Basic Design Study Report
on
The Project for Establishment
of
Microwave Link for Meteorology
in
The People's Republic of Bangladesh

June 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

In response to a request from the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a basic design study on the Project for Establishment of Microwave Link for Meteorology and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team headed by Mr. Makoto Kasuga, Deputy Director, Observations Management Division, Observations Department, Japan Meteorological Agency, from January 13 to February 16, 1992 (Mr. Makoto Kasuga has been assigned to Director of Kushiro Local Meteorological Observatory since April 1, 1992).

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

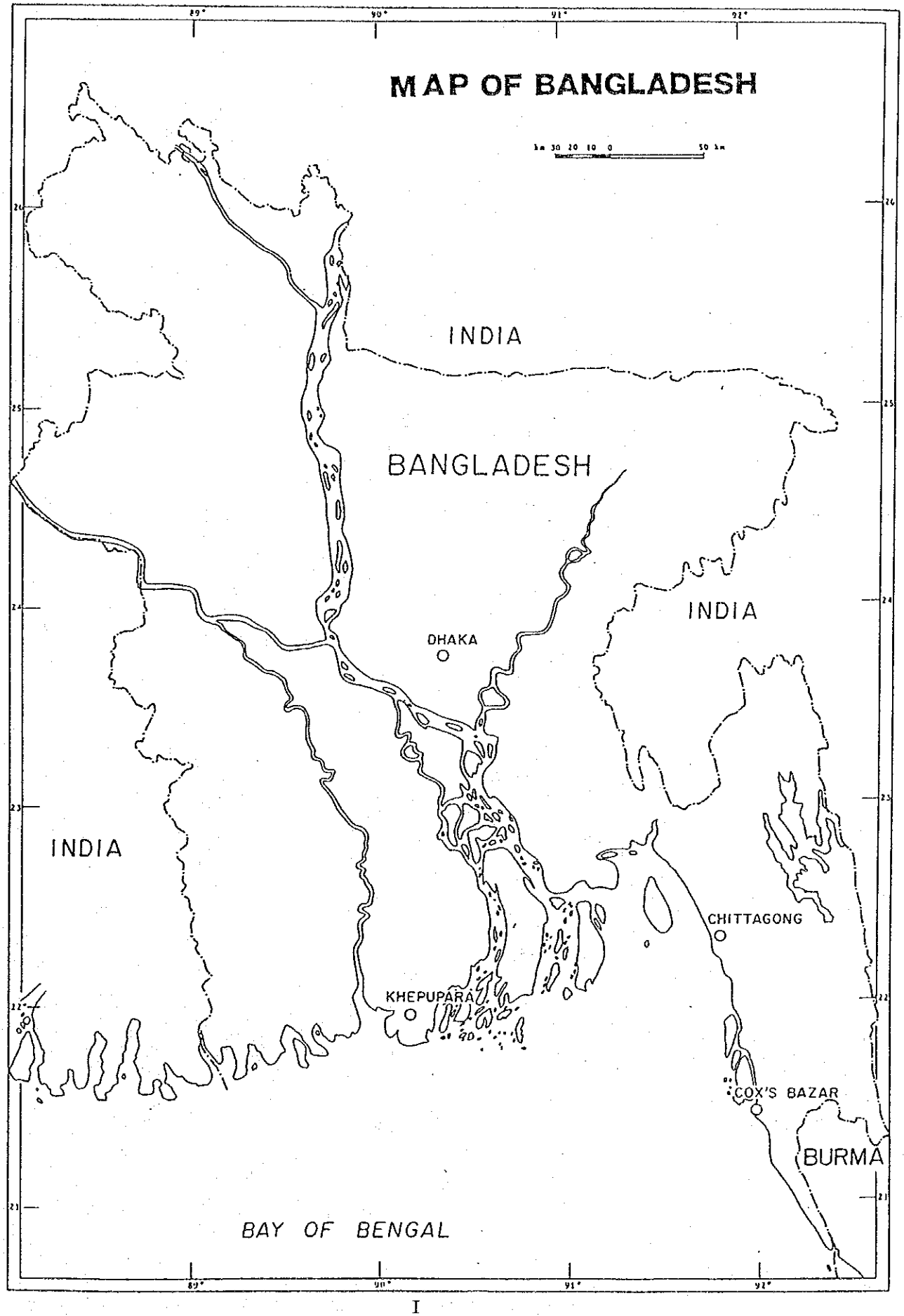
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the teams.

June 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency


MAP OF BANGLADESH
INDIA
BANGLADESH
INDIA
INDIA
DHAKA
CHITTAGONG
KHEPUPARA
COX'S BAZAR
BURMA
BAY OF BENGAL

Summary

The strong cyclone which landed in the People's Republic of Bangladesh on the early morning of April 30, 1991, caused severe rain storms and storm surges exceeding 7 m in height at Chittagong, near its landing point, and in other coastal areas along the Bay of Bengal, resulting in nearly 140,000 deaths and affecting more than 10 million people in all.

Bangladesh is situated on the largest delta in the world, where the Ganges and the Brahmaputra join and flow into the Bay of Bengal. Most of her land consists of plains lying below 10 m above sea level, and rain storms and storm surges caused by cyclones are liable to result in enormous damages.

In response to a request from the Government of Bangladesh, the Government of Japan had provided the Grant Aid for the installation of meteorological radars for monitoring the cyclones at Cox's Bazar and Khepupara in 1988. On the occasion of cyclone of April 1991, the two radars tracked the movement of the cyclone traveling northwards in the Bay of Bengal from its early stage and the data from the radars proved useful to the Bangladesh Meteorological Department (BMD) in issuing forecasts and warnings.

The transmission of the radar data from the two radar sites to the Storm Warning Center (SWC) in Dhaka, however, has been via the shortwave radio (SSB) or ordinary telephone lines, which are frequently cut off by adverse weather conditions, and unreliable.

In view of these circumstances, the Government of Bangladesh formulated a project for the establishment of a microwave link for meteorology, and made a request to the Government of Japan for the Grant Aid to realize the project.

In response to this request, the Government of Japan decided to execute a basic design study and a mission headed by Mr. Makoto Kasuga, then the Deputy Director of the Observations Management Division, Observations Department, Japan Meteorological Agency (JMA), was dispatched to the site by the Japan International Cooperation Agency (JICA) between January 13 and February 16, 1992. The mission ascertained and confirmed the background of the project and the contents of the request and carried out surveys of the conditions of their surroundings, construction, power supply, transportation, etc. at the proposed sites for the meteorological telecommunication facilities to be constructed.

After the completion of the site survey, the mission examined the effects of the project and the appropriateness for its implementation by Grant Aid and carried out a basic design study determining the optimum scale and particulars of the meteorological telecommunication links to be constructed, the results of which were compiled in a Draft Report. JICA dispatched a second mission headed by Mr. Makoto Kasuga, now the Director of Kushiro Local Meteorological Observatory, JMA, between April 20 and May 1, 1992, to explain the contents of the Draft Report and to discuss the report with the officials

concerned of the Government of Bangladesh for its final confirmation.

An outline of the Basic Design is given below.

(1)Implementation Agency

Bangladesh Meteorological Department

(2)Design Scale

Digital radio telecommunication links for meteorology will be constructed between Cox's Bazar and Chittagong (Eastern Route) and between Khepupara and Khulna (Western Route). The existing Bangladesh Telegram and Telephone Board (BTTB) links will be used between Chittagong and Dhaka and between Khulna and Dhaka. A remote display system will also be installed at the SWC in Dhaka to display the radar images transmitted from the two meteorological radars at Cox's Bazar and Khepupara.

(3) Contents of Design

a) Radio Telecommunication Equipment

The numbers of installation points is shown below:

Items	Capacity	E	W	D
Radio	34Mbps	4	4	0
	2Mbps	2	3	0
Multiplexer	8Mbps	2	4	0
	2Mbps	2	6	0
	Channel Board	2	6	2
Antennae		5	6	0
Rectifiers/Batteries		5	5	0
Standby Generators		1	1	1

note:"E" for Eastern Route, "W" for Western Route and "D" for Dhaka

b) Facilities

Radio Shed	:Cox's Bazar radar site, Bungalow, Total floor area: 21.25 m^2
Antenna Structures	:Cox's Bazar radar site, Antenna pole: 6.7 m height :Khepupara radar site, Bracket of roof--top antenna pole

c) Remote Display Equipment

Items	C	K	D
Signal Distributor	1	1	0
Modem	1	1	2
Telephone	1	1	2
Data Processing Unit	0	0	2
Color Display	0	0	2
Printer	0	0	2
UPS	0	0	2

note:"C" for Cox's Bazar radar site, "K" for Khepupara radar site and "D" for SWC in Dhaka

(4) Scope of Bangladesh Side

The scope of works to be undertaken by the Government of Bangladesh is as follows:

a) Removal of existing (unnecessary) antennas
b) Leveling of site
c) Power supply for new radio sheds, provision of telephone lines, laying of water supply and drainage pipes, if necessary
d) Power and water supply for construction
e) Payment of Bank fees

(5) Design and Construction Periods

Execution Design	: 6 months
Manufacturing and Construction	:12 months

(6) Project Evaluation

Besides the effects listed below, the implementation of the present project will contribute greatly to the welfare of the inhabitants (reduction of cyclone disasters) and the project falls within the scope of the Japan's Grant Aid system. Its implementation is therefore judged appropriate. It is thought that there are no personnel and financial considerations on the Bangladesh side that would cause problems in the operation and management of the facilities to be constructed under this project.

(7) Improvement Effects of the Project

(a) Concerning SWC in Dhaka

The radar images can be continuously monitored at the SWC in Dhaka.

As a result, it is possible to estimate the location, intensity, moving direction, heavy rain area, landing location, etc. of the cyclone, and to improve the accuracy in weather forecasts and warnings for cyclones, and also to issue weather forecasts and warnings quickly.

Thus, about 25 million habitants in the coastal area of the Bay of Bengal attacked by cyclones every year can take appropriate action for evacuation, and the nation's trust relating to the forecasts can be obtained by improving the forecast accuracy.

(b) Concerning Khepupara Radar

Not only can the radar data of Khepupara be transmitted to SWC in Dhaka, but also the telecommunication performance will be improved in Sreepur, Barisal, Patuakhali and Khepupara. As a result, about 300 links presently in operation will be improved. Thus, it will be possible to offer convenience to the users in areas farther than Khulna where the telecommunication performance has been unfavorable and, further, to secure an emergency link for disaster prevention.

(c) Concerning Cox's Bazar Radar

The radar data of Cox's Bazar can be transmitted to the SWC in Dhaka.

By self-efforts of BTTB, it will be possible to expand the channels in the empty capacity which will be newly established. It is thus expected that the telecommunication performance will be improved in the general public link between Cox's Bazar and Chittagong.

By implementing the present project, improvement can be expected in the accuracy in cyclone forecasts and warnings, and the rapidity in issuing weather forecast and warnings. The nation's trust with respect to the forecasts will be thereby increased and the habitants in the coastal area of the Bay of Bengal can take appropriate action for evacuation. This will contribute to the reduction of cyclone disasters and the improvement of the Bangladesh nation's welfare.

Further, the present project is expected to contribute significantly to the 4th Five-Year (1990 to 1994) Plan of the Government of Bangladesh in which a strong emphasis is put on the countermeasures against flood disasters due to cyclones.

The maintenance and management of the telecommunication links will be carried out by BTTB after the completion of the project. BTTB can afford

to maintain, manage and renew the telecommunication links by the telecommunication charges for the new links.

LIST OF ABBREVIATIONS

BER	Bit Error Ratio
BMD	Bangladesh Meteorological Department
BS	British Standard
BTTB	Bangladesh Telegraph and Telephone Board
CCIR	Comité Consultatif International des Radio-Communications (International Radio Consultative Committee)
CCITT	Comité Consultatif International Télégraphique et Téléphonique (International Telephone and Telegraph Consultative Committee)
CPP	Cyclone Preparedness Program
CRT	Cathode Ray Tube
DVIP	Digital Video Integrator and Processor
EC	European Community
GDP	Gross Domestic Product
GMS	Geostationary Meteorological Satellite
GNP	Gross National Product
GTS	Global Telecommunication System
JICA	Japan International Cooperation Agency
MUX	Multiplex Equipment
MTI	Moving Target Indicator
M/W	Micro Wave
NOAA	National Oceanic and Atmospheric Administration of the USA
OECF	Overseas Economic Cooperation Fund
PSK	Phase Shift Keying
SSB	Single Side Band
SWC	Storm Warning Center
TAPP	Technical Assistance Project Proforma
Tk	Taka
UHF	Ultra High Frequency
UNDP	United Nations Development Program
UPS	Uninterrupted Power Supply
VDF	Voice Distribution Frame
WMO	World Meteorological Organization

CONTENTS

List of Tables

LIST OF FIGURES

BASIC DESIGN DRAWINGS

Chapter 1 Introduction

On the early morning of April 30, 1991, a strong cyclone hit the People's Republic of Bangladesh. In Chittagong, near the landing point of the cyclone, and other coastal areas of the Bay of Bengal, about 140,000 persons were killed in the rain storm and storm surge of more than 7 m in height. Overall, 10 million people were affected.

Bangladesh is situated in the world-largest delta, where the Ganges and Brahmaputra rivers join and flow into the Bay of Bengal. The land is flat except for a part of the southeastern and northwestern areas; almost all the national territory lies on a plain of less than 10 m above sea level.

In addition to such topographic and geographical conditions, cyclones from the Bay of Bengal accompanied by rain storms and storm surges, hit the country every year in pre- and post-monsoon seasons and damage the coastal region of the Bay of Bengal and the inland lowlands. The damages in the past have been enormous; In 1970, about 500,000 people were killed by cyclones and in 1985, about 11,000 were killed; since 1960, the human losses have totaled approximately 700,000 and economic losses have amounted to 4 billion U.S.dollars.

In order to reduce the cyclone disasters, the country has been tackling the construction of cyclone shelters and embankments, and increasing afforestation of mangroves etc. On the other hand it is necessary for the country to improve accuracy in meteorological information, to establish refuge system and to diffuse meteorological knowledge among its inhabitants. Such being the case, the Government of Bangladesh plans "Measures for Inundation Disasters by Cyclones" as an important project in its Fourth Five-year Plan for 1990-95. However, GNP has not grown as expected and economic difficulty has continued due to repeated natural disasters.

In 1988, the Government of Japan provided Grant Aid for installing, at the request of the Government of Bangladesh, meteorological radars to monitor cyclones at Cox's Bazar and Khepupara on the coast of the Bay of Bengal.

On the occasion of the cyclone on April 29/30, 1991, the information given by the meteorological radars at Cox's Bazar and Khepupara proved effective in issuing forecasts and warnings of the cyclone by the BMD. However, the radar sites at Cox's Bazar and Khepupara and the Storm Warning Center in Dhaka were not directly connected by good quality telecommunication links of good quality, which limited the forecaster's ability in following the movement of the cyclone changing every second.

In view of such situations, the Government of Bangladesh formulated a project for establishment of microwave link for meteorology, which is indispensable for connecting the Storm Warning Center (SWC) in Dhaka with the radar sites at Cox's Bazar and Khepupara, and for continuously monitoring the images of meteorological radars in SWC in order to improve the accuracy

in cyclone forecasts and eventually to reduce cyclone disasters. The Government of Bangladesh then made a request to the Government of Japan for its Grant Aid to realize the project.

In response to this request, the Government of Japan decided to execute the study for the basic design and the Japan International Cooperation Agency (JICA) dispatched to Bangladesh a mission headed by Mr. Makoto Kasuga, Deputy Director, Observations Management Division, Observations Department, Japan Meteorological Agency (JMA), during the period between January 13 and February 16, 1992. The mission grasped and confirmed the backgrounds of the project and the contents of the request and carried out surveys of the condition of the existing telecommunication facilities, construction, electricity, transportation, etc. at the proposed sites for the required meteorological telecommunication facilities.

After executing a site survey, the mission examined the effects of the project and the appropriateness for its implementation by the Grant Aid, and carried out the basic design study determining the optimum scale and particulars of the meteorological telecommunication links to be constructed, and prepared a draft report.

JICA dispatched a second mission headed by Mr. Makoto Kasuga, Director, Kushiro Local Meteorological Observatory, JMA, to Bangladesh from April 20 to May 1, 1992 to explain the contents of the draft report and to discuss the report with the officials concerned of the Government of Bangladesh.

The present report has been compiled modifying the draft report based on the results of the above discussions.

The composition and study itinerary of the mission and the minutes of discussions are attached in the related Appendices.

Chapter 2 Background of the Project

2-1 Background of the Project

2-1-1 Outline of Bangladesh

(1) Natural Conditions

1) Geography

The People's Republic of Bangladesh is bordered on the east, the west and the north by India and on the south by the Bay of Bengal. It is bordered on the southeast by Myanmar. The location and area of the country is as follows:

20°34' – 26°38' N. Latitude,
88°01' – 92°41' E. Longitude,
Area: 143,998km^2.

The country extends over the world-largest delta where the Ganges and Brahmaputra rivers, originating from the Himalayas and Tibet respectively, join and flow into the Bay of Bengal. About 10% of the territory is occupied by rivers. As shown in Fig. 2-1-1, almost all the territory, except for the Sylhet hills in the northeast and the Chittagong hilly region in the east south, is occupied by level ground of less than 10 m above the mean sea level. The topographic features illustrate that the greater part of the territory is easily affected by floods caused by heavy rains and cyclones in the rainy season.

2) Climate

The climate of Bangladesh belongs to the subtropical monsoon type and is divided, as indicated in the Fig. 2-1-2, into four seasons: dry season, pre-monsoon season, monsoon season and post-monsoon season. The frequency of occurrence of cyclones in the Bay of Bengal is highest in pre-monsoon and post-monsoon seasons as shown in the Fig. 2-1-3. The four seasons are characterized as follows:

a) Dry season (December – February)

The temperature and humidity is rather low with little rain and the climate is congenial. Cyclones are sometimes generated and approach the country even in the first half of December.

b) Pre-monsoon season (March - May)

In the first half of the period, namely, in March through April, the cold air remains in the upper layer and the warm and humid air is in the lower layer. As a result, the atmosphere is unstable and sometimes storms occur, called Nor-westers, which cause strong squalls and tornadoes.

In the latter half of the period, April through May, which is the hottest season similar to September, the precipitation increases compared with that in the first half of the period. In Dhaka, approximately 19% of the annual precipitation is recorded in this period. Also, cyclones come from the Bay of Bengal (Fig. 2-1-3) and a lot of damage is caused by rain storms and storm surges.

c) Monsoon season (June - August)

In the monsoon season the southwest winds blow from the Bay of Bengal. The temperature and humidity are high, and the precipitation is the most plentiful in the year. In Dhaka 46% of the annual precipitation is recorded in this period. During this period, the upstream regions of the Ganges and Brahmaputra rivers are flooded by abundant rains causing a high water level. As a result, the agricultural lands and residential districts in the lowland areas are sometimes inundated with water.

In this period, the occurrence of cyclones in the Bay of Bengal decreases, but when a cyclone comes, its influence is strengthened by the inland flood and the stricken area increases.

d) Post-monsoon season (September - November)

In this season the precipitation is smaller compared with the monsoon season and the temperature is lowering gradually from September. The frequency of occurrence of cyclones in the Bay of Bengal is highest in this period (Fig. 2-1-3) and the coast of the Bay of Bengal and the inland area are attacked by rain storms and storm surges.

3) Meteorological disasters

a) Factors of meteorological disasters

Bangladesh is almost free from disasters due to earthquakes and volcanoes. In this country natural disasters mean meteorological disasters. Recent examples are the floods in the monsoon seasons of 1987 and 1988 and the serious cyclone disaster in April, 1991. Main factors of meteorological disasters are listed in the following Table 2-1-1:

TABLE 2-1-1 MAIN FACTORS AND DETAILS OF METEOROLOGICAL DISASTERS

Factors	Disasters
Cyclone	Storm surge, rain storm, flood, submersion, soil runoff
Nor-wester	Hail, gale.
Monsoon	Flood, submersion, soil runoff.
No precipitation	Drought

b) Damages by cyclones in the past

Among the above factors of disasters, the cyclone causes exceptional damages. Table 2-1-2 shows the damages caused by cyclones during the last 32 years (1960-1991). Taking into consideration the maximum wind speed measured by meteorological observatories, the scale of the cyclone in April, 1991 was bigger than the one in November, 1970 which caused the larger damage. It was also estimated that the height of the tide was very near the past highest record of October, 1966.

On the other hand, the number of deaths and missing persons was reported to be about 140,000, less than one third of the worst, 500,000 recorded in November, 1970. It seems that the loss of human lives was reduced compared with that caused by the cyclone of 1970, although it was estimated that the scale of the cyclone was the largest in the past. This explains the effects of the improvement of the cyclone monitoring system and cyclone shelters which have been constructed since the disaster in 1970.

TABLE 2-1-2 DAMAGES CAUSED BY CYCLONES

Date	Maximum wind speed (m/s)	Height of tide (m)	Number of the dead and missing	Value of damage (1,000 Taka)	Affected area
Oct. 9, 1960	45	-	3,000	-	
Oct. 30, 1960	58	4.5 to 6.0	5,149	-	
May 9, 1961	41	2.5 to 3.0	11,416	-	
May 30, 1961	41	6.0 to 9.0	-	-	
May 28, 1963	56	4.0 to 5.0	11,520	-	
Apr. 11, 1964	-	-	196	-	
May 11, 1965	45	3.5	19,279	523,000	Barisal,Khulna
May 31, 1965	-	6.0 to 7.5	-	-	
Dec. 14, 1965	58	4.5 to 6.0	873	559,000	Cox's Bazar,Teknaf
Oct. 1, 1966	41	4.5 to 9.0	850	-	Sandwip
Oct. 11, 1967	-	2.0 to 8.5	-	-	Khulna, Sundarban
Oct. 24, 1967	-	1.5 to 7.5	-	-	Cox's Bazar
May 10, 1968	-	2.5 to 4.5	-	-	
Apr. 17, 1969	-	-	75	-	
Oct. 10, 1969	-	2.5 to 7.0	-	-	Khulna
May 7, 1970	-	3.0 to 5.0	-	-	Chittagong
Oct. 23, 1970	-	-	300	-	Khulna, Dhaka,Chittagong
Nov. 12, 1970	62	6.0 to 9.0	500,000	1,176,000	Khulna, Chittagong
May 3, 1971	-	2.5 to 4.0	-	-	
Sep. 30, 1971	31	2.5 to 4.0	-	-	
Nov. 6, 1971	-	2.5 to 5.5	-	-	
Nov. 18, 1973	-	2.5 to 4.0	-	-	
Dec. 9, 1973	34	1.5 to 7.5	185	951,000	Patuakhali
Aug. 15, 1974	27	1.5 to 6.5	350	980,000	Chittagong
Nov. 28, 1974	45	2.0 to 5.0	3	-	
Oct. 21, 1976	29	2.5 to 5.0	-	-	Chittagong
May 13, 1977	34	-	-	-	Khulna, Patuakhali
Dec. 10, 1983	27	2.0	240	-	
Oct. 15, 1983	27	-	1043	-	Chittagong
Nov. 9, 1983	34	-	300	-	Chittagong
Jun. 3, 1984	25	-	-	-	
May 25, 1985	43	3.0 to 4.5	11,069	1,000,000	Chittagong, Noakhali
Nov. 29, 1988	45	1.5 to 3.0	2,000	10,900,000	Khulna
Apr. 29, 1991	63	6.0 to 7.5	140,107	-	Chittagong
Jun. 2, 1991	28	2.0	-	-	Chittagong

-: Unknown.

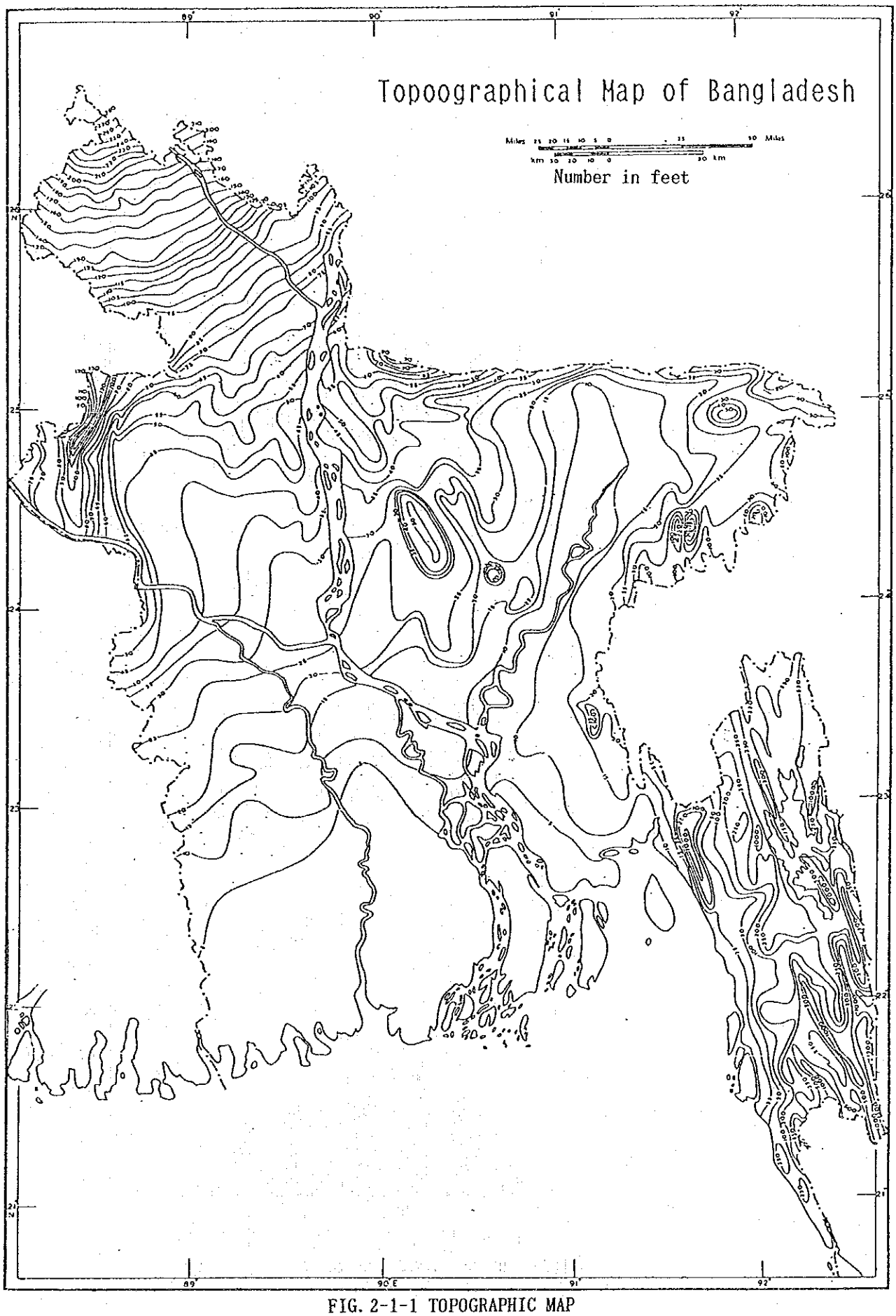


FIG. 2-1-1 TOPOGRAPHIC MAP

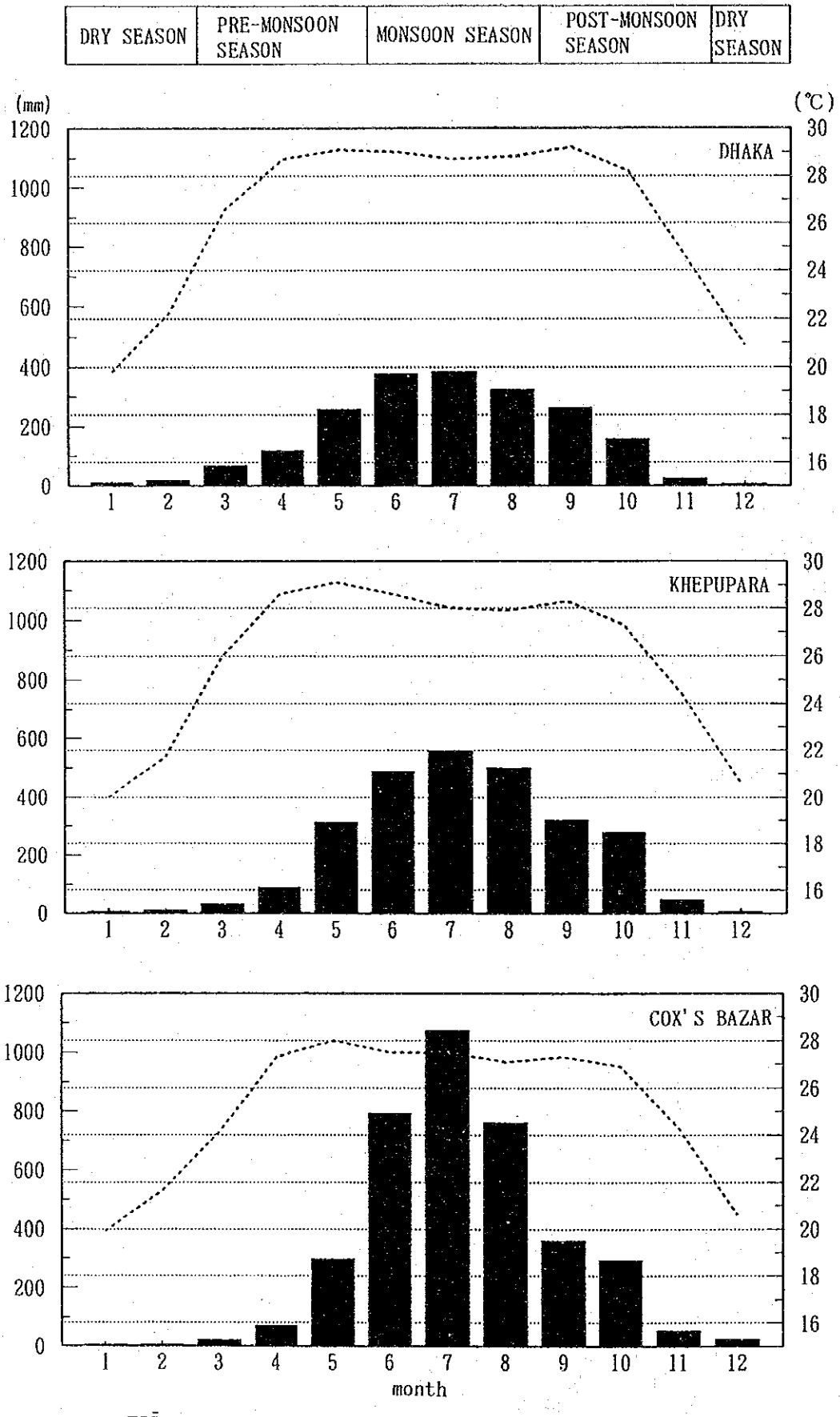


FIG.2-1-2 MONTHLY PRECIPITATION AND MEAN TEMPERATURE
Line:Temperature Bar:Precipitation

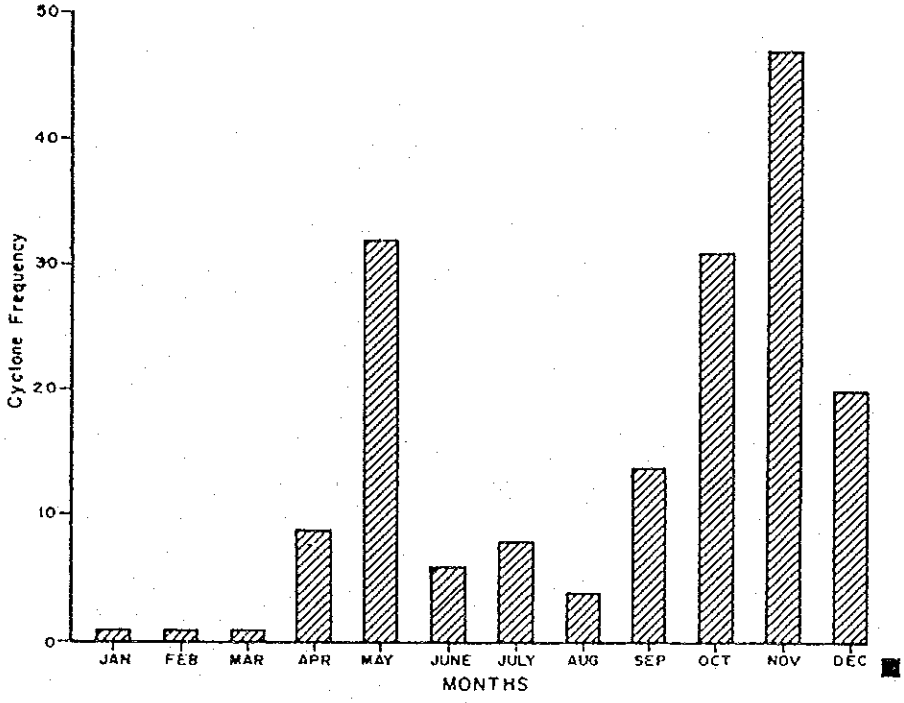


FIG. 2-1-3 ANNUAL DISTRIBUTION OF CYCLONES IN BAY OF BENGAL

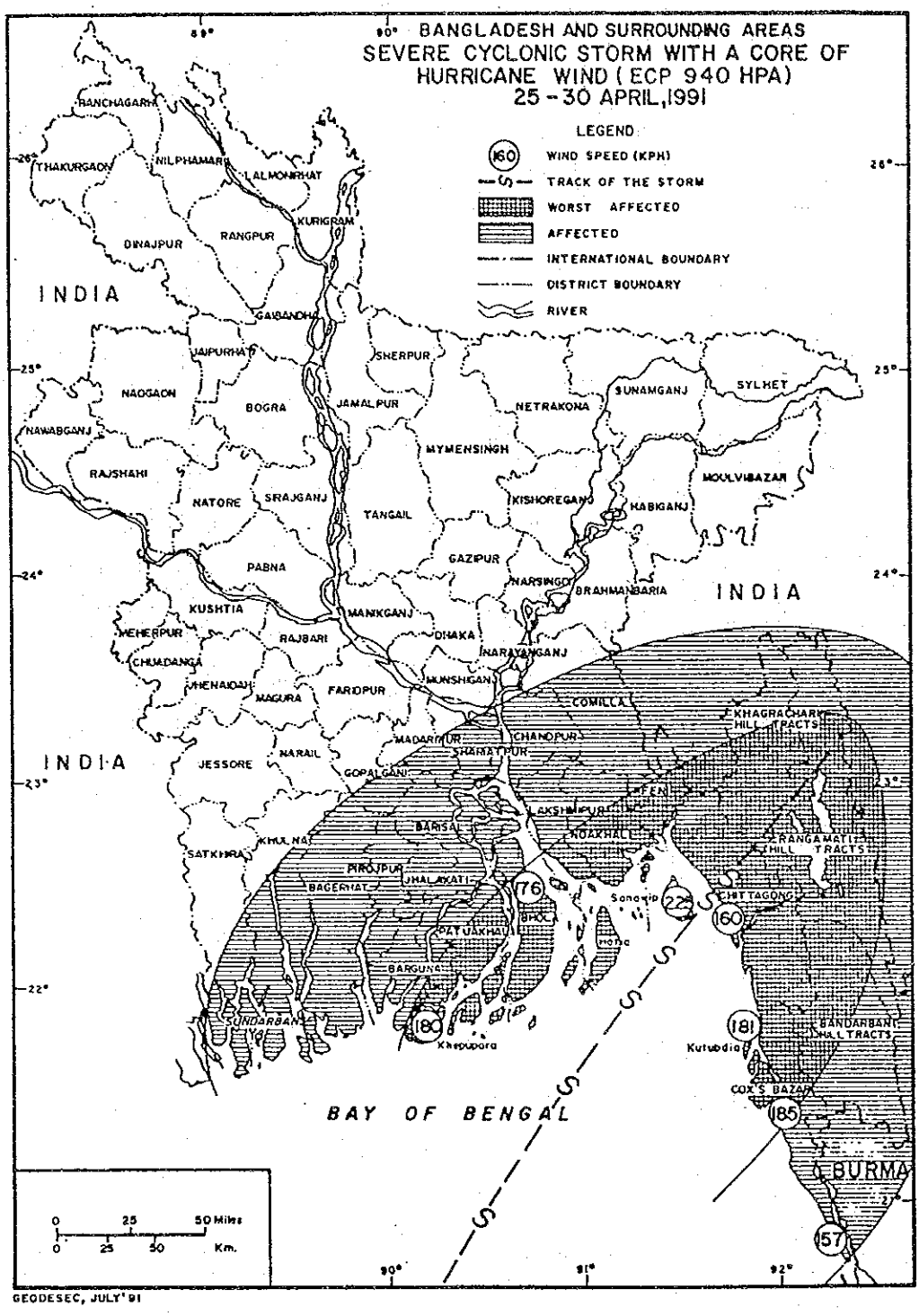


FIG. 2-1-4 CYCLONE TRAJECTORY AND DAMAGED AREA, 25-30 APR., 1991

c) Cyclone damage on April 29/30 1991

The cyclone, which originated in the south of the Bay of Bengal on April 23, 1991, went north, and landed at the northern part of Chittagong early on the early morning of April 30. It caused serious damages over the whole coastal regions in the south and southeast of the country indicated by the shaded portion in Fig. 2-1-4. The damage caused by the cyclone on 29/30 April 1991, which was announced by the Government of Bangladesh at the end of 1991, is listed in Table 2-1-3.

TABLE 2-1-3 DAMAGE BY CYCLONE ON 29/30 APRIL 1991

Contents		Records
Number of Affected Districts		19
Number of Affected Sub-districts		102
Number of Affected Municipalities		9
Number of Affected Population		10,798,275
Area Damaged to Crops	Fully	539.3 km^2
	Partly	3,203.5 km^2
Number of Houses	Fully Destroyed/Damaged	819,608
	Partially	882,750
Number of People Killed		138,882
Number of People Missing		1,225
Number of Animals Killed		1,061,029
Number of People Injured		139,054
Number of Educational Institutions Damaged/Destroyed		
	Fully	3,865
	Partially	5,801
Length of Earthen Roads Damaged	Fully	1,222 km
Number of Bridges and Culverts Damaged		496
Length of Embankments Damaged	Fully	195 km
	Partially	933 km

(2) Social Environment

1) Living environment

a) Population

Bangladesh has the ninth largest population in the world based on estimated figures of 1989. As indicated in Table 2-1-4, the population in-

creased at the rate of 2.2% per annum during the 80s. The growth rate of population has recently become less, but the population of Dhaka increased remarkably in the second half of the 80s compared with that in the first half of the decade.

TABLE 2-1-4 POPULATION OF BANGLADESH

Year	National population	Population in Dhaka
1974	71,479,071	1,679,572
1981	87,120,119	3,430,312
1984	98,000,000	3,950,000
1988	106,600,000	
1991	108,000,000	6,105,160

The population density of the country is 750 inhabitants/km^2 and is higher in the southern to eastern regions which face the Bay of Bengal.

b) Economy

The Bangladesh economy is based on agriculture, which occupies about 40% of the gross national product (GNP). The production of rice, the most important agricultural product, has not supplied the domestic demand due to repetitive disasters. The import of rice has been one of the factors which press worse upon the balance of international payments. On the other hand, jute and jute products, which are very important export items of the country, had been developed smoothly until the middle of the 80s.

However, in August, 1990, when Bangladesh had not recovered from damages by the floods in 1987 and 1988, "The Gulf Crisis" occurred. This war gave a great blow to the economy in the country. Moreover, it further suffered from a cyclone disaster in April, 1991. Therefore, it is anticipated that the growth rate of GDP will fall considerably below the initial projection.

2) Transportation

a) Air transportation

The civil aviation services undertake the long distance transportation connecting the main cities in Bangladesh, transporting mainly passengers by regular flights. When disasters occur, the air transportation plays an active part in transporting relief goods and rescue parties and also the sick and wounded inhabitants. It is an important and speedy means of

access to the affected areas.

The aircraft always utilize the meteorological information for ensuring safe and economic operation not only at the time of take-off and landing but also during flight.

b) Railways

The total extension of railways is about 2,900 km. The national railways took over the assets of the days of English rule. The railways were constructed on a fill-up ground, but they are subject to erosion due to floods and submersion. Their maintenance is important for safe operation. And it is, therefore, necessary to improve the meteorological information.

c) Land transportation

The extension of main paved roads amounted to 12,960 km as of 1989. The length of paved roads has been extended by 2.8 times in the 12 years since 1977. As the means of transportation, passenger cars, buses and trucks are used for transportation of medium distance, and for short distance in urban areas, rickshaws and auto-rickshaws are used besides car traffic.

As the area of rivers occupies nearly 10% of the national territory, the main roads are often interrupted by rivers, and ferryboats connect the roads. Moreover, the water level of the rivers varies according to the season. It is desirable that the inland transportation of the equipment for the project be carried out during the dry season since transportation conditions are subject to the season.

d) Transportation by water

Because of seasonal variations of land transportation, rivers are mainly used for a medium distance transportation. Shipping accidents with many victims are often caused by strong wind and high waves. The provision of accurate weather information will therefore be necessary for ensuring the safe operation of ferries and other ships that navigate on the inland waters.

3) Communication

The situation of communication of Bangladesh as of 1990 (except * of 1985) is indicated below. Radios are owned by 1 out of 139 persons and TV by 1 out of 224 persons.

Post offices : 7,982,

Telegraphic offices	: 1,151,
Telephones	:206,000,
Radios	:775,000*,
TV sets	:482,000.

In the field of telecommunication, trunk lines are being constructed between main cities. The lines between Dhaka and Chittagong and between Dhaka and Khulna are of good quality and reliability. On the other hand, there is room for improving quality and reliability in the links connecting between local central cities and surrounding farm villages, and between their telephone offices and each house.

4) Electricity

Power generation often does not meet demand and irregular power failures and unstable voltage and frequencies have been recorded. The recent situation of electricity in this country is indicated in Table 2-1-5.

TABLE 2-1-5 PRESENT CONDITIONS OF ELECTRICITY

Year	1987	1988	1989	1990
Generating capacity (MW)	1,607	2,146	2,365	2,352
Maximum power demand (MW)	1,084	1,317	1,393	1,509
Generated energy (106kWh)	5,587	6,541	7,115	7,732
Consumed electric energy (106kWh)	3,485	3,772	4,695	5,258
Total extension of transmission line (km)	2,479	2,527	2,625	2,625
Total extension of distribution line (km)	50,151	57,627	63,261	69,921

2-1-2 Meteorological Services in Bangladesh

(1) Present Conditions of Meteorological Services

1) Organization and budget of BMD

a) Services

Bangladesh Meteorological Department (BMD) is the sole organization for providing meteorological services in Bangladesh. The services are classified as follows:

Observation: Surface observation,

Rawinsonde observation,
Pilot balloon observation,
Radar observation,
Seismological observation,
Astronomical observation, etc.

Meteorological communication:

Collection of internal observation data,
International exchange of data.

Analysis and provision of meteorological information:

Weather forecast,
Advisory,
Warning,
Aeronautical meteorological information,
Marine meteorological information,
Seismological information,
Agricultural meteorological information,
Astronautical information,
Climate data, etc.

Investigation service:

Meteorological investigation,
Climate and agricultural meteorology.

Personnel training:

Training of personnel in accordance with standard defined by the World Meteorological Organization (WMO).

Manufacture, repair and calibration of meteorological instruments.

b) Organization

The organization chart of the BMD is shown in Fig. 2-1-5. The BMD has its Headquarters in Dhaka and controls all observatories in the whole country. The southern observatories are under the control of the Meteorological and Geophysical Center, Chittagong. The other observatories are directly under the supervision of the Storm Warning Center(SWC) located at Dhaka, (see Fig.2-1-7).

Headquarters	: 1,
Regional Meteorological Center	: 2,
Aeronautical Forecasting Offices	: 2,
Surface Observatories	:35,
Pilot Balloon Observatories	:10,
Rawinsonde Observatories	: 3,
Radar Observatories	: 3,
Geophysical Observatory	: 1.

The person or sections responsible for the present project are as follows:

Project Director	:Director, BMD
Radar and related equipment	:Electronic and Instrument Division, Meteorological Workshop and Laboratory,
Telecommunication equipment	:Telecommunication Division
Forecast and warning	:Storm Warning Center
Administrative works	:Planning Division, Meteorological Training Institute
Cox's Bazar Radar	:Senior Electronic Engineer
Khepupara Radar	:Senior Electronic Engineer

c) Personnel

The BMD has 1,057 staff in total, who are divided into higher-ranking staff and general staff. In Table 2-1-6, they are classified in accordance with the WMO standard.

The Classes I to III of higher-ranking staff are administrative posts including weather forecasters and engineers and their candidates. The general staff range from persons who assist higher-ranking staff to non-technical staff. At the stage of implementing the present project, it is planned that the personnel corresponding to Classes I and II promote the project. On the other hand, at the stage of maintenance after the completion of the project, the staff of Classes III and IV, the lower classes among the higher-ranking staff, will often take charge of the work and sometimes general staff will be in charge of auxiliary work such as the operation of power generators. Therefore, the equipment and facilities must be designed taking into consideration that staff who do not necessarily have high-level knowledge of technology attend on the spot.

TABLE 2-1-6 NUMBER OF STAFF BY JOB RANKING

Job ranking		Number	Level of responsibility
Higher-ranking staff	Class I	53	Senior Weather Forecaster
	Class II	57	Weather Forecaster
	Class III -IV	761	Senior Meteorological Observer
General staff		186	
Total		1,057	

d) Budget

The budgets of the BMD for the last 5 years are shown in Table 2-1-7. Although the revenue has increased year by year, a provisional budget varied according to the plan of services. For example, in the budget for 1987/88, a provisional budget increased for an instant, because in these years the meteorological radars in Khepupara and Cox's Bazar were replaced by Japan's Grant Aid. When executing new projects, the BMD made a request to its Government in advance for the budget, in local currency, necessary for the execution of projects.

TABLE 2-1-7 BUDGET EVOLUTION OF BMD

Fiscal year	Recurrent Expenditure	Provisional
1987/88	34,700	162,100
1988/89	36,610	29,243
1989/90	41,971	–
1990/91	43,259	13,000
1991/92	47,531	–

Unit: Thousand Taka

2) Meteorological observation, collection of data, forecast and analysis, and dissemination of forecast and warning

a) Elements and time of observation

The BMD executes meteorological observations as indicated in Table 2-1-8 in accordance with the arrangement of the WMO regulations. Radar observation is normally carried out every three hours, but special observation is carried out every hour while meteorological disturbances are indicated on a radar screen.

The location of the BMD radars is shown in Fig. 2-1-6. The radars at Cox's Bazar and Khepupara which were installed in 1988 by Japan's Grant Aid together with the Dhaka Radar previously installed, can monitor the northern part of the Bay of Bengal. Thus, the radar observation network plays a central part in the cyclone monitoring system of BMD.

TABLE 2-1-8 ELEMENTS AND TIME OF METEOROLOGICAL OBSERVATIONS

Classification	Observation time (UT)	Elements of observation
Surface observation	00, 03, 06, 09, 12, 15, 18, 21	Weather, wind direction, wind speed, air pressure, air temperature, humidity, precipitation, cloud, etc.
Pilot balloon observation	00, 06, 12, 18	Wind direction and speed.
Rawinsonde observation	00, 12	Air pressure, air temperature, humidity, wind direction and speed.
Radar observation	00, 03, 06, 09, 12, 15, 18, 21	Central position and moving direction of cyclone, position and growth or decay of rain area
	Every hour (when disturbance is observed)	

b) Collection of data

The observation data obtained at every observatory is collected by the Meteorological Communication Center in SWC, Dhaka. This Meteorological Communication Center uses the following means of telecommunication in communicating with each observatory or in obtaining foreign meteorological data:

Shortwave radio :Voice communication by shortwave radio called SSB.(Fig. 2-1-7)
Public telephone :Communication by ordinary telephone.
Teleprinter :Character information exchange by public line, dedicated line or shortwave radio broadcast.
Meteorological facsimile :Acquisition of image information such as weather charts through international shortwave broadcasting.

Shortwave radio is used to collect data observed in remote places, except for Chittagong, Bogra, Ishurdi, Jessore, Sylhet, Cox's Bazar and New Delhi where teleprinters are used through dedicated circuits because of high frequency of communication.

When the frequency of communication increases as in the case of cyclone attacks, public telephone is also used. For example, when the cyclone hit the country in April, 1991, BMD always connected SWC with Cox's Bazar and Khepupara through public telephone circuits as emergency measures for

close exchange of information.

c) Forecast and analysis

SWC prepares the data for analysis as indicated in Table 2-1-9 based on the observation data collected from various places and issues forecasts and warnings after examining the actual situation and prediction.

TABLE 2-1-9 DATA USED FOR METEOROLOGICAL ANALYSIS

Data for analysis	Data source
Weather chart	Weather charts are prepared and analyzed based on surface observation, rawinsonde observation and pilot balloon observation data as well as meteorological facsimile weather charts broadcasted from foreign countries.
Radar report	Coded position, moving direction and speed of cyclone, extension, growth or decay of rain area are indicated.
Polar-orbital satellite	Images from the American meteorological satellite. NOAA
Geostationary Meteorological Satellite(GMS)	Images from the Japanese meteorological satellite, "HIMAWARI"

d) Dissemination of weather forecasts and warnings

Besides forecasts and warnings for the public, special forecasts and warnings for aviation, riverine and maritime ports are issued and disseminated to the organizations indicated in Table 2-1-10. The contents of rainstorm advisory and warning for the riverine and maritime ports are shown in Table 2-1-11.

TABLE 2-1-10 DISSEMINATION OF FORECASTS AND WARNINGS BY BMD

Classification	Destination
Mass media	Bangladesh Television
	Bangladesh Radio
	Newspaper companies
Ministry of Relief and Rehabilitation	Directorate of Relief and Rehabilitation
	Cyclone Preparedness Program(CPP)
Transportation	Bangladesh Inland Water Transport Authority
	Civil Aviation Authority
	Railway
	Port Authority
Rivers	Bangladesh Inland Water Transport Authority
	Power Development Board
Police	All Deputy Commissioners and Superintendent of Police
Others	Bangladesh Telegraph and Telephone Board (BTTB), Other governmental organs, Local authorities, Bangladesh Red Crescent Society

The system of collection of meteorological data and dissemination of forecasts and warnings to the outside organizations concerned are shown in Fig. 2-1-8. The forecasts and warnings issued by BMD are disseminated mainly to the general public through mass media and to persons in charge of relief on the spot through the Ministry of Relief and Rehabilitation. The authorities concerned in this country are responsible for taking the following measures in accordance with the level of warning which indicates the degree of danger of cyclone disaster:

(i) From genesis of cyclone to level 2

As soon as a low pressure area is formed in the Bay of Bengal, BMD issues the first cyclone information including advisories and warnings.

Once the first cyclone information is communicated to the Ministry of Relief and Rehabilitation, the Cyclone Preparedness Program (CPP) is established in the ministry.

Then the forecasts and warnings are communicated by telephone/teleprinter from BMD to CPP.

At the same time, the cyclone information are communicated to the mass media such as radio, television and newspapers, as well as the authorities concerned as indicated in Table 2-1-10.

(ii) Higher than level 3

When the danger level of a cyclone warning reaches level 3, radio and television immediately extend the broadcasting hours and cooperate in making the cyclone information known to the public.

The BMD is obliged to issue the following forecasts and warnings in accordance with the Standing Order for Cyclone:

Level 4	:warning will be issued 24 hours before the landfall of a cyclone
Level 5 – level 7	:warning of danger will be issued 18 hours before the landfall of a cyclone
Level 8 – level 10	:warning of serious danger will be issued 10 hours before the landfall of a cyclone

(2) Measures taken by BMD against the Cyclone of April, 1991

1) Summary of cyclone

This violent cyclone was generated as a depression near the Andaman Islands in the southeastern part of the Bay of Bengal on April 23th, 1991. After remaining there for two days, its center pressure decreasing, it reached 10° N.L. and 89° E.L. in the south of the Bay of Bengal at 9:00 on April 25 (local time). In the evening of the day, it was developing further and moved towards the northwest. It reached 11° N.L. and 88.5° E.L. at 24:00 on the same day and developed into a cyclone. Its moving speed decreasing, it reached 13° N.L. and 87.5° E.L., at 12:00 on April 27, and developed into a strong cyclone, and then turned its moving direction toward the north. The strong cyclone developed more and reached 14.5° N.L. and 87.5° E.L. at 24:00, April 27. On the morning of April 28, the cyclone turned its direction toward the NNE and reached 16.8° N.L., 88° E.L. at 18:00 on the same day. Then, moving in the same direction and catching the southeastern coast of Bangladesh in its storm, the cyclone landed at the coast just on the north of Chittagong on the early morning of April 30., going toward the NNE, and it decayed rapidly in the inland region.

The maximum height of the storm surge reached 7.5 m (Dr. M. Ahmed, BCAS Field Rep. May 91).

The cyclone caused serious damages especially in the Chittagong area. The cyclone trajectory and the damaged area are indicated in Fig. 2-1-4 and the summary of damages is shown in TABLE 2-1-3.

2) Issuance of advisories and warnings

BMD is the sole governmental organ responsible for the issuance of advisories and warnings on natural disasters by cyclones, etc. SWC of BMD issued the first advisory of the cyclone on April 25th, 1991 five days before its landfall. The SWC issued a warning including a forecast of the landfall area and time 27 hours before landfall of the cyclone. In the BMD the Director and other personnel worked day and night on analysis and forecasts and issued 29 times the special weather bulletins relating to advisories and warnings. The time and main contents of issuance are shown in Table 2-1-12.

The data used for making weather forecasts are as follows:

a) Meteorological observation data of the world obtained through Global Telecommunication System (GTS).

b) Meteorological facsimile data (receivable from Japan, Japan's global model precisely predicated the cyclone in Bangladesh; Nakayama, et. al., Weather, 1991).

c) Satellite images of GMS and NOAA.

d) Data of surface observation at every 3 hours, pilot balloon observation at every 6 hours, upper air meteorological observation at every 12 hours and radar information at every hour or by continuous observation.

The observations by radars at Cox's Bazar and Khepupara and their reports were carried out as follows:

April 25 to 27:

Observations at every 3 hours or every hour and their reports to SWC by SSB and teleprinters.

April 28 to 30:

Continuous monitoring. Voice reports by SSB and BTTB telephone. BTTB cooperated in holding the lines between the two radar sites at Cox's Bazar and Khepupara and SWC in Dhaka continuously. But, the telecommunication tower at Chittagong collapsed. From then on, they were obliged to depend on SSB to communicate with Cox's Bazar.

The cyclone images obtained by Cox's Bazar radar and the excerpts from the special weather bulletin issued by BMD are shown in Appendix 8.

TABLE 2-1-11 CONTENTS OF RAINSTORM ADVISORY AND WARNING
MARINE PORTS OF BANGLADESH

Distant Cautionary Signal No. 1:	This indicates that ships may be exposed to danger after they have left the harbour as there is a region of squally weather in the distant sea where a storm may form.
Distant Warning Signal No. 2:	This indicates that ships may be exposed to danger after they have left the harbour as a storm has formed in the distant sea.
Local Cautionary Signal No. 3:	This indicates that the port itself and the ships therein may be threatened as the port is threatened by a squally weather.
Local Warning Signal No. 4:	This indicates that the port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precautions.
Danger Signal No. 5:	This indicates that the port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the south of the port.
Danger Signal No. 6:	This indicates that the port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the north of the port.
Danger Signal No. 7:	This indicates that the port will experience severe weather from a storm of slight or moderate intensity, that is expected to cross over or near the port.
Great Danger Signal No. 8:	This indicates that the port will experience severe weather from a storm of great intensity, that is expected to cross the coast to the south of the port.
Great Danger Signal No. 9:	This indicates that the port will experience severe weather from a storm of great intensity, that is expected to cross the coast to the north of the port.
Great Danger Signal No. 10:	This indicates that the port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port.
Failure of Communications:	This indicates that the communications with the meteorological warning centre have broken down and the local officer considers that there is danger of bad weather.

Signal No. 1 :	This indicates that your area is threatened by a squally weather. Keep watch to the next situation. If there is a possibility for any area to face scattered Nor'wester or storms, then the riverports are advised to hoist this signal. But the movements of rivercraft will not be stopped when this signal is hoisted. The recipients of this signal must be prepared to face a squally weather or temporary bad weather.
Signal No. 2 :	This indicates that your area is threatened by gusty/squally wind with a maximum speed of 61 km./hr.(38 m.p.h.) due to a deep depression formed in the Bay or Nor'wester i.e., when in any area, due to depression in the Bay gusty/squally wind with a speed of 51-61 km./hr. (32-38 m.p.h.) will be just prevailing then the riverports must be advised to hoist this sinal. For any other reason, if there is a chance of widespread squally wind over any area, then also this signal is to be hoisted. (Vessels of 65 feet or less in length are to seek shelter immediately).
Signal No. 3 :	This indicates that a storm will hit your area very soon, and all rivercraft must take immediate shelter. If on any area, there is a continuous squally wind with a speed of 63-87km./ hr. (39-54 m.p.h.) then this signal is to be hoisted. But this signal is not to be hoisted for a Nor'wester. During Nor'wester, wind speed may exceed 128 km./hr. (80 m.p.h.) but it does not last or longer period. For temporary Nor'wester, plying of rivercraft should not be totally stopped.
Signal No. 4 :	This indicates that a severe storm will hit your area very soon. All rivercraft must continue to remain in shelter. This signal is to be hoisted when any area is threatened by a severe cyclonic storm with a speed of 87 km./hr. (54 m.p.h.) or more.

TABLE 2-1-12 SPECIAL WEATHER BULLETINS ISSUED BY BMD FOR THE CYCLONE IN APRIL, 1991

No.	Date	Time	Category of advisory and warning	Contents
1.	425	1120	M advisory 1	1,400 km SSW from Chittagong (10° N. 89° E.)
2.	25	1350	M advisory 1	1,240 km SSW from Chittagong (11.5° N. 88.5° E.)
3.	26	500	M advisory 2	Growing and beginning to move to the north.
:	:	:		
:	:	:		
10.	27	1330	M advisory 2	1,120 km SSW from Chittagong (13° N. 87.5° E.)
:	:	:		
:	:	:		
15.	28	1420	M warning 4 R advisory 2	820 km SW from Chittagong, 20 km/h to NNE.
:	:	:		
17.	28	2130	M danger warning 5	700 km SW from Chittagong, 20 km/h to NNE.
			R warning 3	Hit the coastal area of Chittagong - Cox's Bazar at night, April 29.
:	:	:		
20.	29	1230	M serious danger warning 10	450 km SW from Chittagong, 25 km/h to NNE.
			R serious danger warning 4	Hit Meghna on the coastal area of Chittagong - Cox's Bazar late at night. Storm surge of 4 - 7 m. Inhabitants on the coast should remain in the shelters.
:	:	:		
23.	29	1930	M warning of serious danger 10	225 km SW from Chittagong, 35 km/h to NNE.
			R warning of serious danger 4	will hit near Meghna on the coastal area of Chittagong - Cox's within 4-6 hours. Wind of 60 m/s, storm surge of 4-7 m. Inhabitants on the coast should continue to remain in the shelters.
:	:	:		
26	29	2230	M warning of serious danger 10	72 km SW from Chittagong, 35 km/h to NE.
			R warning of serious danger 4	Will hit near Chittagong on the coastal area of Chittagong - Cox's. Wind of 60 m/s and storm surge of 4-7 m. Inhabitants of the coast should continue to remain in the shelters.
:	:	:		
29.	30	620	M advisory 2	
			R warning 3	The cyclone landed early in the morning, moved to 50 km N of Rangamati at 6 o'clock, passed India and decayed. The inland wind is strong and the rivers are dangerous. The inhabitants in shelter should remain there until noon. Special meteorological report is finished.

M: for maritime ports, R: for river ports (See Table 2-1-11)

3) Disaster prevention system

Of the natural disasters in Bangladesh, the cyclone causes the most serious damage. Bangladesh suffers much from gales and heavy rains. The coastal region especially suffers greatly from storm surges. For this reason, cyclone shelters have been constructed to receive inhabitants when warnings are announced since the cyclone disaster in 1970. A cyclone shelter can receive 500 to 2,000 inhabitants. Its floor is 10 m above the ordinary sea surface. The meteorological observatory in Khepupara with a radar also serves as a cyclone shelter which can receive 500 inhabitants.

Bangladesh published a guidebook titled "Standing Order for Cyclone" so that on the occasion of a cyclone the organizations concerned can act promptly and effectively on pertinent responsibility and obligation. The organizations concerned will be responsible for preparing its own action program and taking action in minimizing the loss of life and property during the emergency period of a cyclone.

For example, the Bangladesh Television and the Bangladesh Radio broadcast cyclone advisories and warnings even by interrupting ordinary programs. The CPP informs all the inhabitants of a dangerous situation through more than 20,000 trained volunteers using bullhorns and megaphones. The Control Room of the Ministry of Relief and Rehabilitation gives instructions to the organizations concerned for seeking their cooperation so that all the CPP-related activities go smoothly and effectively during the cyclone emergency period.

4) Problems

When the cyclone approached in April, 1991, ordinary observations at every 3 hours at the radar sites at Cox's Bazar and Khepupara were changed to special observations at every hour or to continuous special monitoring. Also in SWC in Dhaka the analysis and forecast services were continued day and night and the special weather bulletins relating to advisories and warnings were issued 29 times during the six days.

In spite of such efforts, the two radars could not be utilized sufficiently. That is, the radar data are transmitted from each radar site to SWC in code form and plain language form and the following problems still exist:

a) Detailed radar image information cannot be transmitted.

b) It takes time for analysis and data transmission at the radar site and for interpretation of the radar data in SWC.

c) Other data available at radar sites are few and sometimes a cyclone central position is erroneously determined.

d) The telecommunication is frequently interrupted due to weather, disaster, etc.

2-1-3 Present Conditions of Telecommunication Network

(1) Present Condition of Telecommunication Network in Bangladesh

The telecommunication network of Bangladesh Telegraph and Telephone board (BTTB) is composed of three trunk lines; the eastern route trunk line which connects Dhaka to Cox's Bazar, the western route trunk line which connects Dhaka to Barisal, and the northern route trunk line which extends from Dhaka to the radio stations at Sylhet, Mymensingh and Bogra. A branch line system is extended from a repeater station and a terminal station on each trunk line. Besides, there is a ongoing project under which a UHF radio telecommunication network of a small capacity for countryside will be constructed. The present conditions of the telecommunication network of BTTB are shown in Fig. 2-1-9(1) and (2).

(2) Present Condition of Telecommunication Links from each Radar Site to Dhaka

The existing telecommunication links between the two radar sites at Cox's Bazar, Khepupara and Dhaka are as follows (see Table 2-1-13):

1) Eastern route (Cox's Bazar side)

a) Dhaka – Chittagong

Between Dhaka and Chittagong, an analog radio equipment of 6 GHz band with transmission capacity of 1,800 channels and a multiplexer has been operative since March, 1980 to transmit telephone, telegraph, television signals, etc.

b) Chittagong – Cox's Bazar

Between Chittagong and Cox's Bazar, an analog radio equipment of 6 GHz band with transmission capacity of 960 channels, and a multiplexer has been operative since October, 1978, to transmit telephone and television signals, etc. However, the equipment is obsolete and the disconnection of the link due to fading has been observed on propagation paths.

2) Western route (Khepupara side)

a) Dhaka – Khulna

Between Dhaka and Khulna, the radio system has been operative since April, 1990 and is composed of a digital radio equipment (transmission capacity of 140 Mbps, 1,920 channels converted into telephone), and a digital multiplexer.

b) Khulna – Khepupara

The section between Khulna and Khepupara is composed of three transmission sections.

In the section between Khulna and Barisal, an analog radio equipment with transmission capacity of 960 channels has been operative since November, 1977. Each transmission distance from Sreepur Repeater Station to Khulna and from Sreepur Repeater Station to Barisal is approximately 50 km. The propagation paths are on the plain where the disconnection of the telecommunication links occurs frequently due to fading phenomenon.

The section between Barisal and Patuakhali is on a branch line system where an analog radio equipment of 2 GHz band with transmission capacity of 120 channels and a multiplexer has been operative since May, 1982. The number of channels now in use is around 65.

In the section between Patuakhali and Khepupara, there is an analog radio equipment of 400 MHz band. It has a capacity of 12 channels, while the number of usable channels is only 4.

TABLE 2-1-13 PRESENT CONDITION OF TELECOMMUNICATION LINKS

Existing circuit route	Manufacturer	Date of manufacture	Capacity of channels	System characteristics
Cox's Bazar - Chittagong	GTE	'78 Oct.	960	Analog
Chittagong - Dhaka Central	NEC	'80 Mar.	1,800	Analog
Khepupara - Patuakhali	GTE	before '72	12	Analog
Patuakhali - Barisal	MOTOROLA	'82 May	120	Analog
Barisal - Khulna Radio set:	FUJITSU	'77 Nov.	960	Analog
Carrier terminal:	NEC			
Khulna - Dhaka Central	FUJITSU	'90 Apr.	1,920	Digital
Dhaka Central - Dhaka BMD	MOTOROLA	'91	72	Analog

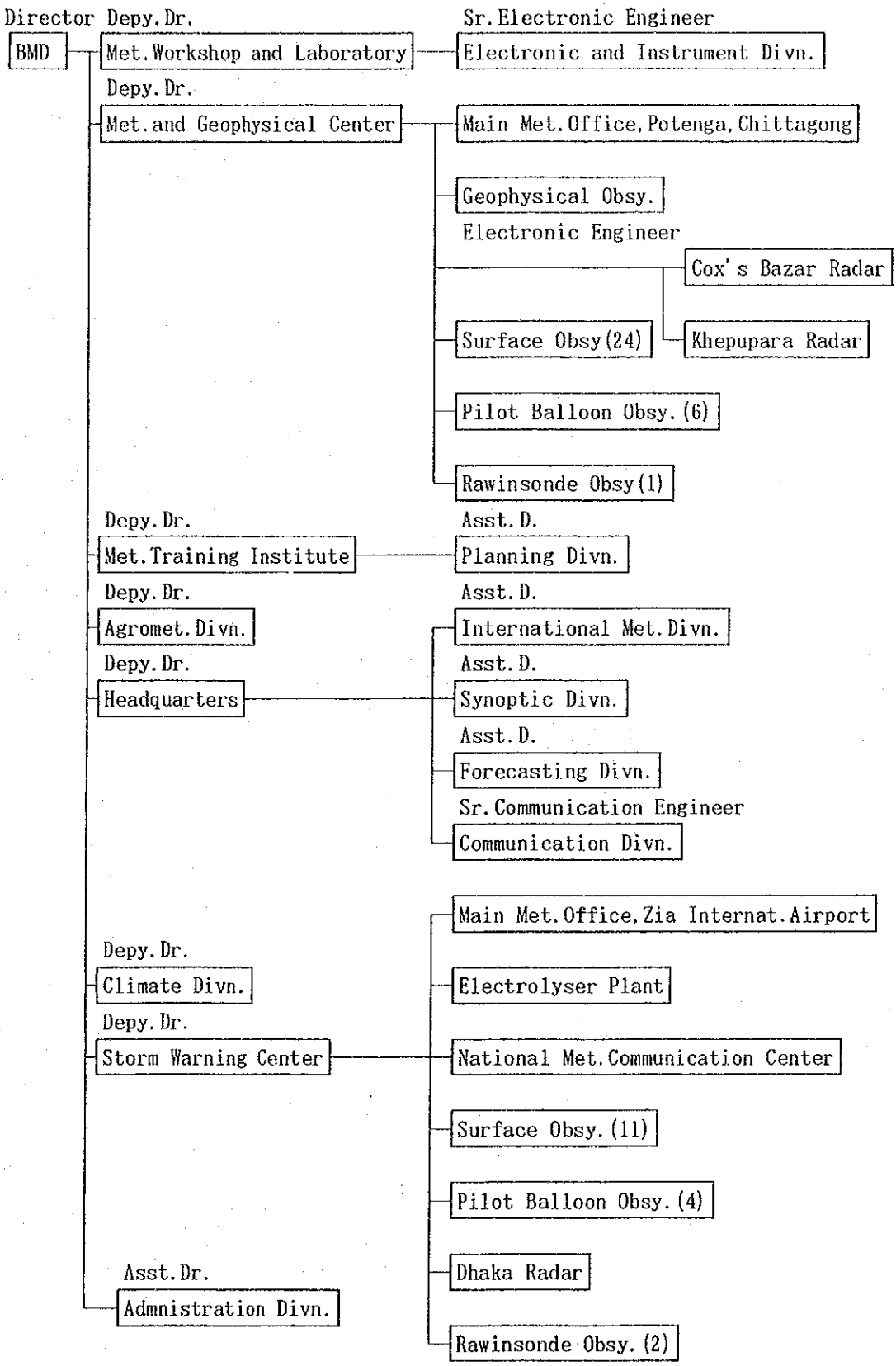


FIG. 2-1-5 ORGANIZATION CHART
Digit in ():Number of Stations

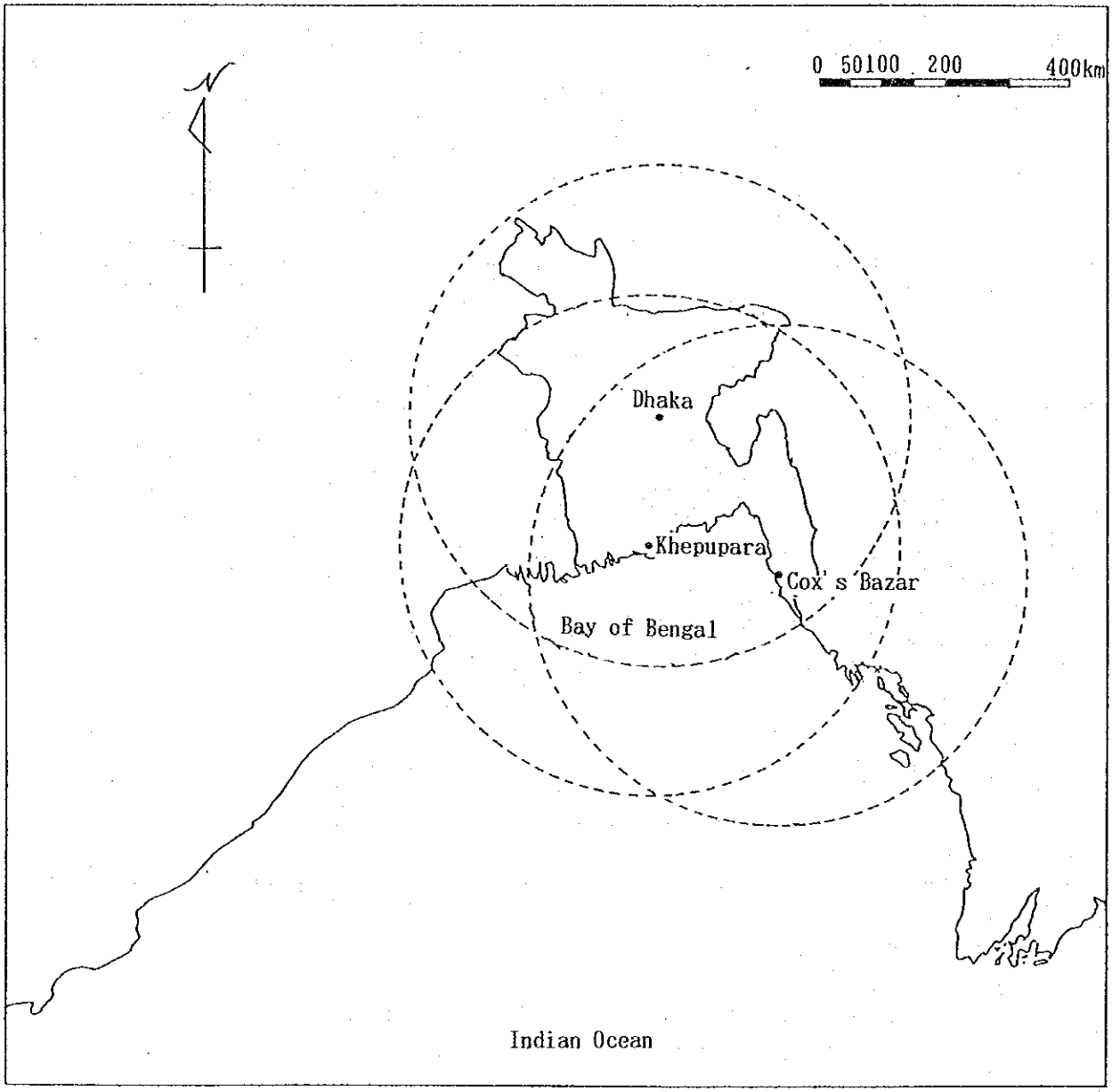


FIG. 2-1-6 DETECTION RANGE OF BMD RADARS

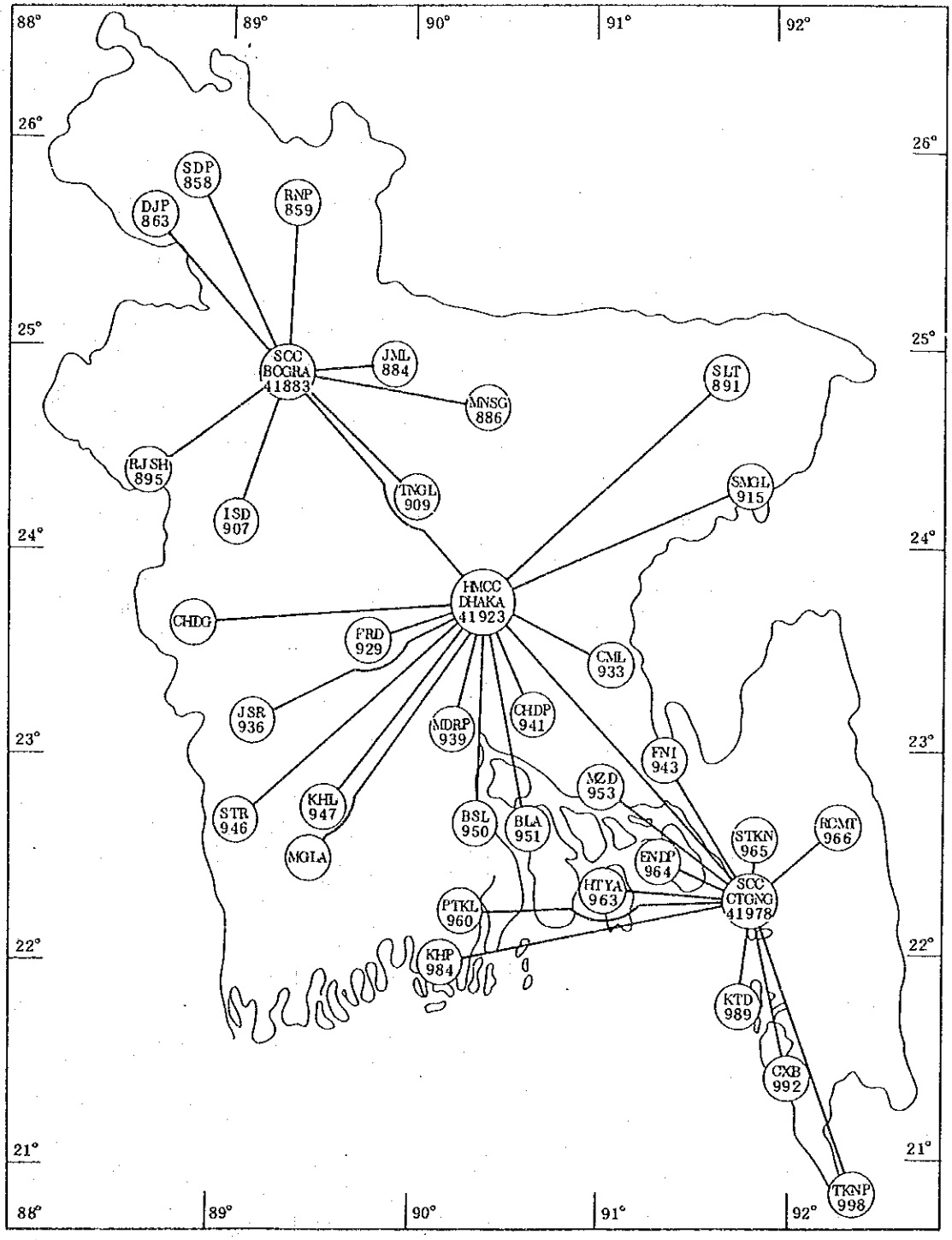


FIG. 2-1-7 BMD'S OBSERVATORIES AND EXISTING SSB NETWORK

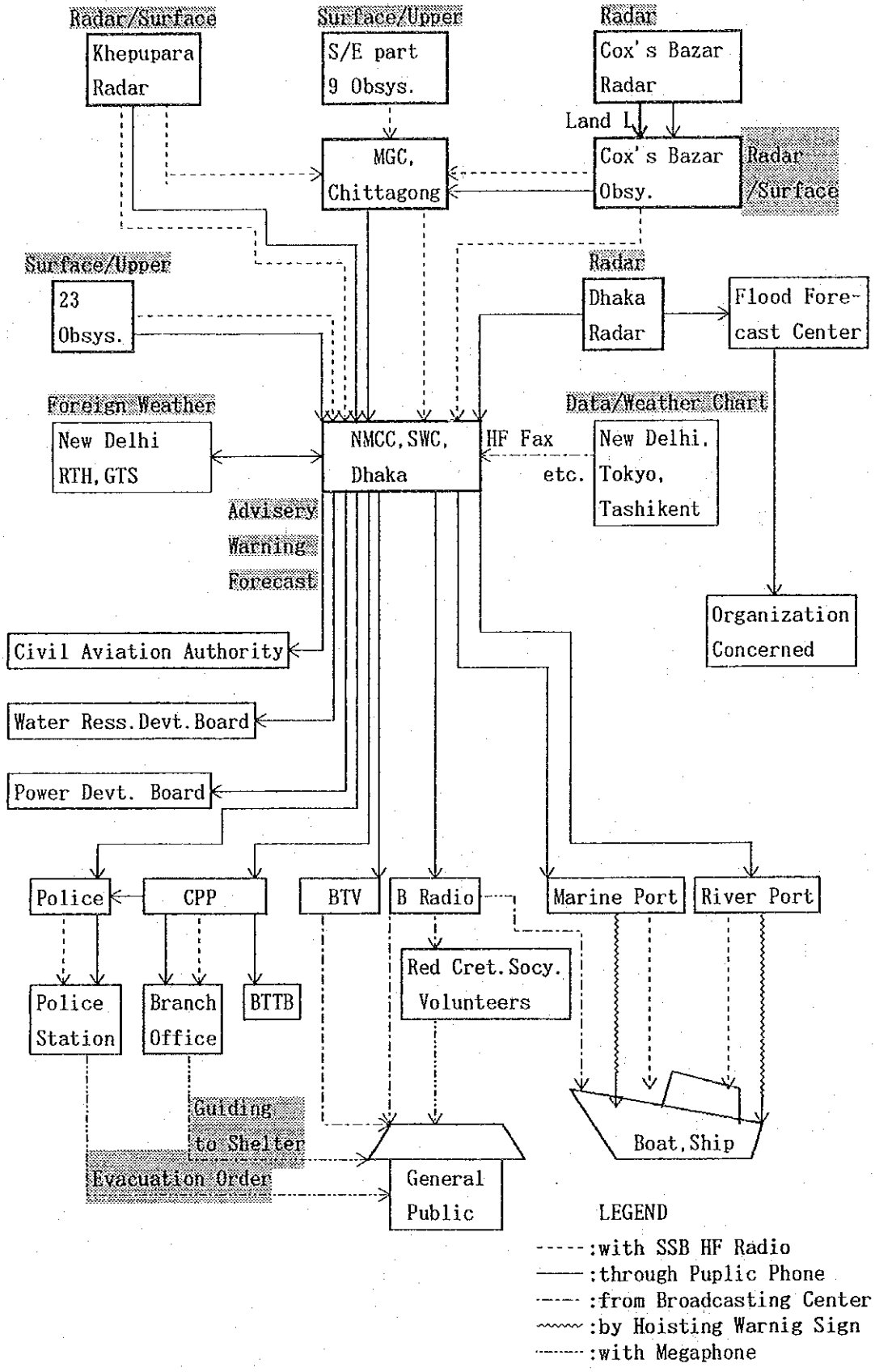


FIG. 2-1-8 COLLECTION AND DISSEMINATION SYSTEM

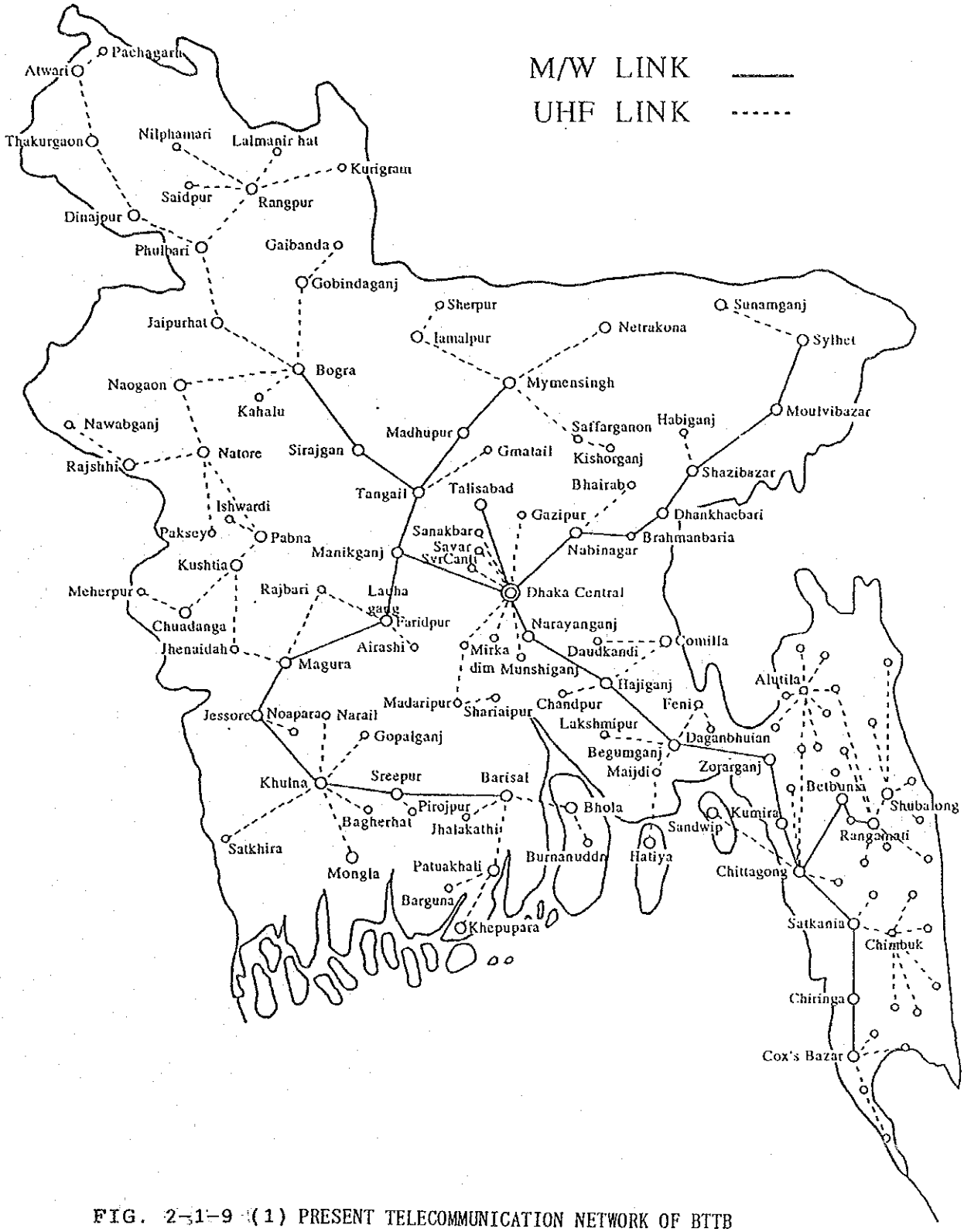


FIG. 2-1-9 (1) PRESENT TELECOMMUNICATION NETWORK OF BTTB

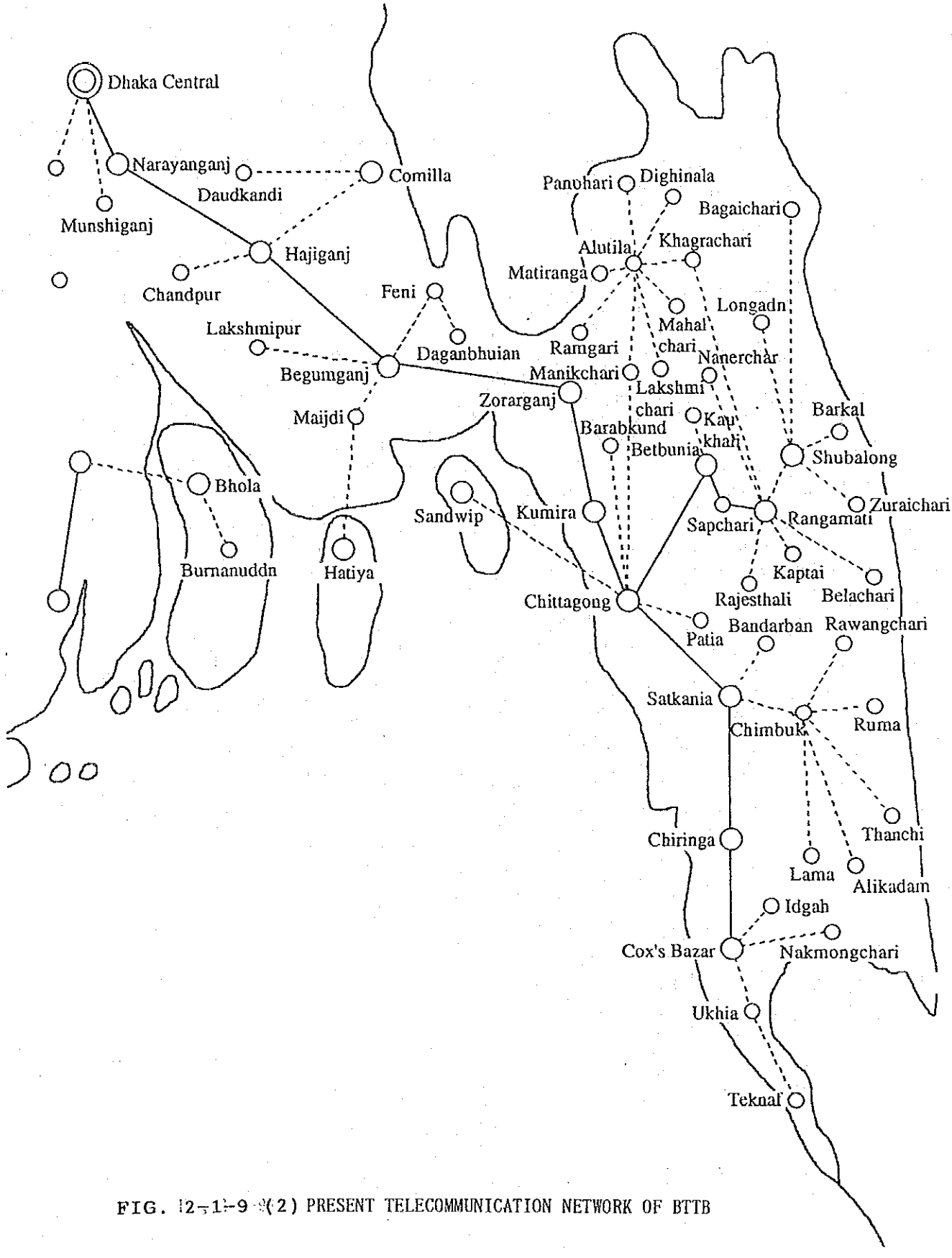


FIG. 2-1-9 (2) PRESENT TELECOMMUNICATION NETWORK OF BTTB

2-2 Outline of the Request

2-2-1 Details of the Request

As mentioned above, most of Bangladesh territory is situated on a low-land of less than 10 meters above the mean sea level with areas subject to flood damages due to heavy rains and storm surge caused by cyclones coming from the Bay of Bengal. Such damages including the cyclone damage in April, 1991 are caused almost every year. These damages have been serious problems in the country.

In such a situation two meteorological radars, installed at Cox's Bazar and Khepupara in 1988 by Japan's Grant Aid, have become powerful means of monitoring cyclones and of timely providing weather forecasts and warnings to the public.

However, the means of transmitting the radar data from the radar sites to SWC in Dhaka are totally insufficient. The central position of cyclones, the rainfall areas, etc. interpreted by images of the radar on the spot are reported to Dhaka by the short wave radiotelephone (SSB) or common telephone on a verbal information basis. But, the means of communication lacks reliability because it is sometimes interrupted due to meteorological conditions. The establishment of telecommunication links which enable SWC to analyze and utilize the realtime radar image from the two radar sites in order to issue early and reliable forecasts and warnings of cyclones is needed by all means.

For that reason, the Government of Bangladesh formulated the Project for Establishment of Microwave Link for Meteorology. This plan was approved as a priority project by the Government, but due to a shortage of local resources, a financial assistance for this project is required from abroad.

In view of such a situation, the Government of Bangladesh requested the Grant Aid from the Government of Japan.

2-2-2 Contents of the Request

(1) Objective

The objectives of the request are to establish the reliable microwave link between SWC in Dhaka and the two radar sites in Cox's Bazar and Khepupara in order for SWC to receive in realtime radar images obtained by these two cyclone monitoring meteorological radars previously installed by Japan's Grant Aid, and eventually to contribute to the reduction of the damages to human lives and properties by improving cyclone forecasts and warnings using the radar images directly.

(2) Executing agency

Bangladesh Meteorological Department (BMD)

(3) Contents of plan

The reliable microwave links will be established between Dhaka and Cox's Bazar and between Dhaka and Khepupara utilizing the existing telecommunication facilities of BTTB to the maximum extent possible, and the digitized color radar images observed by the two meteorological radars at Cox's Bazar and Khepupara will be transmitted to SWC in real time, and displayed on the color monitor display for realtime use.

(4) Main equipments and facilities

Radio telecommunication equipment, remote display equipment and necessary electric supply equipment, steel towers and sheds.

Chapter 3 Outline of the Project

3-1 Objective

The objective of the "Project for Establishment of Microwave Link for Meteorology" is to establish a microwave link for meteorology between the Storm Warning Center (SWC) in Dhaka and the two radar sites at Cox's Bazar and Khepupara for improving the cyclone forecast and warning system and eventually reducing the damages to human lives and properties.

3-2 Study and Examination on the Request

3-2-1 Study of Appropriateness and Necessity of the Project

The project, requested by BMD, aims at establishing a microwave link for transmitting radar images in real time from the radar sites to the Storm Warning Center (SWC) in Dhaka, the national meteorological forecast and warning center, to utilize more efficiently the two meteorological radars at Cox's Bazar and Khepupara constructed in 1988 with Japan's Grant Aid.

The present system of voice communication of radar data (SSB shortwave radio telephone or common public telephone) lacks reliability and accuracy because it is sometimes interrupted due to weather conditions, status of radio wave propagation, etc. and has the limitation of transmission of voice information; only a small quantity of information can be obtained. For this reason, the use of radar images in SWC has been rather limited.

If this project is realized, the above situation will be improved remarkably, and the SWC will be able to constantly monitor significant weather phenomena such as cyclones using wide-range images of multiple radars. This will contribute greatly to the improvement of accuracy in weather forecasts and warnings, and eventually become a powerful means of reducing the tremendous cyclone damages; about 700,000 lives have been lost and an economic losses have amounted to about four billion U.S. dollars since 1960. The project will have a wide effect on the inhabitants of about 25% of a total population of Bangladesh in the coastal region of the Bay of Bengal .

Therefore, it can be said that this project is necessary for Bangladesh and an appropriate project for Grant Aid from Japan.

3-2-2 Study of Execution and Operation Plan

As described in TAPP (Technical Assistance Project Proforma, December, 1988), it is planned that BTTB takes charge of the operation and maintenance of the new microwave links after the completion of the installation. Discussions on this matter have been held several times so far between BMD and BTTB, and the results of them were recorded in the minutes of discussions. Both BMD and BTTB have reached concurrence on this matter satisfactorily.

In Bangladesh, the facilities introduced and installed by any department of the Government are maintained normally by the department which is specialized in those facilities. Therefore, it is natural that BTTB takes charge of operation and maintenance of a part of the telecommunication links of the project. BTTB has specialized engineers and much experience in operation and maintenance of microwave telecommunication networks. If the equipment of the new telecommunication links is installed in the BTTB facilities, it is considered that BTTB need not increase the staff for operation and management. There-

fore, it is desirable that BTTB should take charge of operation and maintenance of the new links for their effective operation.

BMD estimates the operation and maintenance costs at 271,000 Taka per year including its share of operation and maintenance expenses to BTTB. As it corresponds to approximately 0.6% of the BMD's budget for 1991/92 (recurrent cost of 47,531,000 Taka, see Table 2-1-7), it is considered that there is no problem in the financial bearing capacity of BMD.

3-2-3 Study of Relation and Duplication with Similar Projects and Aid Programs of International Organizations

The Government of Bangladesh formulated the Fourth Five-Year Plan (1990/91-94/95). In this plan the Government adopted flood control as a policy with overriding priority and has actively tackled the reduction of flood and cyclone disasters repeated every year for stabilizing people's livelihood.

On the other hand, the Government formulated a Flood Action Plan with economic and technical aid by the World Bank, UNDP, EC, USA, France and Japan, which includes improving forecasting and warning of cyclones as a project of defense against cyclones in the coastal region of the Bay of Bengal.

The Government of Japan organized in April, 1989 the Assistance Forum for Bangladesh to study the present condition of the country, and dispatched in April, 1990 a comprehensive survey mission for the purpose of economic cooperation and adopted flood control as one of the priority objectives. Moreover, formulating the "Rehabilitation Plan for Cyclone" using OECF's funds, the Government of Japan plans to rehabilitate BMD's observatories damaged by the cyclone in April, 1991 in the coastal region.

This project will play an important role in promoting the above similar projects but has no duplication with the other similar projects.

3-2-4 Study of Contents of the Project

The purpose of this project is to secure the telecommunication facilities for transmitting data of radar images (2,400 bps) obtained in radar sites at Cox's Bazar and Khepupara to the Storm Warning Center (SWC) in Dhaka. The existing telecommunication facilities must be utilized to the maximum extent possible to curtail expenditures. For this reason, the Basic Study Team studied if the existing telecommunication links are suitable and if the existing facilities including antenna towers and station buildings can be used for the links to be installed.

The routes of the existing links regarding this study and the surveyed BTTB links are shown in Fig. 3-2-1.

(1) Availability of Existing Telecommunication Links and Sections

1) Outline of existing links

The existing telecommunication facilities between BMD in Dhaka and the two radar sites included in this study are outlined in Table 2-1-13. Other than the route described in the lowermost row of Table 2-1-13, the listed routes form a part of the national telecommunication network mentioned in paragraph 2-1-3.

2) Outline of performance test

The following tests were carried out for the existing links of BTTB in order to judge if the links have enough performance and reliability for the transmission of data of 2,400 bps:

a) Receive test tone level test,
b) Frequency response test,
c) Idle channel noise test.

The performance tests were made on two routes of BTTB's links regarding a) Eastern route (Cox's Bazar - Dhaka Central) and b) Western route (Khepupara - Dhaka Central). In both routes, performance tests were also made between Dhaka and main demarcation points (Chittagong, Barisal and Khulna). The unified radio equipment is used in the section between demarcation points.

3) Performance of existing links

The results of the studies including performance tests are as follows:

a) Eastern route (Cox's Bazar - Dhaka Central)

(i) Cox's Bazar - Dhaka

There is no problem in the input and output levels and frequency characteristics, but idle channel noise is very high. In the section between Cox's Bazar and Chittagong, the existing radio equipment and multiplexer are obsolete and the frequency of disconnections is high. Sometimes the links are disconnected due to fading.

(ii) Chittagong - Dhaka

There is no problem in the input and output levels, frequency characteristics and idle channel noise. The links have good performance and reliability for the data transmission.

b) Western route (Khepupara–Dhaka Central)

(i) Khepupara – Dhaka

As a result of tests, the output level proved much lower than the ordinary level. In the section between Khepupara and Patuakhali, the telecommunication facilities are obsolete and the idle channel noise is high.

(ii) Barisal – Dhaka

As a result of tests, the output level proved much lower than the ordinary level. Moreover, it seems that idle channel noise increases when the signals are adjusted to the ordinary level.

In the section between Barisal and Khulna, the links are sometimes disconnected due to fading.

(iii) Khulna – Dhaka

In the section between Khulna and Dhaka, both performance and reliability are good.

4) Urban link between BTTB Central Station and SWC in Dhaka

This link has been operative for data transmission (2,400 bps) from March, 1992 as a part of the Global Telecommunication System (GTS) between New Delhi in India and Dhaka. The performance test was already completed and there is no problem in transmitting radar image data at the same speed (2,400 bps). However, it is necessary to add additional channel units to the multiplexer for this project because only 6 channel are actually mounted on the multiplexer in this section.

5) Conclusion

Based on the above mentioned studies, the availability of each existing link and the necessity of each new link are summarized in Table 3–2–1. The sections which require new links are Cox's Bazar – Chittagong on the eastern route and Khepupara – Khulna on the western route.

TABLE 3-2-1 PRESENT STATUS OF BTTB LINK

Section		Availability of existing link	Necessity of new link
Cox's Bazar	– Chittagong	No	Yes
Chittagong	– Dhaka Central	Yes	No
Khepupara	– Patuakhali	No	Yes
Patuakhali	– Barisal	No	Yes
Barisal	– Khulna	No	Yes
Khulna	– Dhaka Central	Yes	No
Dhaka Central	– BMD in Dhaka	Yes	No

(2) Clearance of the Radio Propagation Routes

1) Test route

Two buildings may obstruct the urban propagation route between BTTB in Dhaka and SWC; one is a multi-storied apartment (4.4 km from BMD, 57 m high) and the other is a building the construction of which is now interrupted (3.8 km from BMD, 45 m high, final planned height of 65.3 m). For this reason, a mirror test was executed to confirm the clearance between the sites.

The clearance test was also carried out on two rural routes between Cox's Bazar radar and BTTB in Cox's Bazar and between Khepupara radar and BTTB in Khepupara where the new links are required because of no existing links.

2) Result

The good clearance between the antennas of BTTB and BMD in Dhaka was confirmed. Also, the Fresnel zone cutoff area is about one fourth by the high apartment block, and it is considered that the building is not a serious obstacle to the radio circuit.

However, the second building mentioned above, if completed in the future up to the planned height, will impede the clearance, and the fresnel zone cutoff area will be more than half. In this case, it is anticipated that the propagation loss cannot be neglected and some measures (relocation of antenna and radio equipment) will be necessary. The satisfactory clearance was confirmed between Cox's Bazar radar and BTTB in Cox's Bazar and between Khepupara radar and BTTB in Khepupara.

(3) Availability of the Existing Facilities

The study on the availability of the existing facilities was conducted at the following sites for the installation of radio equipment and operation of the new links:

Eastern route:	Radar site in Cox's Bazar,
	BTTB in Cox's Bazar,
	BTTB in Chiringa,
	BTTB in Satkania,
	BTTB in Chittagong,
Western route:	Radar site in Khepupara,
	BTTB in Khepupara,
	BTTB in Patuakhali,
	BTTB in Barisal,
	BTTB in Sreepur,
	BTTB in Khulna,
Dhaka:	Dhaka Central Station of BTTB,
	SWC.

The results of the site survey are listed from Table 3-2-2 (1) to Table 3-2-2 (4). They can be summarized as follows:

1) Electric power supply equipment

Commercial electric power supply is relatively stable and no interruption of supply was experienced during our study, but in Khepupara the voltage may vary up to about 20%. Two radar sites are not equipped with rectifiers and batteries. The other sites are equipped with the existing facilities which have no problem concerning capacity except for BTTB in Chittagong. But the models are old except at some stations. For this reason, it is necessary to provide rectifiers and batteries with necessary capacity for the new telecommunication equipment.

Moreover, it is necessary to install engine generators at some stations where the models are old and the stand-by machines are not available (BTTB in Chiringa and Khepupara and BMD in Dhaka).

2) Station buildings

Additional space is necessary in the existing radio stations to house the new equipment. Additional space is available at the existing BTTB stations, SWC and the Khepupara radar, but the radar site in Cox's Bazar has no additional space in the existing building, so that a new radio shed is required at this site.

3) Steel towers for telecommunication

For confirmation of availability of the existing steel towers to be equipped with new antennas, the site surveys were conducted at four sites between Cox's Bazar and Chittagong on the eastern route and at five sites between Khepupara and Khulna on the western route.

All the steel towers were constructed 15 years ago, but it is considered that they are satisfactorily utilizable taking into consideration the facts that the tower construction was done well, and that serious damages were not found, and that maintenance and repairs have been executed appropriately. The survey was executed from the standpoint of the maximum use of existing steel towers for curtailing expenditures. The results of the survey are as follows.

a) On eastern route:

There is no problem in using existing steel towers at Cox's Bazar, Chiringa and Satkania for installing antennas for this project. The upper part of the existing steel tower in Chittagong was destroyed by the cyclone in April, 1991 and the height was reduced from 84 m to 61 m. After the repair work was completed, many antennas have been installed and there remains an uncertainty in using this tower for this project. For this reason, the utilization of the self-supporting steel tower of 99 m height, which is to be constructed at the end of 1992 at the latest on the same site by Saudi Arabian aid, would be appropriate for this project. In case that this new tower will not be completed before the completion of the works for this project, it is necessary that the existing tower should be used temporarily.

b) On western route:

As for the existing five steel towers on the western route, it is difficult to install additional antennas simply for this project in view of wind pressure loads. Especially at Khepupara, Patuakhali and Khulna, the wind pressure loads are liable to be in excess even now. For this reason, it is necessary to replace the existing antennas by the new ones for reducing the wind pressure load. Thus, it is possible to use the existing steel towers at all sites.

(4) Remote Display Equipment

Here, the remote display equipment to be installed at the radar sites in Cox's Bazar and Khepupara and SWC in Dhaka are examined.

In the discussions between BMD and the Basic Study Team, BMD expressed their intention to install two additional radar image monitor displays and to have a spare display as mentioned below. The existing monitor displays total 4; one at each site of Cox's Bazar radar site, Cox's Bazar observatory, Khepupara radar site and SWC.

It is considered that the existing two monitor displays are enough at Cox's Bazar and an additional one is not necessary. At Khepupara it is considered that an additional one is necessary as a spare display which can be used immediately in case of the failure of the main display. At SWC, it is also desirable that two monitor displays should be installed to monitor radar images at the same time from two sites for grasping accurately the whole image of a cyclone when weather forecasts and analyses are made. Therefore, two new displays are needed. Taking into account the convenience of maintenance and management, it is recommended that two new displays should be placed in SWC and that the existing one in SWC should be used as a spare display in Khepupara radar.

In addition, it is necessary to install a dedicated telephone at each site of SWC and the radar sites for SWC to give instructions to each radar site and to receive many pieces of information from each radar site.

3-2-5 Study of Necessity of Technical Cooperation

The Bangladesh party asked for the following technical cooperation in the request and the discussions made at Basic Design Study stage.

Receiving trainees:
(i) Four persons for radar engineering and radar image analysis,
(ii) Four persons for operation, repair and maintenance of microwave equipment,

Long-term dispatch of expert:
One microwave engineer.

The above technical cooperation was requested by both BMD of the executing agency of this project and user of radar images, and BTTB which will take charge of operation and maintenance of the newly installed telecommunication links.

For BMD, the training of the engineers at both radar sites and the radar analysts in SWC is indispensable for upgrading experience and technical level . Moreover, it is necessary to dispatch experts in these field from Japan after the completion of the training in order to strengthen the technical capacity of BMD, although this is not included in the request.

It is appropriate to introduce digital links, taking into account the

recent situation of the improvement in telecommunication networks in Bangladesh and the characteristics of digital links which are free from noise overlap. On the other hand, the number of digital link engineers at BTTB is insufficient. So, the training of the engineers is required for the maintenance and management of the new links in the eastern and western routes. In addition, guidance by Japanese experts on the spot will be even more useful.

3-2-6 Basic Policy of Cooperation

From the above mentioned studies, this project has been judged as appropriate to be executed with Japan's Grant Aid, because its effect, feasibility and executing capacity of the recipient country are appropriate enough to meet the basic policy of Japan's Grant Aid.

For this reason, the outline of the project is examined and basic design study is executed, on the assumption that Japan's Grant Aid would be finalized in the following paragraphs.

However, it is adequate to adjust the contents of the project to those mentioned in "Study of Contents of the Project",in paragraph 3-2-4, each item of which is based on the results of the study and examination carried out in response to the request.

TABLE 3-2-2 (1) RESULTS OF SITE SURVEY-1

	COX'S BAZAR RADAR	COX'S BAZAR	CHIRINGA	SATKANIA
COMMERCIAL POWER	3φ4W220V	3φ4W230V	1φ2W220V	3φ4W220V
ENGINE GENERATOR	45KVA65A 3φ4W230V INSTALLED '88 APR NISSAN DIESEL	27KVA400/230V KOMATSU 24KVA 3φ4W400/230V STAH FORD	13.3KVA60.5A 1φ220V MANUFACTURED '75 SEP LEROY-SOMER MOBIL ENG/GEN 11KVA 3φ4W220V MANUFACTURED '72	12.5KVA19.2A 3φ4W 380/220V 2SET MANUFACTURED '68 UNITED STATES MOTORS
I V R	45KVA65A 3φ4W 400/230V MANUFACTURED '87 SEP KOBAYASHI ELECTRIC CO.			
A V R	7.5KVA 3φ 220V ± 1%		13KVA59A 1φ2W 220V ± 1% IREM(ITALY)	
RECTIFIER		-48V50A 2SET HARNER SIMMONS LIMITED -24V16A MANUFACTURED '86 APR APOLLON-DIAMOND -24V75A 2SET HARNER SIMMONS LIMITED	-48V50A 2SET HARNER SIMMONS LIMITED	-48V50A 2SET INSTALLED '76 HARNER SIMMONS LIMITED -24V25A MANUFACTURED'84 OCT POWER CONVERSION PRODUCTS INC(USA)
BATTERY		-48V400AH HARNER SIMMONS LIMITED -24V60AH APOLLON-DIAMOND -24V200AH HARNER SIMMONS LIMITED	-48V130AH YUASA	-48V210AH YUASA MANUFACTURED '84 FEB -24V160AH INSTALLED '87 GLOBE BATTERY DIVISION
ANTENNA TOWER		74.3m SQUARE TYPE SELF- SUPPORTING (4.3m TV USE)	80.0m SQUARE TYPE SELF- SUPPORTING	90.0m SQUARE TYPE SELF- SUPPORTING
OTHERS	RADIO BUILDING IS NECES- SARY, EXISTING RADAR SITE HAVE NO SPACE FOR THE NEW EQUIPMENT.	REWIRING FOR EXISTING POWER CABLE IS NECESSARY, OTHERWISE MAY OCCUR ACCI- DENT COUSED BY DISORDER CABLE WIRING.	SAME AS COX'S BAZAR	SAME AS COX'S BAZAR

TABLE 3-2-2 (2) RESULTS OF SITE SURVEY-2

	CHITTGONG	KHEPUPARA RADAR	KHEPUPARA	PATUAKHALI
COMMERCIAL POWER	3φ 4W220V	3φ230V	3φ 150~220V	3φ230V
ENGINE/GENERATOR	22KVA33.5A 3φ4W 380/220V MANUFACTURED '84 SEP NIPPON ELECTRIC INDUSTRY CO.	45KVA 3φ4W400/230V INSTALLED '87 SEP TOSHIBA	6KVA220/110V MANUFACTURED '75 OCT LEROY-SOMER(FRANCE)	6KVA3 220/110V MANUFACTURED '75 年 OCT LEROY-SOMER(FRANCE)
I V R		45KVA65A 3φ4W 400/230V MANUFACTURED '87 SEP KOBAYASHIELECTRIC CO.		
A V R	22KVA 3φ 4W380/220V MANUFACTURED '84 SEP ELECTRIC CO LTD	7.5KVA 3 φ 220V± 1%		
RECTIFIER	RADIO ROOM 1 -48V80A 2SET MANUFACTURED '84 SEP SANKEN ELECTRIC CO LTD -24V12A MANUFACTURED '84 OCT APOLLON-DIAMOND RADIO ROOM 2 -24V25A MANUFACTURED '84 OCT POWER CONVERSION PRODUCTS INC(USA) -24V150A 2SET HARNER SIMMONS LIMITED -12V4A MANUFACTURED '85 JUN APOLON-DIAMOND MULTIPLEXER ROOM -24V50A HARNER SIMMONS LIMITED		-48V NOKIA -24V GTE OLD TYPE	-48V NOKIA -48V NEC MANUFACTURED '84 FEB -24V OLD TYPE HARNER SIMMONS LIMITED
BATTERY	RADIO ROOM 1 -48V800AH MANUFACTURED '84 AUG YUASA -24V60AH MANUFACTURED '87 POWER CONVERSION PRODUCTS INC(USA) RADIO ROOM 2 -24V170AH POWER CONVERSION PROCUCTS INC (USA) -24V160AH GLOBE BATTERY DIVISION -12V120AH APOLLON-DIAMOND		-48V NOKIA -24V GTE OLD TYPE	-48V NOKIA -48V210AH MANUFACTURED '83 DEC YUASA -24V GTE
ANTENNA TOWER	61.0m TRIPOD SELF-SUPPORING		67.0m GUY TYPE	67.0m SQUARE TYPE SELF-SUPPORTING
OTHERS			SAME AS COX'S BAZAR	SAME AS COX'S BAZAR

TABLE 3-2-2 (3) RESULTS OF SITE SURVEY- 3

	B A R I S A L	S R E E P U R	K H U L N A	DHAKA CENTRAL
COMMERCIAL POWER	3φ230V	3φ230V	3φ230V	3φ4W230V
ENGINE/GENERATOR	15KVA 3φ4W 400/230V 2SET MANUFACTURED '77 JUN FUJITSU	12.5KVA 3φ4W 400/230V 2SET MANUFACTURED '77 JUN FUJITSU	48KVA 3φ4W380/220V MANUFACTURED '90 APR FUJITSU	
I V R				
A V R	15KVA21.7A 3φ4W 400/230V MANUFACTURED '77 JUL FUJITSU	3φ400V MANUFACTURED '77 OCT FUJITSU		
RECTIFIER	-48V NOKIA -48V FUJITSU -24V OLD TYPE HARNER SIMMONS LIMITED	-48V NOKIA -48V65A MANUFACTURED '77 OCT FUJITSU -24V75A HARNER SIMMONS LIMITED	-48V200A MANUFACTURED '90 APR FUJITSU -24V35A MANUFACTURED '73 JUN NEC -24V50A MANUFACTURED '84 OCT -24V35A MANUFACTURED '84 OCT -24V26A MOTOROLA MANUFACTURED'84 NOV	-48V NEC -24V NEC
BATTERY	-48V NOKIA -48V FUJITSU -24V GTE OLD TYPE	-48V NOKIA -48V FUJITSU -24V OKI/NEC	-48V FUJITSU -24V NEC -24V MOTOROLA	-48V200AH YUASA -24V200AH YUASA
ANTENNA TOWER	75.0m SQUARE TYPE SELF-SUPPORTING	127.0m GUY TYPE SUDA	75.0m TRIPOD SELF-SUPPORTING	75.0m TRIPOD SELF-SUPPORTING
OTHERS				EXTENSION OF MOTOROLA'S CHANNEL UNITS ARE NECESSARY.(24 UNIT)

TABLE 3-2-2 (4) RESULTS OF SITE SURVEY- 4

	DHAKA BHD			
COMMERCIAL POWER	3φ4W230V			
ENGINE/GENERATOR	15KVA 3φ4W 400/230V MANUFACTURED '77 JUL SANYO DENKI			
I V R				
A V R				
RECTIFIER	-24V35A GLOBE BATTERY DIVISION			
BATTERY	-24V 180AH GLOBE BATTERY DIVISION			
ANTENNA TOWER				
OTHERS	EXTENTION OF MOTOROLA'S CHANNEL UNITS ARE NECESSARY. (24 UNIT)			

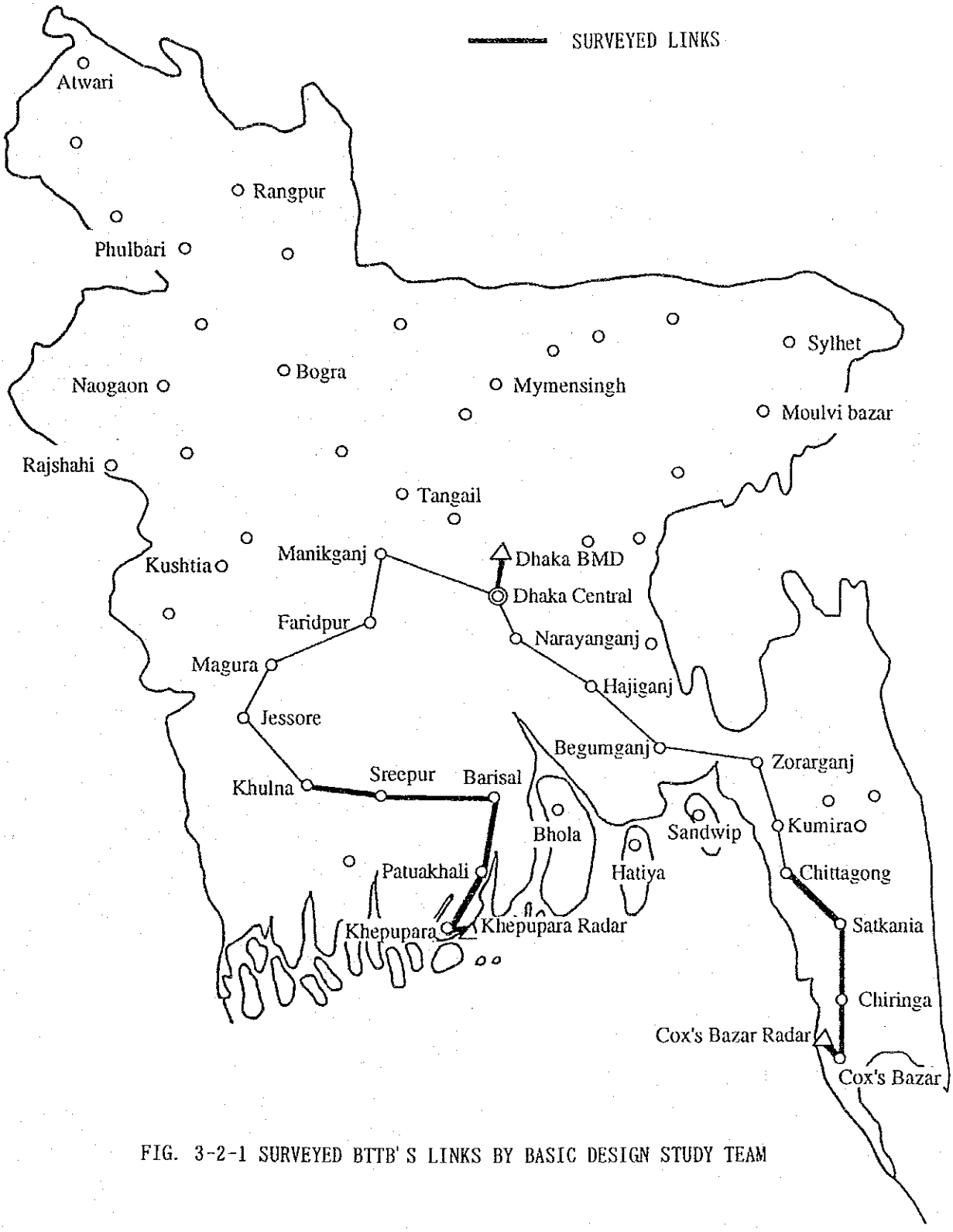


FIG. 3-2-1 SURVEYED BTTB'S LINKS BY BASIC DESIGN STUDY TEAM

3-3 Project Description

3-3-1 Executing Agency and Operational Structure

BMD will be a supervisor and user of the equipment and facilities to be installed by the project. As mentioned in paragraph 3-2-2, both organizations of BMD and BTTB have been agreed on the system that BTTB will take charge of the operation and maintenance of telecommunication links. BMD considers increasing the staff of radar sites and SWC, about one person each. But it is thought that BTTB need not increase any staff for operation and maintenance, because most of the equipment relating to this project will be installed in the existing facilities of BTTB. As for the execution and operation expenses of this project even including the personnel expenses of BMD and cost for maintenance and leasing the existing links to be paid to BTTB, (see paragraph 3-2-2), they are about 0.6% of BMD's budget. Moreover, the growth rate of the budget is approximately 8% on the 4-year average as indicated in Table 2-1-7. Therefore, there is no problem in the bearing capacity of expenses.

3-3-2 Outline of Planned System

As a result of the study and examination mentioned in the preceding paragraph 3-2, it is considered that the following outline is adequate to this project.

(1) Telecommunication Links

The outline of the new sections of microwave links and the existing sections to be used for this project are as follows (see Fig. 3-2-1). The existing links to be removed after the completion of the project are also indicated below.

1) Eastern route (Cox's Bazar - Dhaka)

a) Newly established section
BMD radar site in Cox's Bazar - Chittagong Station (BTTB)
(Repeater stations: Chiringa (BTTB) and Satkania (BTTB))

b) Section using existing BTTB links
Chittagong Station - Dhaka Central Station

2) Western route (Khepupara - Dhaka)

a) Newly established section
BMD radar site in Khepupara - Khulna Station (BTTB)

(Repeater stations: Patuakhali (BTTB), Barisal (BTTB) and Sreepur (BTTB))

b) Existing BTTB links to be removed after completion of new links
Khepupara (BTTB) – Patuakhali – Barisal – Khulna

c) Section using existing BTTB links
Khulna Station – Dhaka Central Station

3) Dhaka Central Station (BTTB) – BMD radar tower in Dhaka

The existing microwave circuit installed by BMD will be used after increasing its channels.

4) BMD radar tower in Dhaka – SWC in Dhaka

The existing communication cable will be used.

(2) Remote Display System

1)Radar sites

a) The output signals of the existing Digital Video Integrator and Processor (DVIP) will be sent to the telecommunication link through MODEM (2,400 bps).

b) A dedicated telephone will be installed for the exchange of information between each radar site and SWC in Dhaka.

2) SWC

a) Radar data received by telecommunication link will be displayed on the image monitor display through a modem.

b) Two image monitor displays will be installed so as to monitor the images of two radars at the same time for grasping the entire image of a cyclone,and one display will have functions of a spare display if the other goes wrong. (The existing image monitor display will be used as a spare in Khepupara).

c) Two dedicated telephones will be installed for the exchange of information between SWC and each radar site.

3-3-3 Outline of Equipment and Facilities

The outline of equipment and facilities necessary for each site is as follows:

(1) Radio Equipment

Transmission capacity:	34 Mbps	1+1 system,
	2 Mbps	1+1 system.

Regarding the sections between BTTB in Chittagong and BTTB in Cox's Bazar and between BTTB in Khulna and BTTB in Patuakhali, the transmission capacity will be 34 Mbps, taking into consideration the future project of BTTB and the necessity of replacing the existing transmission link in the latter section.

Regarding the section between BTTB in Cox's Bazar and the radar site in Cox's Bazar and that between BTTB in Patuakhali and the radar site in Khepupara, the transmission capacity will be 2 Mbps, which is the minimum capacity necessary for data transmission.

Frequency band to be used: 2 GHz band.

The frequency band to be used will be 2 GHz band. As it is supposed that the existing facilities will be used as much as possible, the load on the existing antenna towers must be minimized. For this purpose it is necessary to select an antennas with small load. A grid antenna which have small wind pressure load can be used for 2 GHz band. Therefore, a grid antenna will be used.

(2) Multiplexer

The number of channels of the multiplexer will be the number necessary for radar transmission. However, the number of channels between Khulna and Khepupara will be determined taking into consideration the replacement of the channels of the existing transmission link.

At BMD in Dhaka and BTTB Central Station, only a channel board is added to the existing multiplexer.

(3) Electric Power Supply Equipment

The stations with newly-established radio transmission equipment will be provided with a direct current electric supply equipment composed of

rectifier and battery with the minimum necessary capacity will be installed except Khulna, Dhaka BMD and BTTB Dhaka Central Station.

BTTB in Chiringa, BTTB in Khepupara and BMD in Dhaka will be provided with an engine generator.

(4) Radio Shed and Antenna Bracket

The radio shed for radio/transmission will be built at the radar site at Cox's Bazar and will house radio equipment, multiplexer, rectifier, batteries and spare parts.

At the radar sites at Cox's Bazar and Khepupara, there is no steel tower and it is impossible structurally to install antennas directly onto the existing buildings. Therefore, it is necessary to set up a bracket for the installation of microwave antennas.

(5) Remote Display Equipment

The signal distributor, modem and dedicated telephone will be installed at the two radar sites.

In SWC, modems, data processors, color monitor displays, printers, UPS and two dedicated telephones will be installed to receive and display the data signals from the two radar sites.

3-4 Technical Cooperation

As a result of the study in paragraph 3-2-5, the following technical cooperation is considered necessary:

3-4-1 Execution of Training

Radar engineering and radar image analysis
:4 persons (to be sent to Japan)
Operation, maintenance and repair of digital telecommunication links
:4 persons (to be sent to Japan)

3-4-2 Dispatch of Experts

Radar engineering and radar image analysis
:1 person (to be sent from Japan to Bangladesh)
Digital telecommunication engineering
:1 person (to be sent from Japan to Bangladesh)

For BMD, four persons, namely, one radar engineer from each radar site of Cox's Bazar and Khepupara and one radar analyst and one engineer for remote display maintenance in Dhaka, will be trained. It is desirable that the experts in these fields should be dispatched for technical cooperation and guidance of trainees, and for strengthening the technical capacity of BMD after the completion of the training in Japan.

Also, it is desirable that a total of four persons, one person each from Cox's Bazar, Chittagong, Khepupara and Barisal should be trained for BTTB in order to maintain the reliability of newly-established telecommunication links. Concerning Khulna and Dhaka, the present personnel for the existing digital links will be put in charge of the new links, and the training will not be required specifically. However, it is desirable that an expert in digital telecommunication engineering should be dispatched from Japan to carry out technical guidance in the above-mentioned places for the expansion of the technical base of local engineers.

Chapter 4 Basic Design

4-1 Design Policy

The objective of the telecommunication link to be constructed by the present project is to transmit the radar image signals of the BMD (Bangladesh Meteorological Department). Taking into consideration the facts that the project includes the replacement of the existing BTTB links and the expansion of the links by the BTTB, the standards of the new links will conform to the international standards recommended by CCITT (Comité Consultatif International Télégraphique et Téléphonique) and CCIR (Comité Consultatif International Radio-Communications) which have a high generality .

4-2 Study and Examination on Design Criteria

4-2-1 Radio Equipment

(1)Link Quality

1) Link quality

The quality of the digital radio link will conform to CCIR recommendation 634. The following conditions will be met between the terminals of Cox's Bazar radar site and Chittagong BTTB and between the terminals of Khepupara radar site and Khulna BTTB.

a) The period of time when BER (Bit Error Ratio) > 10^{-3} will not exceed 0.054% of any month.

b) The period of time when BER > 10^{-6} will not exceed 0.4% of any month.

c) The period of error time will not exceed 0.32% of any month.

d) Residual BER will meet 5×10^{-9}.

2) Fading probability

Calculation of fading occurrence probability will conform to CCIR report 338.

(2) Radio Frequency

Radio frequency will be 2 GHz band (CCIR recommendation 283-5).

(3) Antenna

Considering the utilization of the existing structures for antennas, the antenna height from the ground will meet the effective radius of the earth coefficient of K=4/3 and a clearance coefficient of more than 1.0 as close as possible.

(4) Design Specifications

Basic design will be carried out based on the following prior conditions.

Radio frequency	:2 GHz,
Transmission capacity	:34 Mbps and 2 Mbps,

Modulation mode	:4 PSK,
Transmission output	:+30 dBm,
Minimum reception input(10^{-3}BER)	:–83.5 dBm (34Mbps),
	:–93.5 dBm (2Mbps),
Antenna gain	:

Antenna diameter	gain
1.2m	25.3dB
1.8m	28.5dB
2.4m	31.0dB
3.0m	32.9dB
3.7m	34.5dB
4.6m	36.4dB

4–2–2 Power Source

(1) Primary Power Source

Commercial alternating electric power may be used at stations where the transmission equipment will be installed. In Chiringa BTTB, Khepupara BTTB and Dhaka SWC, new engine generators will be provided and the existing ones will be used as spare equipment.

(2) Secondary Power Source

In the case where the primary power source can not be used, electricity will be supplied from the battery system to the newly installed equipment. Battery operation time will be 4 hours, provided that the electricity consumptive volume of the equipment is fed in a continuous manner.

(3) Supply Standards of Commercial Power

380 V, 50 Hz, 3–phase 4–wire.

(4) Automatic Voltage Regulator

Input and output power will both be 380 V and 3–phase 4–wire and the output voltage precision will be ± 1 %.

(5) Battery

The battery system will be composed of 24 lead batteries (48V).

(6) Rectifier

The rectifier unit will be of 1+1 mode including one spare unit.

(7) Engine Generator

It will be of air cooled type.

The output power will be of AC 380 V, 50 Hz, 3-phase 4-wire. It is considered that generation capacity of 2 to 3 kW will be introduced for the telecommunication facilities as well as the additional facilities such as lightings.

4-2-3 Radio Shed and Concrete Mast for Antenna

(1) Radio Shed

The new radio shed at Cox's Bazar BMD radar site consists of; a radio room housing the telecommunication equipment, a battery room, and a spare parts store room (see Table 4-2-1)

The height of eaves will be 3.4 m (ceiling height: 3.2 m), taking into consideration the height of telecommunication equipment and the wiring space needed for the cable rack.

TABLE 4-2-1 NEW RADIO SHED AT COX'S BAZAR

	Finishing				Floor area
Room Name	Floor	Skirting	Wall	Ceiling	(m^2)
Radio Room	Terrazzo	Mortar H=100	Mortar, painting	Fair-faced concrete painting	10.0
Battery Room	Acid resistant ceramic tile	Acid resistant ceramic tile	Acid resistant ceramic Mortar painting	Fair-faced concrete painting	5.0
Spare Parts Store	Mortar	Mortar	Mortar, painting	Fair-faced concrete painting	6.25

Positions and dimensions of wall openings will be so designed as to prevent the wind and rain water leak due to cyclone. A direct reinforced concrete foundation will be adopted as a foundation and reinforced concrete slabs will be laid on gravel of the floor.

(2) Concrete Mast for Antenna

The new concrete mast for antenna at Cox's Bazar Radar Site will be 6.7 m in height and made of reinforced concrete in consideration of the workability.

At Khepupara BMD Radar Site, the new antenna will be installed on the roof of the existing radar station, which works also as a cyclone shelter. Considering the conditions of the existing radar station, reduction of construction period and supply of construction materials, the new antenna bracket will be mounted on the concrete foundation directly.

(3) Design Criteria for Radio Shed and Concrete Mast for Antenna

1) Wind load

The design criteria for wind velocity in the present project shall be 67 m/sec, the maximum instantaneous wind velocity that has been ever recorded.

2) Seismic load

Although Bangladesh Meteorological Department (BMD) observes earthquakes, no horizontal seismic factor has been defined. Accordingly the horizontal seismic factor is evaluated to be K=0.1 based on "Seismic Risk Maps for High Seismic Regions in the World" published by Building Research Institute, Ministry of Construction.

3) Bearing capacity

Regarding the ground at the Cox's Bazar project site, at least 10 t/m^2 of ground bearing capacity can be expected.

4) Concrete strength

Local materials will be used for the construction as stable supplies of high-quality concrete aggregate and cement (BS standard material) are available in Bangladesh. Both deformed and round reinforcing bars are produced in the country and conform to BS specifications. Apart from the fact that the bars are bent in the middle for easy transportation, the quality of concrete with a compressive strength of 180 kg/cm^2 (28 days strength), which has been generally in use in Bangladesh, will be applied to the project.

5) Design standard

Bangladesh has received a strong influence of Pakistan and India in geographic and historical aspects, so that British Standards (BS) are largely used for design methods/standards. As a large amount of materials and equipment will be supplied locally in the present project, the Japanese standard and BS will be used.

4-2-4 Remote Display

(1) Data Sending System at two Radar Sites

1) Signal source

Output signals from DVIP (Digital Video Integrator and Processor) will be branched into three systems by installing additional distributor.

2) Signal characteristics

Branch output signals are as follows:

a) Grid unit	:2.5 km x 2.5 km,
b) Range	:600 km x 600 km,
c) Unit grid data	:4 bit.

3) Linkage to existing line

Two of the three said branched systems (for Khepupara, 1 system) will be connected to the existing local monitor circuits.

4) Linkage to new line

The other branched system will be connected to the VDF (Voice Distribution Frame) terminal of the multiplexer through a modem (2400 bps, CCITT[V26] pattern (error free mode)) so as to be connected to the microwave link for Dhaka.

5) Modem interface

Interface between the distributor and the modem will be as follows:

a) For data	:RS232C,
b) AZ angle	:12 bit,
c) El angle	:12 bit,
d) Radar operation data	:RANG,

RANG. CORR ON/OFF,
MTI ON/OFF.

(2) Data Processor and Display Equipment in Dhaka BMD

1) Signal source

Radar data signals of two sites outputted from the VDF terminal will be inputted to the radar data processor through a modem.

2) Peripheral equipment of data processor

The radar data processor will have drive functions for the input signal memory, two color displays and two printers.

3) Main function of data processor

The radar data processor will provide the following functions to the system composed of one color display and one printer.

a) Main memory	:Hard disc more than 20 Megabyte,
b) Image accumulation number	:More than 500 images,
c) Data record	:5 inch floppy disc more than 1 Mbyte,
d) Construction	:The display system consisting of a color display and a printer will be so constructed that both two systems can select independently any station.

4) Function of color monitor display

The functions of the color monitor display will be as follows:

a) Number of colors	:7 including CRT base dark color,
b) CRT	:More than 20 inches,
c) Resolution	:640 dots (horizontal) x 480 dots (vertical),
d) Display range	:600 km x 600 km,
e) Display data	:7–step echo intensity,
f) Additional information	:Map, date and time superimposed on echo.

5) Standby power source

The standby power source (UPS) for the radar data processor and the color display will be as follows:

a) Output :3 kVA, 115 V single phase 50Hz,
b) Input :220/115V single phase 50/60Hz,
c) Battery operation time :More than 10 minutes without input.

(3) Dedicated Telephone

Off-hook call

4-3 Basic Plan

4-3-1 Basic Plan of Telecommunication Link

After consideration of the results of the study and examination of the radio path profile and transmission quality for each section of radio transmission routes, and the replacement of existing channels (Khulna-Sreepur-Barisal-Patuakhali-Khepupara) and so on, the microwave links for radar data transmission will be planned as shown in Fig.4-3-1. Further, the system configurations for planned radio links and for the remote display are shown in Fig.4-3-2 and Fig.4-3-3 respectively.

4-3-2 Equipment and Facilities Plan

Equipment and facilities necessary for each site are tabulated in Table 4-3-1.

TABLE 4-3-1 NECESSARY EQUIPMENT AND FACILITIES FOR EACH SITE

		Cox's Bazar Radar Site	Cox's Bazar BTTB	Chiringa BTTB	Satkania BTTB	Chittagong BTTB	Khepupara Radar Site	Khepupara BTTB	Patuakhali BTTB	Barisal BTTB	Sreepur BTTB	Khulna BTTB	Dhaka BTTB	Dhaka BMD
Radio	34Mcapacity		○	○	○	○			○	○	○	○		
	2Mcapacity	○	○				○	○	○					
Multiplexer	8M		○			○			○	○	○	○		
	2M	○				○	○	○	○	○	○	○		
	CH Unit	○				○	○	○	○	○	○	○	○	○
Antenna	1.2 mφ	○	○				○	○						
	2.4 mφ							○	○					
	3.0 mφ		○	○	○	○			○	○		○		
	3.7 mφ										○			
	4.6 mφ										○			
Engine Generator				○				○						○
Rectifier/Battery		○	○	○	○	○	○	○	○	○	○			
Antenna Structure		○ Note 1					○ Note 2							
Equipment Building		○												
Collar Monitor System														○
M O D E M		○					○							○
Telephone set		○					○							○
Air-Conditioner		○	○			○								○
Test Equipment						○				○				○

Note 1 : Antenna Pole (Monoblock type)
Note 2 : Antenna Pole on the roof top

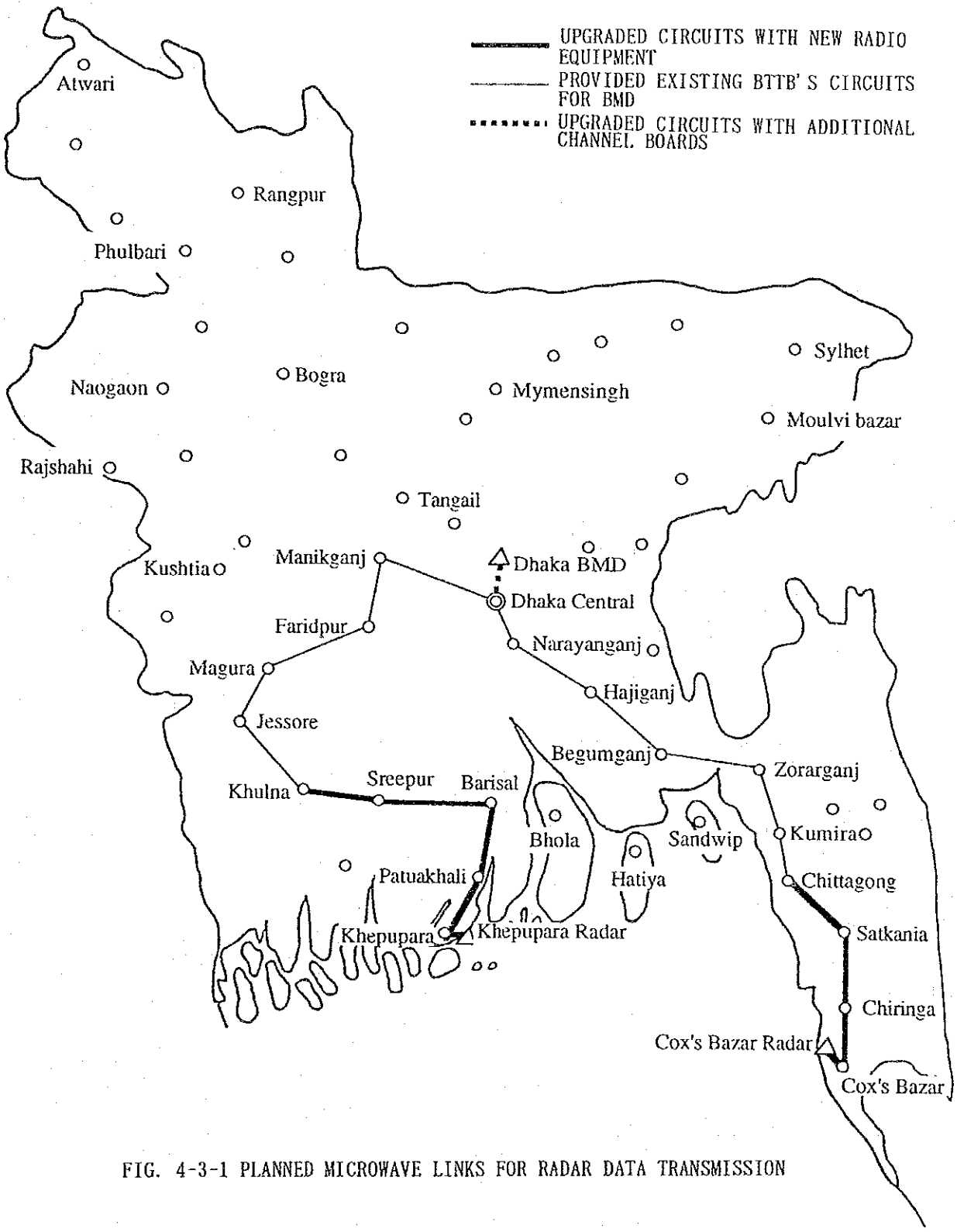


FIG. 4-3-1 PLANNED MICROWAVE LINKS FOR RADAR DATA TRANSMISSION

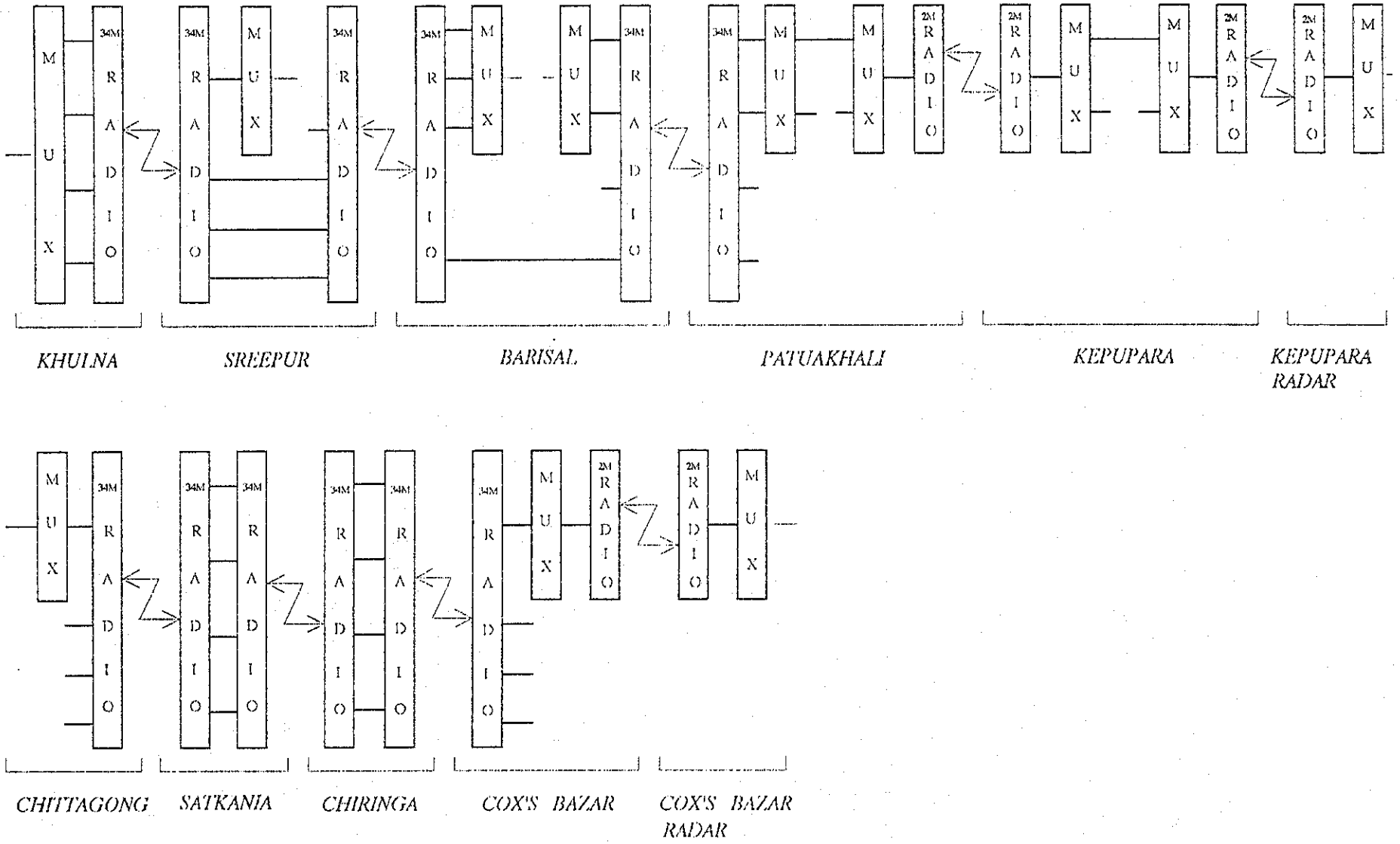


FIG.4-3-2 SYSTEM CONFIGURATION FOR PLANNED RADIO LINKS

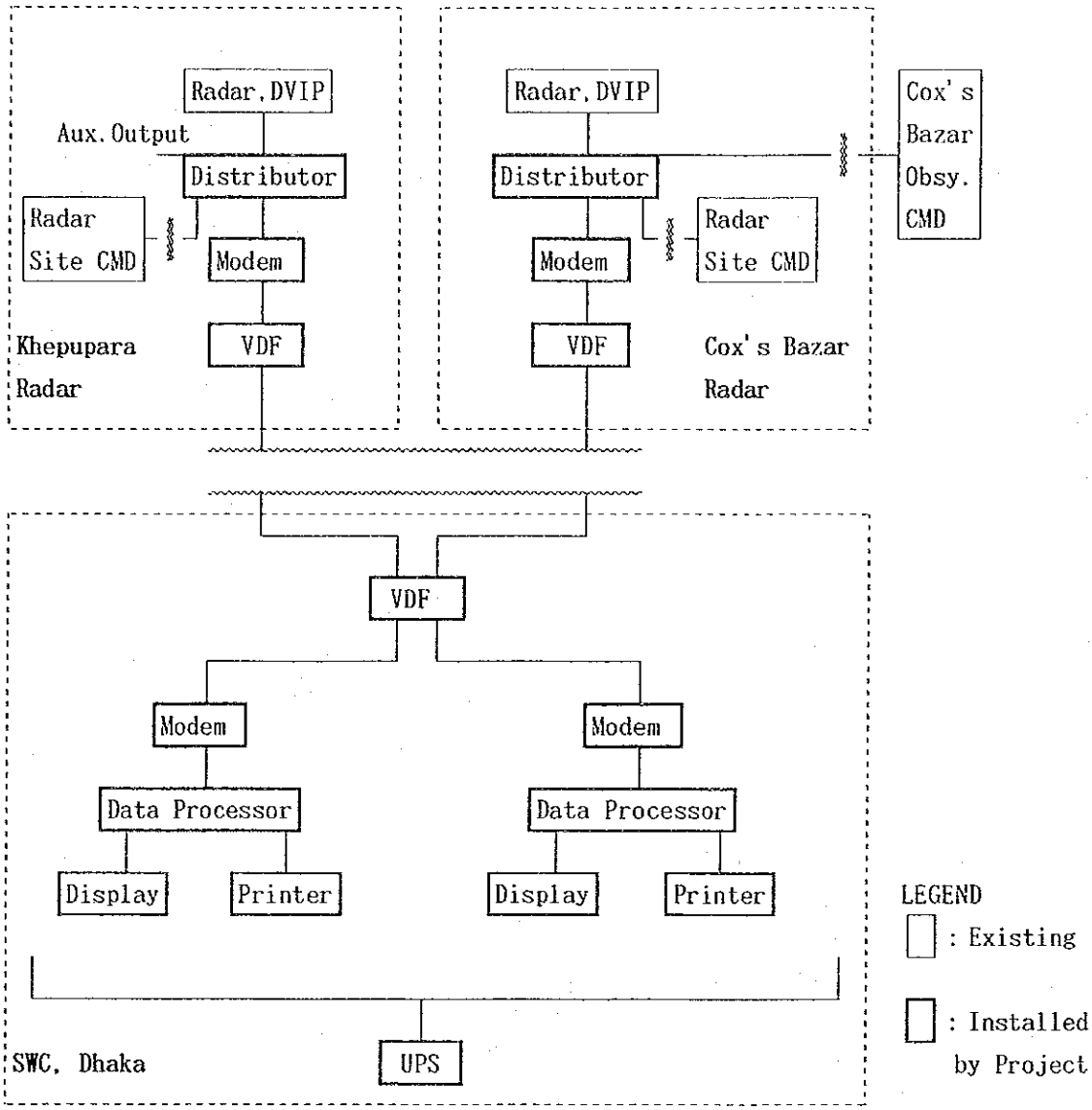


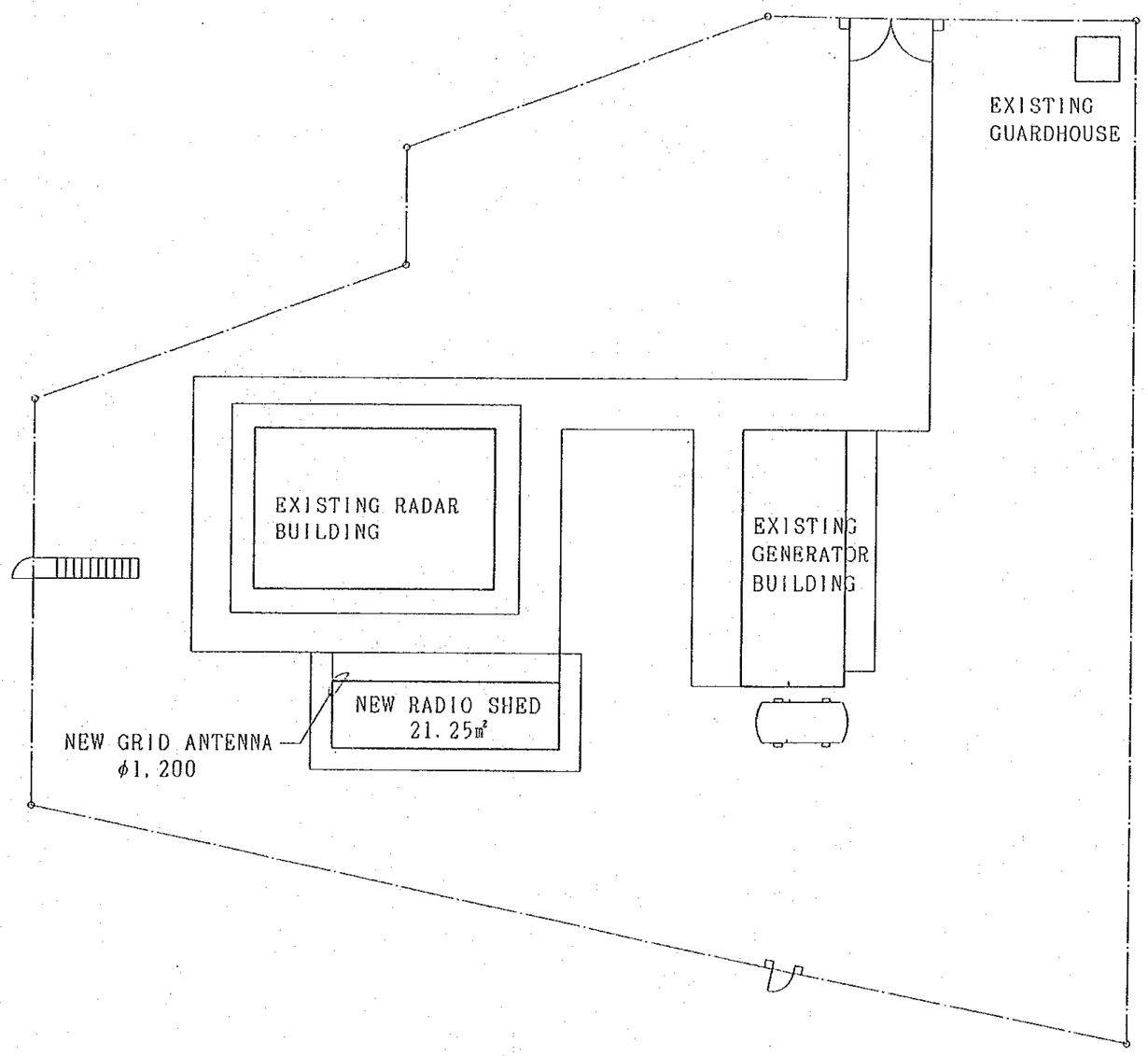
FIG. 4-3-3 SYSTEM CONFIGURATION OF PLANNED REMOTE DISPLAY SYSTEM

CMD:Color monitor display installed by the previous project, 1988

4-3-3 Basic Design Drawing

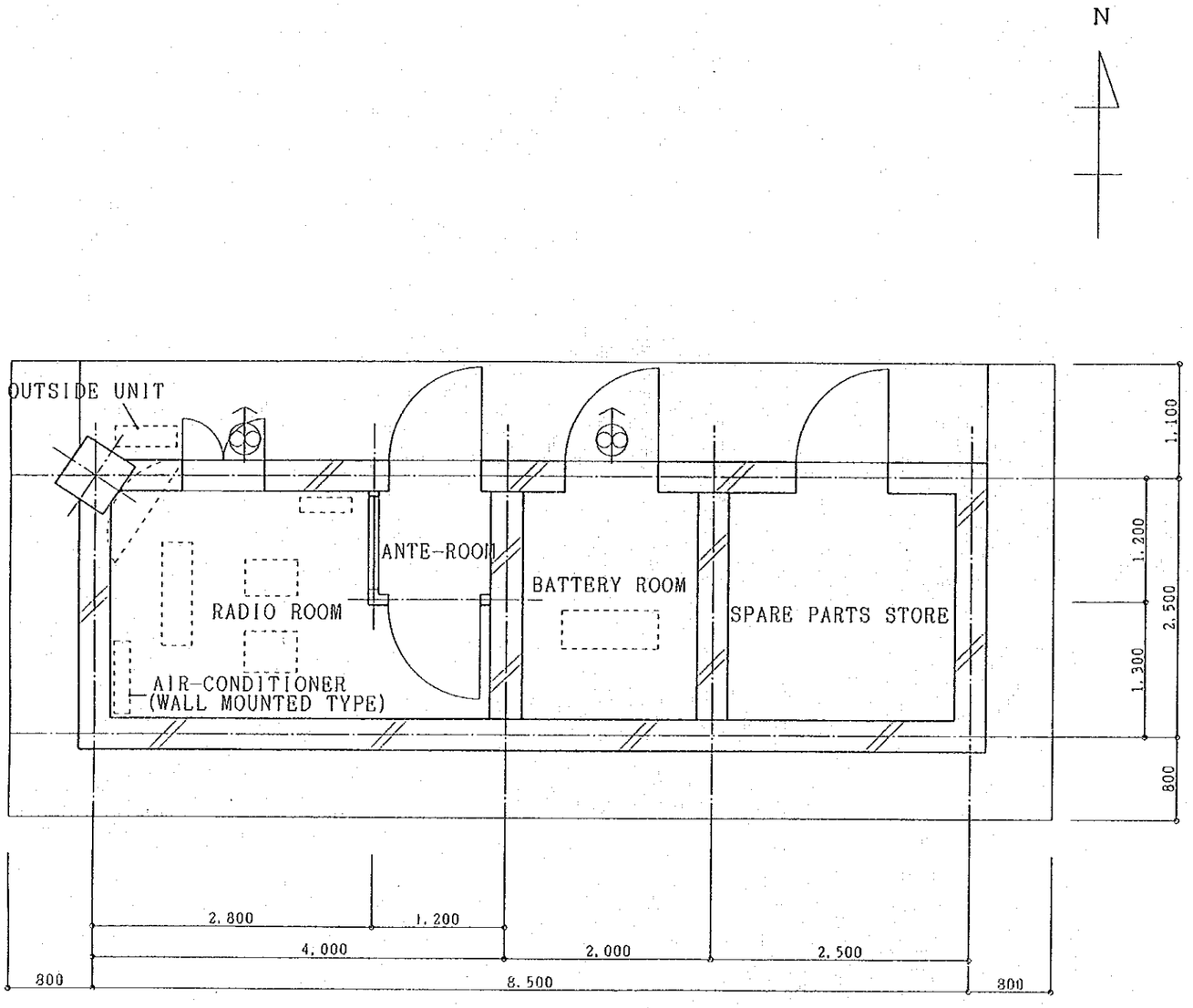
(1) Cox's Bazar Radar Site,	Site Layout Plan
(2) Cox's Bazar Radar Site,	Radio Shed Details-1
(3) Cox's Bazar Radar Site,	Radio Shed Details-2
(4) Khepupara Radar Site,	Roof Plan, and Concrete Mast Plan & Elevation

BASIC DESIGN DRAWING

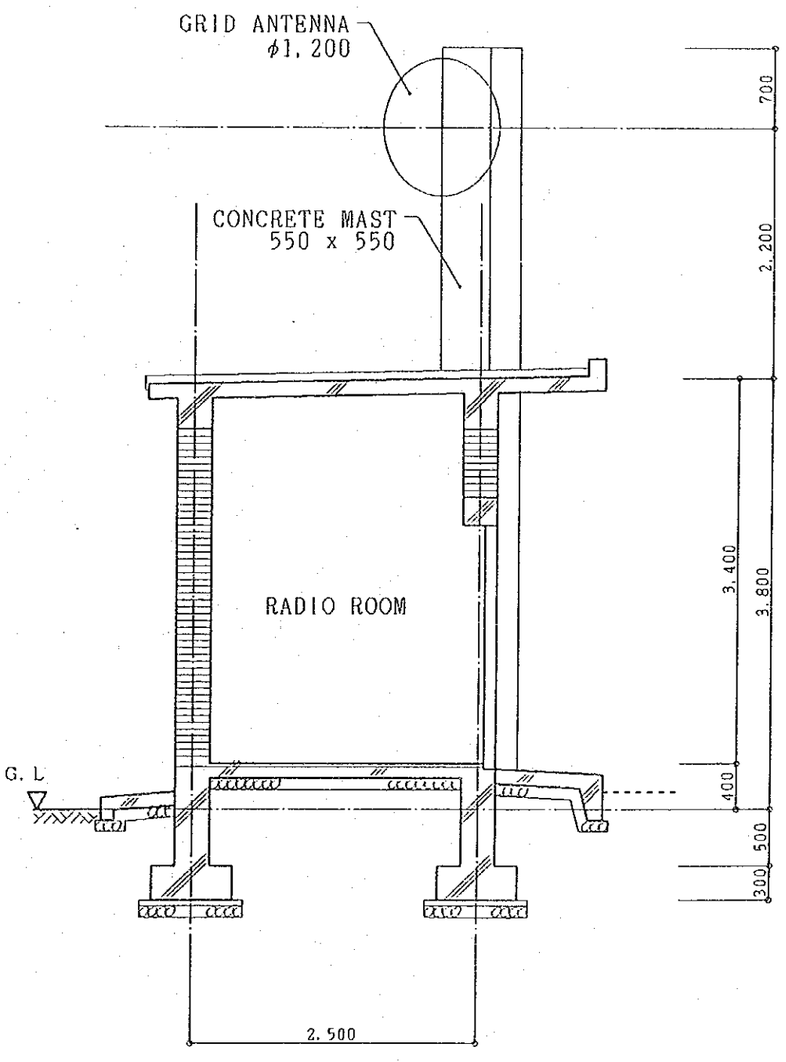


SITE LAYOUT PLAN 1:200

BASIC DESIGN DRAWING



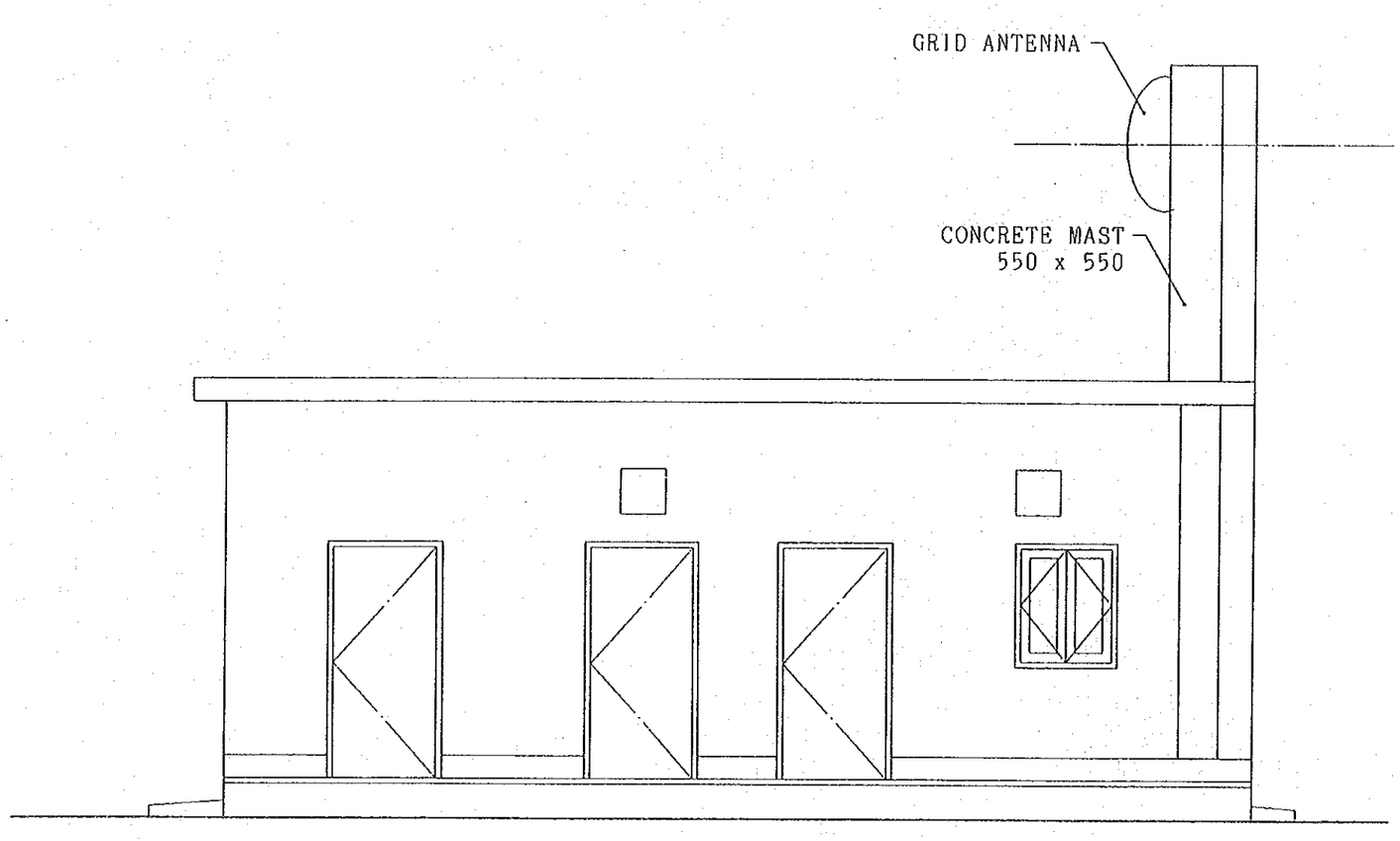
PLAN 1:50



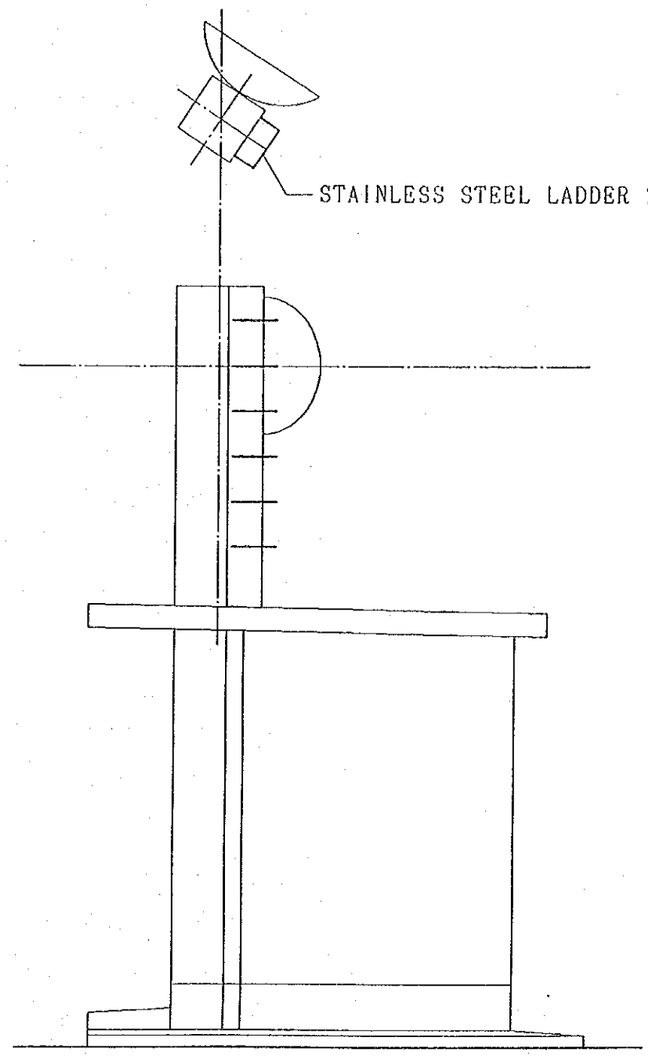
SECTION 1:50

(2) COX'S BAZAR RADAR SITE, RADIO SHED DETAILS-1

BASIC DESIGN DRAWING



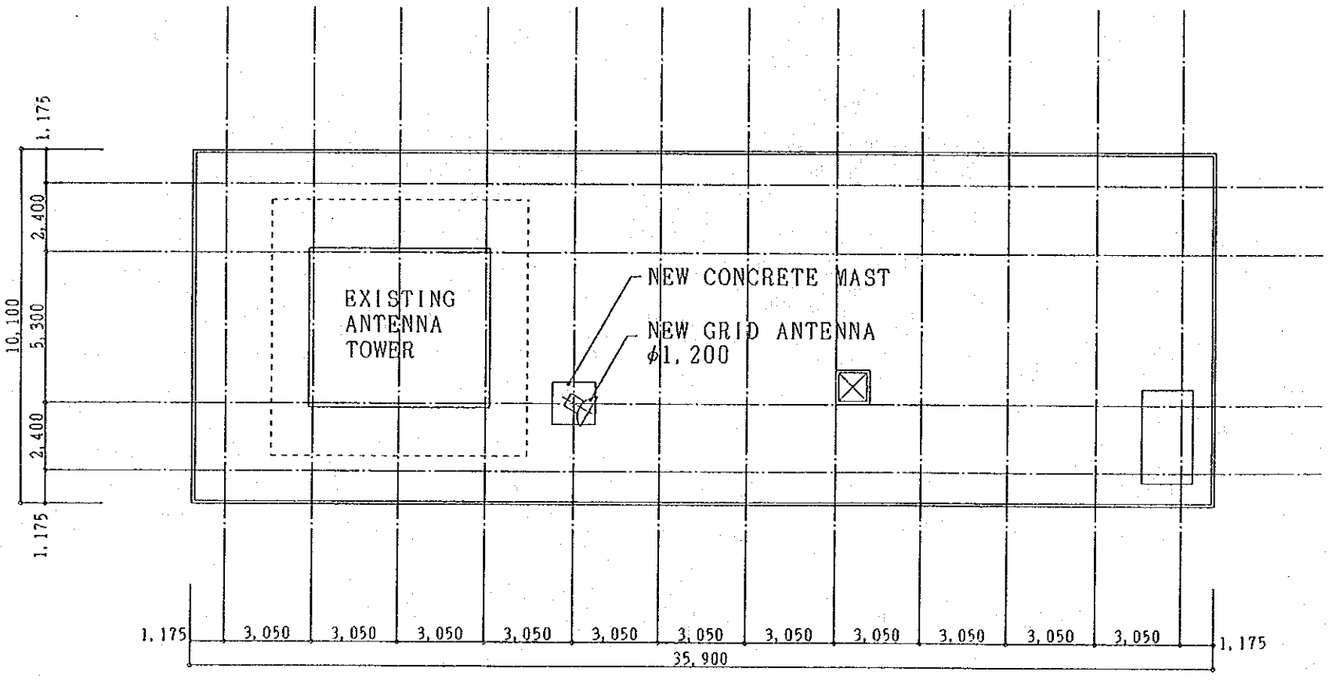
NORTH ELEVATION 1:50



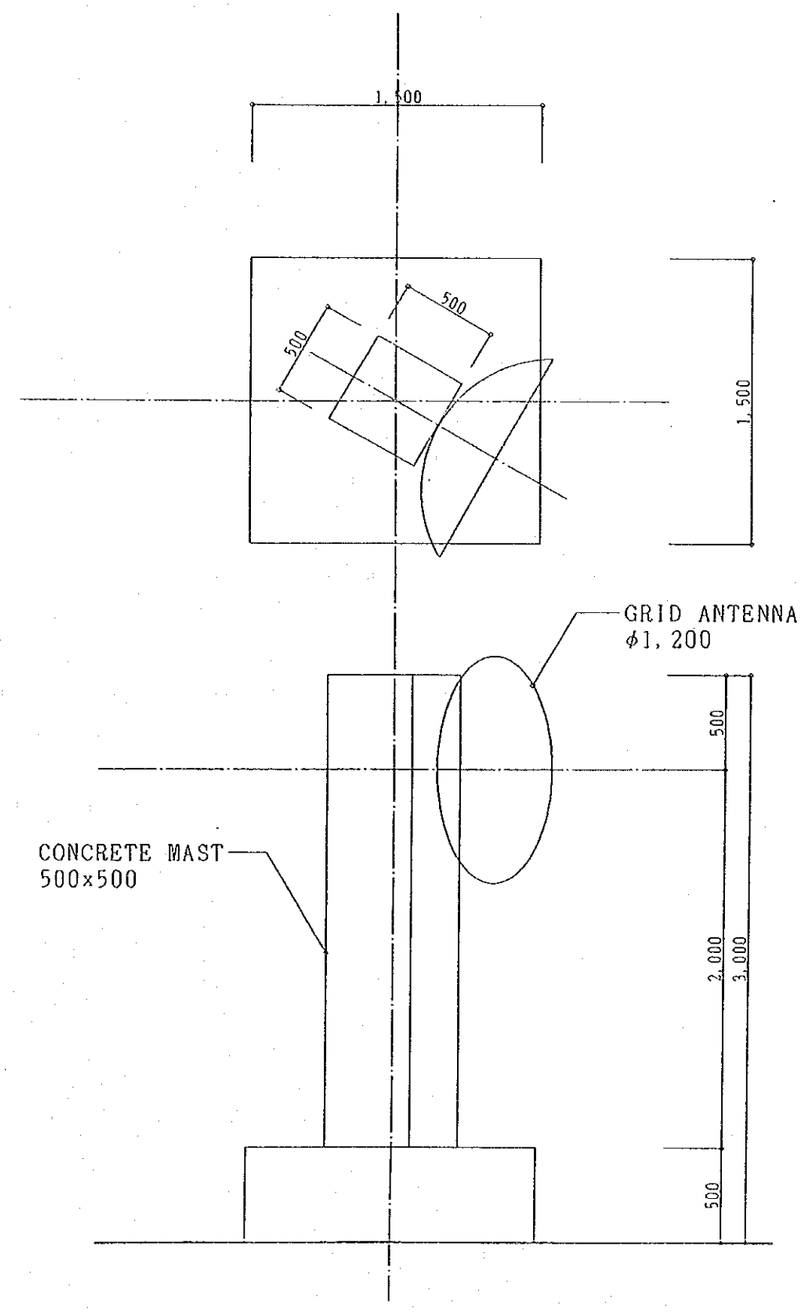
WEST ELEVATION 1:50

(3) COX'S BAZAR RADAR SITE, RADIO SHED DETAILS-2

BASIC DESIGN DRAWING



ROOF PLAN 1:200



CONCRETE MAST PLAN & ELEVATION 1:30

(4) KHEPUPARA RADAR SITE, ROOF PLAN AND CONCRETE MAST PLAN & ELEVATION

4-4 Implementation Plan

4-4-1 Construction Condition

(1) Installation of Telecommunication Equipment

All the excellent telecommunication companies, which are well experienced in works relative to telecommunication and capable of being our subcontractors, have their head offices in Dhaka. As such companies can supply equipment, craftsmen, laborers and transport means, it is considered that they are very useful from the points of view of observing the term of the construction, maintaining the required quality and performance, and so on.

The sites for installing the telecommunication equipment will spread over 11 places in the coastal zone of the Bay of Bengal. Transportation is in difficult conditions in the rainy season, so that it is necessary to work as intensely as possible in the dry season. For the western route in particular, difficulties are anticipated on the road between Patuakhali and Khepupara which has not been paved yet. Further, since we have to transport the electric precision devices over a long transportation distance, great attention will be paid in selecting the transport companies, locally, which will be charged with the inland transportation.

(2) Constructions of Radio Shed and Concrete Mast

All the excellent telecommunication companies, which are well experienced in works relative to telecommunication and capable of being our subcontractors, have their head offices in Dhaka. As such companies can supply equipment, craftsmen, laborers and transport means, it is considered that they are very useful from the points of view of observing the construction period, maintaining the required quality and performance, and so on.

At Cox's Bazar, where the radio shed and the concrete mast for an antenna will be constructed, and at Khepupara, where the concrete mast for an antenna will be constructed, it is impossible to supply construction materials such as cements, aggregates, steel bars, bricks, concrete blocks, etc. However, these materials can be obtained in Chittagong and Barisal, the nearest towns to both sites.

The distance between Chittagong and Cox's Bazar is approximately 161 km (about 4.5 hours by car), and the distance between Barisal and Khepupara is approximately 96 km (about 4 hours by car and ferry). It is an indispensable condition to secure trucks as transport means in order that the construction would proceed smoothly.

In the present project, the construction of the radio shed should be carried out in the dry season, that is, from November to next April. However, even in the dry season, rainfall and spring water are anticipated. Thus the

drainage treatment on excavation and the prevention of the mixing cement with rainwater and spring water should be well considered.

4-4-2 Implementation Method

The installation work under the project of Japan's Grant Aid must be commissioned to Japanese firm with ample experience in telecommunication work in foreign countries and with sufficient capacity to ensure completion of the work. An open tender will be held for pre-qualification and the contractor will be selected by bidding from among the qualified bidders.

The telecommunication equipment installation work will consist of the following stages;

(a) Fabrication in Japan,
(b) Shipping,
(c) Installation,
(d) Adjustment of the installed equipment,
(e) All other related works.

Local telecommunications firms may participate in the project as subcontractors but must not contract to do the whole or th main part of the work.

As the project consists of various interrelated technical fields such as meteorology, radio, transmission, power supply, architectural and civil engineering, a certain amount of interface and adjustment between them will need to be executed.

The project will be implemented under the supervision of a resident project manager who will be stationed in the main project office, Dhaka. The construction team will be divided into two groups of the eastern route and the western one for performing the construction.

Concerning the relevant governmental agencies of the recipient country, the Bangladesh Meteorological Department (BMD), the executing agency of the project, will be in charge of procurement of the telecommunication equipment and the construction of the telecommunication facilities. And the Bangladesh Telephone and Telegraph Bureau (BTTB) will be in charge of operation and maintenance of the telecommunication links after the completion of the project.

During the construction and installation works close contact must be maintained with these two organizations, well as the local JICA office and relevant governmental agencies to avoid unnecessary delays or misunderstandings.

4-4-3 Construction and Supervisory Plan

(1) Construction Design

The present project will be carried out on the premise of using the existent facilities belonging to BTTB. The project sites are extensively distributed in the coastal area of the Bay of Bengal, and it may be difficult to carry out the installation works including transportation. Therefore, it is necessary to conduct the detailed examination of the project by visiting the project sites again, based on the results of the basic design study.

After making a contract between BMD and consultants, the construction design will be executed based on the results of the site survey to be made by the engineers of respective consultants in meteorology, radio, transmission, electric power source, data processing, architectural and civil engineering work.

(2) Construction supervision

As the sites related to the present project are extensively distributed, it is desirable that construction supervision should be carried out by the combination of the resident supervision and spot supervision. As various technical fields are concerned, it is required to dispatch engineers as resident supervisors who have a comprehensive capability in adjustment and supervision in relation to each technical field. The resident supervisors will be charged with supervision of a construction progress, inspection of and guidance in the drawings and constructions, explanation to and liaison with the agencies of the recipient country, regular or temporary reporting and so on.

As for the spot supervisors, engineers in five fields of meteorology, radio, transmission, electric power source, architecture and civil engineering will be dispatched timely in accordance with a construction progress to carry out the technical supervision.

4-4-4 Procurement Plan

The construction materials which are available in Bangladesh are limited to primary commodities such as aggregates, cements, bricks, concrete blocks, wood, steel bars and the like. It is desirable that these materials should be procured locally from the viewpoints of utilization of local materials and reduction of project expenses. However, in the present project, the telecommunication equipment will be procured in Japan so as to secure the quality and performance, and to observe the term of works.

These materials and equipments will be shipped to Chittagong, and then transported to each site by trucks. On planning the transportation, it is

necessary to consider the actual state of the roads and weather conditions in Bangladesh.

4-4-5 Work Schedule

Concerning the scope for Japanese side described in the following paragraph 4-4-6, the detailed design and the construction/procurement will be carried out in accordance with the work schedule shown in Table 4-4-1.

The period required for each work is as follows:

Work Schedule	Period(Month)
Detailed Design	
Sight Survey	:0.5
Detailed Design /Preparation of Tender Document	:3.0
Approval	:0.5
Tender/Evaluation	:1.5
Contract Negotiation	:0.5
Construction/Procurement	
Pre-construction Arrangement	:1.0
Construction of Radio Shed etc.	:2.5
Manufacturing	:5.0
Transportation	:1.5
Installation/Adjustment	:5.0
Inspection/Hand-over	:0.5

4-4-6 Scope of work

In the case of implementing the present project by Japan's Grant Aid , it is appropriate to share the scope of work between the Japanese and Bangladesh governments, as follows;

(1) Scope for the Japanese Side

1) Telecommunication equipment

a)The present project includes equipment manufacture in Japan, transportation, installation, adjustment and hand-over of the equipment.

b) Equipment items

(i) Radio and transmission equipment,
(ii) Electric power supply equipment,
(iii) Remote display equipment.

c) Work items
(i) Installation of each equipment,
(ii) Replacement of antenna (transfer, new installation or removal),
(iii)Common work,
(iV) Adjustment.

2) Construction of radio shed and concrete mast

a) One (1) radio shed at the Cox's Bazar BMD radar site
Two (2) concrete masts for antenna (Cox's Bazar, Khepupara BMD Radar sites)

b) Work items

(i) Architectural and civil engineering works
Foundation, main structure and finishing
(ii) Electric work
Work inside the shed, grounding equipment work and air conditioner installation.

(2) Scope for the Bangladesh Side

1) Works related to telecommunication equipment

a) Removal of existing unused antennas (Khulna, Patuakhali).

2) Works related to the radio shed and concrete mast

a) Construction site arrangement (including removal of obstacles)
(Construction site :Cox's Bazar).

b) Electric power supply and telephone line supply necessary for the radio shed to be constructed, and installation of water supply and drainage pipes, if necessary (Construction site :Cox's Bazar).

c) Offer of necessary furniture.

d) Supply of temporary electricity and water for construction.

e) Various juridical procedures required by the present project in Bangla-

desh.

f) Payment of bank fee (issuance fee of Authorization to Pay of the Japanese Foreign Exchange Bank and payment fee on the basis of the bank agreement).

g) Procedures for customs clearance and duty exemption of construction materials and equipment for meteorological and telecommunication under the Japan's Grant Aid .

h) Tax exemption, and offer of facilities for entry and stay in Bangladesh and departure therefrom with respect to the corporations and individuals of Japanese nationality who will work for the present project.

i) Securing of the sites for the temporary offices, workshops, material storage space, and so on, which are necessary for the construction.

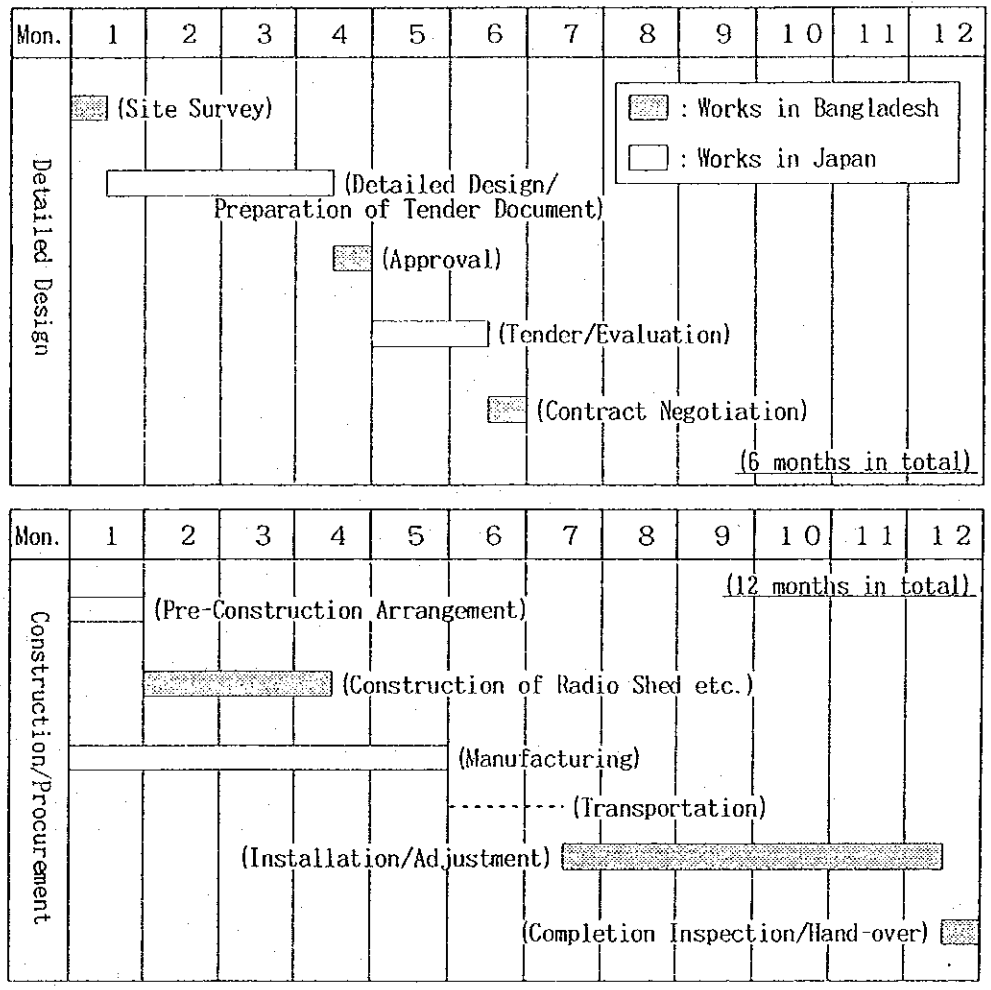
j) Appropriate and effective maintenance and operation of the facilities and equipment to be constructed and offered.

3) Cost of Undertakings of the Bangladesh Government

The total cost of the works for which the Bangladesh Government is responsible is estimated about 355,000Tk. This consists of the following costs.

	(Approx.)
a) Removal of the unused antenna	: 20,000Tk
b) Leveling and reclamation of the site	: 21,000
c) Cost of installing electric power, water supply, and telephone system	: 50,000
d) Furniture	: 20,000
e) Bank handling charge	:244,000
Total approx.	:355,000Tk

TABLE 4-4-1 WORK SCHEDULE



Chapter 5 Project Evaluation and Conclusion

5-1 Project Evaluation

The following effects are expected to be achieved as a result of implementation of the plan.

5-1-1 Actual State and Problems

(1) Problems in Radar Data Transmission

Bangladesh has been seriously attacked by cyclones every year, losing numerous human lives and properties. The cyclone on 30th April 1991 resulted in great damage and about 140,000 deaths.

The meteorological radars constructed by Japan's Grant Aid at Cox's Bazar and Khepupara in 1988 played an important role in issuing weather forecasts and warnings relating to the said cyclone.

However, problems occurred in accuracy and rapid distribution of the forecasts and warnings, because the Storm Warning Center(SWC) in Dhaka, which is the forecasting center, and each radar site were not connected by a good quality link of good quality, so that it was impossible to directly monitor the radar images of the two radar sites at SWC in Dhaka.

(2) Present Status of Western Route

Regarding the western route transmitting the radar data from Khepupara to Dhaka, the route between Dhaka and Khulna has been provided with an updated digital link and has sufficient reliability, while the route from Khulna to Khepupara is inferior in reliability and incapable of transmitting the radar data.

(3) Present Status of Eastern Route

As for the eastern route transmitting the radar data from Cox's Bazar to Dhaka, the route between Dhaka and Chittagong is sufficient in reliability, while the route between Chittagong and Cox's Bazar is inferior in reliability and incapable of transmitting the radar data.

5-1-2 Countermeasures taken in the Present Project

(1) Improvement in Radar Data Transmission

The telecommunication links between SWC in Dhaka and the radar sites in Cox's Bazar and Khepupara will be improved for transmission of the radar images, and these radar images will be displayed continuously at SWC in Dhaka.

In practice, the existing facilities and telecommunication links belonging to BTTB will be used as much as possible.

(2) Improvement in Transmission Link between Khulna and Khepupara

A digital microwave link of 2 GHz and 34/2 Mbps will be installed on the route between Khulna and Khepupara radar. As the existing steel tower of BTTB is insufficient structurally to support the new antenna, the existing telecommunication links including an antenna will be renewed.

(3) Improvement in Transmission Link between Chittagong and Cox's Bazar

A digital microwave link of 2 GHz and 34/2 Mbps will be installed between Chittagong and Cox's Bazar radar.

As the existing steel tower of BTTB is structurally sufficient to support the new antenna, the steel tower of BTTB will be used to install the telecommunication equipment for BMD.

5-1-3 Effects and Degree of Improvement of the Project

(1) Concerning SWC in Dhaka

The radar images can be continuously monitored at the SWC in Dhaka.

As a result, it is possible to estimate the location, intensity, moving direction, heavy rain area, landing location,etc. of the cyclone, and to improve the accuracy in weather forecasts and warnings for cyclones, and also to issue weather forecasts and warnings quickly.

Thus, about 25 million habitants in the coastal area of the Bay of Bengal attacked by cyclones every year can take appropriate action for evacuation, and the nation's trust relating to the forecasts can be obtained by improving the forecasting accuracy.

(2) Concerning Khepupara Radar

Not only can the radar data of Khepupara be transmitted to SWC in Dhaka, but also the telecommunication performance will be improved in Sreepur, Barisal, Patuakhali and Khepupara. As a result, about 300 links presently in operation will be improved. Thus, it will be possible to offer convenience to

the users in areas farther than Khulna where the telecommunication performance has been unfavorable and, further, to secure an emergency link for disaster prevention.

(3) Concerning Cox's Bazar Radar

The radar data of Cox's Bazar can be transmitted to the SWC in Dhaka.

By self-efforts of BTTB, it will be possible to expand the channels in the empty capacity which will be newly established. It is thus expected that the telecommunication performance will be improved in the general public link between Cox's Bazar and Chittagong.

By implementing the present project, improvement can be expected in the accuracy in cyclone forecasts and warnings, and the rapidity in issuing weather forecast and warnings. The nation's trust with respect to the forecasts will be thereby increased and the habitants in the coastal area of the Bay of Bengal can take appropriate action for evacuation. This will contribute to the reduction of cyclone disasters and the improvement of the Bangladesh nation's welfare.

Further, the present project is expected to contribute significantly to the 4th Five-Year (1990 to 1994) Plan of the Government of Bangladesh in which a strong emphasis is put on the countermeasures against flood disasters due to cyclones.

The maintenance and management of the telecommunication links will be carried out by BTTB after the completion of the project. BTTB can afford to maintain, manage and renew the telecommunication links by the telecommunication charges for the new links.

5-2 Conclusion

By implementing the present project, the effects are expected as mentioned above and, at the same time, it will contribute to the reduction of cyclone disasters and eventually to the improvement in the life of the habitants in the concerned area. Moreover, this project is a feasible scheme in the framework of Japan's Grant Aid system. In consequence, it is considered appropriate to implement the present project. As for the operation and management of the present project, there also seems to be no problem on the Bangladesh side in manning and financial aspects. However, the present project would be carried out more smoothly and effectively, if the following points are realized.

5-2-1 Reception of Trainees in Japan

Since the equipment is mainly composed of the latest digital telecommunication systems, technology needs to be transferred to Bangladesh. For this reason, trainees from Bangladesh will be received in the final stage of manufacturing equipment in a factory, so as to be given guidance in the offered equipment. It is desirable that the number of trainees and the training period should be arranged as follows:

number of trainees	: 8 persons,
period of training	: 2 months.

5-2-2 Dispatch of Experts

In order to actually operate the telecommunication equipment, experts will be dispatched from Japan, who will give technical guidance in the maintenance, management and operation of the equipment. Thus , the technical transfer to Bangladesh will be carried out and the effects of the offered equipment will be enhanced. The number and the specialized fields of the experts and the dispatch period will be as follows:

expert in telecommunication	:1 person for 1 year,
expert in meteorology	:1 person for 3 months.

5-2-3 Future Plan for Comprehensive Natural Disaster Prevention in Bangladesh

The natural disasters in Bangladesh consists mainly of cyclone disasters

and flood disasters. Cyclone disasters are caused by storms and storm surges due to a cyclone. And the cyclone disasters occur within a short time and cause serious damage. On the other hand, flood disasters are caused by heavy rainfall in the Monsoon season. The heavy rain, having fallen on an extensive area in the Himalayas, India and Bangladesh, causes the rivers to be inundated. Although the human damage due to a flood disasters is not as serious as that due to a cyclone disaster, it causes severe damage to agriculture.

The objective of the present project is to realize the improvement in accuracy in cyclone forecasts and warnings and quick distribution of them by transmitting the radar data to Dhaka by means of microwave link and by utilizing the radar data at SWC, which is the urgent requirement of Bangladesh for reducing serious cyclone damages. The implementation of the project will thus contribute to the reduction of cyclone disasters. However, we further propose the following plans in order to increase the effects of the project.

(1) Establishment of Comprehensive Cyclone Monitoring System

Automatic meteorological observation equipment for measuring rainfall, temperature, wind direction and speed etc. will be installed at the weather stations near the microwave relay station, and the observation data will be sent to SWC in Dhaka using the microwave telecommunication facilities which will be constructed by the present project. Thus, the system capable of improving the accuracy of radar data, and of performing short-term weather forecast and flood prediction will be established using the meteorological data at various places. Further, the result thereof will be sent to the Directorate of Relief and Rehabilitation, Bangladesh Television, Bangladesh Red Crescent Society and so on.

(2) Installation of Meteorological Radar in the North

In order to reduce flood disasters due to heavy rain in the Monsoon season, a meteorological radar will be installed in the north of Bangladesh for monitoring the heavy rain causing a flood and improving the accuracy in weather forecasts and warnings. By transmitting this radar data to the Storm Warning Center in Dhaka, it will be possible to monitor over the whole country, and thus to establish an integrated system for prevention of natural disasters.