

No. 04

**BASIC DESIGN STUDY REPORT
FOR
TELECOMMUNICATION DEVELOPMENT PROJECT
IN
THE REPUBLIC OF MALDIVES**

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of Maldives, the Government of Japan decided to conduct a Basic Design Study on the Telecommunication Development Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Maldives a study team headed by Mr. Seikou FUKUDA, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from October 20th to November 13th, 1984.

The team had discussions with the officials concerned of the Government of Maldives and conducted a field survey.

After the team returned to Japan, further studies were made and the present Report has been prepared.

I hope this Report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

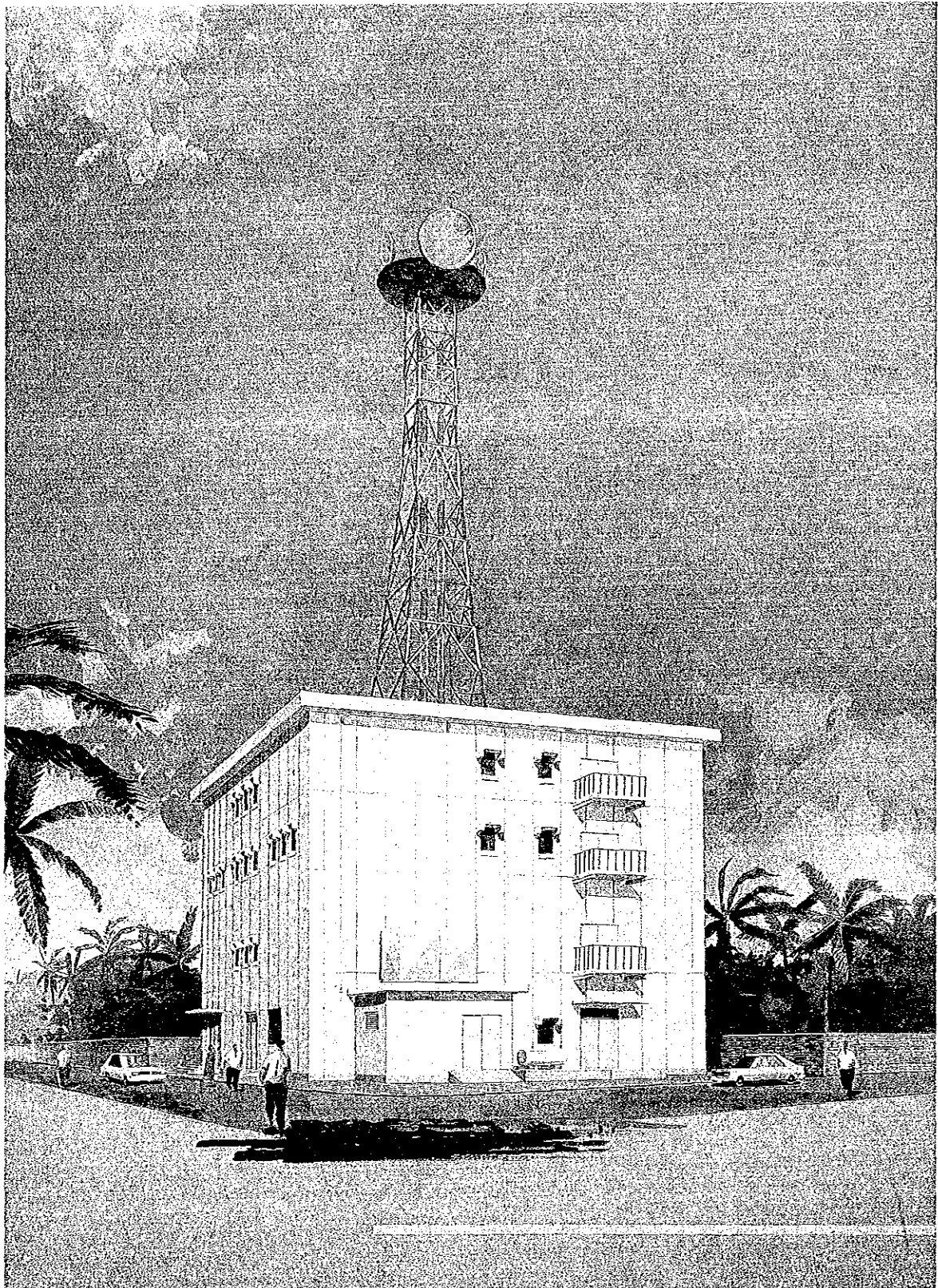
I wish to express my deep appreciation of the officials concerned of the Government of the Republic of Maldives for their close cooperation extended to the team.

March, 1985

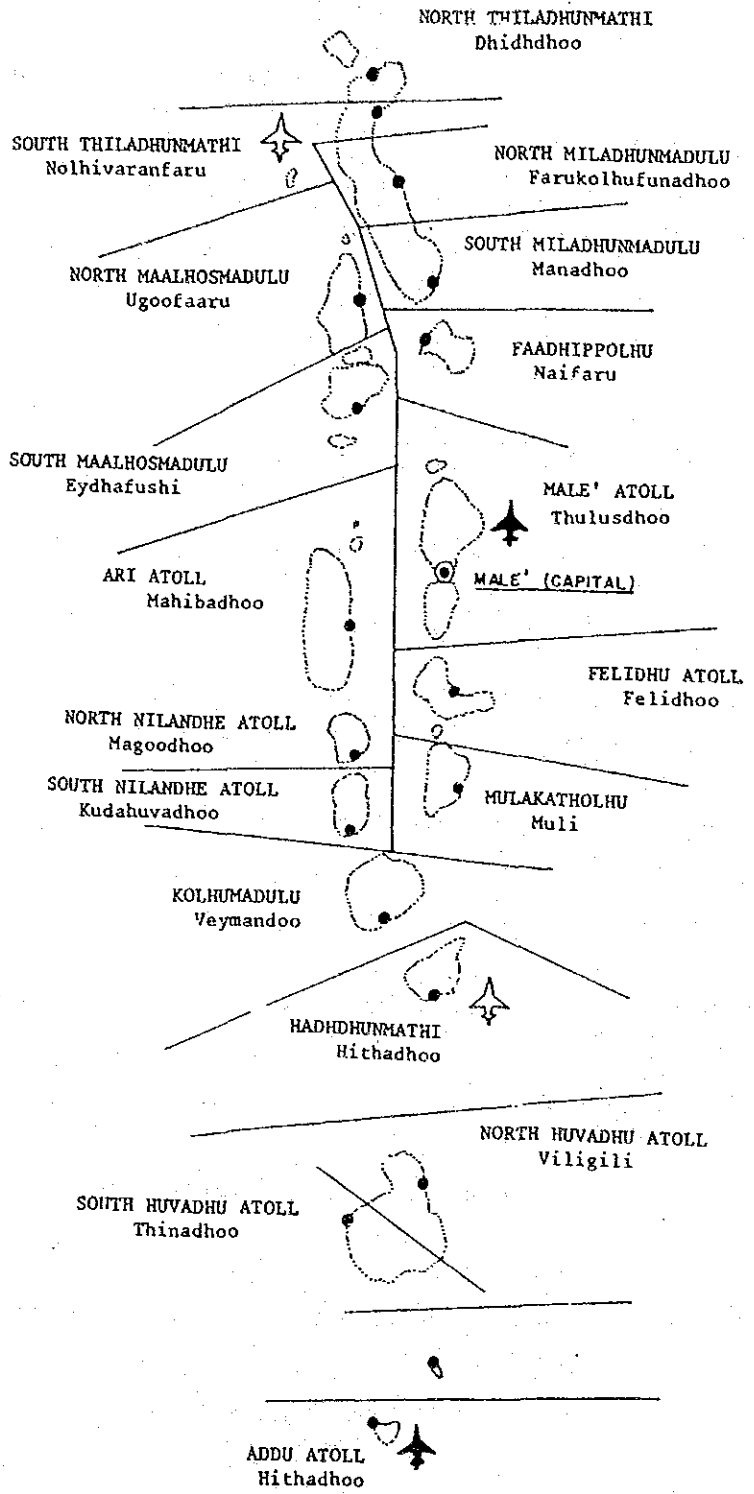
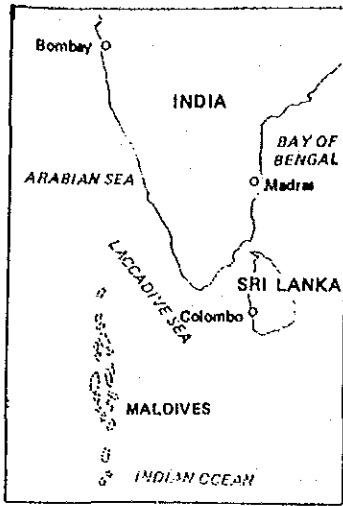


Keisuke ARITA
President

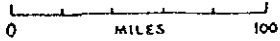
Japan International Cooperation Agency



MALE' TELECOMMUNICATION CENTRE



- ATOLL CAPITALS
- AIRPORTS
- ✈ In operation
- ✈ Under construction



REPUBLIC OF MALDIVES

BASIC DESIGN STUDY REPORT
FOR
TELECOMMUNICATION DEVELOPMENT PROJECT
IN
THE REPUBLIC OF MALDIVES
MARCH, 1985

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SUMMARY

SUMMARY

The state of telecommunications, in the Republic of Maldives, still remains at a very basic level of development. This situation, in view of the welfare of the people and national socio-economic development, poses many problems. In an island nation, such as the Maldives, telecommunications system, which can be said to serve as the nervous system of a nation, should weigh heavily on the basic foundation of the country and the well being of its populace. However due to the remoteness of its geographic location and the present state of the economy, telecommunication in the Maldives is not seeing rapid development.

At present, communication between the far away atolls (cluster of islands) and islands are dependent on short wave radio sets and simple hand held radio sets, equipped in the atoll or island offices (regional administration centres). Because the frequency used is shared, by more than one user, allowable transmitting time is very limited. At worst of times, it may take three days for one call to get through to its destination. In an event of an emergency, such as that would require medical aid, this lack of communications must be said to be highly inadequate. Automatic telephone system is in operation only on Malé Island, the national capital. However the equipments of the system has already become outdated (a step-by-step system made in 1958 by a British manufacturer), lacks adequate capacity and spare parts are becoming difficult to procure (the manufacturer has already stopped production of the equipment).

The Maldivian Government and people are making concentrated efforts, aimed at a balanced socio-economic development through exploitation of its three main industries, fishery, tourism and maritime transport as well as the development of the outlying atolls. The development of telecommunication is an indispensable element in achieving this aim.

In the light of the above situation, in 1984, the Maldives Government, based on a master plan prepared by the UNDP (United Nations Development Program) in 1981 drafted a 3-year Plan for the Development of Telecommunications. The main components of the Plan is the introduction of inter-atoll communication system to Addu, Faadhippolhu and Ari Atolls, and the upgrading of Malé telephone system. Against this background the Government of the Maldives has requested Japan's Grant Aid to assist in realizing a portion of this Plan. The contents of the said request are a) inter-atoll communications system to Ari Atoll, b) development of Malé telephone system and c) construction of Malé Telecommunication Centre, to house the equipments for the above a) and b), as well as training facilities for the personnel and administrative sections of the Department of Posts and Telecommunications (POSTEL).

The Basic Design Study Team confirmed the necessity for an early implementation of the above request, and established the scope of the Grant Aid as follows;

a) Ari Atoll Communication System

To establish telephone communications on 9 islands having relatively high populations, out of 18 islands of the atoll. Connection with Malé will be made by trans-horizon communication to Mahibadhoo Island, located in approximately the center of the atoll. The subscribers on the remaining 8 islands will be connected by radio concentrator system (RCS). The main RCS equipment will be housed in a shelter, to be built on Mahibadhoo Island. The RCS terminals for the individual islands will be equipped in the respective Island Offices. Mahibadoo Island will be equipped with two telephone sets. The other islands will have one set each. These will all be public telephones, allowing all of the inhabitants access to communication. Operation of the telephones is planned to be delegated to the Island Office.

b) Malé Telephone System

To upgrade telephone service on Malé, a Telephone System composed of the digital switching equipment and cable network (subscriber lines and telephone sets are not included) is planned. The digital switching equipment is planned to have a capacity of 7,000 subscriber lines or twice that of the existing capacity. This capacity will be sufficient to meet subscriber demand increase up to the year 1995. The cables will be directly buried, as is the existing system. Consideration will be given to utilize as much as possible the existing cable system.

c) Malé Telecommunication Centre

The construction of Malé Telecommunication Centre, to house the telecommunication equipment of the above mentioned systems is proposed. The Centre building is planned to be a 4-storeyed steel structure with a total floor area of approximately 1,570 sq. mts. A steel tower approximately 30 mts. high is planned to be erected on the roof. The Centre will also house training facilities and administrative sections of POSTEL, besides the above mentioned equipment.

In preparing the Basic Design for the building, consideration to the following restrictive conditions of the Maldives was given a) hardly any construction material are locally produced; b) port facilities are inadequate, therefore, limits the volume and weight of material that require to be brought in; c) skilled labour is scarce. To mitigate these restrictions and to establish a telecommunication building of required and adequate quality the Centre building is proposed to be of pre-fabricated construction.

The construction schedule for the three components of the Project are as follows;

- Ari Atoll Communication System 21 months
- Malé Telephone System 22 months
- Malé Telecommunication Centre 20.5 months

The implementing body of the Project will be POSTEL which operates and maintains the existing telecommunication system. However the institutional capability of POSTEL is still limited. As such, it is recommended that it strengthen its staff recruitment and training capacity.

After the implementation of this Project the annual revenue of POSTEL will be 5.09 million Rf. while the expenditure is expected to be 2.343 million Rf. This would mean a profit of 2.747 million Rs. As POSTEL returns all profits to the national treasury it will contribute greatly to the increase of national finance.

With the implementation of the Project, telephone communications would be established in 9 of the islands of Ari Atoll, serving 5,600 inhabitants, and will serve as a model for introducing communication systems in areas with similar geographic characteristics. The Malé Telephone System would, by the increased subscriber lines and the added functions of the digital switching equipment, greatly up-grade telephone services.

This Project will form the nucleus of future development of telecommunication system and perform a major and integral part in the national development of the Maldives. The introduction of a modern and efficient telecommunication system, which would facilitate communications at a volume and quality not possible at present, should have a great impact on its prospects for social and economic development.

The economic foundation of the Maldives is still not very solid, as not much time has elapsed from independence and because it is a remote group of small islands. Under these circumstances it must be considered difficult for the Maldivian Government, to raise funds by its own efforts, without foreign assistance.

In consideration of all of the above mentioned factors, in conclusion, it is deemed appropriate that the Project be implemented by Japan's Grant Aid.

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

The main objectives of the social and economic development of the Republic of Maldives are the development of its economy, based on the three main industries; fishing, tourism and shipping and to lessen the difference in the degree of development between Malé Island (the national capital) and the outlying atolls, where by an balanced socio-economic development may be achieved and improve the welfare of the people.

Telecommunications is one of the most important infrastructure necessary in the process of social and economic development as well as being an essential element in guaranteeing the well being of the people and social stability. However due to the remoteness of its geographical location and the prevailing economic situation telecommunication, in the Maldives, is lagging in development and as a result stagnating social and economic development.

In 1981, the Government of Maldives requested the UNDP (United Nations Development Programme) to carry out a feasibility study for telecommunications development. Subsequently UNDP in collaboration with ITU (International Telecommunication Union) carried out a feasibility study and drafted a 'master plan' up to the year 1995. The 'master plan' is composed of a) Malé Telephone System, b) Inter-atoll communication c) maritime communication, and d) training of telecommunication personnel.

Of the above projects maritime communications is being implemented with funding and aid from the Asian Development Bank and UNDP, and is expected to be completed by March, 1985. The remaining three projects still remains to see implementation.

Under these circumstances, in 1984 the Maldives Government, based upon the above 'master plan', drafted a 3-year Plan for Telecommunication Development centered around introduction of inter-atoll communication system and up-grading of Malé telephone system. With the above mentioned as the background, the Government of Maldives has made the request for Japan's Grant Aid for realizing a portion of the 3-year Plan.

JICA (Japan International Cooperation Agency) has dispatched to the Maldives, from 20th of October to 13th of November (25 days), the Basic Design Study Team headed by Mr. Seikou Fukuda, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, to conduct the Basic Design Study for evaluating the feasibility and contents of the request and to establish the scope of the Project. To facilitate the evaluation the team studied the present situation and future plans of the telecommunication sector, general situation of building construction and infrastructure. The Team also made a study of the other islands of Malé Atoll and those of Ari Atoll. (See Appendix-1 for composition and schedule of the Basic Design Study Team). This report is based on the analysis and evaluation of materials and data, obtained during the Basic Design Study.

CHAPTER 2 BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Socio-Economic Situation

2-1-1 General

The Republic of Maldives is an archipelagic nation stretching 820 km north to south and 130 km east to west, and is composed of 1,200 islands making up 19 atolls.

Most of the islands, including Malé Island, the capital, is small and on the average has a diameter of no more than 1.6 km. All the islands are flat with the level not exceeding 2.5 mts. and surrounded by reefs.

The official count of the islands by the government numbers 1,187, the total land area adding up to 298 sq. km. Of these islands 202 are inhabited. The population, by a 1983 estimate, is 175,000 out of which 22% or 37,000 are living on Malé. 100% of the nation are Muslims.

The Maldives gained independence from British protectorateship in 1965 and became the 114th member of the United Nations. In 1968 monarchism was replaced with a republican form after 80% approval in a national referendum. Mr. Amir Ibrahim Nasir who had been the prime minister under the Monarchy took the first presidential office. In 1978, he retired from the office for health reasons and Mr. Maumoon Abdul Gayoom, the young Minister of Transportation was promoted to the presidency by general election. The new government adopted a democratic system based on separation of the three powers and establishment of the regional autonomy, under the slogan of 'government better open to the nation' and 'guaranteeing of fundamental human rights'. Her policy aims at socio-economic collaboration with other Islamic countries and politically strict neutrality, while domestically marking local development and correction of regional economic difference between the other atolls and extreme concentration around the capital island of Malé.

Fisheries, tourism and international shipping are major industries for Maldives, and support the national economy. However, the national finance has been in a unbalanced status for years, and the deficit has been mostly covered by overseas funds. According to data by the World Bank, GDP per capita in Maldives sits at 373 US dollars in 1982, so that overcoming of poverty as well as relief for the unemployed is one of her serious problems. Moreover, the government holds many problems such as development gap between Malé and local atolls, necessity of grade-up in education, shortage of skilled workers, sanitary conditions to be improved etc.

The government of Maldives is now drafting the first 3 year national development plan under the above mentioned socio-economic situation. The government intends to announce an overall and definite development plan and external aids receiving policy, after making adjustment between sectors which have formerly been drafting such kind of plan respectively. The aim of development however, may not differ so much from items drafted up until now; (1) increase of national income, (2) impartial distribution of the development benefit between Malé and local atolls, (3) population control, (4) education grade up, (5) sanitary condition improvement, (6) reduction of economic dependency on external assistance and (7) control of immigration to Malé Island.

Strategic means for the above are (1) promotion of the above three major industries (2) development of local atolls, (3) improvement of living environment and creation of employment in local atolls, and (4) development of agricultural resources and promotion of domestic industries.

To implement such strategies and plans it is imperative that domestic industries particularly those of the outlying atolls be developed. However the undeveloped state of telecommunications, which is among the most important of basic infrastructures, is standing as an obstacle against the impetus for national development.

2-2 Present Conditions of Telecommunications

The means to connect many islands, scattered over the ocean, rapidly through telecommunication network does not exist in Maldives and as a result, it hinders seriously the execution of the national development plan, especially the development of atolls other than Malé atoll.

Since a manual telephone switchboard for 20 subscribers was introduced in Malé the capital of Maldives, in 1955, development and expansion of the telecommunication facilities has proceeded gradually, however the effort has been mostly concentrated on Malé except for the provision of radio equipment for inter-atoll communication of unstable and poor-quality HF band communication to 22 islands among the 202 inhabited islands. Remaining 180 inhabited islands are provided with simple hand held radio equipments, but since these equipment are not for long distance use, the communication with nearby islands with HF communication equipment can scarcely be performed.

On the other hand, only Malé Island is provided with the automatic telephone exchange and satellite earth station in the Maldives playing important roles required for the capital city, however, the automatic switching equipment is already superannuated and the facilities have not suitably been arranged, therefore good quality telephone service is becoming more and more difficult to provide.

Thus the telecommunication network in the Maldives is considered to still be in an underdeveloped stage at present, though this may be caused partly by difficulties of its geographical condition.

Besides, the telecommunication facilities, operation & maintenance staffs and administration staffs are accommodated in 3 different buildings, the allocated spaces being narrow and the indoor conditions not suitably controlled for sophisticated telecommunication equipment.

One more serious obstacle to telecommunication development which can be foreseen is the lack of organized O&M (Operation & Maintenance) staff training in Maldives though it has been recognized as indispensable.

2-2-1 Principal government offices and operating agencies

Telecommunication services in the Republic of Maldives are provided by Department of Posts and Telecommunications (POSTEL) under direct administration of the President's Office and also by C&W (Cable and Wireless), a private telecommunication operating company of the United Kingdom.

POSTEL provides domestic telecommunication services, while C&W, international telecommunication services in the main according to the agreement with POSTEL.

POSTEL is composed broadly of the postal service division and telecommunication service division and employs 164 members on its staff. Among these, 38 are assigned to the administrative section common to all the other sections; 33, for radio section; 22, for telephone exchange section; 25, for telephone cable section and 46, for postal service division.

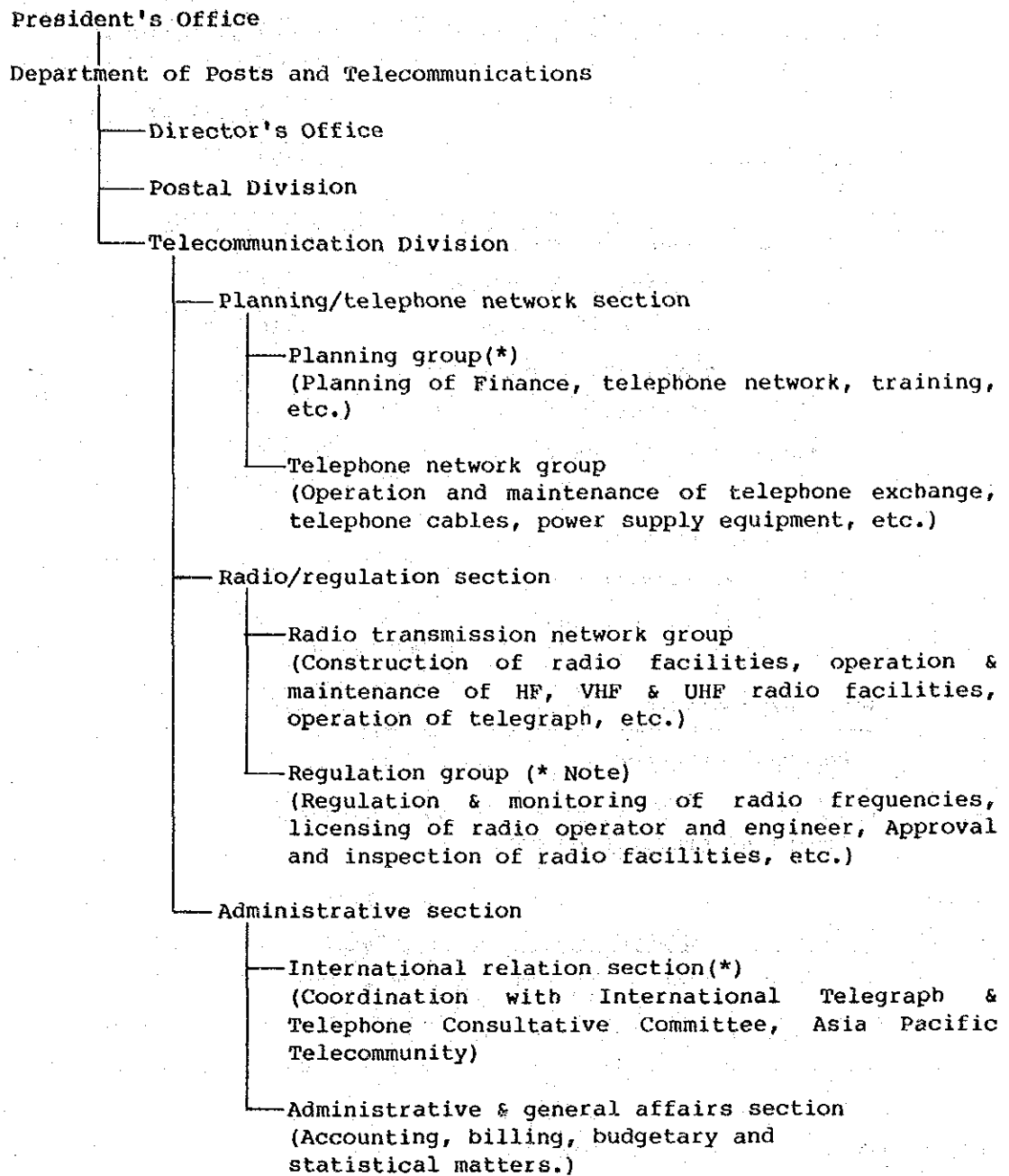
Operation and maintenance of the telecommunication facilities are conducted by two different groups, one for radio transmission network and the other one for telephone network. All of the maintenance staff consisting of 13 persons for radio facilities, 10 operators for telephone exchange facilities and 25 persons for telephone cable facilities are stationed in Malé Island. Maintenance of the radio facilities installed in the other islands is done by a number of maintenance crew dispatched from Malé as required. POSTEL has no vessel of her own for this purpose.

Since POSTEL has no appropriate organized training school, a number of staffs are dispatched to institutions in foreign countries to improve their capabilities for operation and maintenance.

Presently five POSTEL staffs are abroad for training in short-term or long-term courses. It is noted, that Japan, in its group training courses for 1984, received two persons from the Maldives; i.e., one for Radio Communication Engineering and the other one for Telecommunication Management.

Expansion of telecommunication network, from now on, necessitates adequate manpower for O&M, to furnish telecommunication services.

FIG-1 gives the organization of POSTEL.



*Note: This service is furnished by President's office at present, but the group or section will become an independent office by 1986.

FIG-1 ORGANIZATION OF POSTEL

POSTEL's balance sheet for 1983 is summarized as follows:

(Unit: RF 1000)

Total revenue	3,595
<hr/>	
Telephone connection charge	18
subscription charge	455
local call charge	1,167 *1
inter-atoll call charge	84
international call charge	342 *2
Revenue from telegrams	143
Rental for leased lines and equipment	186
Frequency registration fee	12
Rental for satellite earth station	1,172 *2
Miscellaneous revenues	26
Total expenditure	1,421
<hr/>	
Personal expenses	463
Administrative expenses	882
Equipment procurement cost	76
Profit	2,174

Note *1: From January to September

*2: Received from C & W

Although no revenue from local telephone calls, for a three-month period from October to December 1984, was appropriated, the balance gives a profit of Rf 2,174,000 (approx. 75 million yen) because no depreciation for existing facilities and buildings was appropriated.

Total amount of this profit from POSTEL was absorbed by the Maldives' national treasury, however, the national finance shows a deficit of 28 million Rufia (approx. one billion yen).

TAB-1 shows the tariff for telecommunication services.

2-2-2 Telecommunication Facilities and Services

1) Local telephone services in Male

Automatic telephone services are provided by POSTEL using 4-digit telephone numbering scheme in the city of Malé at present. Number of subscribers, as of the end of October, 1984 reached 2,062 consisting of 412 (20%) by governmental organizations, 619 (30%) by private firms and 1,031 (50%) by residences. The existing automatic telephone switching equipment was installed in Malé, after 20-year use in Singapore. This equipment is a step-by-step system (BPO Type 4000) manufactured by GEC in 1958. The capacity is 3,000 subscriber lines. And it is scheduled to install additional equipment for 1,000 subscriber lines of the same type of equipment as the existing equipment, but these equipment and materials are superannuated and it seems it would be difficult to maintain service quality after installation.

A fact also to be noted, is that, when spares for operation and maintenance are to be taken into account, the actual capacity of the telephone service furnished may fall by less than 3,600 subscriber lines.

TAB-1 Tariff for Telecommunication Services

Telephone Services

Telephone Connection Charge	Rf 100 *1
Subscription Charge - Business	Rf 50 per month
" " - Residence	Rf 25 per month
Local Call Charge (Ordinary sub.)	Rf 0.4 per call *2
" " " (Radio telephone sub.)	Rf 0.75 per call
Inter-atoll Call Charge by	
HF communication	
First 3 minutes	Rf 5.0
Additional minute	Rf 2.0
International Call Charge	
To Japan, UK	
First 3 minutes	Rf 82.05
Additional minute	Rf 27.35
To Sri Lanka, India	
First 3 minutes	Rf 53.55
Additional minute	Rf 17.85
To U.S.A.	
First 3 minutes	Rf 110.55
Additional minute	Rf 36.85

*1: Preparation and installation of telephone set and subscriber's lead-in wire shall be made by subscriber (Approx. Rf 800 is needed).

*2: Subscription charge covers up to 100 calls per month.

- Contd. to following page. -

(TAB-1 CONTD.)

Telex Service

Installation charge	Rf 380
Power line installation charge	Rf 76
Grounding " " "	Rf 152
Voltage regulator " " "	Rf 38
Leased line connection " "	Rf 100 *3
Telex terminal rental charge	Rf 620 per month
Voltage regulator " " "	Rf 38 per month
Leased line charge	Rf 100 per month *3
Communication charge	
To Japan	Rf 27.35 per minute
To Sri Lanka, India	Rf 17.85 per month
To U.S.A.	Rf 36.85 per month

*3 To be paid to POSTEL, while other to C & W.

Telegram Service

Domestic telegram	Rf 1.4 for first 7 words
	Rf 1.0 per word for additional words.

International Telegram

To Japan	Rf 16.1 for first 7 words
	Rf 2.3 per word for additional words.
To Sri Lanka	Rf 9.1 for first 7 words
	Rf 1.3 per word for additional words.

Although the switching equipment has been superannuated, after 27-year use since manufacturing, there has been no such serious failure as to result in a complete interruption of telephone services because of an appropriate maintenance work under a direction by an engineer from Sri-Lanka. Required amount of maintenance spares tends to increase year by year, but procurement of the spare becomes more and more difficult. Spares in stock may be enough to maintain the equipment for the time being, but using up all the spares will make maintenance of switching equipment impossible and as a result, affect the functions of the capital city seriously.

Present grade of telephone service is not sufficient, for example, unsuccessful dialling is experienced very often especially during the busiest hours due probably to excessive traffic over operating capability caused by insufficient number of equipment installed. It occurs due to the presence of subscribers with only one line each dialling so frequently that the "busy" probability is increased.

Supplement of such equipment, incorporated in the switching equipment, is no longer possible because the manufacturer has already stopped manufacturing the equipment.

Addition of second or third-subscriber lines, to heavy-traffic subscribers, can not be accepted at present due to insufficient capacity of subscriber lines of the switching equipment.

Although POSTEL advises subscribers to refrain from non-urgent calls to improve connection during hours before noon, the results have not been fruitful. Heavy traffic may be attributable to many telephone-number enquiries due probably to the incompleteness of the presently circulated telephone directory.

All the telephone cables, connecting telephone sets with switching equipment, are directly buried under the ground without using ducts or manhole and there still remain areas in Malé, where telephone installation is impossible due to non availability of cables.

Telephone charges account for a large portion of the total income of POSTEL, but the telephone charge processing is being made by a very basic method so that monthly readings of subscriber meters installed in telephone switching equipment room are compared with the same in the previous month and the balances are obtained by manual computation.

At present 7 staffs engage in charge computation works, there have been frequent complaints on incorrect bills resulting from wrong computation.

And since preparation of bills is made only by hand, bills has sometimes not been able to be issued within the next month (for example the bills for October through December 1983 were issued in January 1984). Such inefficiency in charge processing must be improved.

2) Inter-atoll communications

Inter-atoll communication services on HF communication network are provided by POSTEL.

The HF radio communication services are offered by POSTEL to link 20 atoll capital islands and two other islands with Malé telephone network through the HF communication centre in Malé.

The HF radio equipment employed were manufactured by Cubic or Swan Company of the U.S.A. and one out of 7 preset frequencies is selectable. For this equipment, frequencies in 2,3,5 and 8 MHz bands are allocated and a suitable frequency is used according to the time and distance.

HF communication centre at Malé is provided with 4 sets of HF transceivers and each atoll capital island and each of two other inhabited islands, one set of the transceiver. Operation of these HF transceivers installed at islands other than Malé Island is commissioned to the corresponding atolls or island offices. The transceiver installed at each atoll office is used for communication not only with POSTEL's HF communication centre but also with the other government organizations.

The service quality is not very good since the HF circuits on simplex operation offers considerably poor speech quality.

Continuous communication services are not available because the limited number of radio frequencies are shared with other governmental organizations.

An example of the HF inter-atoll communication network is given below.

When a calling party "A" in Malé wishes to talk with an islander "B" in a certain atoll, he first asks the atoll office, through the HF communication centre in Malé, to request B to come to the atoll office, at a specified time, and the atoll office locates the B and conveys the message from A to B.

Since the existing circuit linking Malé Island with the atoll is of HF circuit usable only during a limited time, it may require three days until the communication between A and B is completed.

Such communication system are considered as useless in case of emergencies which may occur in the daily lives of the inhabitants, industrial activities and administration. Especially, for inhabitants in an island, where no complete medical facilities are furnished, it is indispensable to have means to consult with a doctor, through a communication channel available 24 hours, to receive instructions on pertinent treatment.

POSTEL provides VHF/UHF radio circuits for 6 islands including Hulule island with the international airport and C&W, 41 resort islands. These subscribers are directly accommodated in Malé telephone exchange.

POSTEL uses small capacity (1 - 5 channels) VHF and UHF radio equipment while C&W, single channel VHF or UHF radio equipment (some of these single channel equipment can send or receive an additional telex signal simultaneously with telephone signal).

As regards the radio frequency band, 150 MHz VHF band has entirely been occupied or reserved for use by C&W. A part of 400 MHz band has also been used or reserved by C&W, but a certain part of the 400 MHz band are still available for this project.

Since radio frequencies are regarded as a sort of national resource and the radio circuit is indispensable as a part of communication system in Maldives, effective use of the frequencies is of prime importance.

3) Maritime communication facilities

Installation of coast stations was started under the aid of UNDP/ITU in 1982. The transmitting station at Maafushi Island and receiving station at Villingili island close to Male Island are under construction and will be put into service in 1985.

It is planned to link the transmitting station with the receiving station and the receiving station, with Malé through UHF multiplex radio circuits to connect with Malé telephone network.

For maritime ship to shore communication in a harbour or its nearby area a VHF equipment operated in the international VHF band has been delivered and installed at each of 11 islands and scheduled to be installed at each of the other five islands.

Considering that the Maldives is composed of many number of islands scattered extensively over the Indian Ocean, the development of maritime communication facilities will contribute largely to the effective operation of fishery and sea transportation by providing various services such as weather forecasts, navigational warnings, distress communications, etc. for fishing boats, domestic and ocean-going liners.

4) International telephone services

This category of services is undertaken by C&W and the connection to international telephone network is made through the satellite circuit and C&W's international exchange at Hongkong, except for Sri Lanka where the direct connection is made.

Outgoing calls from Maldives are handled by operators of the C&W switchboard but the operator can directly dial an overseas subscriber while the incoming calls can be connected by direct dialling by a distant subscriber or operator. The service quality observed on the actual speech condition, rapidity of connection time, etc. is considered good.

Connection of telephone call to Japan is accomplished in about 5 minutes. However, in case one more international circuit via satellite is used after Hongkong the delay time of speech signal becomes significant causing the conversation sometimes difficult.

5) International telex services

This service is also provided by C&W. All the telex terminal units for the Maldives are accommodated in the C&W telex exchange in Hongkong, through data communication circuits via a satellite link.

The service quality is considered to be satisfactory.

6) Telegraph services

Domestic telegraph services are provided by POSTEL while international telegraph services, by C&W. The former is delivered only to the atoll capital island, through the HF inter-atoll communication network, from where the message is conveyed to the addressee, in an island with no HF communication facilities through a handy radio equipment. Therefore delivery of 9 telegram sometimes may take a few days.

7) Present situation of telecommunication buildings

All the buildings housing POSTEL's equipment and staff are small in area and crowded. The present telephone exchange is located inside the NSS building, which was not built for this purpose, and is of timber construction, presenting problems in terms of fire protection and control of dust and other adverse elements. In terms of space, if the additional 1,000 subscriber lines are installed, there will no longer be any space remaining even for the operation and maintenance staff.

The administrative centre and radio transmitting equipment is accommodated in a section of two storeyed row houses housing various governmental agencies. Hereagain the space is limited hindering the daily activities of the staff.

The postal services operate from the General Post Office facing the dock area and a sub office in the city. The sub office is planned to be closed down as it is being requested to evacuate the premises by the landlord.

The lack of available space is best demonstrated by the fact that POSTEL has built a concrete block structure for housing radio transmitter equipment on the site for the Telecommunication Centre with the knowledge that it must be demolished in the event the Centre is to be built.

8) Others

i) Handy radio equipment

Within any atoll, communication between the atoll capital and other inhabited islands is performed by a handy radio equipment (CB radio equipment). Although such equipment can not offer good speech quality, due to small transmitting power, it is used widely owing to its cheap price.

ii) Radio broadcast

Voice of Maldives broadcasts programmes three times a day by medium wave for approximately 11 hours in total and can be received all over the country. The broadcast transmitting station is in Male island at present, but will be removed to an uninhabited island near to Malé in the near future.

iii) Television broadcast

TV Maldives broadcasts colour TV programmes once (4 hours) a day. Good reception of the TV broadcast signal is obtained only in a limited area, i.e., a range of 60 to 70 km from Male island.

2-2-3 Outline of Requests

A 'master plan' for the development of the national telecommunication services in the Republic of Maldives to cover the period until 1999, was prepared in 1981 with the assistance of UNDP and ITU.

The 'master plan' aims at provision of telephone services to all the inhabited islands in Maldives by the year 1999 through installation of inter-atoll network composed of trunk radio transmission link, telephone exchanges, remote telephone exchanges (a small-capacity telephone exchange remotely controlled from the parent telephone exchange) and radio subscriber telephone equipment, upgrading and expansion of Malé telephone facilities, provision of coast stations for maritime communications and training of operation and maintenance personnel.

The 'master plan' aims at realization of telephone density of 11.9 lines per 100 inhabitants, as an average for whole country, through installation of 15,000 subscriber lines in Malé and 14,580 subscriber lines in the rest of country.

However only a part of the maritime telecommunication facilities, of the 'master plan', has started implementation by aid from UNDP/ITU, as enough fund and manpower are not available for total implementation of the 'master plan'.

POSTEL, however, has established the 3-year plan for Telecommunication Development, in October 1984, on the basis of the said 'master plan' aiming at feasible and realistic development of telecommunication facilities, though urgency in the development of telecommunication network was recognized.

The 3-year Plan proposes (1) introduction of the inter-atoll communication facilities for Addu, Faadhippolhu and Ari atolls and (2) development of Male telephone facilities.

The Government of the Republic of Maldives has requested the Government of Japan's Grant Aid assistance for a) the introduction of inter-atoll communication facilities for Ari Atoll, b) the development of telephone facilities in Male and c) the construction of building to accommodate these facilities.

CHAPTER 3 BASIC PLAN

CHAPTER 3 BASIC PLAN

3-1 Basic Design Policy

As mentioned in the preceding chapter, at present most of the inter-atoll communications is reliant only on unstable and poor-quality HF radio circuits. It is indispensable to introduce a communication network, which can provide stable and good-quality communication circuits, for these isolated islands, in the areas of administration, education, medical care (supplementing lack of medical facilities through consulting with doctors in Malé), etc.

Development of communication network will play an important role in achieving one of major aims of the national development plan, i.e., development of atolls other than Malé, consisting of promotion of local industries, adjustment of product shipment, etc.

Under such circumstances, the development of inter-atoll communication network calls for urgent implementation, and as such it is proposed to introduce the full-scale inter-atoll communication network to Ari Atoll. The survey team studied the priority order for three atolls on the basis of distance from Malé island, number of inhabited islands and POSTEL's capability for operation and maintenance, and reached the conclusion that introduction of inter-atoll communication facilities to Ari Atoll is most preferable, as in the request from the Government of Republic of Maldives.

As for Malé telephone facilities, existing telephone switching equipment is superannuated and in addition procurement of spare parts is becoming more and more difficult. As a result, provision of pertinent maintenance works, is becoming impossible. This may lead to the occurrence of a major failure in the near future and to the total paralysis of the capital city, Malé.

The subscriber line capacity of the existing telephone switching equipment suffices the demand for the time being, but it is practically impossible to accommodate subscribers up to such full capacity unless some component equipment of the switching equipment is added.

It should also be noted that expansion of telephone number capacity and charging function required for full scale operation of the inter-atoll communication is not possible functionally by the existing switching equipment.

A number of such-problems on the existing switching equipment can not be solved through small modification of the existing switching equipment since the switching-equipment manufacturer has already stopped manufacturing the equipment and the maintenance spare parts are no longer available.

Therefore, it is proposed to develop the Malé telephone facilities by replacing the telephone switching equipment, improving charge processing services and expanding the telephone cable facilities.

Construction of the Telecommunication Centre building is proposed, since an existing building that can accommodate the above-mentioned facilities and realize ambient conditions to insure stable operation of equipment for a long period is not available in Malé Island.

Although staffs for operation and maintenance of the facilities to be introduced in this project shall be employed and trained on POSTEL's responsibilities, provision of training room as well as equipment and materials for basic training is introduced in this Project considering that organized training in the Maldives is not sufficient.

3-2 Demand and Traffic Forecasts

1) Telephone demand

Since it has been about 3 years since (1981) that the demand forecast under the UNDP/ITU master plan had been carried out, the survey team conducted a macroscopic demand forecast using forecasting model, population forecast and GDP forecast as follows.

i) Macroscopic forecasting model

Among various methods of macroscopic demand forecast the method to estimate the demand from correlation between GDP per capita and direct telephone density is used. This method is widely used when basic data for forecasting are insufficient.

Using relation between GDP per capita collected in 1982 from 64 countries in the world and direct telephone density (see APPENDIX VII) and status of island countries similar to Maldives (see APPENDIX VII), the following equation for demand forecast model is obtained.

$$Y = 0.000512 X^{1.356}$$

where, Y: No. of direct telephones per 100 persons.

X: GDP per capita in US \$.

ii) Population forecast

National censuses were made each 1967, 1972 and 1977, but no census has been made thereafter. According to the results of these censuses, the population growth for 5 years was 3.4% per annum from 1967 to 1972 and 3.1% p.a. from 1972 to 1977.

Control of population growth and family planning is an important policy in the Maldives at present.

Population forecasts made by the Ministry of Planning and Development (MPD) is given as 3% or so for the time being, but estimates the growth to drop to around 2.7% in 2000.

In a survey by the World Bank, the population growth in lower income countries is forecasted as about 2.9%, which almost coincides with the above figure given by MPD. Therefore the figures given by MPD are employed.

But the population forecasts by MPD are given only for a period from 1985 to 2000, therefore the population in 2005 has been estimated assuming the growth rate of 2.7% per annum on the basis of the population forecast for in 2000.

TAB-2 on the next page gives the results of 1967, 1972 and 1977 censuses and forecast population.

TAB-2 Summary of Population Forecasts

(unit: Thousand)

<u>Year</u>	<u>Whole</u>	<u>Outside</u>	
	<u>Country</u>	<u>Male</u>	<u>Male</u>
1967	103.8	11.5	92.3
1972	122.7	15.3	107.4
1977	142.8	29.5	113.3
1980	155.3	32.1	123.2
1985	181.4	37.5	143.9
1990	210.8	43.6	167.2
1995	243.7	50.4	193.3
2000	278.9	57.7	221.2
2005	303.7	62.8	240.9

iii) Estimated growth of GDP

According to data published by the MPD, GDP's for the past 4 years are as follows:

<u>Year</u>	<u>GDP</u> <u>(Million Rufia)</u>	<u>Growth rate</u> <u>(%)</u>
1980	374.19	-
1981	417.59	11.6
1982	444.67	6.5
1983	461.87	3.9

(1982 constant price)

The average growth rate during the period from 1980 to 1983 was 7.2%. Estimated economic growth rates by the MPD until 1985, published in 1983, is given at about 8% for GDP growth rate from now on because the growth of the tourist industry is expected to contribute significantly to the rise of the GDP and also recovery of fishing and shipping industries are expected, though the GDP growth rates for 1982 and 1983 were low due to drop of the fish market prices and depression of the shipping industry.

Growth rate of GDP has been estimated in the following manner by the survey team:

The growth rate is analyzed through three elements, i.e., 1) the primary industry, 2) the secondary industry and 3) the tertiary industry.

These growth rates, in the above mentioned three industrial sectors, are estimated using regression curves prepared individually for each industrial sector, knowing its past tendency, and combined together to obtain the overall growth rate.

Results of the above analysis show that in the beginning the growth rate will be 7.8% p.a. owing to higher growth rate of tourist industry, 5.8% for the period from 1990 to 1995, 5.0%, from 1995 to 2000 and 4.4%, from 2000 to 2005.

The above results have been applied for estimation of GDP per capita as follows:

Year	G D P		GDP per capita (US\$)
	(million Rf/million \$)		
1985	540.2	77.2	426
1990	785.9	112.3	533
1995	1,040.0	148.6	610
2000	1,325.8	189.4	679
2005	1,645.0	235.0	774

Results of the macroscopic demand forecasts are given in the TAB-3 on the next page.

Results of the macroscopic demand forecasts were examined through comparing with the results of field survey conducted in Malé as follows:

- Number of telephone subscribers as of the end of October 1984 was 2,062 and number of registered waiting applicants amounts to 430 at present, hence the demands come to about 2,500 in total.
- There is a considerable amount of hidden demands by those who have not yet registered officially due to unlikeliness of telephone installation within a reasonable period.
- As for non-residential telephones, there are many number of government organizations and private firms who have their own telephone sets already but require more telephone sets (in such organizations or firms, number of installed telephones is usually insufficient and usage of these telephone is very large.)
- Consequently probability of "busy" telephone line is very large, lowering the service quality. It is desirous to provide additional telephone for such subscribers to improve telephone connection. However, those subscribers usually do not apply for additional telephone installation, since they have not become aware of such situation).
- In the case of residential telephones, there are many number of residents, who are of lower income, yet require telephone installation. It may be explained from the fact that due to insufficient land area for residences in Malé, they usually have to live as a large family therefore such a large family can afford to have their own telephone set, because the total of individual family incomes may be sufficient for payment of telephone charges.

TAB-3 Telephone Demand Forecasts on Maldives

Year	Population ^{*1} (thousand)		GDP per Capita ^{*2} (US\$)	Density of Direct Telephones (Average for whole country)	No. of Direct Telephones			Density of Direct Telephones			No. of Households per ^{*3} Direct Telephones		
	Whole Country	Male			Other Area	Total	Male	Other Area	Male	Other Area	Average of Whole Country	Male	Other Area
1985	161.4	37.5	143.9	426	1.85	3,356	2,953	403	7.87	0.28	8.9	1.3	63.8
1990	210.8	43.6	167.2	533	2.51	5,291	4,550	741	10.44	0.44	6.6	1.0	40.6
1995	243.7	50.4	193.3	610	3.02	7,360	6,182	1,178	12.27	0.61	5.4	0.8	29.3
2000	278.9	57.7	221.2	679	3.49	9,734	7,982	1,752	13.83	0.79	4.7	0.8	22.6
2005	303.7	62.8	240.9	774	4.17	12,664	10,131	2,533	16.13	1.05	3.9	0.6	17.0

*1: Statistical Year Book of Maldives 1983 (Ministry of Planning and Development)

*2: Estimated based on data collected from

" Statistical Year Book of Maldives 1984 " (Ministry of Planning and Development)

" The Economy of Maldives, Problems and Prospects " (Ministry of Planning and Development)

" An Updating Economic Memorandum " (The World Bank)

*3: Estimated from data of 1977 census

Population per household. National Average: 6.1

In Male: 9.7

Outside Male: 5.6

- There were residences, of middle and upper classes, requesting their second telephone set.

Although conveyance of messages may be achieved by bicycle or on foot, without using telephones, since Malé Island is very small, the people are used to staying in their houses during the day time because of the hot tropical climate. As a result, demand for communicating through telephone may become significant.

Considering that a number of buildings with 4 stories or so are about to be completed and also a number of flats are under construction on the reclaimed land (about 48 hectares), the telephone demand will with great probability grow further.

Assuming that 50% of the total number of households in Malé in 1985 and 90% in 2005 will be provided with the telephone and a ratio of number of residential telephone sets to number of business telephone sets is 1:1,* the demand in Malé is estimated as in the table below (* Average value obtained from countries similar to Maldives is about 1:1).

<u>Year</u>	<u>Residential</u>	<u>Business</u>	<u>Total</u>
1985	1,950	1,950	3,900
1990	2,700	2,700	5,400
1995	3,650	3,650	7,300
2000	4,800	4,800	9,600
2005	5,850	5,850	11,700

Compared with the results of macroscopic demand forecasts the estimated values given above are more than the values of the forecasts.

Accordingly, it may be advantageous for the time being, to adopt conservatively estimated values (i.e., by the macroscopic demand forecasts) to avoid excessive provision of equipment.

- Telephone demand outside Malé Island

Verification of telephone demand outside the Malé Island is difficult, since no telephone service is in existence in the area except for a certain number of resort islands near Malé Island. However, the results of the field survey shows that there is a hidden demand of about three telephones, including the demand by government organization in the island.

Considerably large demand was anticipated in Gan Island of Addu Atoll, where a number of medium scale garment factories is in operation, but this must be considered to be an exceptional case.

The macroscopic demand forecast gives about 2 telephones per inhabited island in 1985 and this agrees approximately with the field survey results.

Demand in the remote future, i.e., in 2005, is estimated as 13 telephones per inhabited island, however, the forecast may be regarded as still conservative since difference between Malé and the other islands will probably be narrowed at that time.

Subscriber-line capacity of telephone switching equipment is determined according to results of the demand forecasts.

It is usual in Japan that the subscriber line capacity, of switching equipment to be installed, is so determined as to meet the demand expected in the end of two-year period after completion of installation work, because when the demand is increased, the scheduled expansion work can be accomplished in a comparatively short period (scheduled procurement of communication equipment is easy since it is manufactured domestically) and even when a demand exceeds the forecast an appropriate measure can be taken rather quickly.

On the other hand, in the Maldives, as a developing country, all the facilities need to be imported, consequently it is almost impossible to implement the expansion, including planning and installation works, in a short period as is the case of Japan.

Considering that the facilities once installed must be used over a long period and execution of installation work by their own manpower is considered difficult under the present economical circumstances in the Maldives, the macroscopic demand forecast made for 1995, that is eight years after installation, is applied to determine the subscriber-line capacity of switching equipment as follows:

- Subscriber's demand for 1995 in Malé Island is forecasted as 6,182 subscriber lines, and no subsequent adjustment which could be needed according to later change of demand forecast will be made.
- For islands other than Malé Island, the forecast demand for 1995 is 1,178 subscriber lines, but it is planned to install a minimum number of direct telephone sets through shared use of the telephone. Number of direct telephone sets to be installed and accommodated in the Malé switching equipment is three for each island, which is about a half of the demand forecast.
- A margin of approximately 3% is to be included for operation and maintenance purposes.

Subsequently the capacity of subscriber lines of Malé telephone switching equipment is obtained from the results of macroscopic demand forecast in TAB-3 and the preconditions mentioned above as follows:

Demand within Malé Island	6,182
Demand outside Malé Island	606
Margin for O & M	<u>200</u>
Total	6,988

Thus the subscriber line capacity to be provided is set at 7,000.

2) Demands for non-telephone services

Present conditions of the non-telephone services such as telex, telegraph, data services are summarized as follows:

- Number of telex subscribers is 134, as of the end of October 1984, and grows by 16 subscribers per annum. Main telex subscribers are various government organizations, tourist enterprises, transport enterprises, etc.

- Number of domestic telegrams incoming and outgoing between Malé and other atolls per annum totalled at approximately 33,000 in 1983 and there has been no significant change in the figure for a few years in the past. Data on international telegraph services could not be obtained.

- Data communication services are not available at present, but the international data communication circuit on 2.4 kbps will commence its service for airline companies in 1985.

As regards non-telephone services mentioned above, no rapid increase is anticipated for the time being, however, provision of an additional 5% or so to the designed telephone cable facilities in Malé will be sufficient for the growth of non-telephone services.

3) Traffic forecast

During the field survey, investigation was conducted of the actual traffic in the existing telephone exchange.

Results are summarized as follows:

- Probability of telephone connection during busiest hours (from 0900 AM to 0100 PM) was 20 to 50%.
- Call duration was approximately 110 seconds in average
- Frequency of telephone number enquiries was approx. 150 times per hour.
- No. of international calls per day was 278 for outgoing and 140 for incoming.
- International calls occurred almost uniformly over the period between 0800 AM and 1100 PM.
- Averaged traffic per subscriber was 0.165 Erlang.*

According to the above results, the present characteristic of the traffic will not change significantly if preference is given for the time being to the applicants who require the use of the telephone more frequently (i.e., important subscribers who necessitate the use of telephones more urgently) as standard practice.

Increase of less-traffic subscribers will result naturally in decrease of the mean traffic per subscriber. When such tendency is anticipated, it is necessary to carry out more detailed survey and to elucidate the situation.

Characteristics of telephone traffic in islands excluding Malé and the resort islands has not yet been made clear due to absence of telephone service at present. Therefore further study will be necessary in this respect.

*Note: Unit expressing occupancy of telephone circuit. One Erlang corresponds to one-hour occupancy of one telephone circuit.

Accordingly, 0.165 Erlang means that the telephone circuit is used for 9.9 minutes in total during one hour.

i) Inter-atoll communication facilities

Islands scattered in Ari Atoll are separated from Malé Island by 60 to 110 km, therefore it is difficult to connect these islands directly with Malé telephone exchange.

Accordingly, Mahibadhoo Island, which is situated near the center of the atoll, is designated as the base station of communication network within the atoll and connected with Malé telephone exchange through a communication transmission path. Thus the inter-atoll communication facilities are composed of the subscriber radio circuits connecting the base station with individual islands within the atoll and the multi-channel radio circuits linking Mahibadhoo Island with Malé Island.

Due consideration has to be taken to realize an economical system as far as possible and 9 islands among 18 islands in Ari Atoll are provided with public telephone services for the time being.

Those 9 islands have been selected by the team for the following reasons:

Ari Atoll, composed of 18 inhabited islands, is divided into two administrative regions, i.e., southern and northern, and the capital islands are Mahibadhoo and Rasdhoo respectively.

These two islands and the southernmost island, Maamigili Island where the population exceeds 1,000 are provided with public telephones preferentially. Total population of the remaining 15 islands is 5,607, in and average population per island is 374.

In the beginning a public telephone will be installed in the island with a population exceeding the said average as follows (figures in brackets show the island population).

1. Mahibadhoo (1,062)
2. Maamigili (1,052)
3. Thodhoo (741)
4. Rhasdhoo (540)
5. Dhagethi (511)
6. Omandhoo (469)
7. Fenfushi (448)
8. Ukulhas (407)

The other inhabited islands will be required to use a CB radio set to engage with a near most island to ask conveyance of messages.

Number of direct telephones required has been estimated in the foregoing section, but grasping a precise trend of telephone demand is very difficult. Therefore installation of highly efficient telephone will contribute to collect data on telephone demand.

Two telephones is to be installed in for Mahibadhoo Island, since it is a administrative centre and has the largest population and one each for the other islands. Although operation of public telephone is commissioned to the island office, POSTEL is requested to carry out itinerary maintenance regularly to the installed facilities and also to collect data on telephone demand and traffic characteristics.

To make the power supply equipment economical, it is essential to select a communication equipment of very low power consumption. None of the islands of Ari Atoll has any commercial power therefore provision of power generating equipment is necessary. Stable and continuous power supply is indispensable for telephone services.

Engine generators are used for power supply in general, but in cases where power consumption is low, use of solar-cell power generator is advantageous in view of maintenance and economy.

In Mahibadhoo Island, where both subscriber radio system and multi-channel radio transmission system are installed and the total power consumption is considerably large, engine-generator are provided. Solar-cell power generating system is used for the islands where the terminal unit of subscriber radio are installed. In Malé Telecommunication Centre the power supply prepared for the telephone switching equipment is shared.

The radio terminal unit may be of indoor type, installed in the island office building, or of outdoor type.

In Mahibadhoo island where many number of equipment is to be delivered, simplified prefabricated shelters have to be constructed.

ii) Telephone Facilities in Malé

On the basis of "Basic Design Policy" the replacement of existing switching equipment, expansion of telephone cable facilities and improvement of telephone charge processing are carried out.

Subscriber line capacity of new switching equipment to replace the existing equipment are determined as 7,000 according to the results of demand forecasts made in the preceding paragraph. This capacity has taken into account the future capacity of Malé and inter-atoll network.

The switching equipment to be introduced is provided with operator positions for telephone number enquiry and immediate call charge reporting*, test position for subscriber cables or telephone sets, O&M console, etc. And the equipment shall also have capabilities and functions to improve telephone services.

*Note: Since use of the telephones in each island of the inter-atoll communication is shared with many number of islanders, the call charge must be immediately reported to request and to collect charges.

For the purpose of rational processing of charges for local calls in Malé and inter-atoll calls charge processing by a small office computer using output of telephone charge data through magnetic tape is to be provided.

Necessary number of telephone cables shall be provided to meet the switching equipment capacity, where existing facilities are insufficient.

Electric power required for the facilities is supplied from commercial power. The commercial power is considerably stable at present and the power failure is said to be 2 or 3 times during an one year period, however, a standby engine generator is provided to prevent the service interruption in the event of a long term power failure caused by an accident.

As for the subscriber's lead-in wires and telephone set, they are excluded from the plan since they have to be prepared by the subscribers according to rules of POSTEL.

iii) Basic training

Telecommunication facilities to be introduced for this Project in the Maldives are of completely new system to POSTEL therefore it is indispensable to improve the technical capability of the staff for satisfactory operation and maintenance over a long period, and also to employ new employees.

POSTEL is requested to understand the situation and to make an effort in employment and training of personnel.

Taking into account present situation of manpower of POSTEL and also the Maldives as a whole, full fledged training has yet to rely on training courses and facilities of foreign countries, however, it is desirable that training of core staff, to enhance their technical capability, or basic training of new employees be carried out by the aid of foreign experts assigned to POSTEL.

Provision of training facilities such as basic training equipment & materials for radio equipment and audio and visual equipment is proposed as part of this Project.

iv) Malé Telecommunication Centre

As there are no available facilities to house the above telecommunication equipments in Malé it is proposed that Malé Telecommunication Centre building be built solely for the purpose of housing the said equipments.

The main rooms and spaces to be provided in the Centre are as follows;

Cable Chamber

- * Automatic Switching Equipment Room
- * Operator Console Room
- * Billing Machine Room
- * Radio & Multiplex Equipment Room
- * Maritime Console Room
- Power Room

Of the above rooms those marked with asterisk are to be air-conditioned.

The Power Room will be mechanically ventilated.

Besides the rooms above mentioned, rest rooms for operators and engineers will be provided.

All the rooms mentioned above are those directly related to the operation and maintenance of telecommunication equipment. However the following rooms are also considered necessary to be housed in the Centre although the functions to be accommodated does not have direct bearing on the O&M of telecommunications.

- Offices (for administrative staff)
- Public Service Office
- Training and Meeting Room

The Centre will receive commercial power but as the sub-station of the MEB located nearby lacks the required capacity it is proposed to accommodate a sub-station in the Centre building.

CHAPTER 4 GENERAL CONDITIONS OF THE PROJECT SITE

CHAPTER 4 GENERAL CONDITIONS OF THE PROJECT SITE

4-1 Site for the Malé Telecommunication Centre

4-1-1 Condition of the Site

The land initially allocated by the Maldivian side for the Centre was located 100 mts inland from the northern shore of Malé and had an area of 580 sq. mts. The basic design was carried out with this land as the proposed site. However, at the time of the Draft Report Explanation Team, the Maldivian side proposed to change the site to a new location. The Mission Team, through the below mentioned overall analysis and evaluation, agreed to the change.

- 1) The new site has an area 1.7 times larger than the original site. This added area will allow for a more reasonable block planning as well as making construction easier.
- 2) The new site is more centrally located within Malé, closer to the power generating station of the MEB and as such more suitable as the location for the Centre.
- 3) The position of the road in relation to the new site is similar to that of the original site. Although the building plan would have to be rotated 90 degrees, due to the change in orientation, and some windows must be relocated, the basic plan it would not require any major modifications.
- 4) Telephone cable work must be modified, because there will be an approximately 50 mts. increase in the distance from the existing exchange and a new manhole is planned. However there will be only a slight increase in cost.

The proposed site (the new site will be referred to as the proposed site hereinafter) is located in an area referred to as Penzeemage in Malé Island. It is 1.5 mts. above MSL, of a trapezoid shape, measuring 25 mts in width and 27 mts in length, with an area of approximately 930 sq. mts, generally flat and located at a corner.

It is located 270 mts inland from the northern shore of Malé and is one block south to the official residence of the president. Although the immediate vicinity is mostly a residential area, the proposed site is in proximity of the above mentioned president's residence, the Malé Municipality, which adjoins it, and the commercial centre. In relation with the proposed site; the existing telephone exchange housed in the National Security Service (NSS) building is 340 mts. away while the General Post Office, located at the northern end of Chandani Magu street, is 550 mts. and the POSTEL Head Office is approximately 1 km. away.

The proposed site is surrounded by two roads to the east and north and adjoining land to the west and south. The road on the east side is the Husnuheehaa Magu (road width 5.5 mts) and that on the north side is the Bokarumaa Goalhi (road width 3.7 mts.). A dwelling stands on the adjoining land to the west and the southern side is another government property. As the boundary between the proposed site and adjoining land is, at present, marked only by ropes, and there is a need to fence or wall the periphery. Furthermore part of the wall of the dwelling is within area of the site and requires to be removed.

The proposed site, before being procured by POSTEL, was a nursery for trees. Besides a well at the centre, there stands, a huge mango tree and numerous coconuts and bread trees.

4-1-2 Natural Conditions

1) Climate

The main meteorological characteristic of the Maldives is the monsoon particular to the Indian Ocean. During the North East Monsoon from November to April the air is dry, the winds mild and there is not much rainfall where as during the Southwest Monsoon from May to October there is a great amount of rainfall accompanied by strong winds. During this season the sea is often turbulent. At times of heavy rainfall the roads on Malé are sometimes flooded to 30 cm depth.

The climate of Malé is constant without much variations with an annual mean temperature of 27 to 29°C and mean relative humidity at around 80%. The highest temperature recorded during the past fifteen years is 34.1°C (April 1973) while the lowest is 17.2°C (November 1978). The daily range (the difference between the mean average of the daily high and low temperature of the hottest month) is 5.1°C.

The mean annual rainfall is approximately 2,000 mm.

The average annual maximum wind velocity is 8 mts./sec. and average velocity is 5 mts./sec. Maximum instantaneous wind velocity of 31.9 mts./sec. is on record.

2) Geology

From data collected, the soil of the site can be assumed to have the following characteristics. The strata at 2 mts. depth from ground level is mainly of coral sand and has a N-value of 8 to 15 and is medium grade in terms of load bearing capacity. From 2 mts. depth downwards the stratum is coral and at 20 mts. depth the N-value varies from 26 to 100. This variation is probably caused by cavities in the coral. The water table is 1.2 mts. The soil is assumed to be able to support the building with properly designed foundations.

3) Earthquakes

As there are no records of earthquakes in the Maldives and also being out of any earthquake area, no seismic considerations are given in the building design.

4-1-3 Infrastructure

The main means of transportation on Malé is bicycles. But in recent years the number of automobiles have increased and presently there are 750 vehicles running on Malé Island. Although the roads are not paved, because of the lime contained in the soil, the road surface is hard and uniform.

Transport of goods in and out of the Maldives is largely dependent on sea transport. However, as the port in Malé lacks berths with adequate depth, goods cannot be offloaded directly dockside, but must be brought to shore by means of barges from the ships anchoring some distance off shore, therefore restricting the maximum weight and dimension of materials and equipments which maybe shipped. Domestic transport is also largely dependent on sea transport. At present, there are no regular freight and passenger services between the atolls. Most of the transport is by small wooden vessels called 'dhonis'.

Air-transport capacity has greatly increased with the expansion of Malé International Airport on Hulule Island in 1981. There is a domestic service once a week to Gan Island.

2) Power

The power supply in Malé is by 3 phase 4 wire 400 V/230 V 50 Hz. There are 13 sub-stations located in and around the island out of which sub-stations No. 1 - No. 8 receives at 3.3 kV and supplies at 230 V while sub-stations No. 9 - No. 13 receives at 11 kV and supplies at 400 V.

It has been confirmed that the existing sub-stations close by has no allowance in its capacity. Therefore a sub-station must be established at the site.

3) Water

There is no city water supply in Malé. Collected rainwater and well water from the few non-contaminated wells serves as drinking water. The collection and storage of rainwater is mandatory and provisions for the same must also be made at the proposed site. For utility purposes well water is used. There is an existing well at the proposed site. However, as this well is located in the centre of the site, it must be closed and a new well will have to be bored, for supplying utility water to the new building. The water table is at approximately 1.0 mts. below the existing ground level and should pose no problems.

4-2 Sites for New Installations in Ari Atoll

Ari Atoll where the inter-atoll telecommunication network is introduced is situated in the south-west of Malé Island and composed of 79 islands scattered over the area, about 100 km from south to north and about 30 km from east to west.

There are 18 inhabited islands and 6 uninhabited islands already developed as a resort and a few uninhabited islands are also under planning.

Population of Ari Atoll was 6,219 at 1977 census but it is 8,261 according to the data obtained in this field survey.

Ari Atoll with 18 inhabited islands is administratively divided into two areas, i.e., Northern Ari Atoll with 8 inhabited islands and Southern Ari Atoll with 10 inhabited islands and an atoll chief is appointed for administration at each capital island, i.e., Rasdhoo for Northern Ari atoll and Mahibadhoo for Southern Ari atoll.

TAB-4 on next page shows the present conditions of all the inhabited islands in Ari atoll. In the field survey were visited 12 inhabited islands and one resort island in Ari atoll as well as two islands, i.e., Maafushi and Lhohi situated in the south of Malé.

Following are outlines of these islands;

- The Islands are surrounded by coral reefs and large vessels can not enter inside the reef. A part of the coral reef is cut to enable small boats to reach the jetty.
- Many coconut trees, which are the property of inhabitants, grow thickly.
- Each inhabited island has an island office together with a health centre, a court of justice, etc. and the island chief controls and supervises the island.
- Vehicles such as automobile and autobicycle are not available, therefore transportation of any goods is done by manpower only.
- Inhabitants earn their living through fishery, agriculture, going to Malé or nearby resort islands to work, etc. The agriculture is possible only in those islands with good water and soil. In Feridhoo Island, an Agriculture Centre has been established by the aid of FAO.
- No island is supplied with commercial electric power but most of the islands have privately purchased generators to supply power in the night for a certain amount of charge. Some islands have their own engine generators as a common property of the islanders.

The RCS terminal facilities are to be installed in eight islands as described in 3-3 and the sites in these islands are given below. The telephone sets are to be installed in the island offices, but the radio terminal units and the antenna masts may be installed separately from the island office where necessary.

In Malhibadhoo Island, the site for 80 m guy tower and shelters for radio equipment and power supply equipment is prepared in the east end of the island as shown in FIG-2. For the other 8 islands the proposed locations of radio terminal units and antenna masts are as follows:

<u>Name of Island</u>	<u>Location of Radio Terminal Unit and Antenna Mast</u>
Maamigili	Island Office compound
Thodhoo	About 200 m, north of Island Office
Rasdho	" " , south of Atoll Office
Dagethi	Island Office compound or its adjacent land
Omandhoo	Island Office compound
Fenfushi	About 200 m, east of Island Office or in the island office compound
Ukulhas	About 200 m, north west of Island Office or in the island office compound
Feridhoo	Island Office compound or its adjacent land

Since the field survey was made in a very limited time, exact location of each site could not be definitely determined. According to each island chief who is empowered to make a decision on the use of lands, a suitable land can be prepared when necessary, giving this project priority.

Table 4 Status Quo of Ari Atoll

	No. of Population	No. of Houses	No. of Radio sets	No. of Jetties	No. of Boats	No. of Shops
<u>Mahibadhoo Administration area</u>						
Mahibadhoo *	1062	137	98	1	91	9
Hannyameedhoo *	325	50	30	1	31	2
Omandhoo *	469	95	47	1	41	2
Kuburdhoo	290	49	24	1	18	1
Mandhoo *	221	44	28	-	18	1
Daggethi *	551	85	73	1	44	3
Digura	358	201	46	1	34	2
Fenfushi *	443	80	43	1	61	2
Dhidhoo	108	38	9	1	11	2
Maamigili *	1052	153	62	1	62	6
<u>Rasdhoo Administration area</u>						
Rasdhoo *	540	96	39	1	39	1
Thodhoo *	741	130	44	-	37	2
Ukulhas *	409	60	18	1	35	1
Bodufolhudhoo	313	37	19	1	21	-
Mathiveri	334	44	26	1	23	2
Feridhoo *	407	67	33	1	25	-
Malos	356	66	29	-	29	-
Himandhoo *	317	53	30	-	30	-

Note: Names of visited islands are marked by asterisk.

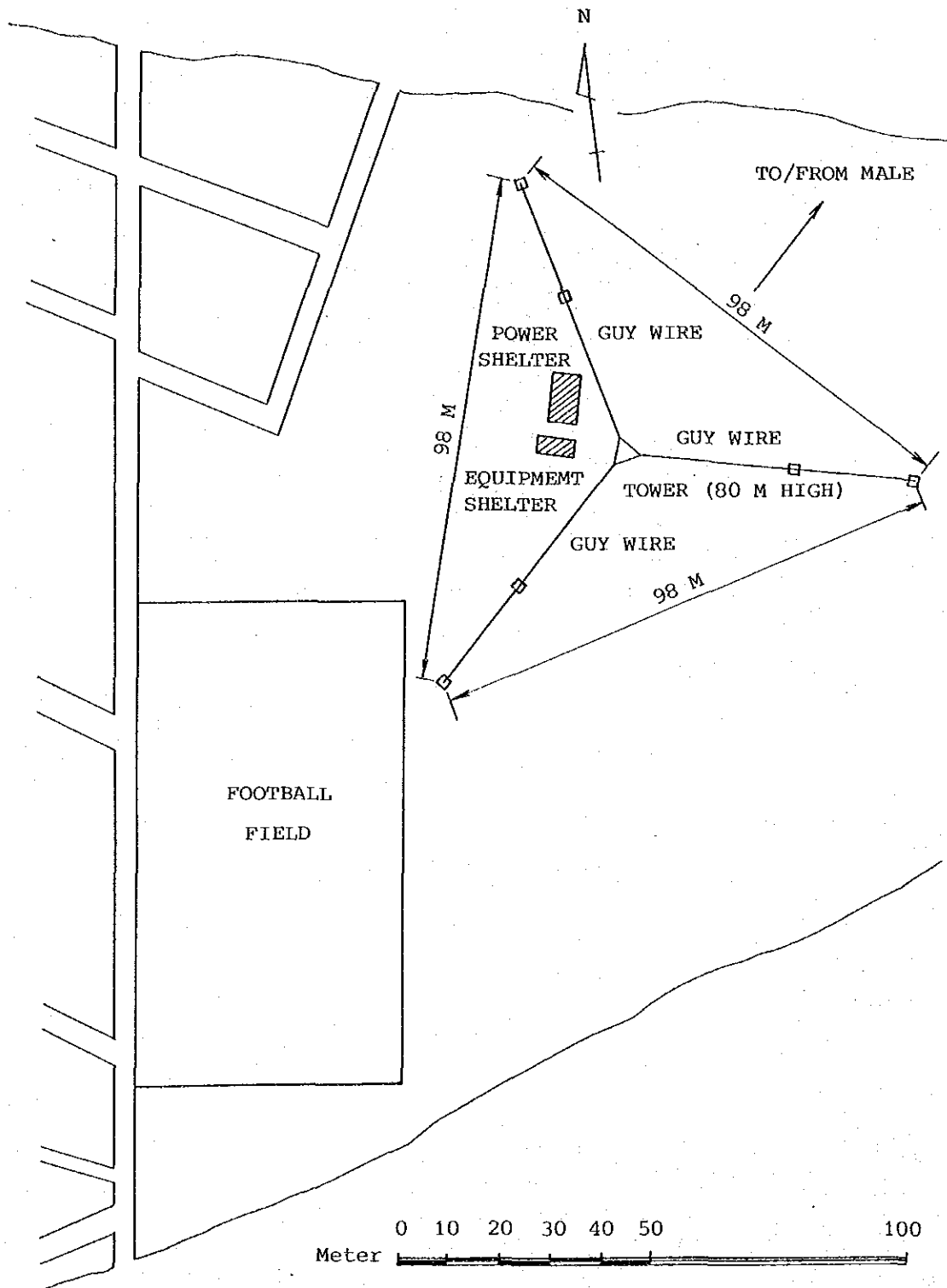


FIG.-2 MAHIBADHOO SITE LOCATION

CHAPTER 5 BASIC DESIGN OF TELECOMMUNICATION DEVELOPMENT

CHAPTER 5 BASIC DESIGN OF TELECOMMUNICATION DEVELOPMENT

5-1 Design Standards

5-1-1 Telecommunication Facilities

Design standards of telecommunication facilities are to conform with recommendations by International Telegraph and Telephone Consultative Committee (CCITT) and International Radio Consultative Committee (CCIR) and also to consult the UNDP/ITU master plan as far as possible.

- Service quality: Grade of service (Probability that all the communication channels are occupied) is to be maintained at 0.01 or less for all the call attempts.
- Numbering plan: Since the capacity in present numbering scheme is not enough, new numbering scheme proposed in the master plan is to be adopted when new telephone when new switching equipment is introduced.
- Charging system: Although details of the system are now under study by POSTEL it is planned to introduce multi-metering according to duration of call for local calls and detailed recording for toll calls.
- Signalling system: Compatibility with the present signalling system shall be considered.
- Transmission loss distribution: 7-dB loss is assigned between local exchanges and also overall reference equivalent of 19 dB at maximum is maintained.

5-1-2 Architectural

There are no building codes or regulations to be referred in the Maldives.

The Malé Telecommunication Centre, which will house telecommunication equipment requiring severely regulated environment, shall be designed basically in accordance with the same standards as similar facilities in Japan. However due consideration shall be given to architectural practices, climate, customs and economic situation prevailing in the Maldives.

Among the factors that need considering are that there are no building material manufactured in the Maldives, the port facilities do not have adequate handling capacity, skilled labour is in short supply and specific parts and materials for maintenance purposes are not available.

5-2 Basic Design I - Telecommunication Plant Installation Plan

5-2-1 Ari Atoll Communication System

1) Choice of Facilities

Subscribers in Ari Atoll area are accommodated in the telephone switching equipment in Malé Island through so called "rural telephone". Use of radio system is indispensable since the presumed subscribers are distributed over many scattered islands, therefore use of ordinary telephone cables is not practical.

Facilities of the radio transmission system should be economical even for the rural telephone and yet suitable for insuring required speech quality.

Since Ari Atoll subscribers are separated 60 to 110 km from Malé a radio link to link the RCS base station with Malé telephone exchange becomes necessary.

It is also essential to save the radio frequencies according to a long-term frequency utilization plan since the radio frequencies are considered as one of important limited resources for Maldives.

Then it is proposed to provide such telecommunication facilities as outlined below taking into account the above:

- i) Ari Atoll Communication System is composed of the subscriber circuits in Ari Atoll and the radio link connecting Ari Atoll with Malé telephone exchange.
- ii) The subscriber circuit uses a radio concentrator system (RCS) where a number of radio frequencies are shared by more number of subscribers between the subscriber and the base station at Mahibadhoo island situated near the centre of Ari Atoll. Subscribers in Mahibadhoo are accommodated directly in Malé telephone exchange without using RCS. There are two systems for realizing the RCS, i.e., analog and digital. The latter seems to be attractive but is still in the stage of development at present and there is no practical installation yet in the world. Therefore it is proposed to use analog RCS in Maldives.
- iii) Multiplex radio transmission link which carries a number of concentrated circuits on two pairs of microwave frequencies is provided between Malé and Mahibadhoo islands.
- iv) There also are two systems, analog and digital with respect to modulation for the multiplex radio transmission system, and line-of-sight (LOS) and trans-horizon (TH) with respect to mode of radiowave propagation.

But, taking into account that the required transmission capacity is rather small, the propagation conditions in the area under consideration are not so favourable for the line-of-sight mode and economy of the provided system is to be pursued, use of the analog TH radio relay system is proposed.

The analog LOS radio relay system may be considered but as an alternative plan.

- v) Accommodations required for the Ari Atoll Communication System facilities are to be prepared as follow:

- Malé: Telecommunication centre to be newly provided will be available for the required installation

- Mahibadhoo: New prefabricated shelters are provided to house the multiplex radio relay equipment, RCS radio transmitters and receivers and power supply equipment including diesel engine generators.

- RCS terminal: In principle, existing island offices are to be used, but if necessary, an outdoor type terminal equipment is to be used depending on actual site conditions.

2) System Composition

Route diagram and basic composition of the Ari Atoll Communication System and configuration of RCS terminal are given in FIG-3 through FIG-6.

Following is the outline of facilities.

i) Concentrator

The concentrator constitutes one of essential parts of RCS facilities and is used to concentrate a number of subscriber's lines into a less number of radio frequency channels. Concentration ratio is determined according to the traffic volume and service quality.

ii) Multiplex carrier telephone equipment

The equipment is to form a single baseband signal where two or more telephone channels are combined on the frequency domain into a single wave or to divide the single wave into two or more individual telephone channels.

iii) Radio transmitter-receiver

This equipment transmits or receives the radio frequency wave modulated by the baseband signal.

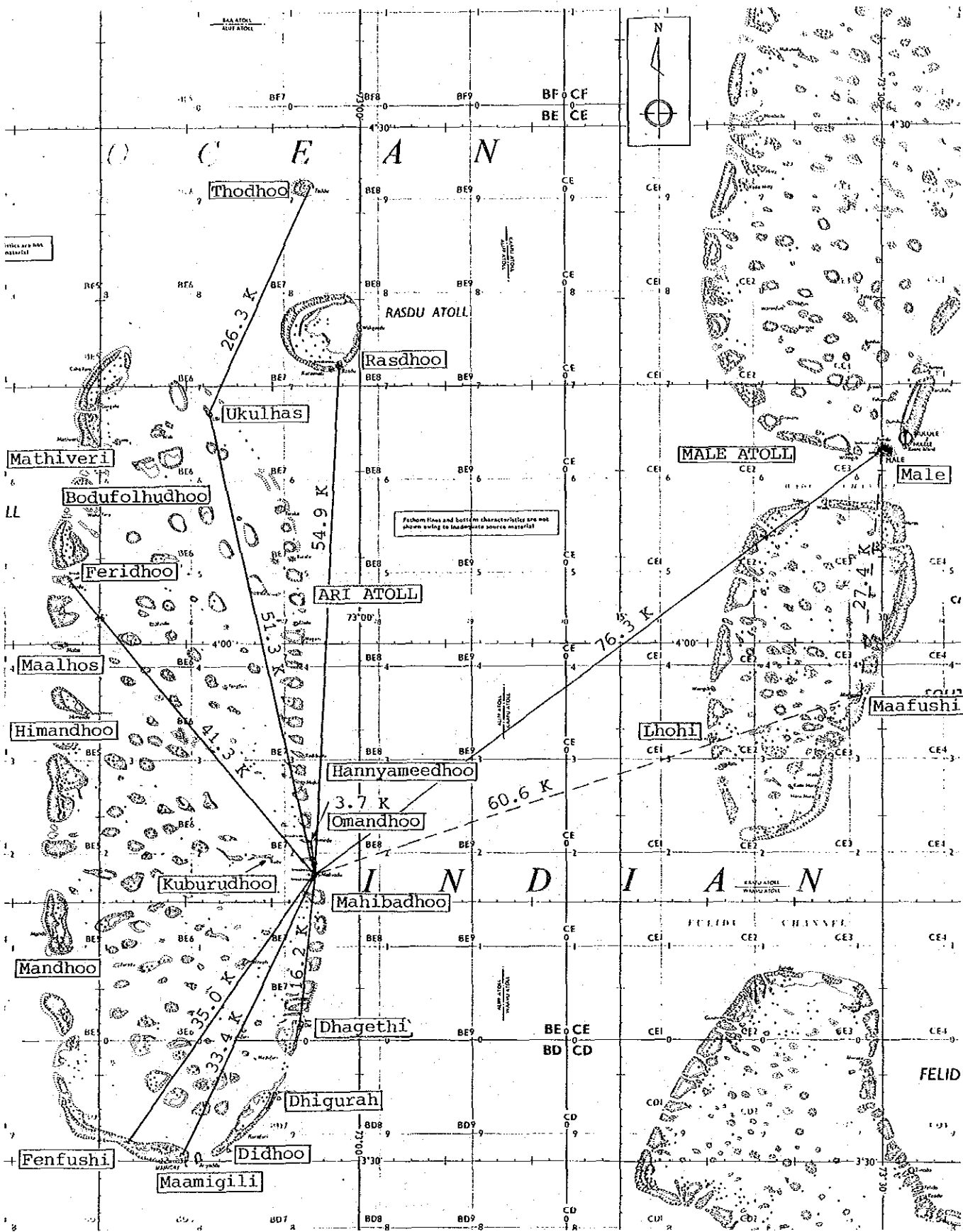


FIG-3 INTER-ATOLL COMMUNICATION NETWORK ROUTE MAP

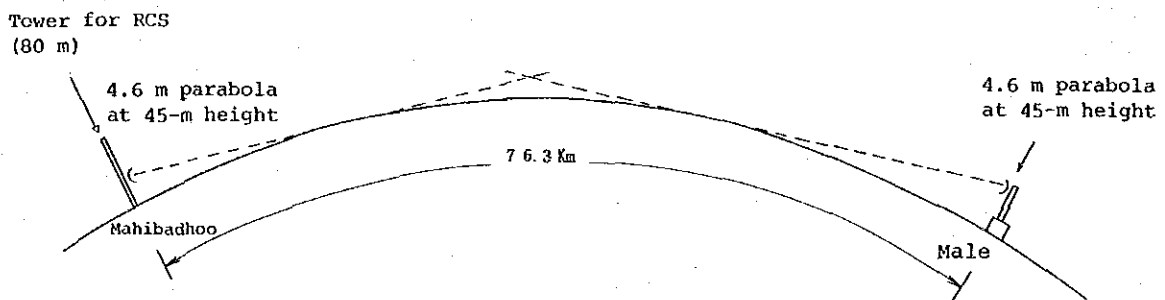


FIG-4 TRANS-HORIZON COMMUNICATION NETWORK

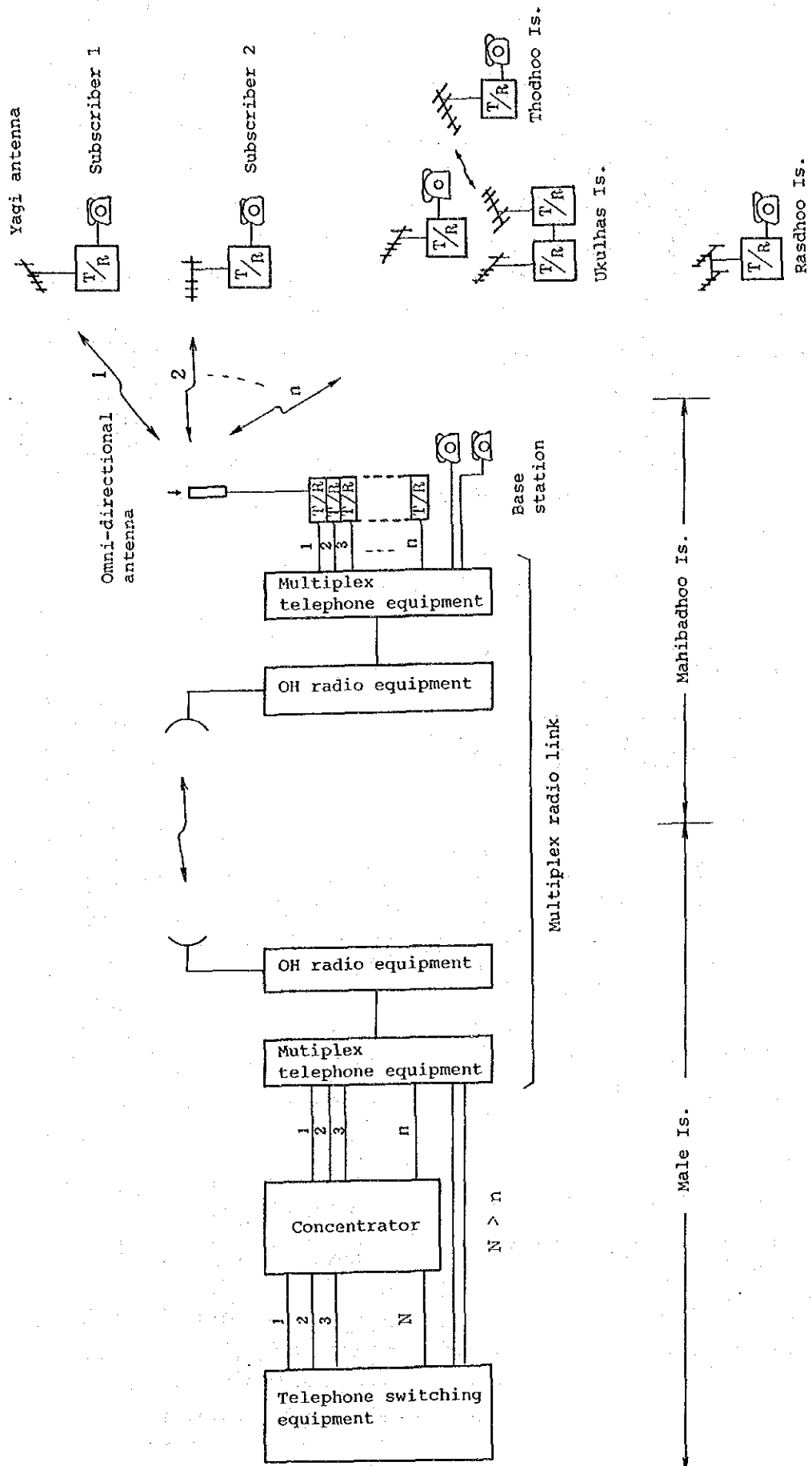


FIG-5 COMPOSITION OF INTER-ATOLL COMMUNICATION NETWORK

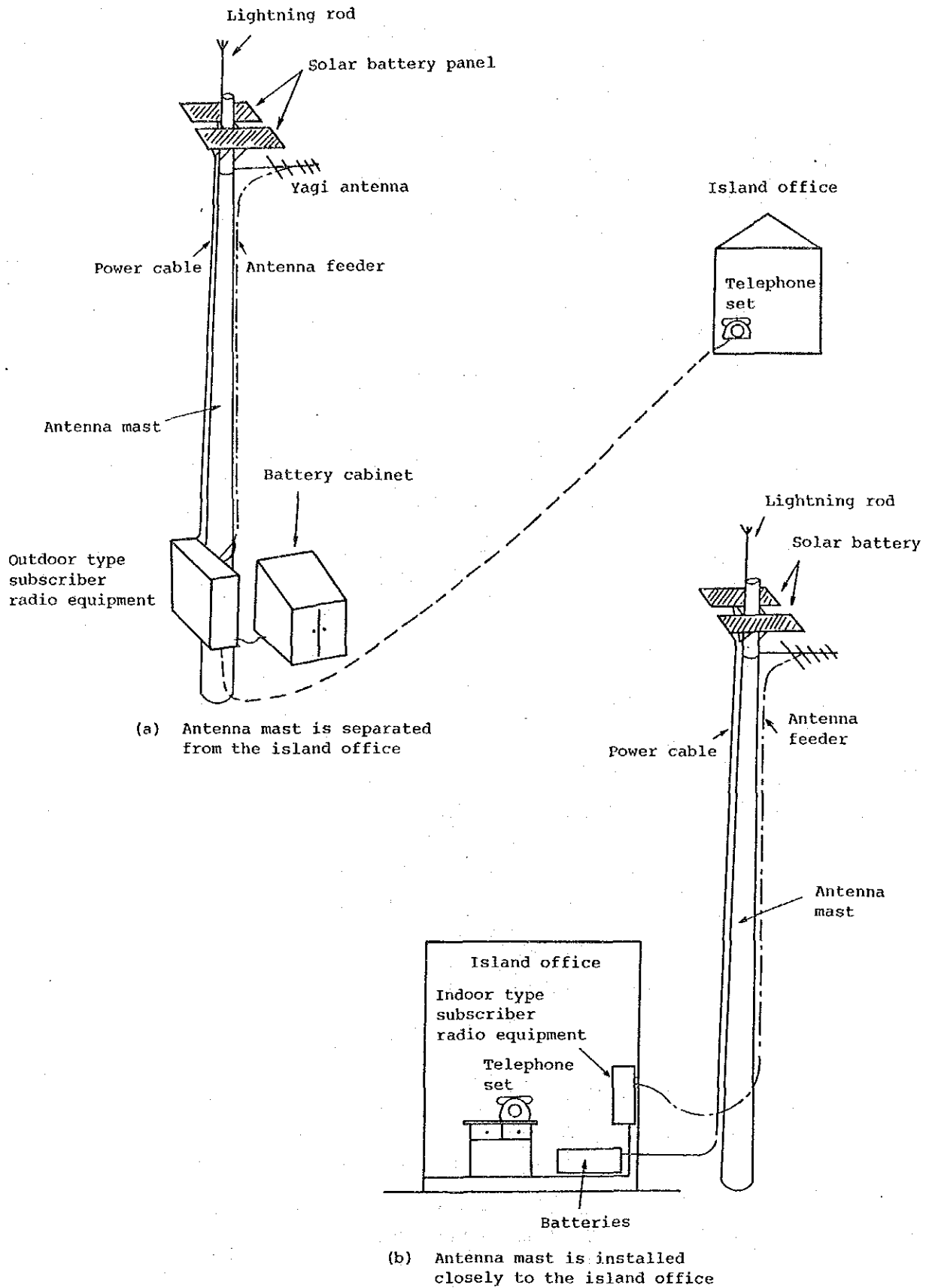


FIG-6 CONSTRUCTION OF RCS TERMINALS (EXAMPLES)

iv) RCS base station

As many number of radio transmitters/receivers as concentrated number of telephone channels transmit/receive radio frequencies to/from the subscriber's terminal units.

v) Subscriber's terminal unit

Any one pair of vacant frequencies is selected to establish a telephone speech path.

3) Facility plan

i) RCS facilities

Analog RCS facilities are planned under the conditions as follows:

- Traffic volume per subscriber is assumed as 0.165 Erlang approximately equivalent to that for the telephone subscriber in Malé island.
- To maintain necessary service quality 5 channels are provided for 8 subscribers.
- It is practical to use rather low frequencies, i.e., 150 MHz or 400 MHz band, but the 150 MHz band has already been used up by or reserved for C&W. Therefore use of the 400 MHz band is proposed.
- Frequency assignment plan is shown in FIG-7. Proposed types and mounting heights of antennas are shown in FIG-8.
- Since the distance between Mahibadhoo and Thodhoo islands is approx. 80 km, the radio frequency signal to/from Thodhoo island is relayed at Ukulhas island by a single channel relay equipment.

ii) Multiplex radio transmission link

The multiplex radio transmission link uses analog OH radio system under the following conditions:

- Proposed transmission link capacity is 12 channels that is a minimum level of translation in multiplex equipment, including 5 channels for RCS, 2 channels for direct connection to two subscribers in Mahibadhoo island and 5 channels for spare.
- Radio frequency band to be used is of 800 MHz or 2 GHz.
- Frequency diversity* is applied to stabilize the circuit performances through minimizing variation range of received signal, caused by reflections or multipath propagation which are liable to occur on over-seawater propagation paths.
- * Note: Special receiving system where a signal is transmitted by two different radio frequencies, these two frequencies are received by two receivers and a stable signal is detected from them.
- Equipment installed at Mahibadhoo is remotely supervised at Malé.

iii) Power supply equipment

- Malé island

Required power for radio communication equipment is supplied from the power supply equipment for Malé telephone switching equipment.

- Mahibadhoo island

Required power is supplied through engine generators, rectifiers and batteries. As the battery holding time, 3 hours are enough because of availability of standby engine generator, and assignment of stationed maintenance crew.

- RCS terminal unit

Solar-cell power generating system is proposed because power consumption by the terminal unit is rather small and maintenance of the solar-cell power generating system is very easy and economical.

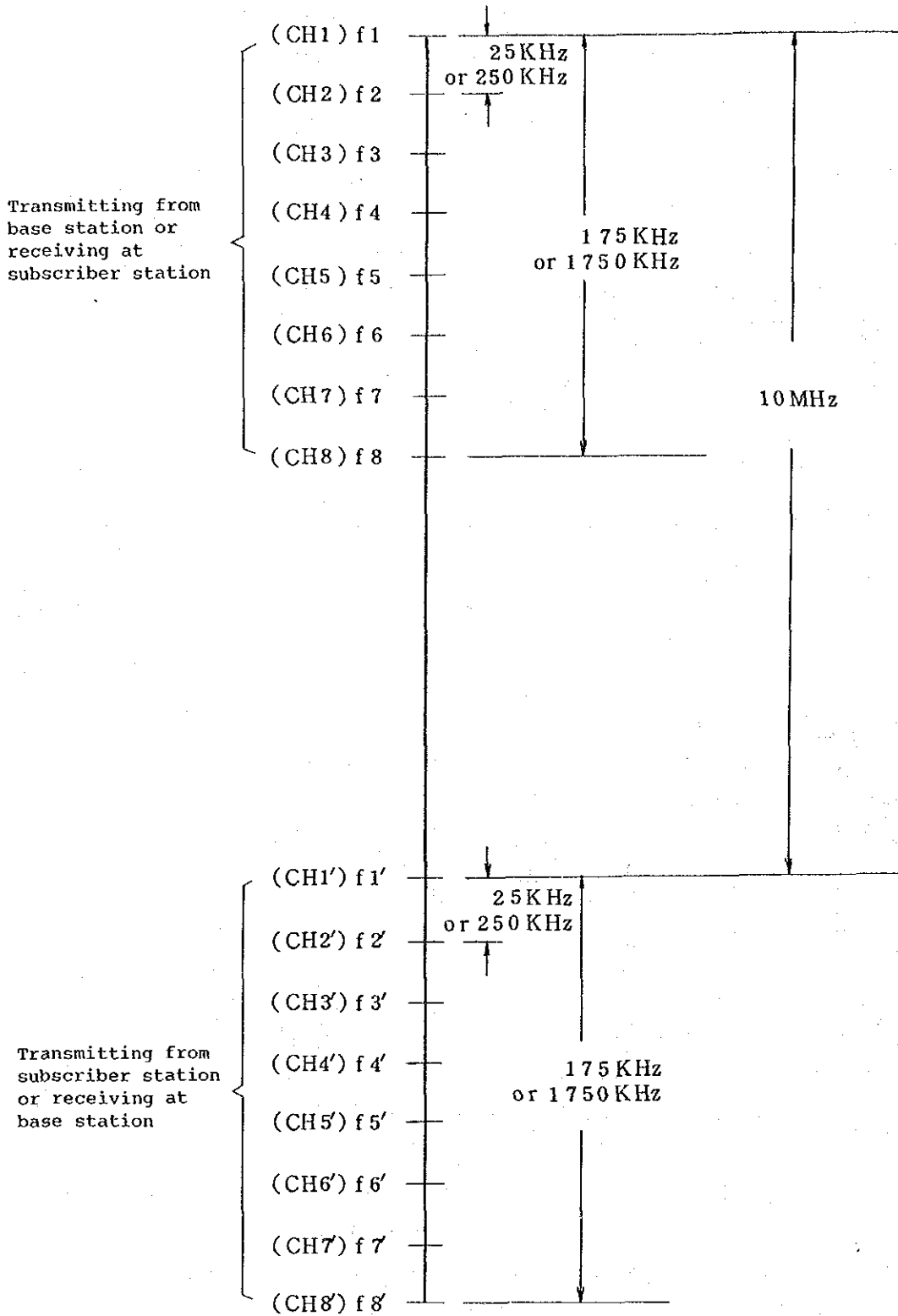


FIG-7 FREQUENCY ALLOCATION PLAN FOR RCS (400 MHz BAND)

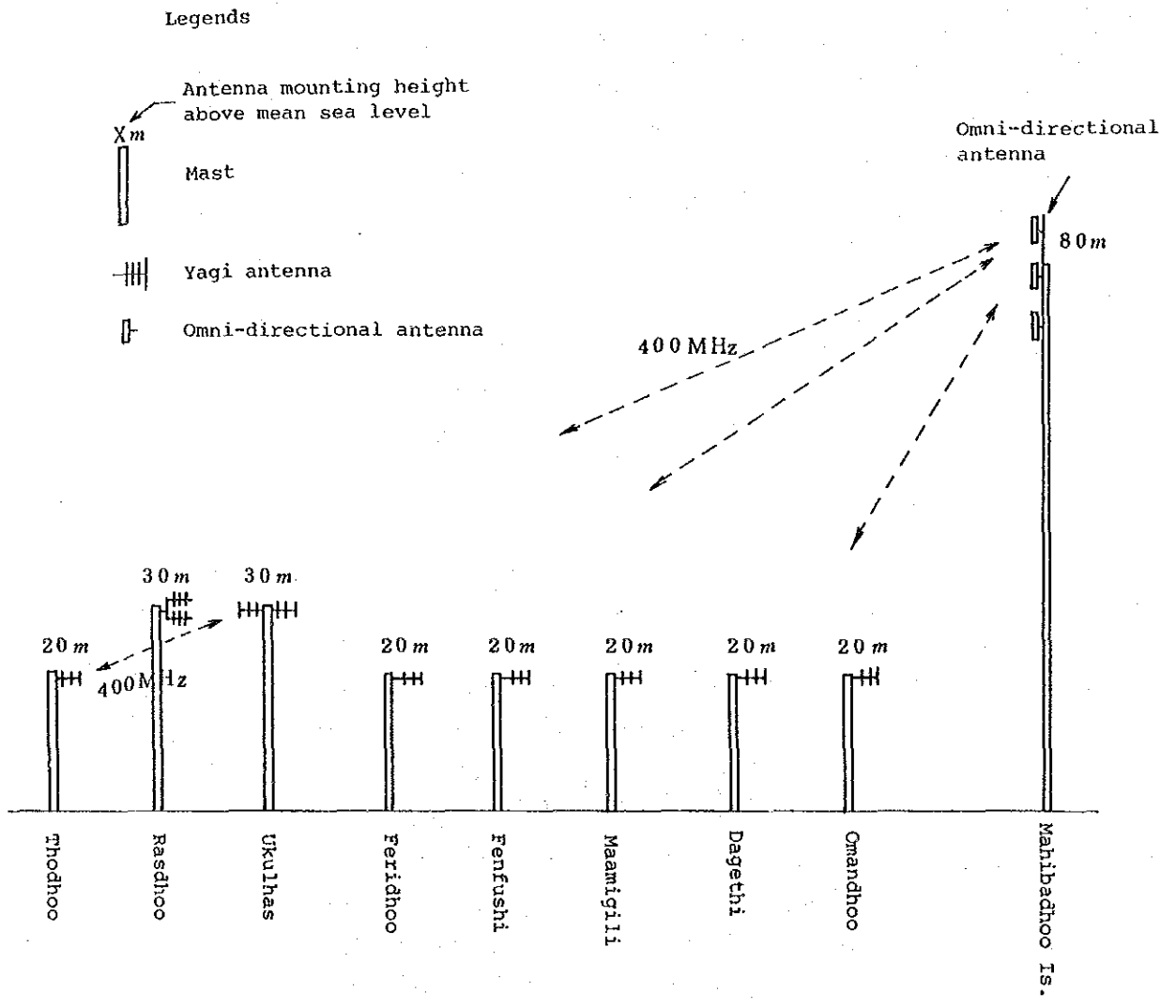


FIG-8 TYPES AND MOUNTING HEIGHTS OF ANTENNAS FOR RCS

iv) Relocation of existing VHF/UHF radio communication equipment

There are 5 existing VHF and 2 existing UHF radio equipment in the NSS building where the existing telephone switching equipment is installed. Accordingly these radio equipment shall be transferred to the new telecommunication centre building where the existing telephone switching equipment is removed. Existing feeders and antennas are replaced with new coaxial cables and antennas and power supply equipment for these radio equipment are provided in this project to minimize the service interruption.

v) Telephone cable facilities

The telephone cable facilities to be provided are;

- a. tie cables to connect the existing exchange office with the new Telecommunication Centre building to accommodate telephone circuits for Ari Atoll in the existing telephone exchange and
- b. distribution cables to connect the radio terminal unit with the telephone set in some islands in Ari Atoll if the island office compound is not suitable for construction of antenna mast. The cables are directly buried under the ground as in the existing cables in Malé Island.

(FIG-13 shows the tie cable plan)

5-2-2 Malé Telephone System

Malé Telephone System consists of the telephone switching equipment, billing machine and telephone cable facilities and the proposed capacity should be 7,000 subscriber lines as given in Para. 3-2 1).

1) Telephone exchange facilities

i) Services to be provided

- Subscriber lines to be accommodated are with the rotary dial telephone, push-button dial telephone, public coin telephone and private (automatic) branch exchange.

- Connections of both local and toll calls are carried out automatically by subscriber's dialling, but for the toll calls manual connection is also to be possible for immediate charge information.
- International calls are handled through C&W's international switchboard in principle but automatic connection by direct dialling is considered for specific subscribers.
- Inter-atoll HF communication circuits and/or maritime communication circuits are accommodated as ordinary subscriber circuits.
- Emergency services are provided for police, fire brigade and hospitals.
- Information services including telephone number enquiry service are provided.
- Announcing service is provided to minimize the number of incomplete calls.
- Abbreviated dialling, automatic call forwarding, call waiting services are considered for a part of subscribers.

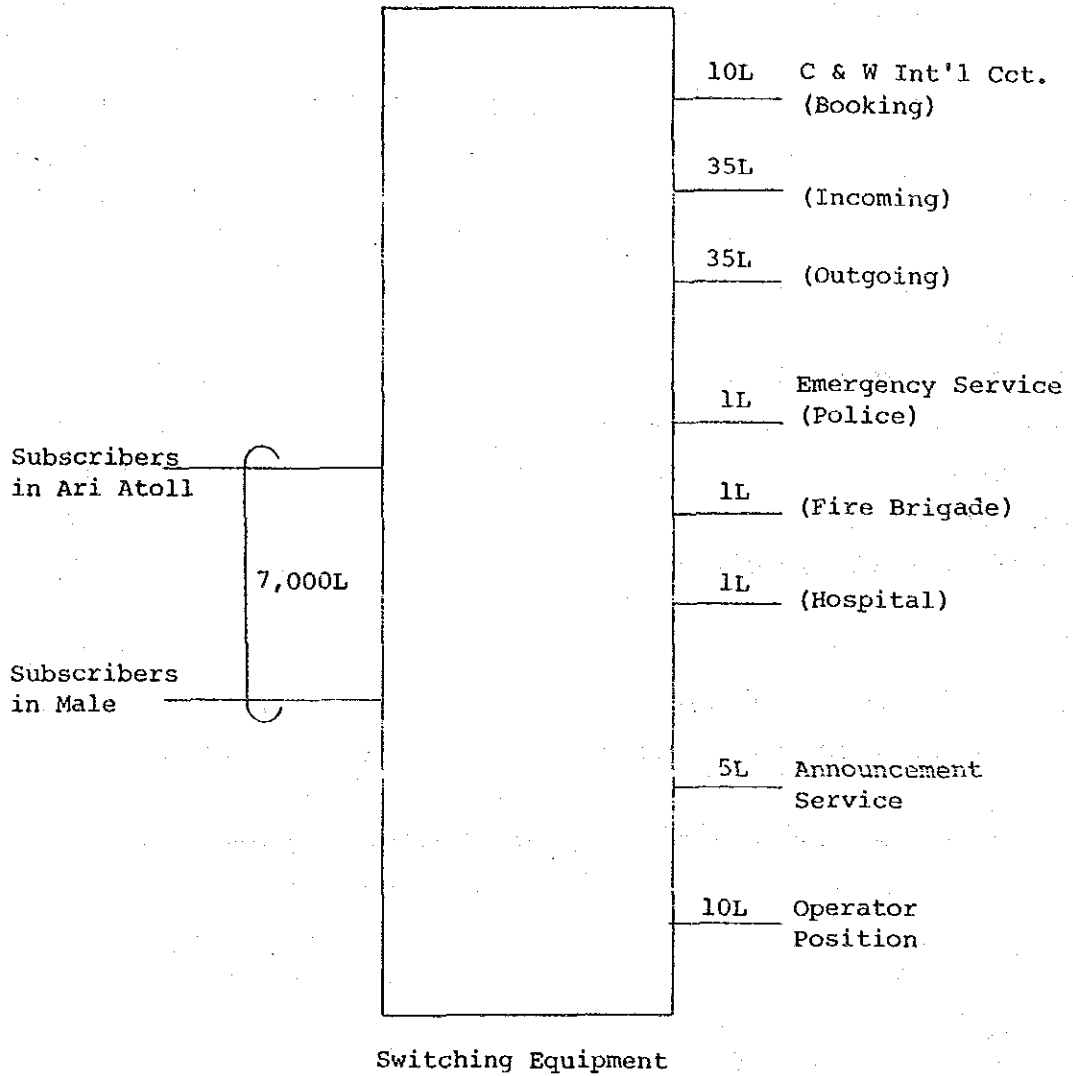
Provision of these services requires not so much additional cost since such features, are the basic functions that the electronic switching equipment has originally.

ii) Accommodation of telephone circuits

Telephone circuit accommodation plan is shown in FIG-9.

iii) Numbering plan

As the numbering scheme adopted at present was prepared only for Malé Island, the telephone number capacity on which necessity of telephone numbers for the inter-atoll communication.



Note : HF and maritime telephone circuits are accommodated to the equipment through ordinary subscriber circuits.

FIG-9 TELEPHONE CIRCUIT ACCOMODATION PLAN

New numbering plan as given in TAB-5 is adopted when the telephone switching equipment is replaced.

TAB-5 Numbering Plan

	<u>Present Plan</u>	<u>New Plan</u>
Malé	2xxx - 7xxx	03-2xxxxx - 7xxxx
Ari-Atoll	-	042-2xxxxx - 7xxxx ^{*1}
Police	9999	100
Fire brigade	-	101
Hospital	9995.9996	102
Booking for toll calls	9992 ^{*2}	180
Booking for international calls	90	186
Phonogram	-	188
Complaint	95	198
Telephone number enquiry	0	175

*1. Inhabited islands are divided into a number of groups and are assigned the corresponding telephone numbers to the respective areas.

*2. It is used for application of inter-atoll HF communication.

iv) Type of switching equipment.

Main types of switching equipment in use in the world are cross-bar type, analog electronic type and digital electronic type at present.

The first two types are being manufactured only for expansion of the existing facilities of the same type, and the main stream of switching equipment in the market is by digital electronic switching equipment.

Such tendencies are observed not only in Japan but also all over the world, consequently even countries having no manufacturing factory of switching equipment are adopting the digital electronic switching equipment taking into account of economical architecture of future telecommunication networks, guaranty of spares and also equipment costs.

As mentioned above it is very hard to find a suitable type of equipment to be replaced for the digital electronic switching equipment.

Therefore the digital electronic switching equipment is introduced in this project.

v) Charging facilities

Data on local call charge are recorded on a meter provided in memory and data on toll and international calls are recorded on a magnetic tape.

vi) Operator positions

Operator positions are used for toll call connection requiring immediate report of call charge and reception of complaint calls in addition to telephone number enquiry service.

Required number of positions is 10 including the supervisor position, taking into account the estimated number of calls for telephone number enquiry service as stated in Para. 5-2-2, 1).

- vii) Miscellaneous equipment for operation and maintenance
- Operation and maintenance (O&M) console is provided for supervision, control and tests of switching equipment.
 - Equipment such as printer and keyboard required for man-machine communication
 - Test console for subscriber telephone circuits
 - Magnetic tape equipment for outputting charging information
 - Other O&M functions such as malicious call tracing, traffic measurement, charge observation, automatic line test.

viii) Power supply equipment

Although the commercial power seems to be considerably stable, more stabilized D.C. current is supplied to the telecommunication facilities from the power supply equipment as shown in FIG-10. This power supply equipment supplies uninterrupted A.C. power through DC-AC inverter for the billing machine. Essential power is also supplied to the air conditioning equipment and emergency lighting in the telecommunication equipment room in the case of commercial power failure.

2) Billing machine

Employing an office computer of a minimum but sufficient capabilities for billing, computation of telephone charges is carried out according to charging data stored on a magnetic tape in the switching equipment. Bills for inter-atoll HF communication and maritime communication are prepared at the respective centres and the obtained data are manually input to the computer.

Main equipment of the billing machine is as follows:

- Central processing unit
- Magnetic disc unit
- Magnetic tape unit
- Printer
- Work station
- DC-AC inverter *

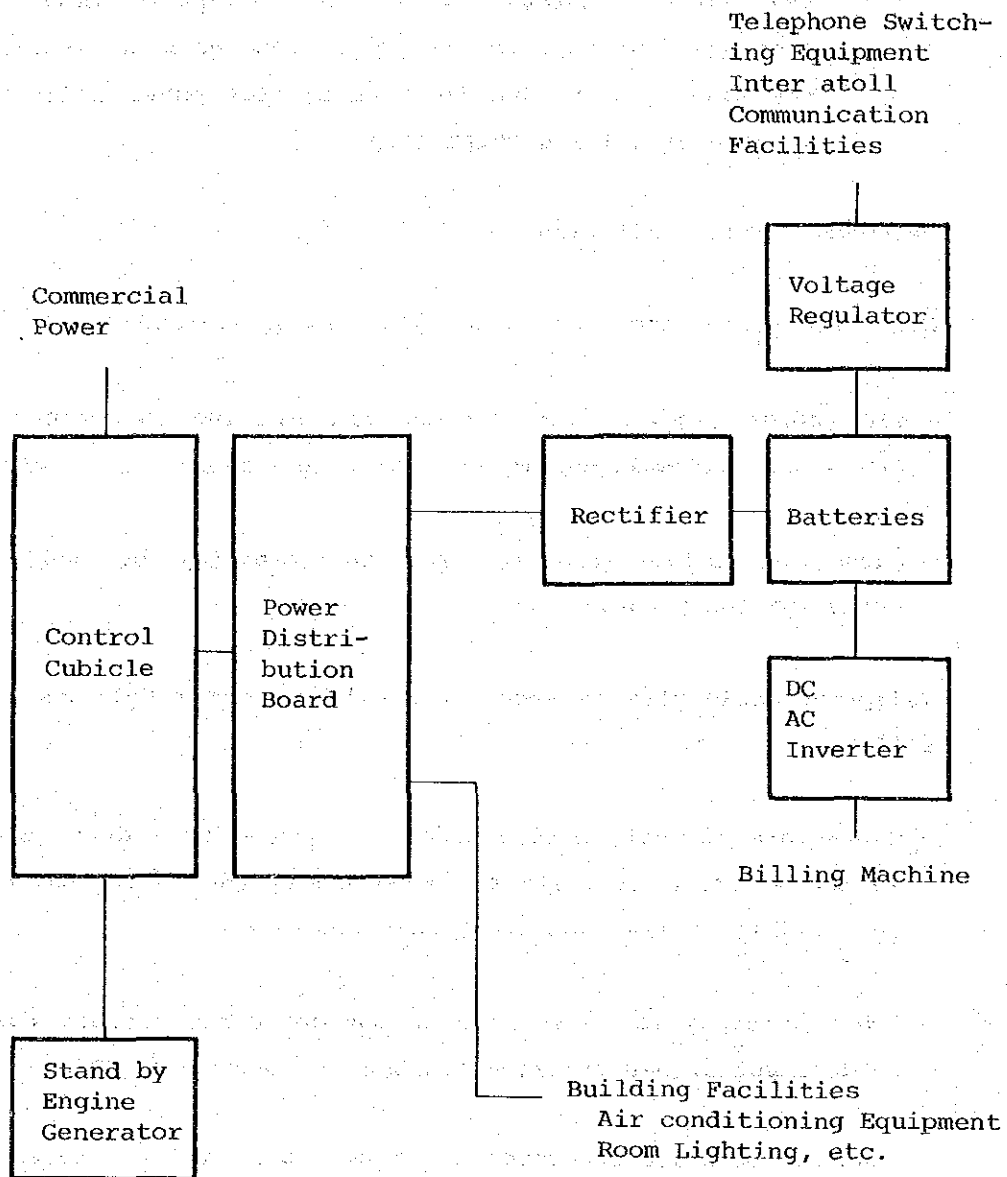


FIG-10 CONFIGURATION OF POWER SUPPLY EQUIPMENT

*Note: This equipment supplies uninterrupted AC power required for the computer through converting the direct current for the exchange equipment to the alternating current to avoid losing the billing data due to a commercial power failure during a process of billing computation.

3) Telephone cable facilities

Cable facilities included in the plan are as follows:

- Tie cables required for transferring all the subscriber lines and C&W lines accommodated in the existing exchange to newly installed exchange.
- Subscriber cables required for the capacity of newly installed switching equipment.

Telephone cable plan is shown in FIG-11 through FIG-13 and outlined as follows:

- Cables are directly buried under the ground to a depth of 0.45 m as in the existing facilities. Accordingly the cables to be provided are of jelly filled and steel-tape armoured.
- Cable jointing is to be made in outdoor cable cabinet box or in an outdoor subscriber distribution box as standard practice.
- Diameter of cable conductor is to be 0.5 mm and the number of pairs, 20, 50, 100, 200, 400 or 800 depending on demand.
- Outdoor cable cabinet and outdoor subscriber distribution box are to be finished to prevent damages from salty water or air and to be suitable for number of cable pairs of 20, 50, 300, 800, 1,600 or 2,400 as required.

Proposed number of lead-in cable pairs to Malé Telecommunication Centre is approx. 11,000 including those for tie cables required for the inter-atoll communication network. The total length of cables reaches approx. 47 km.

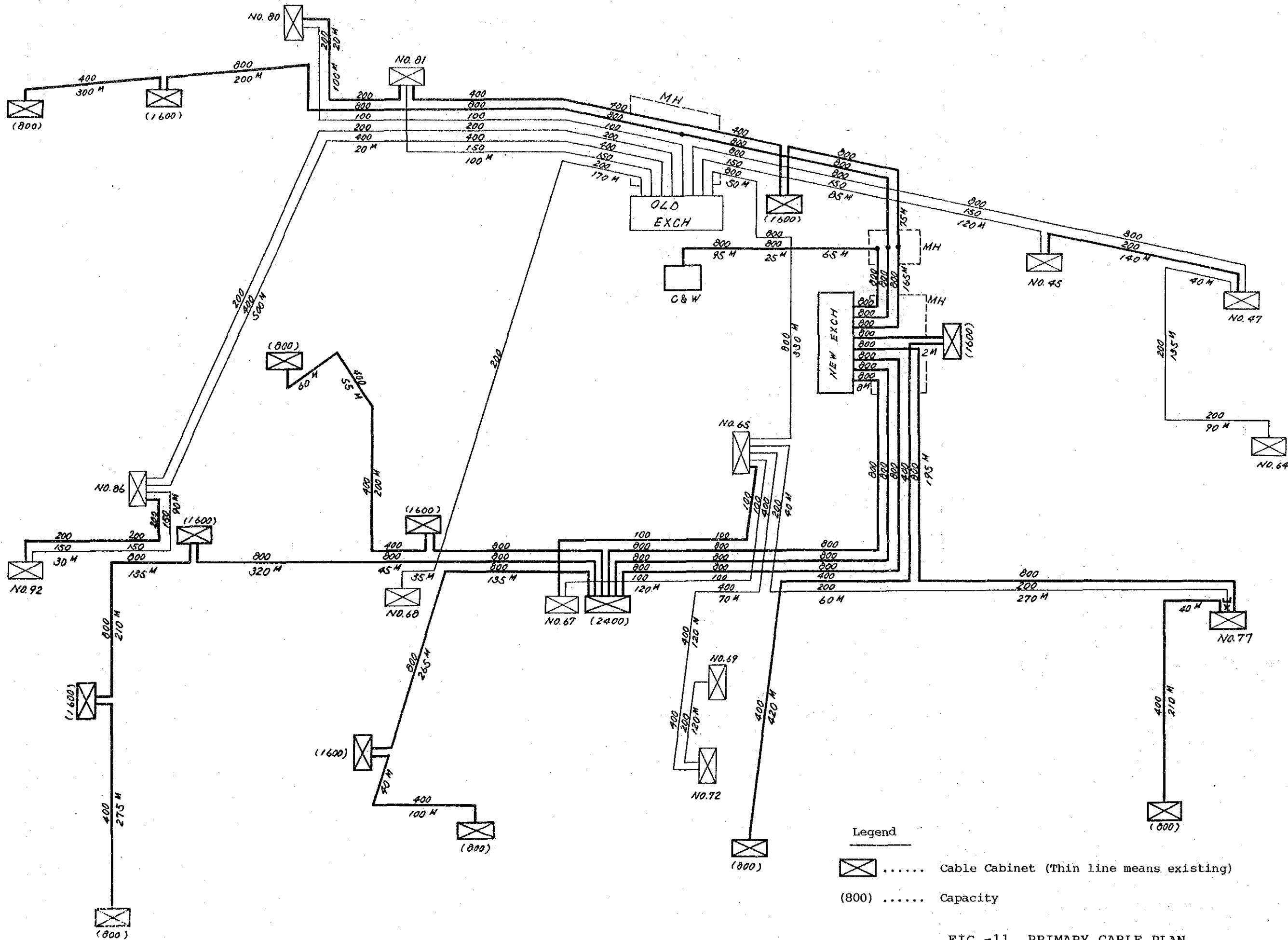


FIG.-11 PRIMARY CABLE PLAN

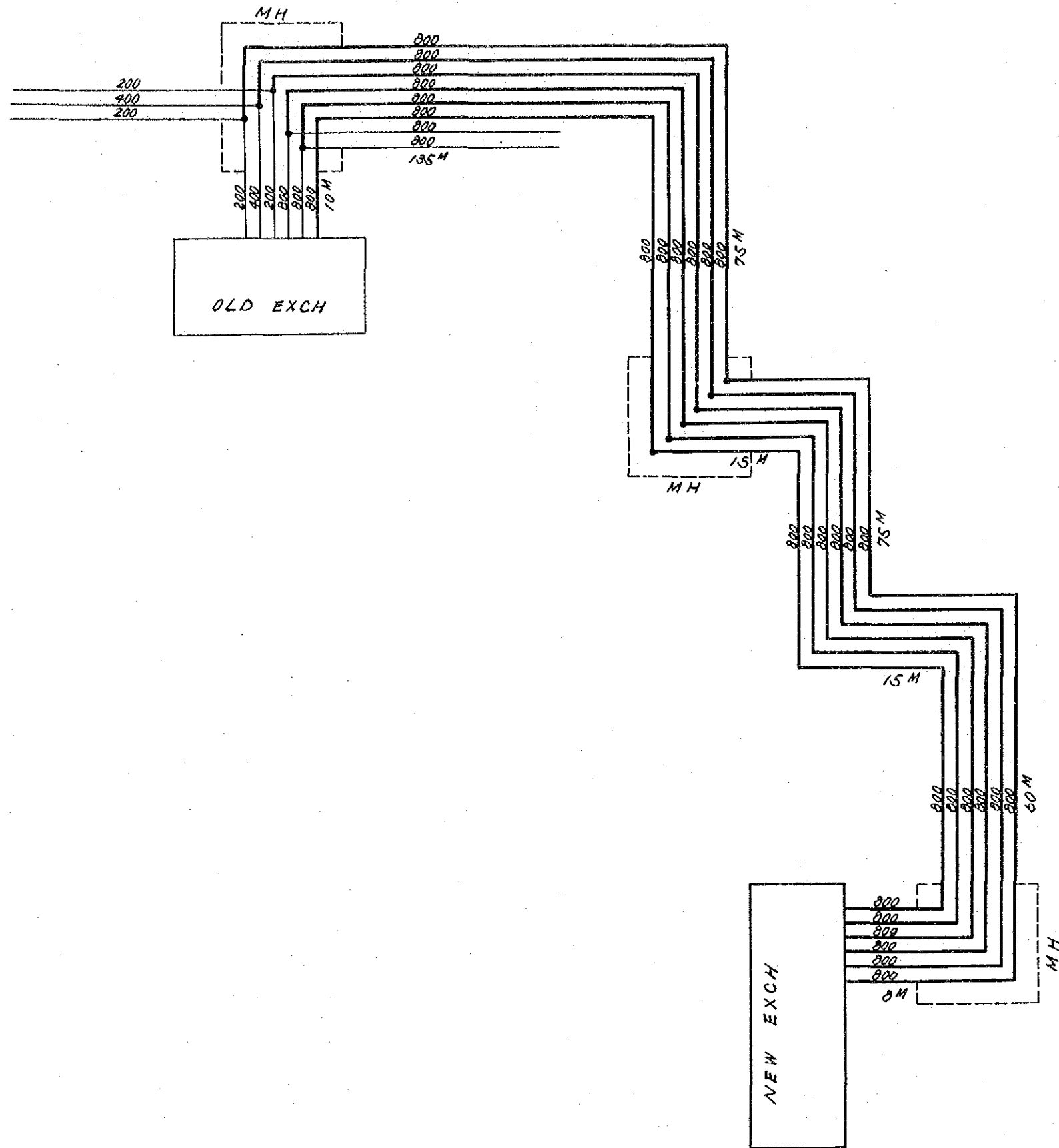


FIG.-13 TIE CABLE PLAN

Main distribution frame (MDF) in the telecommunication centre required for termination of cables is of double-sided type for easiness of maintenance work.

5-2-3 Building design condition for Malé Telecommunication Centre

Outline of rooms to accommodate telecommunication equipment and of those equipment is described below.

- Power room

Normally it is desirous to accommodate the rectifier, batteries and standby engine generator in each room separately, however, all these equipment is accommodated in a single room to utilize the limited space effectively.

In addition to those equipment mentioned above, low tension power receiving board, power distribution board, DC-AC inverter, control cubicle and fuel day tank are accomodated.

Ventilating facilities shall have an enough capacity to release gases produced in storage batteries and to feed a large volume of air for operating the engine generator.

- Cable chamber

Space where the direct buried cable and inside cables are jointed and the cable works are performed.

Through this space the underground cable is guided along the chamber wall to the main distribution frame (MDF) where the switching equipment is connected with telephone cables.

- Telephone switching equipment room

Room to accommodate telephone switching equipment, typewriter, console, etc. required for operation and maintenance, D.C. voltage regulating equipment and power board. Also to be accommodated in the room (without partition) are MDF and subscriber line test position, though those equipments are usually installed in the separate room.