerance of characteristic impedance.

(b) The nominal value and limits of tolerance of the d.c. resistance of the inner and outer conductors.

(c) The temperature coefficient for resistance of the inner conductor and the pressure coefficient for cable capacitance.

(d) The nominal value and tolerance limits of capacitance.

(e) Phase delay, insertion loss and impedance at selected frequencies over the total bandwidth.

(f) The temperature and pressure coefficients of attenuation, and laying effect if known.

2.7. Cable Terminations

2.7.1. General

Terminations shall be applied to both ends of each cable section. The method to be used to make the cable connection to the repeater or equalizer shall be proposed by the Tenderer, who also shall provide following informations as a part of his offer.

(a) The tensile strength of the connection.

(b) The resistance for torsion.

(c) The maximum angle permitted between the cable and the repeater when the latter pass through the drum type cable machinery.

(d) The construction to prohibit water penetrating into the gap between polythene dielectric and outer conductor of the cable.

(e) The maximum voltage the connection will withstand.

(f) The same items in sub-section 2.6.7. as stated (a), (b), (g), and (m).

2.7.2. Quantities of Couplings

If couplings are proposed, the quantities of them shall be proposed by the Tenderer taking into account of the number and the type of spare cables.

3. REPEATERS AND OCEAN BLOCK EQUALIZERS

3.1. General

The tenderer shall provide as part of his offer a complete electrical and mechanical description of the repeaters and ocean block equalizers proposed. Such information shall include, but not necessary be restricted to, the requirements stated in this specification.

The repeaters and the ocean block equalizers shall meet the reliability requirements to be stated in sub-section 1.5. of this specification.

3.2. Electrical Design Requirements

3.2.1. Repeaters

3.2.1.1. Amplification

(a) The repeater shall provide amplification in both directions by means of one or two transistorized amplifiers.

(b) If a single amplifier is proposed, the repeater shall have adequate margins against overload instability over the full anticipated temperature range.

(c) The repeater may have a variable gain facility, controlled by ambient temperature, in order to compensate for cable loss due to temperature change, if necessary. Such a repeater will be related as T-AGC repeater in following sections.

3.2.1.2. Supervisory

(a) The Contractor shall supply repeaters which contain discrete supervisory circuit which enable in-service and out-of-service measurements to be made of system transmission performance and fault localization from the shore terminals.

(b) In case of T-AGC repeater applied, the supervisory circuit shall have facility of varying its tone frequency with ambient temperature variation. The temperature coefficient for the frequency shall be well controled and stable and shall be enough large to give fine resolution of ambient temperature measurement up to 0.1 degree centigrade.

(c) The supervisory system shall be compatible with the terminal supervisory equipment described in Section 8 of this specification.

(d) The frequency stability of the supervisory oscillators shall remain stable over the range of sea-bed temperatures given in Appendix 1 and throughout the anticipated life of the cable system.

(e) The design of the repeaters shall ensure that the failure of any component in the supervisory system will not affect the main transmission path.

3.2.1.3. DC and LF Characteristics

(a) The repeater shall contain adequate protection against d.c. power surges or transients which may occur due to cable faults or lightning disturbance.

(b) The design of the d.c. circuit shall ensure that low frequency fault location tests are possible.

(c) To facilitate system d.c. fault location, the Contractor shall submit data on the d.c. resistance/current charactersitic of the repeater over a range of currents to be agreed between the Purchaser and Contractor.
This feature should only be incorporated if, in doing so, the reliability or per formance of the repeater is not degraded, and does not incur a significant increase in cost.

3.2.2. Ocean Block Equalizers

3.2.2.1. Type

In his offer, the Tenderer shall quote for either system (a) or (b) below.

(a) Two types of ocean block equalizers, non-adjustable ocean block equalizers and shipboard adjustable ocean block equalizers: the non-adjustable ocean block equalizers shall be completed in the manufacturer's factory prior to laying in order to equalize foresseeable misalignment, and the shipboard adjustable ocean block equalizers will be assembled, mounted and sealed, after final adjustment of insertion loss with the system under power, on board the cable ship in order to equalize misalignment measured during cable laying.

(b) A type of ocean block equalizer which shall house both fixed and adjustable equalizer units in one same housing and shall permit final adjustment of insertion loss during the laying operation with the system under power.

3.2.2.2. Temporary Test Point Facility

A temporary test point facility, of suitable electrical impedance, shall be provided in the housing of the shipboard adjustable ocean block equalizer, for the purpose of making transmission meadurements under power during the loading and laying of the system.

3.2.2.3. System Consideration

(a) The total length of a cable section containing an equalizer shall preferably be not less than 0.6 of a nominal cable section.
(b) If the Tenderer proposes two types of the ocean block equalizer, the shipboard adjustable ocean block equalizer shall preferably be inserted into the system at least every two non-adjustable ocean block equalizers.
(c) The response of the fixed equalizer unit or the non-adjustable ocean block equalizer will be agreed with the Purchaser at a suitable point during the submersible plant manufacturing programme.

3.2.2.4. Variable Equalizer Kits

The following requirements apply only if the Tenderer proposes, a type of equalizer which is de-mountable and capable of accepting shipboard designed equalization circuitry.

(a) The Contractor shall make available, in sealed boxes, sufficient equalizer kits containing suitable equalizer units, components and materials, to cover all aspects of shipboard equalization of line equalizers.
(b) The kits for line and spare equalizers shall be identical, the contents being subject to agreement between the Contractor and the Purchaser.

3.3. Mechanical Design Requirements

3.3.1. Housing

(a) The repeater and equalizer housings shall be of a uniform type which has an entry at each end and be designed for laying inline with the cable by means of V-sheave laying gear, a linear engine or a drum-type cable engine.

(b) All housings shall be suitable for laying on the sea bed down to 500 meters.

3.3.2. Sea-cable Connection

The method of making the cable connection to the repeaters and equalizers shall be such that the strength of the connection is not less than the design tensile strength of all cable types except double armoured.

3.4. Information to be Supplied by Tenderer

In his offer the Tenderer shall include and define the following.

3.4.1. Information of Electrical Performance

3.4.1. Repeaters

(a) Electrical block schematic of the repeater.

(b) Maximum permissible voltage between inner conductor and the repeater housing.

(c) Nominal gain/frequency response of the repeater and permissible limits of gain deviation.

(d) Nominal input and output levels against frequency, and permissible limits of variation.

(e) Nominal characteristic impedance and return loss of repeater over operating band width and permissible limits of variation.

(f) Intermodulation products and maximum limits of variation.

(g) Nominal over-load point and permissible lowest level of overload.

(h) Nominal noise contribution and permissible upper level.

(j) The measures taken to ensure that ionization and corona discharge noise will not provide a source of impulsive noise on the completed system.

(k) Nominal potential difference across repeater at stated line current, and permissible limits of variation.

(l) Gain/d.c. line current characteristic and permissible limits of variation.

(m) DC characteristics

   (i) DC capacitance

   (ii) DC feeding current against voltage characteristic

   (iii) DC insulation resistance

(n) Temperature coefficients of gain characteristic

(p) Maximum and minimum ambient storage conditions

(q) Maximum ambient temperature at which repeater can be safely powered.

(r) Nominal phase delay of repeater over operating bandwidth and permissible limits of variation.

(s) For variable gain repeaters, the nominal gain vs. frequency response as parameters of temperature and permissible limits of gain deviation from the nominal.

(t) (i) Basic noise output level vs. frequency characteristic.

   (ii) Loop loss vs. frequency characteristic.

   (iii) Group delay distortion.

(u) (i) Thermal time constant of repeater gain, from the time of power up to gain rising to the nominal.

   (ii) Measures taken to achieve protection against d.c. power surge or transient and maximum value of voltage that the repeater will tolerate.

   (iii) Measures taken to ensure that adequate margins against overload instability will be provided for the repeater and the value of the resultant margin.

(v) Level and frequency stability of the supervisory circuits.

(w) Temperature coefficients of supervisory tone frequency vs. embient temperature for the T-AGC repeater.

(x) Transient responce of repeater gain and supervisory tone frequency against ambient temperature for the T-AGC repeater.

(y) The long term stability of repeater gain for the T-AGC repeater.

3.4.1.2. Ocean Block Equalizers

(a) Electrical block schematic of the equalizer.

(b) Maximum permissible voltage between inner conductor and housing.

(c) Nominal characteristic impedance and return loss of equalizer over operating bandwidth and permissible limits of variation.

(d) DC characteristics

(i) DC capacitance

(ii) DC insulation resistance

(e) Maximum and minimum ambient storage conditions

(f) Loop loss vs. frequency.

(g) Measures taken to achieve protection against d.c. power surge or transient and the maximum value of surge voltage that the equalizer will tolerate.

(h) Measures taken to ensure that ionization and corona discharge noise will not provide a source of impulsive noise on the complete system.

(j) Nominal phase delay of equalizer over the operating bandwidth and permissible limits of variation.

(k) The bandwidth over which equalization is anticipated.

(l) The periodicity of insertion of equalizers.

(m) Standard transmission characteristics of equalizer units for the shipboard adjustable ocean block equalizers, where applicable.

(n) Nominal insertion loss and permissible limits for the housed fixed equalizer.

3.4.2. Information of Mechanical Construction

3.4.2.1. Housing and Sea Cable Connection

(a) Details of the mechanical construction of the housing, including adequate cross-sectional plans showing the method of sealing and connection into line.

(b) Details of the method of electrical connection between the sea cable and the housing.

(c) The qualification tests to which the pressure housing design has been subjected including maximum hydraulic pressure employed and water vapour ingress rates.

(d) Tensile strength.

(e) Torsional strength.

(f) The qualification tests to which mechanical design of the assembled repeater and equalizers have been subjected, including shock strength, vibration strength and air-tightness; in the case of the adjustable equalizers the shipboard sealing method.

(g) Cathodie protection methods, if used.

3.4.2.2. Internal

Diagrams showing the physical location and function of units within the housing.

3.4.2.3. Overall

Dimensions and weights of a complete repeater, equalizer and joint housing.

4. LAYING OF SEA-CABLE

4.1. General

The Contractor shall load, transport, joint and lay the submarine cable, shall deliver and supervise the laying of land cables (i.e. the parts of sea cable on land) unless otherwise agreed.
And shall be responsible for equalizing the system and for meeting all the system performance requirements and guarantees in the Contruct.

4.2. Submarine Cable

4.2.1. The Tenderer shall state the name, owner and main characteristics of the ship he proposes to use the ocean laying and/or burying operations.

4.2.2. The Tenderer shall give details of any similar operations carried out by the ship.

4.2.3. The Tenderer shall provide full details of the following ship facilities:

(a) Cable and repeater/equalizer carrying capacity.
(b) Cable laying/recovery machinery.
(c) Navigation aids including echo sounding equipment.
(d) Cable system powering and testing equipment.
(e) Cable jointing equipment.
(f) Ship/terminal station communications facilities.

4.2.4. The laying ship shall be equipped with navigation equipment the performance of which enables the position of the ship to be established with an accuracy at least as good as that obtainable by using a single frequency receiver in conjunction with the U.S. Navy Transit Navigation

Satellite System (N.N.S.S.).

4.2.5. A cable laying time schedule and procedure shall be included with the offer. If it is not possible to lay the cable in one continuous run, then the detailed arrangements proposed for the transport of the additional cable and for its transfer to the laying ship shall be stated.

4.2.6. The Contractor shall be responsible to carry out cable landing works.

4.2.7. The Purchaser will trench and lay land cables with PEE earth cables, if necessary, and shall be responsible for provision of any necessary ducts. The specification and/or manual for these works shall be provided by the Contractor. The schedule of the work shall be mutually agreed between the Purchaser and the Contructor.
The topographies near the cable route at Cherating and Sematan are shown in Fig. and Fig. respectively.

4.2.8. The Purchaser will provide the entry of building for land cable and PEF earth cable.
The specification and the completion of them shall be recommended by the Contractor.

5. TERMINAL EQUIPMENT - GENERAL

5.1. Performance

5.1.1. CCITT Conformity

Unless stated to the contrary, elsewhere in this Specification, the equipment offered under sections 6 to 8 must be such, that the performance of the circuits provided can conform to all the relevant CCITT recommendations for international circuits.

5.1.2. Design Load

For design purposes, the system shall be considered to be fully loaded with the CCITT recommended channels of 3 kHz bandwidth, with a mean channel loading of -13 dBm0 per 4 kHz band.
Nevertheless, the system performance with regard to carrier leak etc. shall be such that the system can carry any mixture of 3 kHz and 4 kHz channels in accordance with subsection to the standard specified in subsection.

5.2. Environment

5.2.1. Limiting Values

The Tenderer shall state the limiting values of temperature and relative humidity of all the equipment offered for conditions of:

(a) storage

(b) normal operation within the requirements of this specification.

5.2.2. Effects on Performance

The terminal equipment shall continue to operate without damage at air temperatures in the range +5 to +40°C and relative humidities up to 85 %.

5.2.3. Expected Environmental Conditions

The terminal buildings at both terminal stations will be air conditioned. The ranges of temperature and humidity within the buildings with the air conditioning operating normally are given in Appendix 1.

5.3. Material Finish

5.3.1. Details of Finish

The material finish applied to the inside of the equipment racks shall comply with Japanese Industrial Standard JIS K5532 and K5652, Crown Agents Specification CAS 118-1963 or an internationally recognised equivalent.

5.3.2. Colour

The colour to be applied to the outside of all equipment racks to be installed at each terminal station is listed in Appendix 1.

5.4. Equipment Practice

5.4.1. Circuits

The equipment shall employ transistorized circuits throughout.

5.4.2. Construction

The equipment shall be constructed in a recognized form of modular construction.

5.4.3. Dummy Covers

Where shelf or card positions are unequipped, dummy covers shall be provided.

5.4.4. Equipment Practice

The Tenderer shall supply full details of the equipment practice offered, including all rack dimensions.

5.4.5. Weight

The Tenderer shall state the weight of the heaviest rack when equipped to its maximum capacity. Details of the maximum permissible floor loadings for each terminal station are given in Appendix 1.

5.4.6. Cable Entry

The equipment at both terminals shall allow for top cable entry.

5.5. Installation

5.5.1. The Contructor shall be responsible for the installation of all terminal equipment detailed in this Specification.

5.5.2. The schedule and the outline of procedure of installation works shall be proposed by the Contractor and agreed by the Purchaser.

5.5.3. The Purchaser will provide the adequate floor spaces in the buildings, power supply and air-conditioning without delay according to the schedule (4.1.2.). Any information concerning the condition of stations required for the installation works such as layout plan, weight and dimensions of each equipment, construction of suspension for equipment, etc. shall be provided by the Tenderer.

5.6. Cabling

The types of cable used for inter-unit cabling and for installation cabling shall be stated by the Tenderer.

5.7. Labelling

The equipment supplied to both terminal stations shall be labelled and signwritten in English.

5.8. Alarms

5.8.1. Specific Details

The alarm facilities on the equipment being supplied shall be as described by the Contractor in his tender documents.

5.8.2. Fail Principle

The design of the alarm circuits should be such that the failure of the power supply to, or the failure of any active component in, any alarm circuit shall cause an alarm to be given.

5.8.3. Identification

Alarm facilities shall permit the ready identification of the functional element concerned in the fault.

5.8.4. Alarm Extension

The alarm condition extended back to the alarm concentrating equipment should be of the changeover type. i.e. for providing the option of either a voltage free loop or an earth in the alarm condition.

5.8.5. Terminal Details

The Contractor shall provide alarm indicators (audible and visible) which are established under the iron structure at the edge of each rack alignment. The individual rack alarm shall give 'major' and 'minor' alarms, corresponding to urgent and non-urgent faults respectively.

5.9. Power Supplies

5.9.1. Purchaser's Responsibility

Battery rectifier sets and all necessary primary power sources required by this system will be provided by the Purchaser and therefore should not be included in any bid.

5.9.2. Power Requiremtn

It is the Tenderer's responsibility to fully specify in his bid the input power requirements of his equipment, to enable the Purchaser to provide suitable no-break power plant. In particular, the Tenderer shall state:

(a) the voltage and frequency limits of the input power to his equipment to enable it to perform to this specification.

(b) the power consumption of each rack.

(c) the total power requirement of the offered equipment.

5.9.3. Power and Alarm Unit for Transmission equipment and Monitoring equipment for Submerged Repeaters.

The power units and associated alarm facilities used on these equipments shall incorporate the following:

(a) The conversion of the station power source to a form suitable for the requirements of the equipment to be supplied.

(b) The distribution of the derived supply through fused outlets to the apparatus.

(c) Provision of power unit failure alarms and fuse alarms.

5.10 Duplication and Changeover

5.10.1. Duplication Required

The degree of duplication required for the terminal transmission equipment used on this system is defined in the individual equipment specifications under Section 6. However where duplication is provided, it must meet the conditions of this subsection 5.10.

5.10.2. Automatic Changeover Philosophy

All duplication of the terminal transmission equipment should incorporate automatic changeover to the standby set immediately the working path fails, unless there is also a fault condition in the standby path, in which case automatic changeover should be inhibited.

5.10.3. Changeover Alternatives

All changeover equipment shall be equipped for both automatic and manual changeover, and it must be possible to patch these changeover facilities out should the changeover unit become faulty.

5.10.4. Conditions of Changeover

The operational conditions under which changeover from working to standby equipment will take place shall be as stated by the Contractor in his tender documents.

5.10.5. Traffic Interruption

The duration of any interruption to traffic during changeover shall not exceed that stated by the Contractor in his tender.

5.11. Equipment Test and Monitor Points

5.11.1. Test and Monitor Points

All the equipment offered shall have sufficient test and monitor points to enable the performance of the equipment to be monitored without degradation of its performance.

5.11.2. Abuse of Test and Monitor Points

There shall be no disturbance to traffic should the test or monitor points, on any of the equipment supplied, be subject to:-

(a) a short circuit

(b) an open cirucit

5.12. Acoustic Noise

The acoustic noise of the terminal equipment (including the power feeding equipment) shall not exceed 50 dB (A-weighted) with the relevant clouses of JIS C 1502. or equivalent level with British Standard 3489.

5.13. Spares

5.13.1. Minimum Requirements

The following spares shall be offered with the equipment, and the Contractor shall recommend any futher items, peculiar to the equipment offered, that should be held as spares.

Item	Maintenance
Lamps	200 %
Fuses	500 %
Power Smothing Capacitors (Electrolytic)	50 %
Connectors, U-Links etc.	10 %
Fuse Carriers or Holders	10 %
Semiconductor Devices	20 %*

* with a minimum of two and a maximum of twelve of any one type.

5.13.2. Spare Units

The Tenderer shall offer a recommended set of spare units (both active and passive), making due allowance where units are duplicated or common to various items of equipment. The reference code, function, and unit price of each unit shall be shown separately.

5.13.3. Spare Unit Accomodation

Where spare units are recommended, it is preferred that shelf accomodation within the equipment be provided for storage purposes. Included in the accomodation shall be unit positions into which outriggers of each type may be fitted to enable power to be applied to units under fault investigation.

5.14. Test Equipment, Special Maintenance Tools, etc.

5.14.1. List of Test Equipment

The Tenderer shall submit with his bid an itemized list of the test equipment, other than that supplied as an integral part of the terminal equipment, which be recommends should be held at each terminal station for maintenance purposes. This list should include any d.c., l.f. and pulse echo test equipment considered necessary for cable testing. The reference code, appropriate specifications, and unit price of each equipment shall be shown separately.

5.14.2. Special Tools etc.

The Contractor shall supply to each terminal complete sets of special tools, adaptors, test cords etc. as listed in his tender documents.

5.15. Training

5.15.1. General

The Contractor may be required by the Purchaser to provide some form of training for the Purchaser's technical staff. The objectives of this training shall be to provide a through working knowledge of the equipment used on the system thus allowing each of the staff involved to operate and maintain the system as a part of an integrated team.
The Tenderer shall therefore quote for two types of training, viz:

(a) Formal training to be undertaken at the Tenderer's factory and/or training school.

(b) Provision of training staff to undertake formal training in the Malaysia, (or a suitable alternative site to be mutually agreed at a later date between the Tender and the Purchaser). This should be followed by on-site practical training and instruction of the maintenance procedures of the equipment prior to the 'ready for service' date in order to meet the training objective state above.

5.15.2. Quotation for Type (a) Training

A quotation for (a) should be given on a cost per student-week basis and shall include the cost of tuition, single accommodation and food, per week. The cost of these items are to be quoted separately. This quotation should also state what are the minimum and maximum number of students that can be accomodated simultaneously on each course.

5.15.3. Quotation for Type (b) Training

Costs for (b) should be based only on the cost of the provision of the training staff, including travel, residential accommodation and subsistance. It can be assumed that accommodation for the training activities will be provided by the Purchaser.

5.15.4. Course Content

The Tenderer shall submit with his tender a provisional syllabus for the course, together with a timetable showing the approximate time devoted to each section of the syllabus.

5.15.5. Repeat Course

Confirmation is required that repeat courses will be available together with an indication of costs involved for each course.

5.15.6. Course Notes

Full sets of notes of the proposed courses shall be supplied for each student before the course commences and two copies of these notes shall also be supplied before the course commences for use in the Purchaser's Head Office.

2.15.7. Language

The normal language for instruction will be English, except in the case where a Japanese manufacturer conducts courses for Japanese students.

6. TERMINAL TRANSMISSION EQUIPMENT

6.1. Supergroup Translating Equipment including Supergroup Auxiliary Equipment

6.1.1. Frequency Band

This equipment shall assemble supergroups of the basic supergroup band 312-552 kHz into a frequency band suitable for injection into the High Frequency Line Equipment, and in the receive direction shall separate the output of the High Frequency Line Equipment into basic supergroups.

6.1.2. Assembly of Supergroups

The method of supergroup assembly and the interface parameters are left to the discretion of the Tenderer, provided that no conditions in this specification are violated, and subject to the approval of the Purchaser.

6.1.3. Frequency Translation Details Required

The Tenderer shall provide full details of his proposals for frequency translation.

6.1.4. Duplication

The terminal transmission equipment shall be duplicated to the extent that failure of an active unit shall not cause the loss of more than one supergroup.

6.1.5. Carrier Derivation

All supergroup carrier frequency supplies shall be derived from standard frequency source, and shall conform with the requirements of subsection 6.7.

6.1.6. Levels

The Tenderer shall state the nominal level and range of adjustment of the equipment at its supergroup interface. The range of adjustment shall allow the required supergroup levels at each terminal station, as detailed in Appendix 1, to be realised.

6.1.7. Impedance

The impedance of the equipment at its supergroup interface shall be 75 ohms, with a return loss better than 20 dB.

6.1.8. Cross talk

The near and far end crosstalk, with the equipment suitably looped back, shall be better than 80 dB between any two supergroups.

6.1.9. Performance

The frequency response, gain stability, carrier leak, noise, etc. performance of the equipment shall be such that the requirements of the relevant CCITT recommendations for international circuits are met.
The carrier leak and other spurious signals shall meet the requirements for data and facsimile transmission.

6.2. Supergroup Section Pilots

6.2.1. General

As stated in subsection 1.3, the provision of this equipment to monitor the performance of each supergroup over the system is left to the discretion of the Tenderer subject to the approval of the Purchaser.
Where it is provided, it shall meet the requirements of the remainder of this subsection 6.2.

6.2.2. Frequency

The frequency of the pilots 308 kHz shall be such that the performance of the circuits provided by the overall system can meet the requirements of the CCITT recommendations for international circuits.

6.2.3. Generation

The Tenderer shall clearly indicate his proposed method of generating the pilots. Preference will be given to arrangements in which the pilots are derived from the same standard frequency source as the supergroup carriers. The frequency stability of the pilots shall be ± Hz.

6.2.4. Level

The pilot level shall be -20.0 dBm0, with a stability such that the output of the level generator shall not deviate by more than ± 0.1 dB.

6.2.5. Monitoring

Equipment shall be provided to extract the pilots from the transmit and receive transmission paths, and to indicate the deviation of the pilot levels from nominal. The pilot monitoring equipment may be of the cyclic type.

6.2.6. Monitoring Stability

The inherent stability of the pilot measuring equipment shall be such that the indication of a fixed level pilot frequency signal does not vary from the nominal by more than ± 0.1 dB.

6.2.7. Conditions for Stability

The stabilities referred to in subsections 6.2.3, 6.2.4, and 6.2.6 relate to a period of one week, without maintenance adjustment, and for the voltage and environmental flactuations specifified in subsections 5.9.2 (a) and 5.2.1. (b) respectively.

6.2.8. Alarms

A visible and audible alarm shall be given if any pilot level deviates from nominal by ± 3 dB.

6.2.9. Level Recording

It shall be possible occasionally to record the level of a selected pilot over a selected period.

6.2.10. Performance

The noise, crosstalk and harmonic content of the pilot supply shall conform to the requirements of the CCITT recommendations for international circuits.

6.3. Supergroup Regulating Equipment

6.3.1. General

This equipment shall be provided to fulfil either or both of the following functions:

(i) generation of alarms

(ii) regulation of supergroup gain variations due to the submarine segment only, to enable the overall system performance objectives detailed in Section 9 to be realized.

6.3.2. Regulation

The type of regulating equipment provided by the Contractor shall be as described in his tender documents, and the Contractor shall ensure its satisfactory operation bearing in mind any supergroup and group link regulation that may be used on the system.

6.3.3. Auto Control/Fixed Gain Working

The equipment shall operate on fixed nominal gain, or automatic gain control under supergroup pilot control.

6.3.4. Alarms

Alarms shall be provided such that visual and aural indications are given when the gain control of the supergroup exceeds a specified amount. Provision shall be made to cancel alarms whilst the alarms is receiving attention.

6.3.5. Performance

The crosstalk, intermodulation, noise etc. performances of the equipment shall conform to the requirements of the CCITT recommendations for international circuits.

6.4. High Frequency Line Equipment

6.4.1. Equipment Coverage

In the transmit direction, this equipment comprises all that between the h.f. output(s) of the supergroup translating path(s) and the traffic input to the power separating filters.

In the receive direction, this equipment comprises all that between the traffic output from the power separating filters and the h.f. input(s) of the supergroup translating path(s).

In both directions the equipment shall include all necessary items to meet the transmission requirements.

6.4.2. Duplication

The equipment shall be sufficiently duplicated to ensure that the failure of any active unit shall not cause the loss of more than one supergroup of traffic for any period greater than the time required for the automatic changeover to the alternative set. All duplication and changeover arrangements shall conform to the requirements of subsection 5.10.

6.4.3. Signal Injection and Extraction

All engineering service circuits, pilots, repeater supervisory signals etc. necessary for the control and monitoring of the system shall be injected and extracted within this equipment.

6.4.4. Carrier Supplies

All the necessary carrier supplies used in the equipment shall be provided from a standard frequency source. If the available supplies are insufficient, or unsuitable for use with the Tenderer's equipment, then the Tenderer's bid must include any extra master oscillator and carrier generating equipment to meet his requirements.
This carrier generating equipment must satisfy the conditions of subsection 6.7.

6.4.5. Temperature Equalization

The equipment shall include temperature equalizers which will limit the effects of variation in cable attenuation due to temperature, to $\pm$ 0.3 dB at any frequency. The range of temperature fluctuations to be expected over the route is given in Appendix 2. The temperature equalisers shall provide additional compenstation to cover a range 50 % in excess of that shown in Appendix 2, or an extra 3 dB, whichever is the greater.

6.4.6. Cable Length Increase Equalization

The equipment shall include equalization facilities to compensate for increases in cable length due to repairs i- shallow water. These facilities shall compensate for 1 nautical mile of repair cable (1 inch).

6.4.7. Design Requirements

Cable simulators, cable equalizers, and temperature equalizers shall be designated in terms of their loss in dB, at the highest traffic frequency, and shall be adjustable in steps equivalent to 0.5 dB at that highest traffic frequency.

6.4.8. Standard Amplifiers

Prefence shall be given to equiment employing only one type of amplifier in each wideband path.
An exception to this principle may be either the first receive amplifier which may require an improvalnoise performance, or the final transmitting amplifier which may require an improved overload performance.

6.5. Cable System and Frequency Comparison Pilots

6.5.1. General

Pilots shall be provided to enable the performance of the submarine cable system to be adequately monitored. The disposition of pilot frequencies within the transmitted spectrum shall be left to the discretion of the Contractor, subject to the approval of the Purchaser.

The pilots transmitted to line shall comprise at least cable pilots, and frequency comparison pilots, and the Tenderer shall state the frequency and level of each.

6.5.2. Cable Pilots

The cable pilots shall monitor the insertion gain of the submersible plant. At least one cable pilot shall be fed over the cable in each direction of transmission. The points of pilot injection and extraction shall be electrically as near to the submarine cable as possible, but on the four wire side of the directional filters.

6.5.3. System Pilots

The system pilots shall monitor the wideband transmission paths in both directions of transmission. The system pilots shall provide sufficient information to enable the seasonal variations of sea temperature to be assessed, and adjustments made in the terminal equipment to compensate for the resultant change in system gain. It is therefore probable that two pilot frequencies, one near each end of the baseband spectrum, will be needed in each direction of transmission.

6.5.4. Frequency Comparison Pilot

The frequency comparison pilot shall enable the frequency standards used in the terminal stations to be compared. Facilities shall be provided to allow the comparison pilot to be transmitted in either direction of transmission.

6.5.5. Other Pilots

The Tenderer shall state the function of any other pilots be proposes to transmit over the system.

6.5.6. Pilot Generation

All the necessary pilot frequencies shall be generated within the terminal transmission equipment, either from the station standard frequency source, or from individual oscillators. The generation of all pilots that are used in a control function, as distinct from a monitor function, must be fully duplicated with automatic changeover in accordance with Section 5. 10. The duplication of the generation of pilots used solely in a monitor role is left to the discretion of the Tenderer.
The Tenderer shall clearly indicate where the generation of pilots is duplicated.
The Tenderer shall state the output level and frequency stabilities of all pilot generators.

6.5.7. Pilot Monitoring

The Tenderer shall state clearly in his proposal where and how each pilot is to be monitored. The monitoring shall allow the functions specified in paragraphs 6.6.2, 6.6.3 and 6.6.4 to be adequately realized, and meet the alarm requirements specified in Section 5.8.

The received levels of the system and cable pilots shall be permanently recorded.
Permanent recording of remaining pilots is left to the discretion of the Tenderer subject to the agreement of the Purchaser, but facilities and equipment must be provided to record any two other pilots for a short period (typically 24 hours). Chart recorder output points shall therefore be provided on all pilot detectors.

6.5.8. Special Monitors

The Tenderer is invited to quote for the provision of any additional monitoring facilities as a separate optional extra. Where these facilities are offered, the Tenderer shall supply full details of the proposed arrangements.

6.6. Equipment for Engineering Service Circuits (ESC)

6.6.1. Capacity

Duplicated equipment shall be provided at each terminal station to provide three voice frequency engineering service circuits, each of 4 kHz bnadwidth, over the system. Three telegraph engineering service circuits shall be carried on one of the voice frequency engineering service circuits.

6.6.2. Changeover

The changeover from the main to the standby equipment may be manual only.

6.6.3. Channel Disposition

The disposition of the engineering service circuits within the baseband is left to the discretion of the Tenderer, subject to the approval of the Purchaser.

6.6.4. Circuit Requirements

The engineering service circuits shall fulfil the following roles:

(a) Two 4 kHz telephone circuits between the two terminals of each system.

(b) One 4 kHz circuit, equipped with combined speech and three telegraph circuits, between the two terminals of each system.

(c) One 4 kHz omnibus telephone circuit between all three terminals, with selective signalling facilities and capable of being extended to his i.t.m.cs by the Purchaser.

6.6.5. Ancillary Equipment

The Tenderer will offer ancillary equipment to meet each of the roles specified in sub-section 6.6.4, as follows:

for 6.6.4. (a): rack mounted handsets and signalling equipment.

for 6.6.4. (b): equipment to combine a restricted speech channel with 8 telegraph channels corresponding to CCITT Rec. R70 bis, channels 121, 122, 123 with ± 30 Hz modulation.
The speech channel so obtained will be equipped with rack mounted handsets and signalling equipment.
The provision of teletypewriters for use on the three telegraph circuits is excluded from this contract.

for 6.6.4. (c): bridging units, 4 wire handsets and equipment to provide selective signalling facilities.
The selective signalling equipment must have a coding system capable of use with at least twenty different destinations. Where in the Tender Schedule in Part 1 of this specification the Tenderer is invited to quote for the supply of just one segment, the Tenderer will include the necessary bridging facilities in Ilocos Norte as part of that quotation.

6.6.6. Duplicate Carrier and Signalling Generation

All necessary duplicated carrier and signalling generating equipment for the derivation of these circuits shall be included in the terminal transmission equipment.

6.6.7. Performance

The performance of the equipment for the engineering service circuits shall be sufficient to enable the terminal to terminal performance requirements listed in Section 9.10. to be realised, assuming that the system is laid down on the wideband system specification in sub-section 9.4.

6.7. Special Carrier Generating Equipment

6.7.1. General

All carrier frequency supplies necessary for the various translation stages in the supergroup/hypergroup or special supergroup/wideband or high frequency line equipment shall be derived within the terminal transmission equipment from a standard frequency supply.

6.7.2. Equipment Provision

The Tenderer shall provide a suitable master oscillator and a carrier generating equipment to meet the requirements of Section 6.10.1.

6.7.3. Duplication

The master oscillator and all carrier generating equipment offered shall be fully duplicated with automatic changeover compliant with sub-section 5.10 of this specification.

6.7.4. Frequency Comparison

The master oscillator shall include facilities to enable comparison between the distant terminals using the frequency comparison pilot specified in sub-section 6.5.4. The frequency comparison equipment shall adequately display the frequency difference, and generate an alarm compliant with Section 5.8 should this difference exceed a predetermined amount.

6.7.5. Performance Quality

The frequency stability, noise, crosstalk, harmonic content etc. of the output frequencies of the master oscillator and all carrier generating equipment offered shall conform to the requirements of CCITT recommendations for international circuits.

7. POWER-FEEDING AND CABLE-TERMINATING EQUIPMENT

7.1. General

7.1.1. Purpose

This equipment shall be provided at each terminal to feed the submarine cable system with a high-voltage, transient-free, direct current to energize the submerged repeaters described in Section 3 in such a way as to allow the system performance detailed in Section 9 to be realized. The equipment shall include power-separating filters to extract the transmission band from the powered system.

7.1.2. Capacity

The equipment supplied to each terminal shall be capable of supplying the total power required by the segment. Each segment will normally be powered from both terminals simultaneously, with the equipment at each end feeding opposite polarity to line. In the event of failure to supply power from one terminal, the distant terminal will automatically take over the full load without degradation of performance.

7.1.3. Each power feeding equipment shall have redundant power units such that, in the event of failure of one, the other will automatically take over without degradation of system performance.
Each power unit shall be fed from, or incorporate its own, invertor.

The Tenderer shall state his preferred mode of working of the redundant power units at each terminal (i.e. load sharing, hot standby, etc.) and shall explain the reasons for his chice.

7.1.4. Stability

The stability of the line current shall be such that the system stability requirement, as specified in Section 9.8 can be adequately realized.

7.1.5. Primary Power Supply

Preference will be given to equipment that can be driven off existing power supplies within each terminal as listed in Appendix 1. If no such supplies are available, or if these supplies are unsuitable, then the equipment's primary power input requirement shall be continuous d.c. from a battery/rectifier arrangement supplied by the Purchaser (see Section 5.9.4).

7.2. Safety of Operating Personnel

7.2.1. General

The Tenderer's attention is drawn to the personnel Safety requirements listed under Section 1.8. These requirements are particularly relevant to the power feeding equipment.

7.2.2. Mechanical Interlocking

The equipment shall be mechanically interlocked to prevent maintenance staff gaining access to parts at dangerous potentials, whether these are generated at the near end or the far end of the system.

7.3. Protection of the Submarine System

7.3.1. General

The design of the equipment shall ensure that no hazardous current or voltage is applied to the cable system at any t-me during normal operating conditions or under fault conditions arising from faults external or internal to the equipment.

7.3.2. Voltage Limiting

The output voltage from either terminal shall be inherently restricted to a maximum value which cannot damage the cable system. This restriction shall not rely on the voltage alarm devices.

7.3.3. Energizing Methods

A controlled method for energizing the system shall be incorporated in the equipment design. This method shall be as described in the tender documents. Switching surges are to be minimised as far as possible during switch-on or changeover of power units.

7.3.4. Current Control

The current control device(s) shall be connected to the (live' side of the high voltage loop. It shall be possible, by means of variable control, to set the current with an accuracy compatible with the type of submerged repeaters offered.

7.3.5. Lightning Protection

The equipment shall ensure that the submarine cable system and terminal equipment is protedted in the event of a rapid rise in the potential difference between the station earth and sea-earth, or ground-rod earth, connection as a result of a lightning strike at, or adjucent to, either terminal. Proposed methods of protection shall be submitted for approval by the Purchaser.

7.3.6. Current Unbalance Indication

The equipment shall incorporate a device to indicate any unbalance of current in the 'live' and 'earth' sides of the high voltage output power loop.

7.3.7. Fusing

Fusing of circuits shall be arranged to ensure that the blowing of any one fuse shall not cause interruption of the cable current. Feeds to tripping alarms shall be fused separately from each other and other alarm facilities.

7.3.8. Automatic Shutdown

The equipment shall shut down automatically in the event of a complete failure of the power supply feeding the alarms and trips.

7.4. Alarms

7.4.1. General

The equipment shall be fitted with alarms to enable its performance to be closely monitored and supervised. The trips, alarms and lamp indications shall prevent a power equipment fault from causing damage to the submerged repeaters and to protect the power equipment against further damage should any component become faulty.

7.4.2. Duplication

If failure of an alarm would endanger either the cable system or the power feeding equipment, that alarm shall be duplicated.

7.4.3. Testing

It shall be possible to test all alarms with the equipment in service without interrupting the cable current or leaving the system unprotected.

7.4.4. Alarm Facilities

The alarm facilities provided by the equipment and the action each alarm initiates shall be stated in the tender documents.

7.5. Meters and Recorders

7.5.1. Accuracy

The equipment shall provide a method of measuring the output current to an accuracy of 0.1 % or better, and output voltage to an accuracy of 0.5 % or better. The method of carying out these measurements should be stated in tender documents.

7.5.2. Safety Glass

Meters indicating current or voltage in sections of the circuit normally operating at high voltages shall be fitted with static-free safety glass. If the fitting of such glass affects the ability to read the meter, then meter illumination shall be provided.

7.5.3. Recorders

Recorders shall be provided to record the output line current and voltage and the dummy load current and voltage.

7.6. Dummy Load

The equipment shall include a dummy load made up of resistive elements capable of adjustment over the full working range of the equipment.

The dummy load shall be capable of connection to either:

a) an individual power equipment and
b) if possible the entire power feeding suite when the equipment is out of service.

for maintenance purposes.

7.7. Earthing Facilities

7.7.1. General

The Tenderer shall propose PFE Earths at both terminal shall be a beach earth type. The Purchaser may request to change them to the sea earth type. The conditions for the cable of the PFE Earths will be as follows:

(ref. 4.4.2 (7))

i) The cable will be layed by the Purchaser.

ii) Cable length from the terminal station to the beach

at CHERATING	1,030 meters
at SEMATAN	380 meters

iii) The cable will be layed in duct where necessary but shall be protected by armour.

7.7.2. Current Measurements

The power feeding equipment or the cable terminating equipment shall measure the current flowing in each conductor of the power feed earth cable and the portion of the current flowing to the station earth.

7.7.3. Potential Measurements

The facilities of the potential measurement shall be either (a) or (b).

(a) Facilities shall be provided for measuring the potential drop of the earth system by using one conductor as a pilot.

(b) Facilities shall be provided for measuring the potential difference between the power feed earth system and the station earth system.

The Tenderer shall state his preferred method.

7.7.4. Changeover

Facilities shall be provided for earthing the power feeding system solely through the station earth, and then safely disconnecting and isolating the power feed earth, to enable maintenance work to be carried out without deenergizing the system.

7.7.5. Automatic Changeover

Protective devices shall be provided to route the cable return current automatically to the station earth should the power-feed earth become disconnected. The operation of the devices shall not cause interruption or interference to the system or permit rises in power equipment earth potential sufficient to damage the equipment or endanger personnel. Audible and visible alarms shall be given on operation of the device.

7.8. Wiring

7.8.1. Return Conductors

The equipment frameworks or cubicles shall not be used as the return conductor on any circuit.

7.8.2. Isolation of High Voltage Output

The equipment high-voltage output circuit shall be isolated from the rest of the equipment and connected to earth only via the power-feed earth. High voltage 'live side' wiring and 'earth side' wiring shall be separated from each other and from the framework by an appropriate air space.

7.8.3. Insulation of High Voltage Wiring

The insulation properties of the entire high voltage output loop wiring on both the 'live' side and 'earth side' shall be suitable for the maximum output voltage that the equipment is capable of delivering.

7.8.4. Length of Wiring

The wiring shall be as short as possible, especially that in the highvoltage output loop, and be accessible for easy inspection and identification when the equipment is de-energized.

7.8.5. High Voltage Soldered Connections

All high voltage soldered connections shall be rounded to prevent corona discharges.

7.9. Cable Termination

7.9.1. General

The complete submarine cable terminating device and power separating filter shall preserve the coaxial form of the transmission path. The cable termination shall be soldered permanently.

Provision shall be made for cable testing by the use of removable soldered straps so that the cable termination itself need not be disturbed.

7.10. Performance

7.10.1. General

The overall performance of the equipment shall enable the system performance requirements listed in Section 9 to be adequately realized.

7.10.2. Power Separating Filter Loss

The pass band loss of the power separating filter shall not exceed 1.2 dB over the system baseband.

7.10.3. Power Separating Filter Return Loss

The return loss over the pass band of the power separating filter against a non-reactive resistor equal in value to the modulus of the characteristic impedance of the cable shall not be worse than 20 dB. This measurement shall be made at the submarine cable port when the h.f. port is properly terminated and the d.c. port is both open and short circuit. A similar measurement shall be made at the h.f. port with the submarine cable port terminated in the non-reactive resistance and the d.c. port is both open and short circuit.

7.10.4. High Frequency Noise

The noise produced by the power feeding equipment shall not exceed a level of -120 dBm in any 3 kHz slot within the transmission band. Measurements are to be made at the power separating filter h.f. output point, with the equipment under load sharing conditions and delivery any voltage between zero and estimated full system volts.

7.10.5. Acoustic Noise

The acoustic noise output of the equipment shall meet the requirements of Section 5.12.

7.10.6. Corona Discharge

The Contractor shall be required to demonstrate to the Purchaser, before final acceptance of the equipment, that all parts of the equipment, where high voltages may exist, shall be free from ionisation discharge when tested to the maximum voltage capable of being generated by the equipment, plus 20 %, at a temperature of 20°C and relative humidity of 40 %.

7.10.7. Regulation

The load regulation of the equipment shall be sufficient to allow the cable system to be powered from either one or both terminals without manual adjustment of the line current and without degradiation of the system performance.

8. SUBMERSIBLE REPEATER MONITORING EQUIPMENT

8.1. General

Monitoring equipment for submerged repeaters (m.e.s.r.) shall be provided at each terminal. This equipment must be capable of monitoring the individual performance of the submerged repeaters whilst the system remains in service, so that a faulty repeater may be identified.

8.2. Compatibility

The type of monitoring equipment offered will depend upon the type of submerged repeaters offered under Section 3.

8.3. Without Repeater-Noise Locating Facilities

For those submerged repeaters offered under section 3 without facilities for localizing repeater noise, it is envisaged that Tenderers will offer standard, commercially available measuring equipment, or a monitoring equipment specifically designed for use on a submarine cable system.
The equipment offered will enable measurements to be made of the frequency and level of each repeater supervisory tone without degradation of system

performance. The contractor shall submit the facility for measuring method of the T-AGC Repeater temperature SV oscillator tone frequency to get information of water surrounding it.

8.4. Method of Working

The Tenderer shall describe the method of working of the offered m.e.s.r., and shall state what individual repeater and system measurements can be made while the system is in service, and what additional measurements are possible when the system has been taken out of service.

8.5. Manual and Automatic Monitoring

The m.e.s.r. shall enable the performance of each repeater to be determined:

a) by manual controls which shall permit the characteristics of any one repeater to be measured.
b) by an automatic method whereby the performance of each repeater is presented in a permanently recorded form by a teletypewriter. If possible, facilities may be provided to stop and hold the automatic measurement at any time in order to observe a particular repeater, and to continue automatic measurement when required.

9. OVERALL SYSTEM PERFORMANCE OBJECTIVES

9.1. Introduction

Although the Purchaser will be responsible for the laying and commissioning of the system, the overall system objectives are detailed in this Section for the guidance of the Tenderer.

The performance of the equipment supplied by the Contractor shall not prevent these objectives being attained.

9.2. General

9.2.1. Temperature Equaliser Settings

The overall system performance objectives relate to the system performance with temperature equalizer settings appropriate to the cable and repeater temperatuer conditions at the time of commissioning.

9.2.2. Stability of Performance

The Tenderer shall produce evidence to show that the satisfactory performance of the system can be maintained over the life of the system, which shall be at least 25 years, over the range of cable temperature variations given in Appendix 2a, and when the maximum cable repaire allowance in shallow water and a maximum stated number of additional repeater sections in deep water are included.

9.2.3. Interface

The interface of the system with on-going systems shall be the CCITT interconnection points S and S' (recommendation G371) at supergroup frequency on the supergroup distribution frame (s.d.f.) at each terminal. The relative levels at these points are indicated in Appendix 1 (A, B and C).

The impedance of the submarine cable system at the point S and S' shall be 75 ohms with a return loss of not worse than 20 dB.

9.3. Overall Gain

The overall insertion gain of the system between s.d.fs, with the terminal transmission equipment swithced to its main (regular) path at each terminal, at a frequency of 412 kHz, shall be kept within the nominal value ± 0.25 dB throughout the life of the system.

The change in insertion gain at any frequency within the system bandwidth, when changing from any combination of transmit and receive transmission paths to any other combination, shall not exceed 0.5 dB.

9.4. Insertion Gain/Frequency Response

The insertion gain/frequency response of the system for any combination of transmit and receive paths shall not exceed the following limits:

a) ± 1.5 dB relative to the insertion gain at mid frequency for the wideband path at any suitable flat wideband extraction point after the wideband residual equalizer.
b) 1.0 dB spread over any supergroup band between the points S and S'.

c) 0.5 dB spread over any group bandwidth within any supergroup band between the points S and S'.

9.5. Noise

With the system lined up to meet the requirements of Sections 9.2, 9.3 and 9.4, withall the pilots connected, and with a white noise test signal of bandwidth corresponding to the full traffic band and a mean power level of ($-13 + 10 \log_{10} N$) dBm0, where N is the number of equipment 4 kHz channels transmitted in one direction, a-plied at the wideband input in both directions simultaneously, then the average weighted noise in an unloaded 3 kHz test channel shall not exceed 1 pw/km of route length. The weighted noise in the worst channel shall not exceed 3 pw/km.
The above criteria refer to measurements taken at a point of zero relative level.

This requirements must be met when noise due to equipment down to the supergroup distribution frame has been included.

These noise objectives shall be met for any combination of transmit and recive terminal equipments.

The white noise tests shall be made using not less than 5 test frequency slots chosen to sample the baseband frequency range at approzimately equal intervals.

The weighting shall be in accordance w-th the CCITT Recommendation G223 for a 3 kHz telephone channel.

9.6. Crosstalk

For any combination of transmit and receive terminal equipments, the crosstalk between:

a) any two 3 or 4 kHz bandwidths corresponding to channels in the transmit path, and
b) any two 3 or 4 kHz bandwidths corresponding to channels in the receive path, and
c) any 3 or 4 kHz bandwidth in the transmit path to a similar bandwidth in the receive path, shall be better than that corresponding to a crosstalk path attenuation of 80 dB between equal level points.

9.7. Hum Modulation

The amplitude modulation by hum of any h.f. test signal shall be such that the ratio of the test signal to any sideband shall be greater than 56 dB. The test signal shall be derived from a battery operated signal generator.

9.8. Carrier Leak and Spurious Signals

9.8.1. Carrier Leak

The carrier leaks from the submarine terminal equipment shall not exceed -55 dBm0.

9.8.2. Spurious Signals

The level of any spurious signal in the traffic band from any sourse shall not exceed -70 dBm0p.

9.9. Stability

9.9.1. Stability Over 24 Hours

The overall insertion gain of the system shall not charge by more than 0.3 dB in any period of 24 hours except when changes in the battery supply voltage and/or ambient temperature of the terminal exceed the limits specified in sections 5.9 and 5.2.1 (b) respectively. Variations in gain which can be shown to be due to changes in cable temperature shall be excluded.

9.9.2. Effect of Line Current Changes

The overall insertion gain of the system at any frequency shall not change by more than 0.5 dB for line current changes ± 0.2 % of the nominal line current.

9.9.3. Effect of Changes in Carrier Supply

The overall insertion gain of the system at any frequency shall not change by more than ± 0.25 dB when the level of any one carrier supply to either terminal translation equipment is changed by ± 2.5 dB.
This requirement shall be met for all combinations of terminal transmission equipment.

9.9.4. Effect of Test Equipment

The connection of test equipment to the system shall not cause a disconnection in the main traffic path, nor a change in the level of the transmitted and received signals in excess 0.25 dB.

9.10. Pilots

9.10.1. Switching

Switching of pilot facilities shall not cause disconnection of the main traffic path nor any change in the level of the transmitted or received pilots in excess of 0.1 dB.

9.10.2. Error

The error in any system pilot level due to any interfering signal shall not exceed 0.1 dB when the system is operating under full load conditions and with all engineering service circuits active.

9.11. Engineering Service Circuits

9.11.1. Relative Levels and Impedances

The relative levels and impedances of the sudio terminations at each terminal station are given in Appendix 1.

9.11.2. Voice Channels

The general characteristics of the voice channels shall be in accordance with CCITT recommendation G151 for ordinary 4 kHz telephone channels, unless tighter limits are imposed in this specification, in which case the latter shall apply.

9.11.3. Combined Speech and Telegraph Channels

The characteristics of the combined speech and telegraph channels shall be generally in accordance with the relevant sections of CCITT Recommendation H34, except for item 4 (Filters) of that recommendation.

9.11.4. Noise Level

With a channel input at one terminal terminated in the correct impedance, the channel noise level measured at the corresponding channel output at a point of zero relative level shall not be greater than a value corresponding to 3 pw (weighted) per km of the route length.

9.11.5. Interference

Interference from the engineering service circuits to the traffic band, and from the traffic band to the engineering service circuits, shall not exceed -73 dBm0p.

9.12. Monitoring Equipment for Submerged Repeater

When in use for in-service tests, the monitoring equipment for submerged repeaters shall not cause interference to any traffic channel in excess of -73 dBm0p.

9.13. Impulsive Noise

The impulsive noise generated by the system shall be such as to enable the relevant CCITT recommendations to be met.

DETAILS OF THE TERMINAL STATIONS

(Numbers shown in brackets refer to the relevant sub-section of the technical specification)

1 AIRCONDITIONING

With the airconditioning equipment operating normally, the temperature and humidity of the terminal building will be restricted to 24 $\pm$ 2°C, 55 $\pm$ 10 % respectively.

2 COLOUR OF RACKS

The colour to be applied to the outside of all racks if Slate Gray (5PB6.2/0.2 by Munsell, Brilliance 60%).

3 MAXIMUM PERMISSIBLE FLOOR LOADINGS (5.4.5)

The maximum allowable superimposed floor loading of the carrier terminal room is 740 kg per square meter.

4 CABLE ENTRY (5.4.6)

Top entry is required for all cabling including the main cable, sea cable and power feeding earth cable entering all terminal equipment racks.

5 LANGUAGE OF LABELLING AND SIGNWRITING (5.7)

All labelling and signwriting on the equipment shall be in English.

6 ALARM ARRANGEMENTS (5.8.5)

The Contractor will be required to provide the alarm indicators (aural and visual) which are established under the iron structure at the edge of each rack alignment. The individual rack alarm shall give major alarm and minor alarm according to urgent and non-urgent.

7 PRIMARY POWER SUPPLIES FOR TRANSMISSION EQUIPMENT (5.9.3)

The transmission equipments are required to operate from DC -24 V battery/rectifier arrangement, and AC 220 V 60 Hz single phase static inverter arrangement (no break). Test equipments are required to use an AC 220 V 60 Hz voltage stabilised source.
The Tenderer shall fully specify the power input requirements of this equipment to enable the Purchaser to provide the primary power supplies.

8 PRIMARY POWER SUPPLIES FOR POWER FEEDING EQUIPMENT (5.9.5, 7.1.5)

The power feeding equipment is required to operate from DC -48 V for inverter and DC -24 V for control circuit by battery/rectifier arrangement, and AC 220 V 60 Hz for recorder motor.

The Tenderer shall fully specify the power input requirements of this equipment to enable the Purchaser to provide the primary power supplies.

9 SUPERGROUP INTERFACE PARAMETERS (6.1.6)

The supergroup interface levels/impedances are:

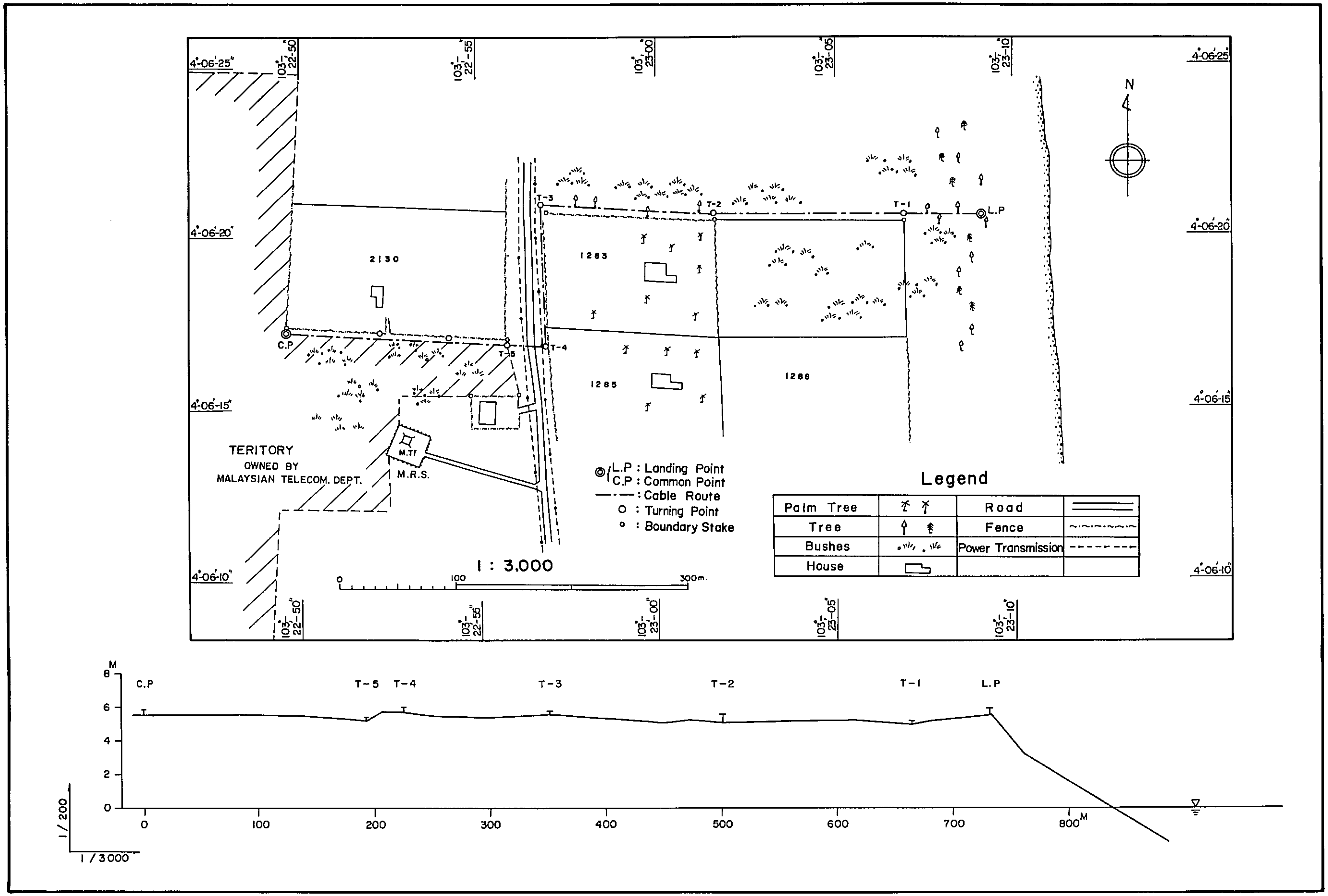
Supergroup In -29 dBr 75 ohms unbalanced.
Supergroup Out -29 dBr 75 ohms unbalanced.

10 ESC CHANNEL INTERFACE PARAMETERS (9.11.1)

The e.s.c. channel audio input/output levels and impedances are:

Audio In	0dBm	600 ohms balanced.
Audio Out	0dBm	600 ohms balanced.

LAND CABLE ROUTE CHERATING



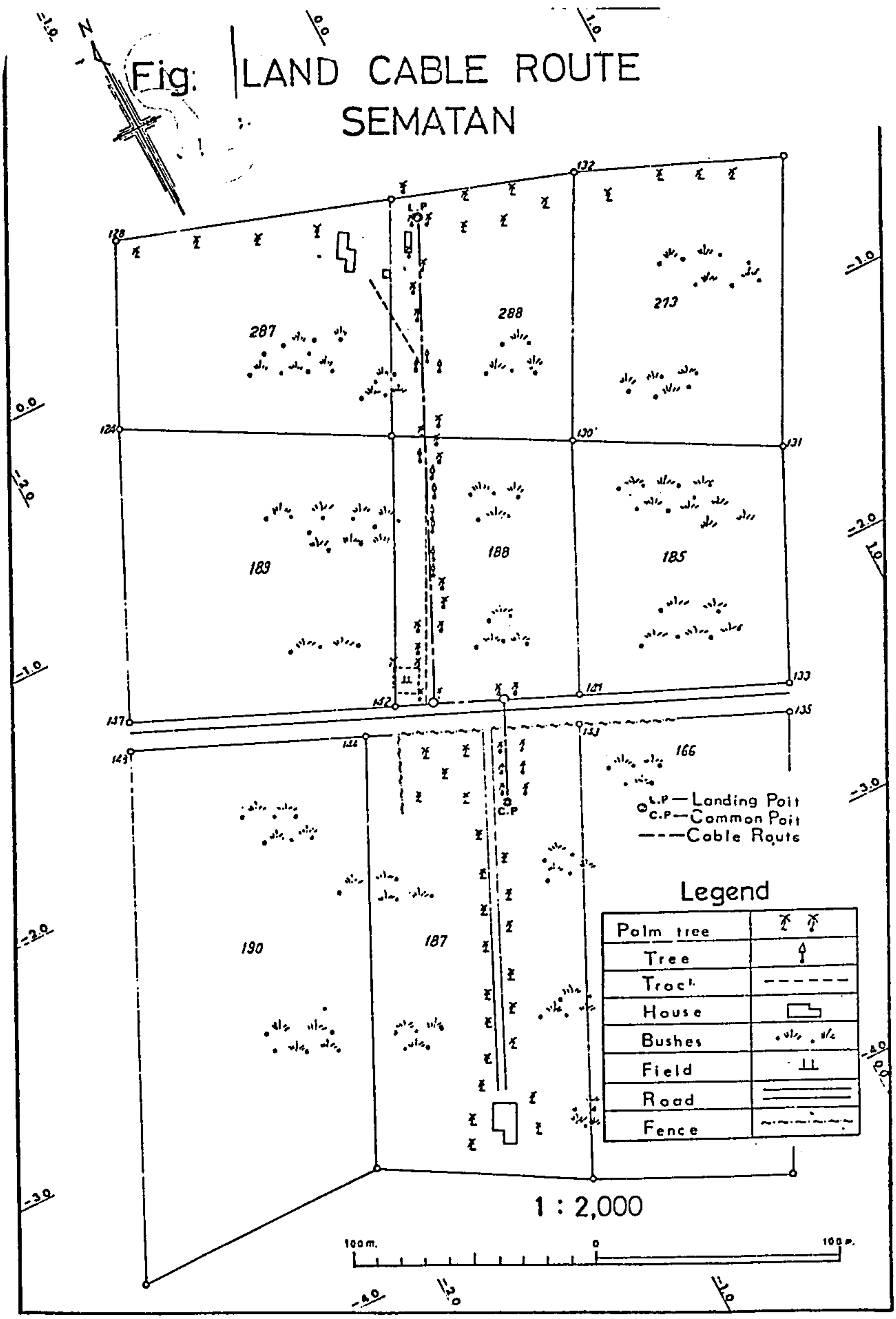
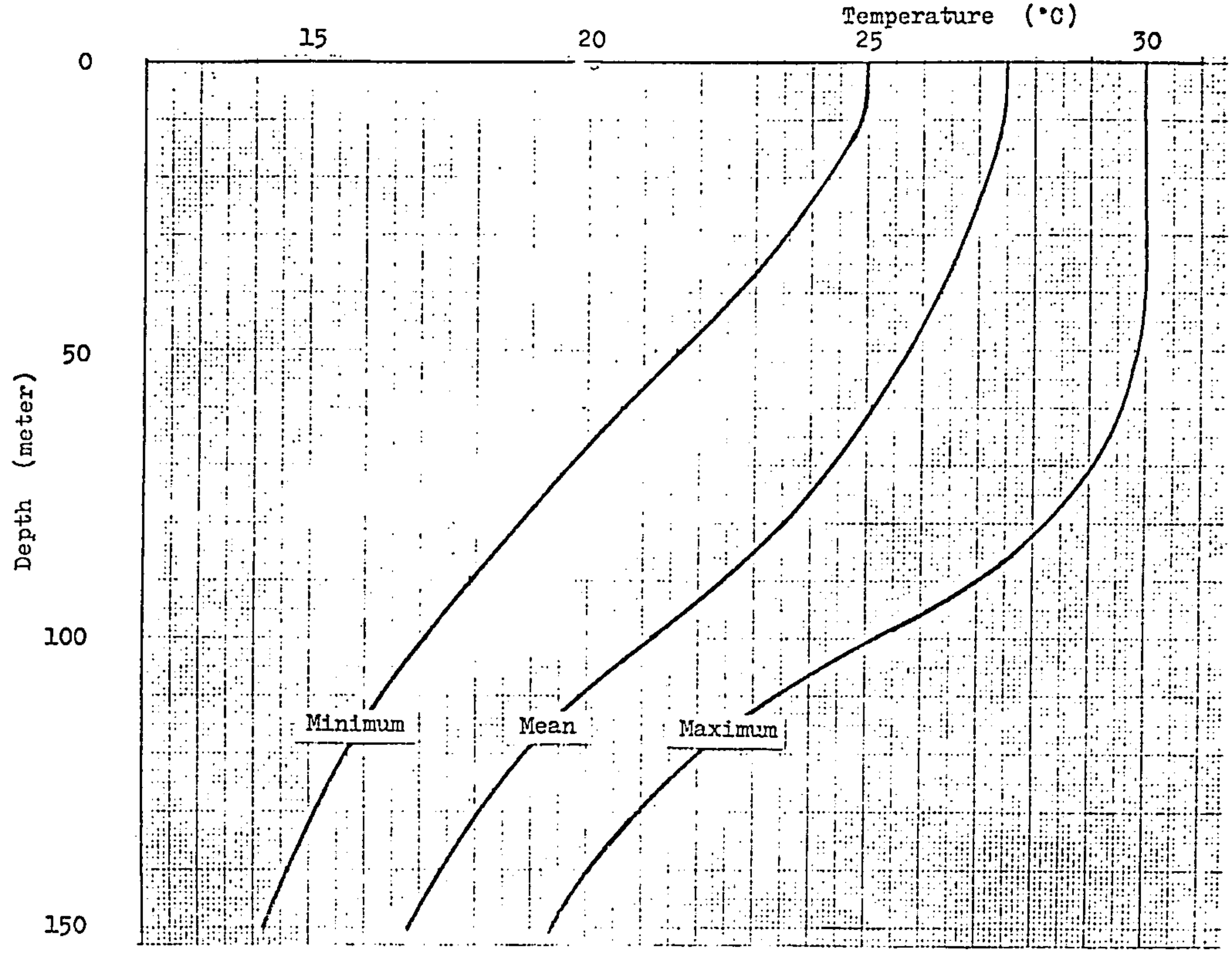
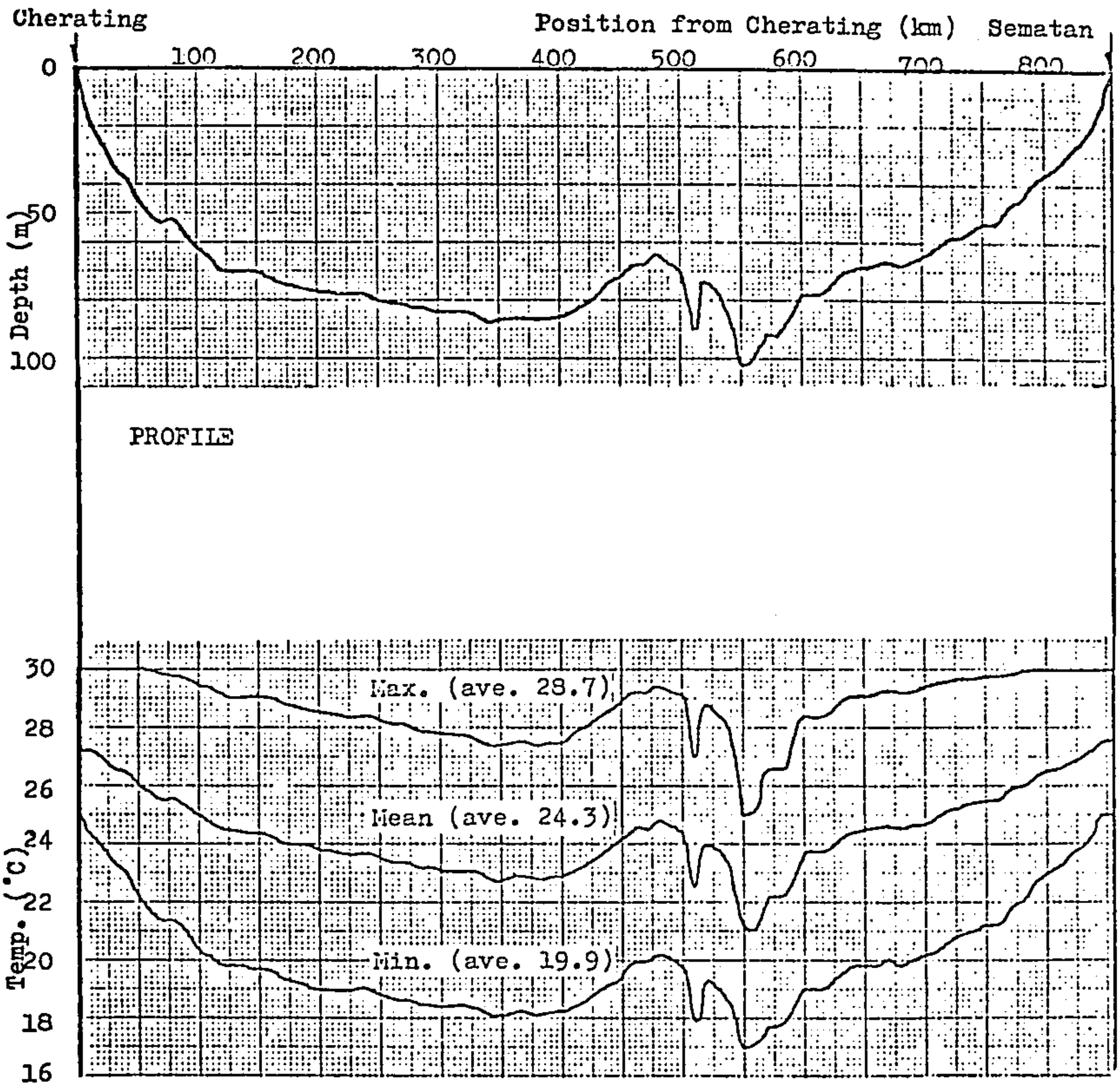


Fig. LAND CABLE ROUTE
SEMATAN
N
L.P
C.P
287
288
273
189
188
185
190
187
166
L.P — Landing Poit
C.P — Common Poit
- - - Cable Routs
Legend
Palm tree
Tree
Track
House
Bushes
Field
Road
Fence
1 : 2,000
100 m.
0
100 m.

Temperature variation on Kuantan - Kuching Cable Route





BOTTOM TEMPERATURE AND ITS VARIATION

Sounding Charts