BANGLADESH METEOROLOGICAL DEPARTMENT

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR STRENGTHENING OF WEATHER WARNING SERVICES RELATED TO NATURAL DISASTERS IN THE PEOPLE'S REPUBLIC OF BANGLADESH

AUGUST, 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN WEATHER ASSOCIATION

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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 Strengthening of Weather Warning Services Related to Natural Disasters and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team from 15th of March to 16th of April, 1997.

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 basic design, and as this result, the present report was finalized.

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.

August 1997

Kimiaki Fujita

President

Japan International Cooperation Agency

August, 1997

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Strengthening of Weather Warning Services Related to Natural Disasters in the People's Republic of Bangladesh.

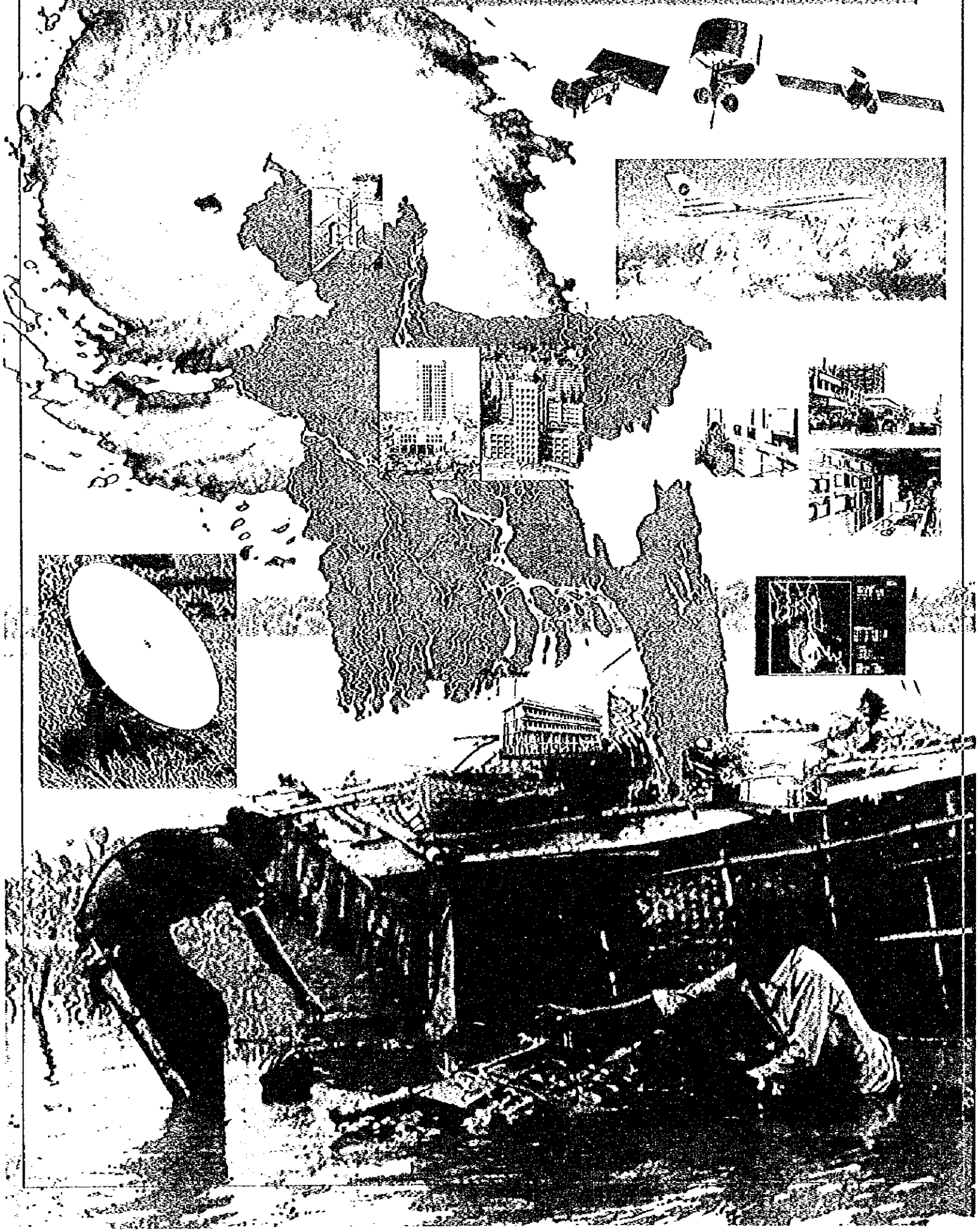
This study was conducted by Japan Weather Association, under a contract to JICA, during the period from March 5, 1997 to August 11, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Bangladesh and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

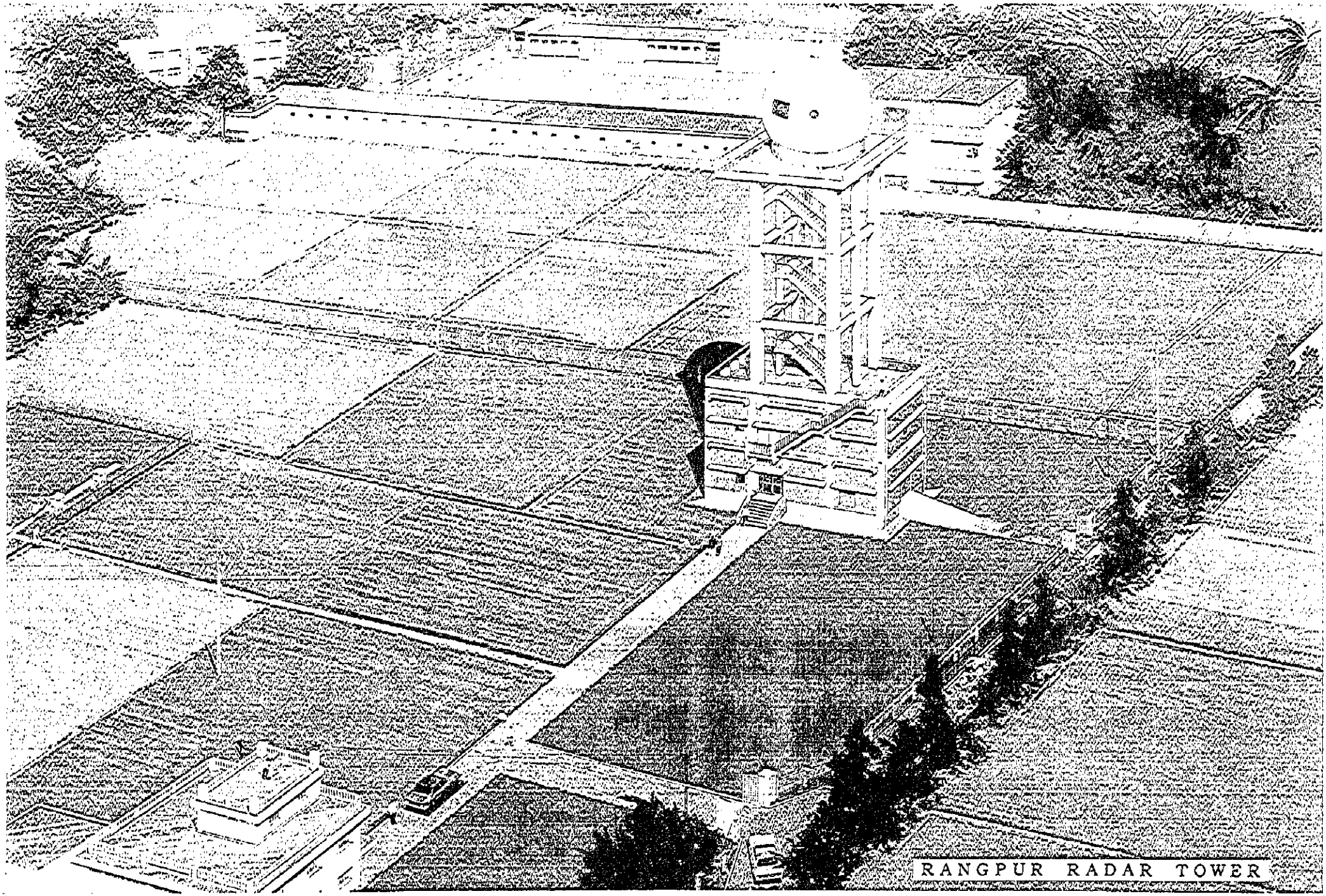
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

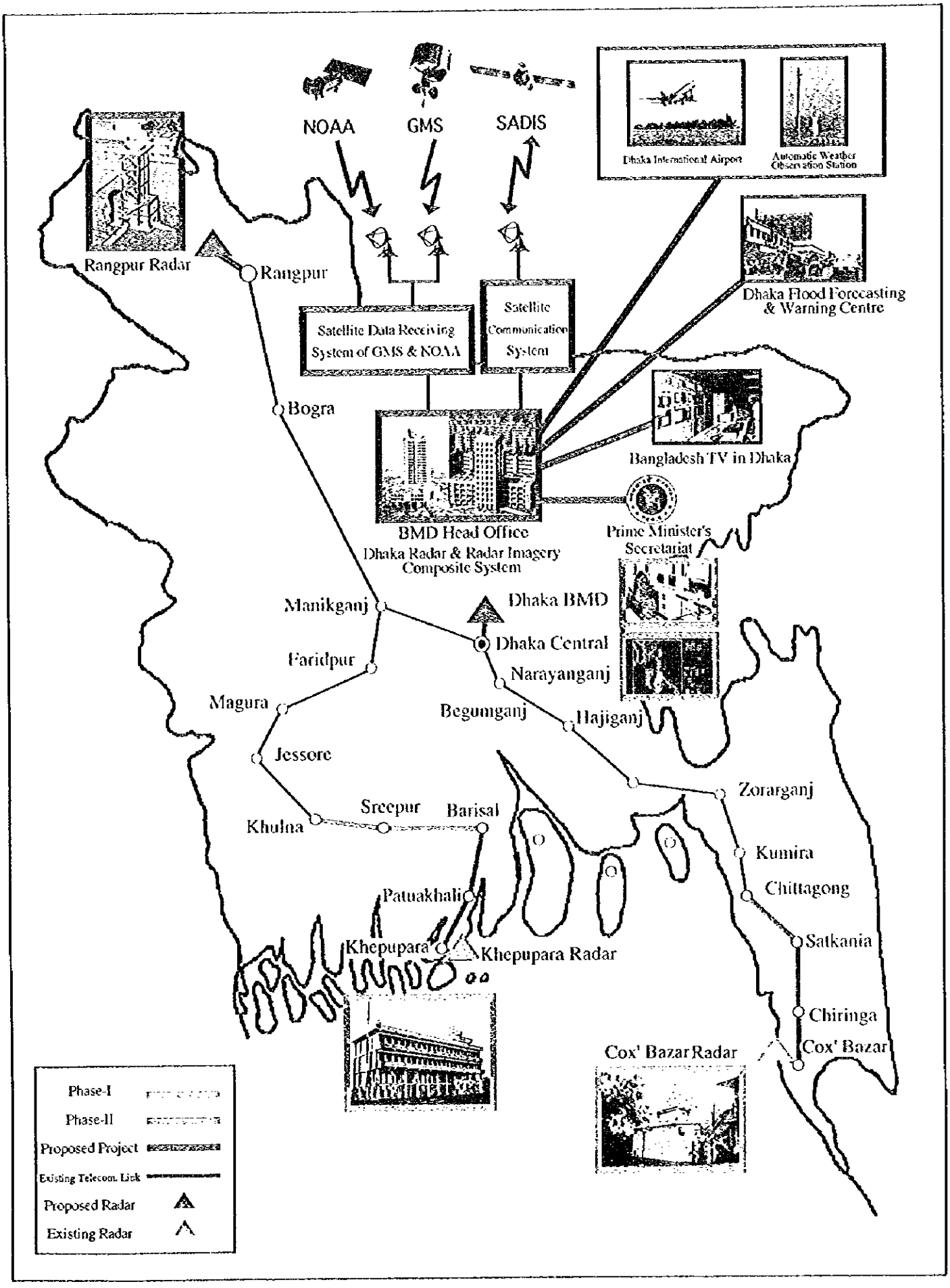
Seiichi Shinoki
Project manager,
Basic design study team on the Project for
Strengthening of Weather Warning Services
Related to Natural Disasters
Japan Weather Association

THE PROJECT FOR STRENGTHENING OF WEATHER WARNING SERVICES RELATED TO NATURAL DISASTERS IN THE PEOPLE'S REPUBLIC OF BANGLADESH





RANGPUR RADAR TOWER



Bangladesh Radar Network

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Chapter 1
Background of the Project

Chapter 1 Background of the Project

Bangladesh has intensive coastal areas which are affected seriously by the frequent visits of tropical cyclones which carry the highest potential for loss of life and property, and has repeatedly suffered from serious damages to economic bases including agriculture. Regrettably, the extensive damage from the natural disaters such as the tropical cyclones and flooding is the determining factor for significant set-back of national economy and development activities of Bangladesh. Bangladesh by now suffered a great financial loss in its history.
Meteorology is a question of life and death in Bangladesh. Looking back to the very recent past, we found that April, 1991 cyclone brought about major disasters to Bangladesh and affected about 15 million people, rendering many of them homeless causing loss of more than 140,000 lives. In Bangladesh, there is, therefore, increasing requirement for meteorological and hydrological services in support of basic human needs such as safety of life and realization of direct economic benefit as well as the protection of physical environment. Increased emphasis is therefore given for the development of meteorological services in Bangladesh towards the promotion of sustainable economic and social development of the country.

As regards meteorological services, Bangladesh is still at its early stage of development, and hence Bangladesh Meteorological Department (hereinafter referred to as "BMD") is expected to continuously play the leading role in providing more authentic warning for the reduction of natural disasters in the county.
BMD is mainly responsible for recording meteorologicl observation round the clock and providing weather information necessary for mitigation and prevention of meteorological disasters and development of socio-economic activities. BMD also provides meteorological information for shipping, country boats and aviation as scheduled, and daily weather forecasts to the general public. Concerning impending tropical cyclone in the area, BMD provides warnings and advisories to as many as all administrative divisions, concerned agencies and mass media, and is now striving for the improvement of its capabilities for meteorological services in order to meet the increasing national and regional demand for natural disaster prevention. This situation urgently requires that BMD should upgrade the weather forecasting, warning and observation facilities to match with people's demand and to meet the function and responsibility as the national meteorological organization in Bangladesh under World Meteorological Organization (hereinafter referred to as "WMO"). This is why Bangladesh formulated this Project for upgrading the hazardous weather monitoring and forecasting capabilities of BMD.

- Necessity of Improvement for Meteorological Services in Bangladesh -

The whole nation of Bangladesh is seriously affected by the frequent visits of natural disasters such as tropical cyclone, storm surges, heavy rain, flood, thunderstorms, norwesters, tornadoes etc. and therefore more reliable and timely warnings are the basic requirements of Bangladesh. The damages caused by natural disasers every year in Bangladesh are enormous. Bangladesh Meteorological Department (BMD), in order to respond to the growing public demand, is now striving for the improvement of meteorological facilities for reliable warnings in the face of natural disasters in accordance with the standard of World Meteorological Organization (WMO). Therefore, there are needs for further improvements in operational capabilities to carry out more effective meteorological services in Bangladesh. BMD provides various kinds of weather information to the nation as the national meteorological organization in the country and is always trying to improve the reliability of the cyclone warnings in order to reduce natural disasters. However, the improvement of the meteorological facilities of BMD has not yet been achieved mainly because of budgetary problems.

BMD has forecasting responsibility for the whole of the country, and it provides cyclone warnings and advisories to all administrative divisions, concerned agencies and mass media. The Flood Forecasting and Warning Centre (hereinafter referred to as "FF&WC") functioning within Bangladesh Water Development Board gets regularly short, medium and long range weather forecasts including heavy rainfall warnings, radar imageries and other hydrological information from BMD. The Dhaka existing radar was established in 1984. The normal age of a radar is about 12 ~ 15 years under proper maintenance and as such, time has now come to initiate necessary action for its replacement. Because it is expected that the Dhaka existing radar will close its life in the very near future. This radar is vital for successful operation of FF&WC. BMD's existing weather radars are now located at Dhaka and also Cox's Bazar and Khepupara supplied by the previous Japan's Grant Aid Assistance. The maximum range of each of these radars is about 400km. The existing system does not therefore cover the upstreams of the Ganges and the Bramaputra as well as the foot hills of the Himalayas. The quantitative and qualitative precipitation measurement over the area is essential for improved flood forecasting & warning system. In order to monitor northern area of Bangladesh and upper stream of the Ganges and Brahmaputra basin, establishment of new meteorological radar system is required and also replacement of Dhaka existing radar system is necessary to cover northeast & centre areas of Bangladesh.

In Bangladesh, the most major natural disasters are cyclone and flood caused by heavy rainfall around the upper stream basins of the Ganges at the Himalayas and the Brahmaputra at the Tibet and also there are other natural calamities like norwester, tornadoes, severe thunderstorm etc.

In conclusion for reduction of the natural disasters in Bangladesh, it is dispensable to establish the radar observation network in Bangladesh incorporating with the existing radar systems at Cox's Bazar and Khepupara for monitoring cyclone, heavy rain and other meteorological phenomena in the whole area of Bangladesh. For detecting and monitoring natural calamities at frequent intervals to forecast their intensity and land-fall more accurately, meteorological radar network will be able to ensure continuous supply of rainfall distribution, intensity and movement, cloud echoes and other necessary information to BMD and other organizations related to reduction of flood disasters.

- The Previous Projects under Japan's Grant Aid Assistance for Bangladesh -

Under "the Project for the Replacement of Weather Surveillance Radars in Bangladesh" by Japan's Grant Aid Assistance, two meteorological radar systems were installed at Cox's Bazar and Khepupara and completed in 1988. These existing radar systems still work well through appropriate maintenance by BMD's skilled engineers for monitoring of tropical cyclone and heavy rain and also contributing effectively to the prevention of natural disasters affected by the frequent visits of tropical cyclone.

By "the Project for Establishment of Microwave Link for Meteorology in Bangladesh" financed by Japan's Grant Aid Assistance, theses radar systems were connected by microwave links to the BMD Storm Warning Centre, Dhaka to transmit radar imageries of cyclone from Cox's Bazar and Khepupara.

It is most imperative that BMD as the national meteorological service should provide accurate and timely meteorological information to the users in order to reduce disasters caused by severe weather phenomena including tropical cyclone and flood. From a long-term point of view, it is also necessary to improve meteorological activities of BMD as the national meteorological organization in Bangladesh so as to play effective role as a member of WMO.

Since the facilities of BMD are likely to be improved greatly by the Project, BMD will be capable of contributing effectively to the mitigation and prevention of tropical cyclone disasters, flood damages and losses by other natural calamities like norwester, tornadoes, severe thunderstorm etc. in Bangladesh. Further, the improvement of observing and forecasting system as a result of this project will highly enhance BMD's activities and will put BMD in a position to play its due role in the economic development of Bangladesh.

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2-1 Objectives of the Project

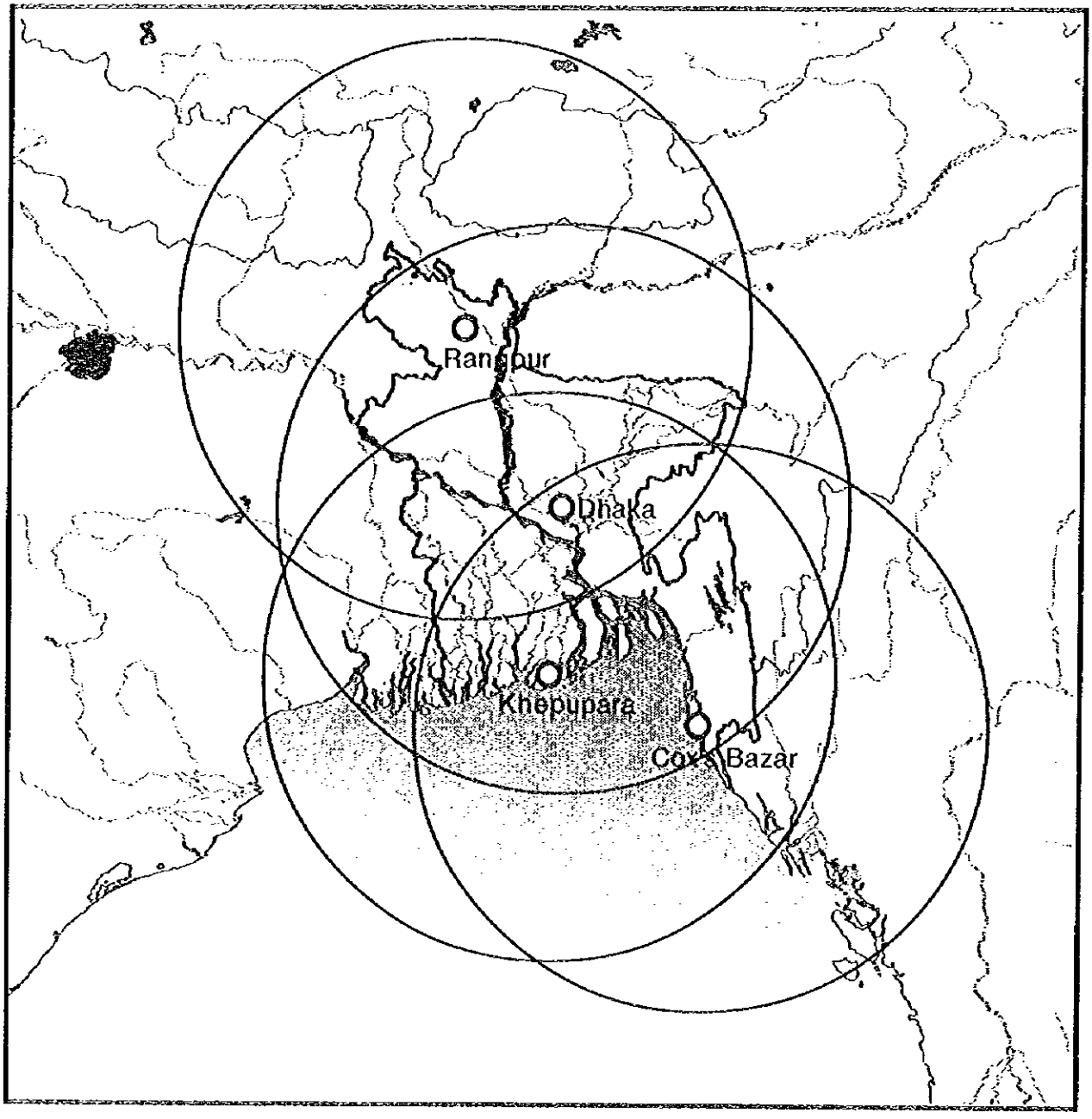
The objective of the Project is to reduce devastations caused by natural disasters through strengthening of weather warning services and improving the observing activities and facilities of BMD. Bangladesh is affected seriously by the frequent visits of natural disasters which carry the highest potential for loss of life and property. Regrettably, the extensive damage from the natural disasters are the determining factor for significant set-back of national economy and development activities of Bangladesh.
In order to monitor northern area of Bangladesh and upper stream of the Ganges and Brahmaputra basin, establishment of new meteorological radar system is required and also replacement of Dhaka existing radar system is necessary to cover northeast & centre areas of Bangladesh. The Project consists of 2 new radar systems at Dhaka and Rangpur incorporating with the existing radar systems at Cox's Bazar and Khepupara supplied by the previous Japan's Grant Aid Assistance, to establish the radar network in Bangladesh for monitoring cyclone, heavy rain and other meteorological phenomena in the whole area of Bangladesh.

In addition, for improvement of BMD's observation, forecasting and dissemination capabilities, and hence the acquisition and utilization of the satellite meteorological data and meteorological products, meteorological satellite systems, meteorological information distribution systems and other necessary systems will be supplied under the Project at Dhaka head office, Flood Forecasting & Warning Centre, Dhaka International Airport and Bangladesh TV Centre to contribute in a greater perspective to the reduction of disasters also caused by heavy rain, thunderstorm, etc. which in turn will add to the safety of people's life through providing warnings and advisories to all administrative divisions, concerned agencies and mass media.

Since the facilities of BMD are likely to be improved greatly by the Project, BMD will be capable of contributing effectively to the mitigation and prevention of tropical cyclone disasters, flood damages and losses by other natural calamities like norwester, tornadoes, severe thunderstorm etc. in Bangladesh. Further, the improvement of observing and forecasting system as a result of this project will highly enhance BMD's activities and will put BMD in a position to play its due role in the economic development of Bangladesh.

"Observation Range of Bangladesh Radar Network" is shown hereunder.

OBSERVATION RANGE OF BANGLADESH RADAR NETWORK



2-2 Basic Concept of the Project

The Government of Bangladesh has officially requested the following systems for implementation of the Project.

(1) Construction of a radar tower building at Rangpur BMD Observation site.

(2) Establishment of S-band meteorological radar system with power supply back-up systems (UPS, generator system, etc.) at Rangpur BMD Observation site.

(3) Replacement of the existing BMD's S-band meteorological radar system with power supply back-up systems (UPS, generator system, etc.) at Bangladesh Islamic Solidarity Education Wakf (IDB-BISEW) building at Agargaon instead of Dhaka BMD head office.

(4) Establishment of radar picture composite processor and display systems for making 4-radar composite pictures at Storm Warning Centre in Dhaka BMD head office.
(4 radars : 2 existing radars at Cox's Bazar & Khepupara and 2 radars to be supplied at Dhaka and Rangpur)

(5) Establishment of computer work station for plotting, analysis and storage of data to introduce improved weather forecastings and warnings at Storm Warning Centre, Dhaka.

(6) Establishment of transmission links between Rangpur BMD Observation site ~ Rangpur BTTB exchange station (2 GHz band microwave link) and between Bangladesh Islamic Solidarity Education Wakf (IDB-BISEW) building at Agargaon ~ Storm Warning Centre (2 GHz band microwave link) for transmitting Dhaka radar imagery to Storm Warning Centre.

(7) Establishment of 3 transmission links (2 GHz band microwave link) for providing radar composite pictures and weather information between the following spans.
1. Dhaka BMD head office ~ Dhaka International Airport
2. Dhaka BMD head office ~ Bangladesh TV Centre
3. Flood Forecasting & Warning Centre (FF&WC) in Dhaka ~ Dhaka BTTB Central station/Bangladesh TV Centre.

(8) Establishment of satellite data display systems of GMS (S-VISSR) & NOAA (HRPT) and satellite communication system for meteorological information (WAFS-SADIS) at Storm Warning Centre, Dhaka.

(9) Establishment of automatic weather observation system, radar & satellite imagery display systems, WAFS display system and weather information & chart display system at Dhaka International Airport.

(10) Establishment of imagery display systems and weather information & chart display systems at Bangladesh TV Centre and Flood Forecasting & Warning Centre (FF&WC), Dhaka.

During the basic design study in Bangladeh, the Government of Bangladesh additionaly requested to include the following system in the Project.

(1) Establishment of a transmission link for providing radar composite pictures and weather information between Dhaka BMD head office ~ Prime Minister's Secretariat.

In connection with all the systems as described above, the study and investigation have been held in Bangladesh and Japan. In accordance with the result of the study, the basic concepts of the Project are as follows.

1. Strengthening of Meteorological Radar Network in Bangladesh

1) Location of radar systems

Under "the Project for the Replacement of Weather Surveillance Radars in Bangladesh" by Japan's Grant Aid Assistance, two meteorological radar systems were installed at Cox's Bazar and Khepupara and completed in 1988. These existing radar systems still work well for monitoring of tropical cyclone and heavy rain and also contributing effectively to the prevention of natural disasters affected by the frequent visits of tropical cyclone. By "the Project for Establishment of Microwave Link for Meteorology in Bangladesh" financed by Japan's Grant Aid Assistance, theses radar systems were connected by microwave links to the BMD Storm Warning Centre, Dhaka to transmit radar imageries of cyclone from Cox's Bazar and Khepupara.

Warning Centre, Dhaka to transmit radar imageries of cyclone from Cox's Bazar and Khepupara. On the other hand, in Bangladesh, the most major natural disasters are cyclone and flood caused by heavy rainfall around the upper stream basins of the Ganges at the Himalayas and the Brahmaputra at the Tibet and also there are other natural calamities like norwester, tornadoes, severe thunderstorm etc.

Regarding installation of meteorological radar systems at Rangpur and Dhaka requested by the Government of Bangladesh, locations of Rangpur and Dhaka are effectively suitable to cover northern & centre areas of Bangladesh. Therefore, in order to monitor and cover the whole area of Bangladesh and northern area of outside Bangladesh such as the foothills of the Himarayas, it is indispensable to establish a networking of weather radars to be composed by 2 new radar systems at Dhaka and Rangpur incorporating with the existing radar systems at Cox's Bazar and Khepupara.
For detecting and monitoring natural calamities at frequent intervals to forecast their intensity and land-fall more accurately, meteorological radar network will be able to ensure continuous supply of rainfall distribution, intensity and movement, cloud echoes and other necessary information to BMD and other organizations related to reduction of flood disasters.
Due to the above reasons, the establishment of new radar system at Rangpur and replacement of Dhaka existing radar system have been confirmed as a pertinent request.

① Rangpur

Rangpur site is located in the premises of the BMD's Rangpur Observatory. The site is virtually flat and sufficiently large to accommodate a radar tower building construction.

② Dhaka

Dhaka existing radar system is located on the top of 12 storied building at BMD head office. To southward approximately 300m from BMD head office, 21st floors building has been constructed by IDB-BISEW (Islamic Development Bank - Bangladesh Islamic Solidarity Education Wakf) project, which is an obstacle to radar observation from BMD head office building. In order to avoid this situation, BMD specially obtained an approval from the Government of Bangladesh to use 21st floor of the IDB-BISEW building for installation of new radar system to be supplied under the Project. Therefore, Dhaka radar site will be IDB-BISEW building, however, securing enough space for installation of the radar system, construction of radar & radome foundations and other

civil works will be held and borne by BMD in accordance with the drawings provided by JICA basic study team.

2) Frequency band of the meteorological radar systems

C band (wave length : approx. 5cm) and S band (wave length : approx. 10cm) are generally used for a meteorological radar system. Making a comparison between C band and S band, the characteristics are specified as follows.

Characteristics	C-band radar	S-band radar
Beam angle	○ Narrower	Broader
Attenuation due to wave guide	More	○ Less
Attenuation due to rainfall	More	○ Less
Observation accuracy in short range	○ Higher	Lower
Observation accuracy in long range	Lower	○ Higher
Transmission power	Lower	○ Higher

C-band radar system has the more advantage of observation accuracy in short range and S-band radar has the more advantage of observation accuracy in long range and also in case of wave guide be longer as the same situation as Rangpur radar system, attenuation of receiving & transmitting power of S-band radar system is less than C-band radar system.

On the other hand, BMD wants to have S-band radar systems for the following advantageous reasons.

i) To be able to cover more widely and to receive accurate observation in long range.
ii) To be able to observe precipitation at the foothills of the Himarayas for flood forecasting.
iii) To be able to unify necessary maintenance method, spare parts and consumables between new S-band radar systems and the existing S-band radar systems at Cox's Bazar and Khepupara.

Due to the above reasons, S-band radar system is recommendable Bangladesh for covering the whole area of Bangladesh and its joining areas.

3) Radar imagery composition

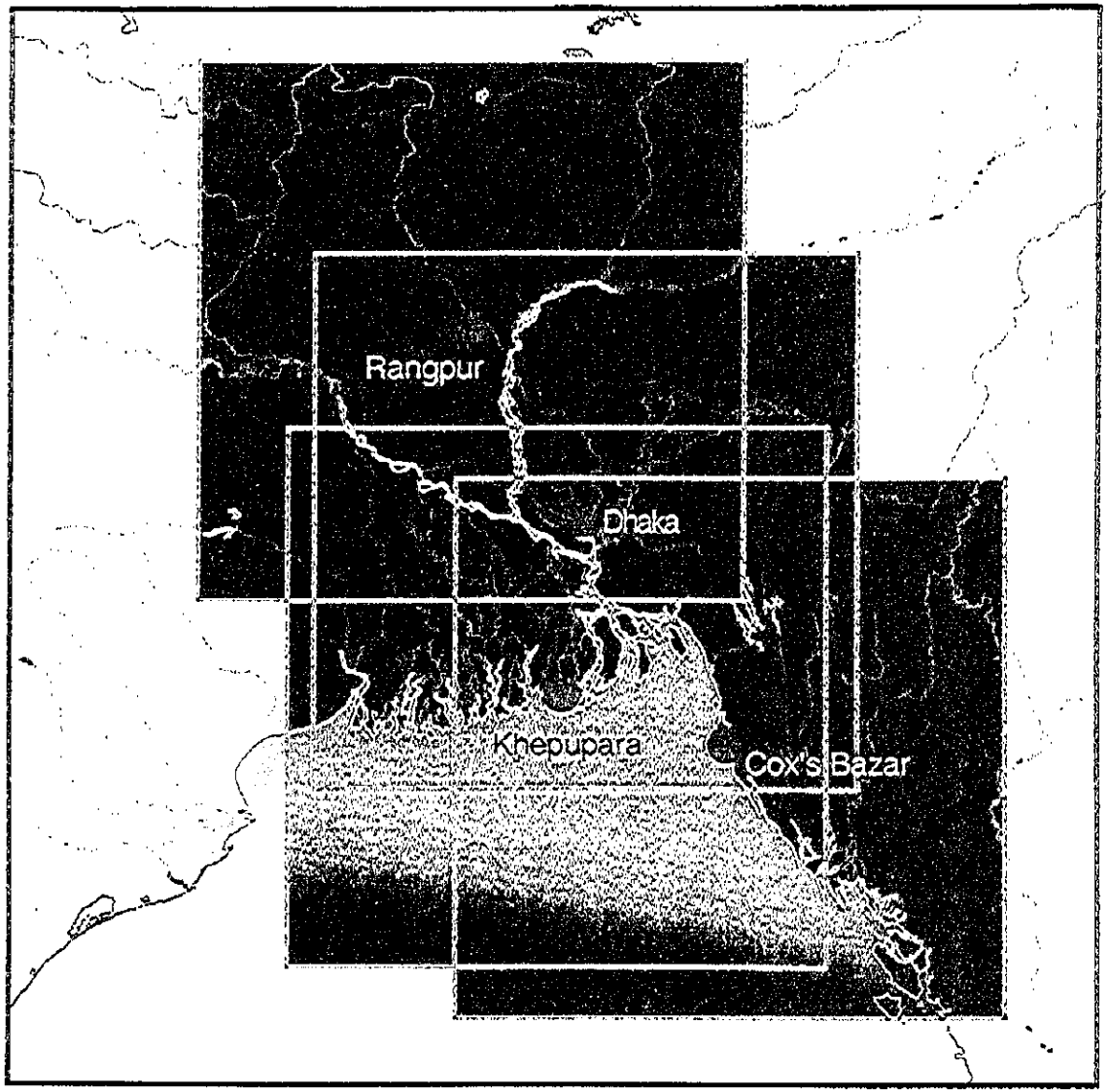
Main observation objectives of the existing radar systems at Cox's Bazar and Khepupara are for cyclone surveillance for cyclone forecasting and new radar systems to be installed at Dhaka and Rangpur are for monitoring of norwester and hevy rainfall for weather forecasting as well as flood forecasting. In consideration of different observation objectives as described above, different operational methods are also expected. Consequently, the following 3 types of radar composite imageries prepared at BMD head office will be required for BMD's routine works and also be disseminated to the Flood Forecasting & Warning Centre, Airport Meteorological Office and Bangladesh TV Centre.

① Rangpur & Dhaka radar composite imageries for monitoring of norwester and hevy rainfall for weather forecasting as well as flood forecasting at northern and centre areas of Bangladesh : "Composite Imagery for Weather & Flood Forecasting"

② Cox's Bazar & Khepupara radar composite imageries for cyclone and rain surveillance at southern area of Bangladesh : "Composite Imagery for Cyclone Forecasting"

③ 4 radar composite imageries for hazardous weather condition surveillance of the whole Bangladesh : "Composite Imagery of Whole Area of Bangladesh"
4 radar imageries of Rangpur, Dhaka, Cox's Bazar and Khepupara radar sites will be composed as single composite imagery . With this imagery, forecasters will be able to detect movement of hazardous weather phenomena and to make accurate weather forecasts and warnings for the whole Bangladesh for reduction of natural disasters.

3 types of "Radar Composite Imageries" as described above are attached hereunder.



COMPOSITE

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10 MAY 97

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Rangpur	OPR	+0.0	OFF
Dhaka	NO OPR	+11.5	OFF
Khepupara	OPR	+0.0	OFF
Cox's Bazar	NO OPR	+11.5	OFF

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	2 <=R< 5mm/h
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COMPOSITE

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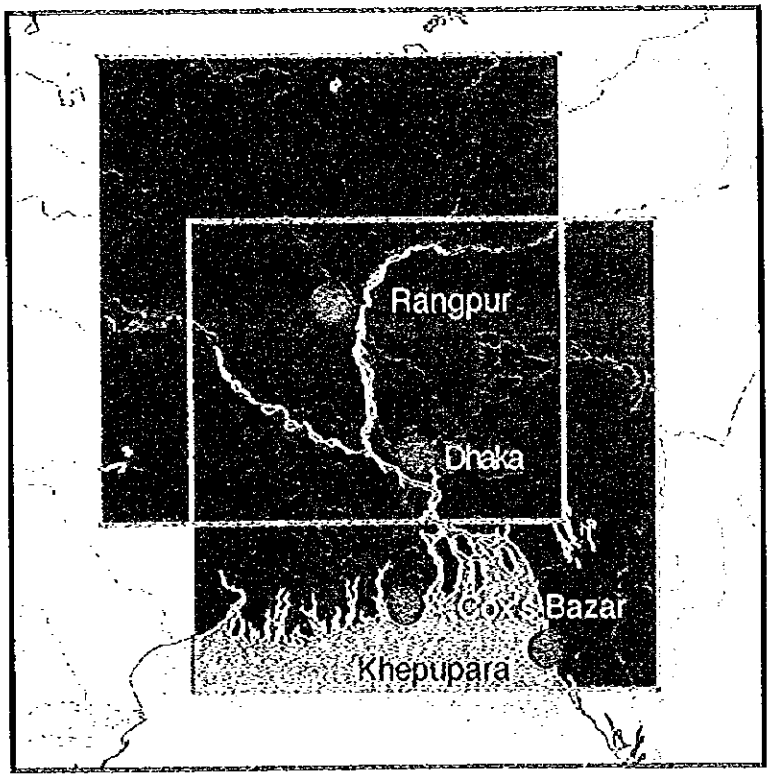
23 May 97



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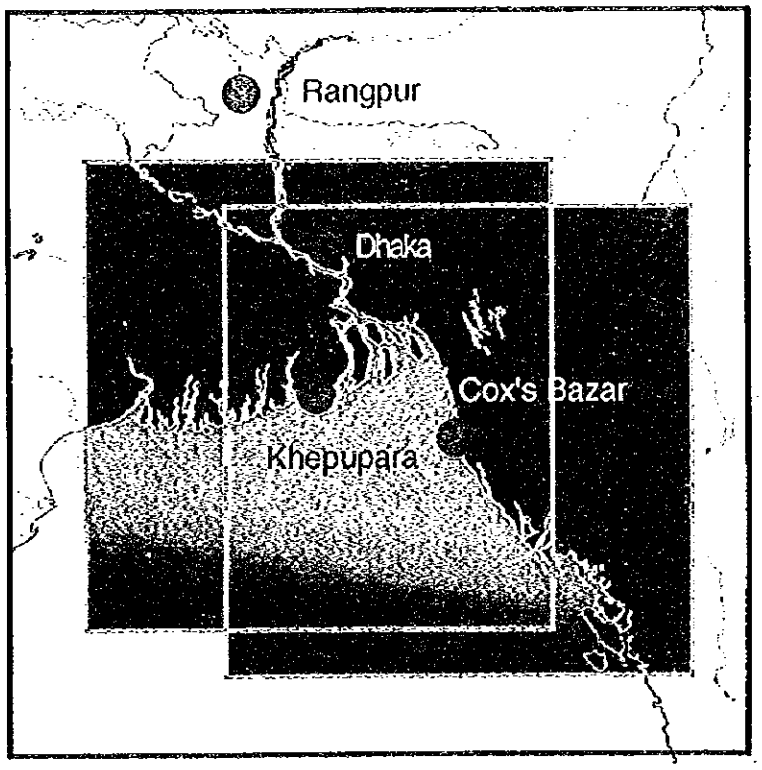

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Cox's Bazar	NO OPR	+11.5	OFF

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	20 <=R<	40mm/h
	40 <=R<	70mm/h
	70 <=R<	100mm/h
	100 <=R<	150mm/h
	150 <=R<	mm/h

2. Establishment of Meteorological Satellite Systems

1) Meteorological satellite imagery receiving systems

At the present, BMD has no high resolution meteorological satellite imagery receiving system. In order to detect movements of hazardous weather phenomena such as cyclone and heavy rain as earlier and wider as possible and to take a global view of northern hemisphere, satellite imageries are very important for early detection of hazardous weather phenomena and also weather surveillance in the area of outside radar covering range.

Japanese Geostationary Meteorological Satellite "GMS" is observing our earth from the altitude 36,000km above the equator at longitude 140°E. Geographical resolution at the point right under the satellite is 8.32kmx5.82km for infrared channel. Bangladesh is, however, located near the edge of its viewing field. So, it is inevitable that the observation resolution in Bangladesh would be broader than the above because the satellite observes the area obliquely at the slope angle of 30°. In order to improve this situation, it is necessary to introduce a high-resolution satellite data receiving system for S-VISSR data of GMS. The distortion correction by coordinate transmission and cutting & zooming of appropriate area will improve the accuracy of the forecast remarkably.

Polar-orbital satellites of NOAA, USA can observe any area only 4 times a day that consists of 2 times each by north-bound and south-bound orbit. The observation area is limited to about 1,000km in radius, but its resolution is much better than GMS because its altitude of orbit is about 840km high, that is much lower than GMS's. Its high resolution data of 1.1x1.1km must be useful for cyclone detecting and accurate forecasting together with GMS. Observation equipment of NOAA, AVHRR (Advanced Very High Resolution Radiometer), has 5 observation channels (visible:1, near infrared:1 and thermal infrared:3). AVHRR data is useful for analyzing such as sea surface temperature that is a cause of cyclone development. Satellite imageries are indispensable information for cyclone surveillance over its generating area.

To avoid observation failure owing to a breakdown of equipment, a concept of dual system should be applied. This means that two sets of receiving equipment will be designed as switchable from GMS to NOAA vice versa in case of a failure.

2) Meteorological data satellite communication system

Modern weather forecasting method applied in developed countries in the meteorological field is numerical weather prediction (NWP). So, it is quite natural as the final target for every national meteorological organization to aim at an introduction of NWP system. For the first step to the final NWP stage, an acquisition of typical NWP products which are in worldwide circulation is a very appropriate request from Bangladesh side.
Acquisition through GTS (Global Telecommunication System : worldwide meteorological telecommunication network of WMO) should be a first option, however, existing GTS link is 2,400 bps international link between Dhaka and New Delhi, India. This transmission speed is not enough for acquisition of weather charts and such graphic materials of NWP.
On the other hand, SADIS, a satellite communication system for the dissemination of WAFS products was adopted and subsequently, based on the relevant action by the ICAO Council. The broadcasts are available through a space segment leased from the Indian Ocean INTELSAT 604 satellite positioned over 60°E longitude. Regarding SADIS, ICAO has offered WMO access to the system for the exchange of basic meteorological information subject to an equitable cost allocation and recovery.

SADIS provided from WAFC London has a point to multipoint capacity to uplink global gridded wind and temperature forecast in GRIB binary format, selected upper wind charts and significant weather (SIGWX) charts in T4 facsimile format and alphanumeric data including amended forecasts and OPMET data (TAFs, METARs, SIGMETs).
This SADIS system has such a big advantage for developing countries that the subscriber charge of satellite link is not required. Under this consideration, SADIS system should be accepted in the Project.

3. Improvement of Processing Capability on Meteorological Data at Storm Warning Centre

At Storm Warning Centre, meteorological information such as radar & satellite imageries, SADIS products, observed data from WMO member countries through Global Telecommunication System (GTS) and domestic observed data received by SSB, telephone and teleprinter are collected.
Observed data are manually analyzed and drawn in weather charts. For the manual preparation, it takes at least one hour and weather forecasts cannot be issued timely. By introduction of new systems under the Project, it will be able to shorten time of data processing and preparation

of weather charts. In stead of a chart plotter system, the laser printer system will be supplied in consideration of easy procurement of consumables and maintenance.
In order to plot the observed data in the weather charts as WMO standard form, it is necessary to install the hardware such as computer system and also the software.

4. Improvement of Dissemination Capability of Meteorological Information at Dhaka International Airport

At Dhaka International Airport, 150 international and domestic frights are landing and taking-off every day. For safety operation of air traffic at the airport, improvement of meteorological observation and data transmitting systems are urgently required.

1) Automatic weather observation system

Presently, aeronautical meteorological observation (pressure, temperature, wind direction and wind speed) is taken by conventional meteorological instruments near the airport control tower. For safety operation and avoiding the present situation, it is strongly required to install the Runway Visible Range (RVR) and Ceilometer to keep as the category -2 airport registration. Therefore, the automatic weather observation system will be required at the runway touch point for safe landing and take off of the air crafts, and also all necessary observation elements (wind speed & wind direction, temperature, humidity, precipitation, pressure, runway visual range and cloud base height) shall be observed by the system. For receiving all necessary data from this system at the airport meteorological office and airport control tower, UHF telecommunication link will be established under the Project.

2) Meteorological information distribution system at Dhaka International Airport

For displaying SADIS products, meteorological information, radar imageries and high resolutional satellite imageries for preparation of weather briefing, installation of meteorological data distribution systems at Airport Meteorological Office, Area Control Centre and Flight Information Centre at the Airport will be necessary for the safety of aviation services.

5. Provision of Meteorological Information to Bangladesh TV Centre, FF&WC and Prime Minister's Secretariat

1) Video signal converting system in Bangladesh TV Centre

At present, weather information program on TV in Bangladesh is neither so attractive nor enough to meet people's demands.

In order to prepare an attractive weather program by Bangladesh TV Centre, visible images such as radar images, satellite images and weather charts will be required. Using those visible meteorological information, Bangladesh TV Centre will be able to provide understandable and attractive weather program for the people of Bangladesh. After completion of the Project, it is expected that it will efficiently make appropriate benefit to the people of Bangladesh.

The meteorological information from BMD head office will be received by this system to be installed at the main control room of Bangladesh TV Centre, and will be converted to the video signals to be suitable for the TV equipment.

2) Meteorological information distribution system at FF&WC and Prime Minister's Secretariat

FF&WC (Flood Forecasting & Warning Centre) is belonged to Hydrological Department of Water Development Board, Ministry of Water Resources. Under FAP10 (Flood Action Plan 10) of Bangladesh government, two projects ("Project for Hydrological Analysis" assisted by DANIDA and "Pilot Project for water level gauge telemeter network" by Japan's Debt Relief Grant Aid Assistance) have been implemented.

As the results of those projects, FF&WC has its own nationwide observation network consisting telemeter network systems, water rain gauges and water level gauges beside rivers of all over Bangladesh. However, these observing points are limited inside Bangladesh. FF&WC can not accurately forecast flood occurrence caused by heavy rainfall at upstream, because there is no observation system of precipitation in Bangladesh. Normally, flood occurs after 10 days from raining at upstream of the rivers.

If the Project is implemented, FF&WC functioning within Bangladesh will get short, medium

and long range weather forecasts including heavy rainfall warnings, radar imageries and other hydrological information from BMD. For improved flood forecasts & warnings services for the safety of people's lives and properties, provision of aerial precipitation data of the upper catchment areas of the Ganges and the Brahmaputra which contribute about 91% of the inflow during the peak floods for improved flood forecasts and warnings will be required. The maximum range of each of these radars is about 400km to cover the upstreams of the Ganges and the Bramaputra as well as the foot hills of the Himalayas. The quantitative and qualitative precipitation measurement over the area is essential for improved FF&WC services. Therefore, the meteorological information display system at FF&WC will contribute the reduction of flood disasters.

In addition, Prime Minister's Secretariat will also be able to receive weather forecasts & warnings, radar imageries and other meteorological information from BMD. For making a final decision and operating the related organizations as the highest authority in Bangladesh for reduction of the natural disasters and prompt relief action, these information will greatly useful.

6. Establishment of meteorological telecommunication links

1) Necessary route of data transmission

The following telecommunication routes were studied for the Project.

① Rangpur BMD Observation site ~ Rangpur BTTB exchange station
② Bangladesh Islamic Solidarity Education Wakf (IDB-BISEW) building at Agargaon ~ Storm Warning Centre, Dhaka
③ Dhaka BTTB Central station ~ Flood Forecasting & Warning Centre, Dhaka
④ Dhaka BMD head office ~ Bangladesh TV Centre
⑤ Dhaka BMD head office ~ Meteorological Office in Dhaka International Airport
⑥ Meteorological Office in Dhaka International Airport ~ Automatic Weather Observation Station in the Airoport
⑦ Dhaka BMD head office ~Prime Minister's Secretariat

① Rangpur BMD Observation site ~ Rangpur BTTB exchange station

The following existing telecommunication links of Bangladesh telegraph and Telephone Board (BTTB) will be required for implementation of the Project.

- Rangpur BTTB exchange station ~ Bogra BTTB exchange station (analog microwave link)
- Bogra BTTB exchange station ~ Dhaka BTTB Central station (digital microwave link)
- Dhaka BTTB Central station ~ Dhaka BMD head office (analog microwave link).

For transmitting radar imageries from Rangpur radar system to be located in Rangpur BMD Observation site to Dhaka BMD head office, it is necessary to connect between "Rangpur BMD Observation site and Rangpur BTTB exchange station" by microwave link (2GHz, 2Mbps) to be established under the Project.
During the basic design study, quality of this existing link was confirmed by the study team as reliable and useful for transmitting radar imageries at 2,400bps transmission speed from Rangpur radar system.
On the other hand, possibility of using satellite communication (Very Small Aperture Terminal: VSAT) between Rangpur BMD Observation site and Dhaka BMD head office was also studied. In Bangladesh, international service of VSAT system has already started and domestic service will start within this year by BTTB. In consequence of study on the recurrent cost of domestic service for VSAT system, it is expected that it will be about US$3,700/month(maximum) for the link. It is sure that BMD can bear this recurrent cost of using VSAT system and also it is possible to include this system for the Project. At the present, however, domestic service has not yet started, thereby, establishment of microwave system as described above is recommendable for the Project.

② Bangladesh Islamic Solidarity Education Wakf (IDB-BISEW) building at Agargaon ~ Storm Warning Centre, Dhaka

To southward approximately 300m from BMD head office, 21 storied building has been constructed by IDB-BISEW project. For installation of new radar system to be supplied under the Project, IDB-BISEW building will be used. Therefore, to connect IDB-BISEW building and BMD head office, establishment of microwave link (2GHz, 2Mbps) will be required for transmitting radar imagery.

③Dhaka BTTB Central station ~ Flood Forecasting & Warning Centre, Dhaka

Between "Dhaka BTTB Central station ~ Flood Forecasting & Warning Centre", the existing digital microwave link (2GHz, 2Mbps) is available and it is useful for the Project. However, it is necessary to put additional channel cards to the existing digital microwave systems. In addition, FF&WC has been agreed on provision of the existing digital microwave link for the Project.

④Dhaka BMD head office ~ Bangladesh TV Centre
⑤Dhaka BMD head office ~ Meteorological Office in Dhaka International Airport
For both routes of ④ & ⑤, new digital microwave links (2GHz, 2Mbps) will be indispensable.

⑥Meteorological Office in Dhaka International Airport ~ Automatic Weather Observation System in the Airport

For receiving all necessary data from this system at the airport meteorological office and airport control tower, UHF telecommunication link between Airport Meteorological Office and Automatic Weather Observation System to be installed on a side of the runway will be established under the Project. Frequency of telecommunication link will be selected with the exception of 106 ~ 137MHz of VHF.

⑦Dhaka BMD head office ~Prime Minister's Secretariat

Establishment of new digital microwave link (2GHz, 2Mbps) under the Project will be indispensable for receiving all necessary information and imageries from BMD head office for making a decision on reduction of natural disaster and prompt relief action as the highest authority.

2) Transmission speed of radar imagery

At least, 2,400bps transmission speed as the same as the existing systems between Dhaka head office and Cox's Bazar & Khepupara radar sites will be applied for the Project.

3) Frequency of meteorological telecommunication system

In consequence of the discussion with BTTB, digital microwave links to be established under the Project will be 2GHz band.

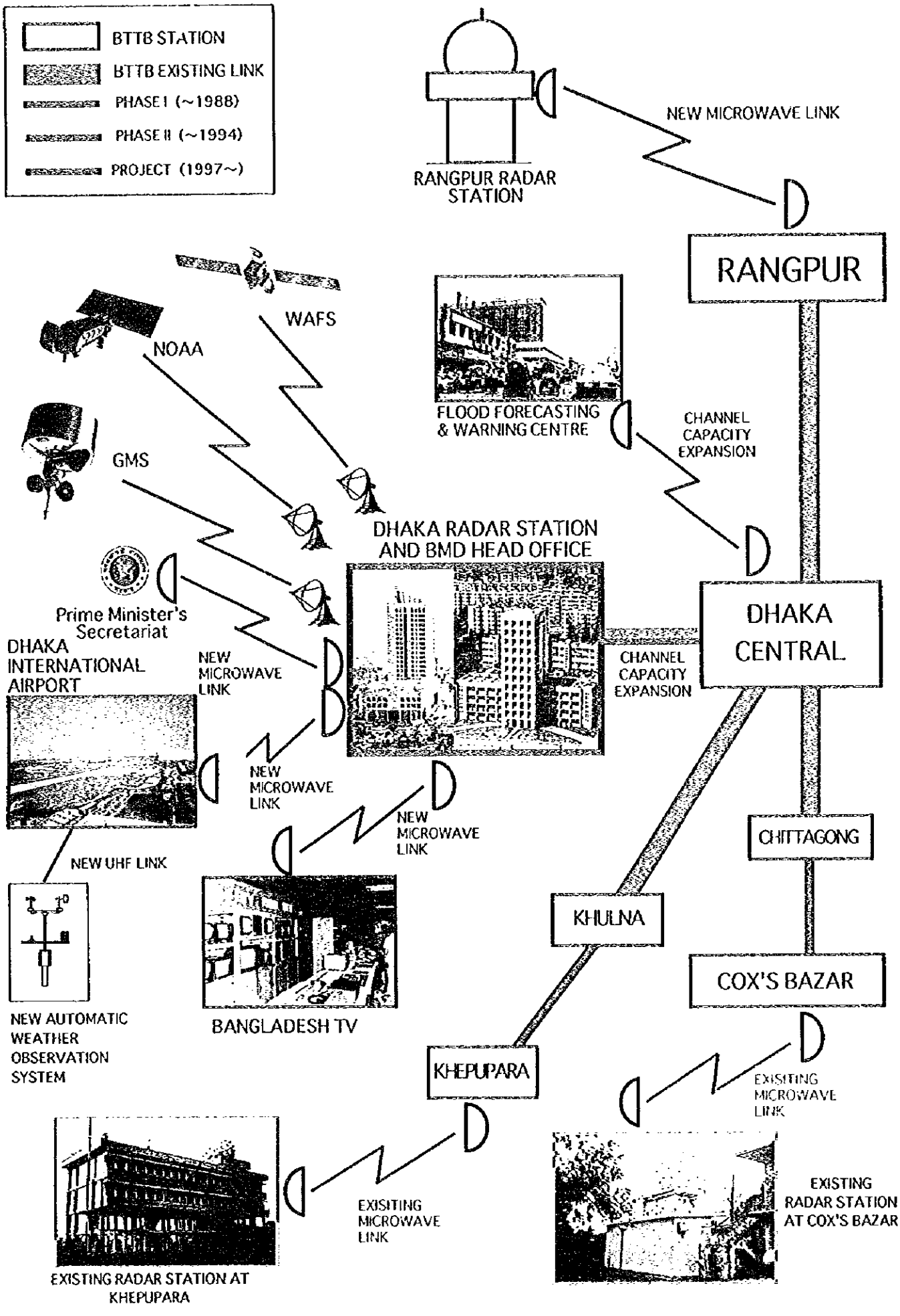
7. Radar Tower Building

A radar tower building will be constructed at BMD Rangpur observation site. Main required rooms are as follows.

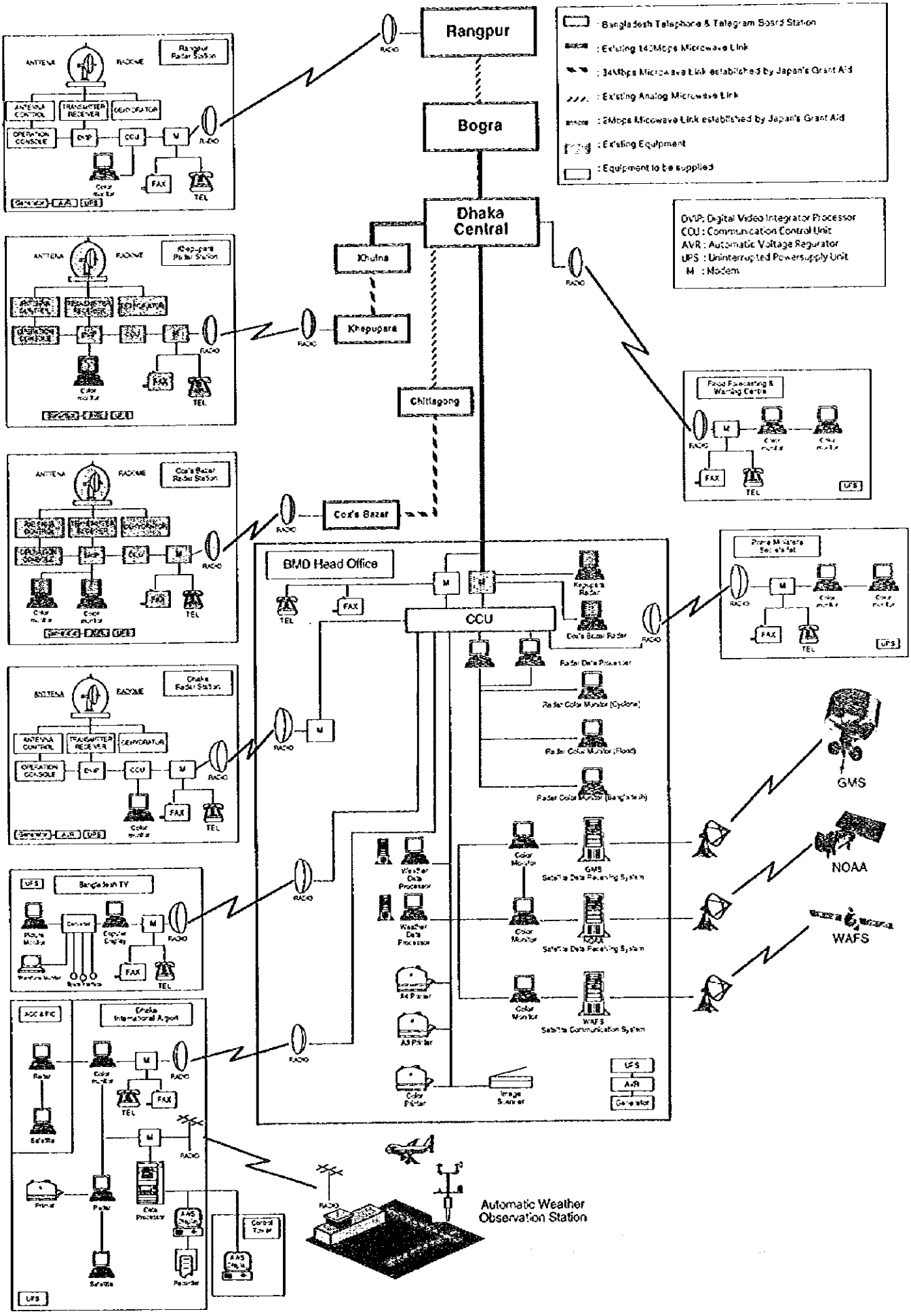
① Radar equipment room	② Radar observation room	③ Analysis room
④ Data room	⑤ Maintenance room	⑥ Tools room
⑦ Electricity room	⑧ Pump room	⑨ Engine generator room
⑩ Store room		

After the implementation of the Project, the weather monitoring system of BMD will be strengthened, the position and intensity of severe meteorological phenomena will be determined more accurately and timely, and the computerized weather data will be utilized adequately, and thus the routine forecast accuracy will be improved greatly. Besides, the accuracy and the reliability of meteorological warnings related to cyclones, storm surges and severe local storms will be improved. And it is expected that with this BMD can contribute to the reduction of natural disasters in the country. At the same time, overall standard of meteorological information will be in better position, and BMD will thus be able to contribute in a greater perspective to the reduction of disasters also caused by heavy rain, norwester, thunderstorm, etc. which in turn will add to the safety of people's life.

"Meteorological Network Configuration in Bangladesh" and "Project Configuration" are attached on next page.



METEOROLOGICAL NETWORK CONFIGURATION IN BANGLADESH



Project Configuration

2 - 3 Basic Design

2 -3 - 1 Design Concept

1. Design Concept of the Equipment

The basic design concept of all the systems to be installed under the Project are as follows.

a. To design all equipment to conform operation and maintenance systems and technical capabilities of BMD.

b. To attempt to make appropriate compatibility and suitability between the equipment to be supplied under this Project and the existing radar systems at Cox's Bazar and Khepupara.

c. To apply, whenever possible, digital communication system as the communication link for transmitting radar imagery to minimize a loss of radar imagery quality as much as possible.

d. To consider BMD's technical level and structure of operation & maintenance for the systems.

e. To minimize recurrent costs of operation and maintenance for the equipment at BMD.

2. Design Concept of the Buildings

1) Building Plan : "Radar Tower Building"

Based on the future plans of the BMD, the design concept is to make building and facility plans for achieving duties as meteorological radar facility which are to become operating bases for weather radar observation. The Plan is to construct meteorological radar tower building at Rangpur that will ensure appropriate and effective operations and accommodate the required systems, equipment, and manpower.

The basic concept is to design the meteorological radar tower building incorporating with the following eight functions.

a. To be capable of properly and efficiently carrying out the five principal components of a meteorological related activity : observation, telecommunication, data processing & analysis, forecasting, and dissemination.

b. To be capable of carrying out various meteorological services as the "Meteorological Radar Tower Building."

c. To provide necessary environment where services to be performed effectively and efficiently in accordance with the flow of the meteorological services.

d. To be capable of responding to the service curriculum, with forecasting and observation sections on 24 hour shifts.

e. To be furnished with suitable equipment (Uninterrupted Power Supply system and Auto Voltage Regulator, etc.) for performing the meteorological services of 24 hours a day, 365 days a year, in round-the-clock operation.

f. Having the mission of supplying uninterrupted radar observation and weather forecast & warning even during heavy rain, flooding, etc., the radar tower building is to be sufficiently robust with adequate countermeasures taken against natural disasters.

g. To be capable of adapting to the meteorological radar system and other related equipment to be supplied under the Project.

h. To be capable of adapting to the meteorological services as duties of the national meteorological organization and the staff members.

2) Structural Design

In order to withstanding natural disasters (especially strong wind, heavy rain and flooding), the safe and economical structural design is to be applied, and local structural materials are selected wherever possible. For design and selection of the foundation structure, the results of accurate soil investigations at the Project site of Rangpur will be applied.

3) Building Equipment Plan

Building equipment required for the round-the-clock operation throughout the year, and the implementation of uninterrupted radar observation and forecasting & warning even during the heavy raining and flooding, are to be planned. The equipment is to be selected from the viewpoint of easy operation and maintenance, taking safety and economy into consideration.

4) Construction Plan

By using the materials available in the local markets in Bangladesh and applying local construction methods, an appropriate and economical construction plan is to be established.

5) Reductions of Operation, Maintenance and Administration Cost

The size and grade of the building is to be appropriately decided so as to avoid imposing any undue technical or financial burdens on the BMD with respect to ongoing operations and maintenance after completion of the building construction. Therefore, reliable and economical construction materials should be selected for the building and also easy local procurement of the materials should be considered for the future maintenance.

3. Design Concept for Implementation Schedule

For smooth implementation of the Project to be carried out by Japan's Grant Aid Assistance, the Client, BMD should be fully conversant with the required procedures. This Project will be third project of BMD under Japan's Grant Aid Assistance and also the previous projects were implemented and completed within a single fiscal year as the same as this Project. Therefore, BMD is very familiar with a project to be implemented under Japan's Grant Aid Assistance and has a good understanding on all the necessary procedures.

Regarding the implementation schedule of the Project, actually, there is no sufficient time spare. Because the expiry date of the Exchange of Notes for an implementation stage will be by March, 1999 and the implementation period is supposed to be required for 13 months after signing of a contract between the Client (BMD) and a Japanese contractor. To avoid the Project delay and to keep the time schedule, the cooperation of both countries, accordingly, is essential to smooth project implementation and the Consultant should then coordinate closely in connection with advance procedures and preparations together with the Client.

4. Design Conditions

1) Meteorological System

a. Meteorological radar system

① Meteorological radar observation network

i) The 2 existing radars and the 2 new radars to be supplied will make the meteorological radar observation network in Bangladesh.

ii) The radar network will include the newly established microwave link as well as the existing microwave links operated by BTTB for transmitting radar imagery transformed into digital signal.

iii) Components of meteorological radar observation network
The system, as outlined below, will be connected to the newly established microwave link as well as the existing telecommunication links.

- Rangpur meteorological radar system
- Dhaka meteorological radar system
- The existing Cox's Bazar meteorological radar system
- The existing Khepupara meteorological radar system
- Radar imagery display system at Dhaka International Airport
- Radar imagery display system at Flood Forecasting & Warning Centre in Dhaka
- Radar imagery display system at Bangladesh TV Centre in Dhaka
- Radar imagery display system at National Disaster Committee (Prime Minister Office)
- Meteorological Information Broadcasting system at Bangladesh TV Centre

② Meteorological Radar System

i) In the interest of standardization between the meteorological observation method and the equipment operations, the meteorological radars to be established under this Project will be made fully compatible with the existing weather radars at Cox's Bazar and Khepupara.

ii) The detecting capability of meteorological radar is determined by such factors as height of installed radar antenna, angle of radar beam transmitted from the antenna (radar beam angle), curvature of the earth and height of meteorological phenomena bearing precipitation (height of cumulonimbus cloud normally is 6 ~ 12 km). For surveillance and monitoring of hazardous meteorological phenomena, the meteorological radar will be designed to have 400 Km radius observation range.

iii) For purposes of radar imageries composite processing, the observation data must be made uniform. To accomplish this, as the same frequency and S-band system (wave length : approximately 10 cm) as the existing radar systems will be adopted to meteorological radar systems to be supplied for the Project.

b. Radar imagery composition & processing system

- For making composite radar imagery, the radar imagery data observed by the 2 existing and 2 new radar systems will be used.

- Enough capability for displaying the radar imageries on a display monitor will be provided.

- Provision of appropriate capability for composing radar imageries from either 2 or 4 stations and for displaying these composite imageries on a display monitor will be considered.

- Future expansion possibility of meteorological observation activities such as an increase in the number of meteorological radars, transmitted data and expanded data processing requirements will be considered.

c. Meteorological satellite imagery receiving system

The technical specifications of meteorological satellite imagery receiving systems of GMS and NOAA to be supplied under the Project shall meet the standard of each meteorological satellite and will be as follows.

- The GMS receiving system can receive high resolution data (S-VISSR).

- The NOAA receiving system can receive high resolution data (HRPT).

- At Storm Warning Centre, Dhaka (24° N, 90° E), meteorological satellite imagery of GMS and NOAA can be received appropriately.

- Allowable wind speed for antenna systems shall be 70m/s and a safety factor shall be added to structural design.

- Satellite imagery printing function will be given to the meteorological satellite imagery receiving systems.

d. Meteorological data satellite communication system

The meteorological data satellite communication system to be installed at BMD head office is one of Very Small Aperture Terminal Systems (V-SAT), which is operated by International Civil Aviation Organization (ICAO) and named as World Area Forecasting System - Satellite Distribution System (WAFS-SADIS). For transmitting the weather forecast products and the real-time meteorological data demanded for preparation of weather forecasts and safe operation of aviation from World Area Forecasting Centre in U.K and for receiving observed data from many ground stations, WAFS-SADIS uses the communication satellite, INTELSAT 604 located in the sky of Indian Ocean.

The system shall satisfy the following requirements.

- To meet the standards of International Civil Aviation Organization (ICAO)

- To have enough capability of data input and transmission to the satellite

- To receive SADIS Products as follows.

  - GRIB code data
  - T4 fax charts
  - OPMET DATA (TAFs, METARs, special AIREPs and SIGMETs)

e. Automatic weather observation system

Automatic weather observation system to be installed on a side of the runway at Dhaka International Airport will consist of the following equipment. For receiving all necessary data from this system at the airport meteorological office and airport control tower, UHF telecommunication link will be established under the Project. The functions of all the necessary equipment shall meet the following requirements as described below.

- To meet the standards of World Meteorological Organization and International Civil Aviation Organization (ICAO)

- To receive the following data of observation elements.

  - Wind speed & direction
  - Temperature
  - Humidity
  - Precipitation
  - Pressure
  - Runway Visual Range (RVR)
  - Cloud base height

f. Meteorological data processing system

For data processing and analyzing for preparation of weather forecast, domestic meteorological data will manually be input and necessary international meteorological data will be selected from data base field automatically and also a weather chart in accordance with the international meteorological code shall be printed out by the meteorological data processing system.

g. Meteorological information distribution system

For provision of radar & satellite imageries and weather charts from BMD head office through meteorological telecommunication systems (microwave links), this system will be supplied at Dhaka International Airport, Flood Forecasting & Warning Centre (FF&WC), Dhaka and Bangladesh TV Centre and Prime Minister's Secretariat. Additionally, data archiving and replaying functions will be added to this system.

h. Video signal converting system

In order to telecast meteorological information to the general public for reduction of natural disasters, video signal converting system will be installed at Bangladesh TV Centre.
The video signal converting system will convert digital signal from meteorological information distribution system to video signal for TV broadcasting as a weather program.

i. Meteorological telecommunication system

The meteorological telecommunication system to be established under the Project must meet the ITU-R recommendations of International Telecommunication Union (ITU).

① Circuit quality

Circuit quality of the digital radio link must conform to the ITU-R recommendation of F.556 (7/86), while bit error rates (hereinafter referred to as "BER") must satisfy the following conditions.

i) The number of duration when the BER exceeds 10^{-3} not exceed 0.054% in any month.
ii) The number of duration when the BER exceeds 10^{-6} not exceed 0.4 % in any month.
iii) The error duration in any month not exceed 0.32%.

② Radio frequency

The radio frequency shall be in the 2 GHz and 400MHz band and also shall meet the ITU-R recommendation of F.283-5 (6/90).

③ Height of Antenna

The height of the antenna shall be considered, in so far as possible, an effective earth radius coefficient of K= 4/3 and the clearance coefficient which shall be at least 1.0.

④ Design Specifications

Transmission links to be established	Distance of the links
a. Rangpur BMD Observation site ~ Rangpur BTTB exchange station	2.5km
b. IDB-BISEW building at Agargaon ~ Storm Warning Centre, Dhaka BMD	0.3km
c. Dhaka BMD head office ~ Bangladesh TV Centre, Dhaka	4.9km
d. Dhaka BMD head office ~ Dhaka International Airport	8.1km
e. Dhaka International Airport ~ Automatic Weather Observation Station (in the premises of the International Airport)	1.2km
f. Dhaka BMD head office ~Prime Minister's Secretariat	1.6km

Transmission links of "a., b., c., d. & f" as described above shall meet the following requirements.

- Radio frequency : 2GHz band
- Transmission capacity : 2 Mbps
- Modulation method : 4 PSK
- Transmitter output : + 27 dBm
- Minimum receiving input (10^{-3} BER) : - 93.5 dBm
- Antenna
  - Diameter : 0.9 m (a., b & f.), 1.2 m (c.) or 1.8 m (d.)
  - Gain : 21.7 dB, 23.7 dB or 27.0 dB

Transmission link of "e." as described above shall meet the following requirements.

- Radio frequency : 400MHz band
- Transmission capacity : 1200bps
- Modulation method : Phase modulation or equivalent
- Transmitter output : + 20 dBm
- Minimum receiving input (10^{-3} BER) : - 98 dBm

The antenna gain shows a standard value, as determined in accordance with the diameter and radio frequency. Minimum receiving input shows an average value.

DC power supply is intended to furnish power from a storage battery to prevent interruptions in power supply to the newly installed digital radio equipment in case of commercial power failure. Accordingly, the storage battery will be capable of supplying the power for 4 hours. The Project sites include Dhaka International Airport, where installation of automatic weather

observation system and establishment of telecommunication link between BMD head office and the airport terminal building will be held under the Project and so serious consideration must be given to achieving mutual accommodation between the equipment to be installed and the existing facilities, particularly as regards the airport facilities, control tower, intra-airport communication, radio facilities and underground lines, as well as aircraft landing, takeoff, and taxiing patterns.

2) Design Conditions for the Radar Tower Building

The following design conditions will be considered in connection with the facility and equipment plans.

a. Facility Plan

In connection with the meteorological radar building plan, sufficient space must be provided to allow BMD staff for working efficiently and also to appropriately accommodate and utilize the systems and equipment at both the new and existing facilities.

The appropriate size and scale of radar tower building will be determined on the basis of the staff, system and equipment required to carry out the functions, role and operations of a meteorological radar system for accurate weather observation.

The number of rooms and floor areas of the radar tower building will be designed on the basis of the administration structure, personnel requirements, systems, equipment, and operating space established under this Project, taking into account the present conditions of BMD (i.e., in terms of the existing systems, equipment, and operating space).

b. Building Equipment Plan

The power supply requirements for the building must be sufficient to support the systems and equipment needs established under the Project, along with general lighting, air-conditioning systems, and other equipment for the building.

In assessing the capacity of air-conditioning systems, the heating values of the personnel using the space, the newly established systems and equipment, lighting and other heat-generating items and thereby determine the methods and types of air-conditioning systems.

With regard to the power supply systems, in order to carry out the role of the building to operate around the clock throughout the year, conducting radar observation and issuing forecasts and warnings even during natural disasters, the power supply system must include

an uninterrupted power supply system and engine generator system to ensure proper operation of the meteorological systems and equipment.

2 - 3 - 2 Basic Design

1. Equipment Plan

The Project consists of replacement of Dhaka existing radar system and establishment of new radar system at Rangpur incorporating with the existing radar systems at Cox's Bazar and Khepupara to establish the radar observation network in Bangladesh for processing and making composite radar imageries. By establishing a meteorological radar network incorporating the 2 new radar systems and the 2 existing radar systems, it will be possible to monitor cyclone, heavy rain and other meteorological phenomena in the whole Bangladesh.

In addition, for improving BMD's capability of meteorological observation and data ingestion & processing and also strengthening the meteorological forecasting and warning, the following systems will be supplied and installed under the Project.

1) Meteorological satellite imagery receiving systems of GMS and NOAA, meteorological data satellite communication system (WAFS-SADIS) and meteorological data processing system at Dhaka head office.
2) Automatic weather observation system at Dhaka International Airport.
3) Meteorological telecommunication links at necessary sections.

In order to disseminate the Project effect and benefit to the Bangladesh nation as soon as possible through improvement of meteorological dissemination capability of Bangladesh for reduction of natural disasters, meteorological information distribution system will be installed at Dhaka International Airport, Flood Forecasting & Warning Centre (FF&WC), Bangladesh and National Disaster Committee (Prime Minister Office) and also this system including video signal converting system will be installed at Bangladesh TV Centre.

Regarding the equipment designation, specifications, quantity and purpose of all the meteorological equipment to be supplied under the Project are described in "Major Equipment Lists" attached hereunder.

1. Weather Radar System (Dhaka and Rangupur)

Equipment Designation	Specifications	Quantity	Purpose
Radome	Diameter: about 9m, Spherical shape , Design wind velocity: Color: White 70 m/s + Safety Factor	2	To protect the radar antenna and maintenance personnel from severe weather conditions. A lightning arrester will be attached to the top of the radome for protection of the radar system.
Antenna Assembly	Frequency Band: S band Diameter about 5m Parabolic antenna Gain: 43 dB or more	2	The parabolic antenna will rotate over an azimuth of 360° and at an angle of elevation of 0~90° in either direction. The waves transmitted from the transmitter/ receiver will be radiated in pencil-beam form into the atmosphere, receive the scattered waves returning from the precipitation particles, and return these waves back to the transmitter/receiver unit.
Antenna Control Unit	Horizontal scan : 360°, 4 rpm Vertical scan : 0 ~ 90° Angle precision (accuracy) :0. 3° or less	2	Based on an antenna control signal pursuant to the radar observation mode, this unit drives the horizontal and vertical antenna motors, controlling the azimuth and elevation of the antenna.
Transmitter / Receiver	Transmitting frequency:2700~2900MHz Transmitting power : 500 kW Pulse repetition frequency : 260 Hz Minimum detectable signal : -110 dBm or less Dynamic range : 70 dB or more	2	The microwave power emitted at the transmitter section is sent to the antenna as the transmitting wave, while a video signal is obtained in response to the strength of the receiver wave. After being converted to a digital value, the video signal is outputted to the signal processor (digital video integrator and processor).
Digital Video Integrator and Processor (DVIP)	Digital video input : 12 bits Ground clutter rejection : 40 dB or more Range correction : 4 ~ 175 Km Averaging over range / azimuth Coordinate transformation from polar to Cartesian Output data: 8 bits, 400 km range	2	After converting the video signal from the receiver into a digital value, ground echo rejection, averaging of the received signal echo intensity correction for distance, and other processing is performed, yielding 8-bit video data, which is then inputted into the data transmission apparatus.
Radar Image Display	Serial port : Supporting Ethernet (desk top type) CPU performance : Pentium100 MHz or more Hard disk : 1GB or more Memory : 128 Mbyte or more Serial ports : 2 or more CRT size : 20 " or larger with mouse and keyboard	2	This equipment will receive the observed image data or composite processed images and will superimpose this data, along with map and range marks, for display. It will also accumulate, play back, and print the imagery received.

Equipment Designation	Specifications	Quantity	Purpose
Waveguide	Loss: 0.07 dB/ m	2	To propagate the microwave signal between the antenna and T/R without loss.
Power Distribution Board	Power input : AC 230 V, single-phrase, 50 Hz Power output : AC 200 V, single-phase, 50 Hz AC 100 V, single-phase, 50 Hz using a no-fuse breaker.	2	The commercial power will be outputted to the automated voltage regulator and the uninterrupted power supply unit so as to distribute a stabilized power supply from these units to the various equipment items in the radar assembly.
Automatic Voltage Regulator	Capacity : about 10 kVA Input : AC 240V ± 20%, single-phase, 50 Hz Output : AC 200V ± 3 %, single-phase, 50Hz	2	This item will be used to stabilize power supply voltage to insure stable operation of the radar assembly
Uninterrupted Power Supply	Capacity : about 15 kVA Input : AC 100V ± 10%, single phase, 50 Hz Output : AC 100V ± 2 %, single-phase, 50Hz Backup time : at least 10 minutes at full load	2	Short-term power backup will be provided to prevent operating errors or damage to the radar facilities as a consequence of brief interruptions in the commercial power supply.

2. Meteorological Data Processing & Display System

2.1 BMD Head Office, Dhaka

Equipment Designation	Specifications	Quantity	Purpose
Composite Processor Unit	Serial port : Supporting Ethernet (desk-top type) CPU performance : Pentium 150 MHz or more Hard disk : 2 GB or more Memory : 128 Mbyte or more Serial ports : 2 or more SCSI control driver software CRT : 20 inch color or more	2	This unit will receive a number of radar images, as relayed from the communication control apparatus, and do composite processing of the received images and will superitmpose this data, along with map and range marks, for display. These image composites will then be sent on to the various image display monitors via the communication control unit and be archived in the storage.
Radar Image Display Unit	Serial port : Supporting Ethernet (desk top type) CPU performance : Pentium100 MHz or more Hard disk : 2GB or more Memory : 128 Mbyte or more Serial ports : 2 or more CPT size : 20 " or larger with mouse and keyboard	3	This equipment will receive the observed image data or composite processed images from Composite Processor Unit and be able to select to display them. It will also accumulate, play back, and print the imagery received.
Meteorological Data Processing &Analisis Unit	Serial port : supporting Ethernet (rack-mount type) CPU performance : Pentium160 MHz or more Hard disk : 2G byte or more Memory : 128 Mbyte or more CRT : 20 inch color or more with software	2	1. This unit will receive meteorological data from inside and outsied of the country through existing network and plot them on the map for the forecaster to be able to make weather map. 2. Forecaster will be able to make products such as weather chart, forecast and warning by using this unit.
Communication Control Unit	Serial port : Supporting Ethernet (rack-mount type) CPU performance : Pentium160 MHz or more Hard disk : 1G byte or more Memory : 32 Mbyte or more Serial ports : 6 or more Built in synchronous telecommunication board Pass Slot PCI x 1 ISA x 6	2	Composite data are received from the signal processor, with the image data distributed to various image display monitors. The image data, as processed by the composite processor, are received and sent on to the various image display monitors.
Computer Network System	Ethernet	1	Each system will be connected each other by Ethernet LAN
Uninterrupted Power Supply	Capacity : 5 kVA Input : AC 100 V ± 10 %, single-phase, 50 Hz Output : AC 100V ± 2 %, single-phase, 50 Hz Backup time : 5 minutes	4	To protect computer equipment, fitted with a hard disk, from total blackout or short interruptions in the commercial power supply.

2.2 Weather Information Display System (FF&WC, BTV, Dhaka International Airport, Prime Minister's Secretariat

Equipment Designation	Specifications	Quantity	Purpose
Radar Image Display Unit	Supporting Serial port CPU performance : Pentium150 MHz or more Hard disk : 2GB or more FD Drive : 1.44 MB Memory : 128 Mbyte or more Serial ports : 2 or more CRT size : 20 inch or more	5	This equipment will receive the observed image data or composite processed images from Composite Processor Unit at BMD and display and archive those data. It will accumulate, play back, and print out the imageries received.
Sattelite Image Display Unit	Serial port : Supporting Ethernet (desk top type) CPU performance : Pentium150 MHz or more Hard disk : 2GB or more Memory : 128 Mbyte or more Serial ports : 2 or more CPT size : 20 " or larger with mouse and keyboard	4	This equipment will receive, display and archive satellite imagery information.
Meteorological Information Display Unit	Supporting Serial port CPU performance : Pentium150 MHz or more Hard disk : 2GB or more FD Drive : 1.44 MB Memory : 64 Mbyte or more Serial ports : 2 or more CPT size : 20 " or larger	4	This equipment will receive, display and archive satellite imageries and the meteorological information.

3. Satellite Data Receiving System (BMD Head Office, Dhaka)

Equipment	Specifications	Quantity	Purpose
High-resolution satellite data receiver for GMS	1. Allowable wind velocity: 70m/s + Safety Factor, 2. Adopting S-VISSR, GMS-5, 3. To display visible/infrared image and sea surface temperature distribution in false color, zoom up function, image enhancement, map overlay, latitude/longitude grid overlay 4. Sequencial image display / Cold area rate indication / Dvorak Index / LOG 10 / Cyclone trucking function/ Coordinate conversion. 5. Ethernet LAN connection / Image printing function / Image format conversion / Data receiving schedule management /Auto Data Save Function	1	To receive S-VISSR data from GMS automatically and display, analize, archive and print out those high resolution data for assisting the forcast work.
High-resolution satellite data receiver for NOAA	1. Allowable wind velocity : 70m/s, 2. Adopting HRPT, 3. To display visible/infrared image and sea surface temperature distribution in false color, zoom up function, image enhancement, map overlay, latitude/longitude grid overlay 4. Sequencial image display / Cold area rate indication / Dvorak Index / LOG 10 / Cyclone trucking function / Coordinate conversion / TOVS data analisis. 5. Ethernet LAN connection / Image printing function / Image format conversion / Data receiving schedule management /Auto Data Save	1	To receive HRPT data from NOAA automatically and make correction, display, analize, archive and print out those high resolution data for assisting the forcast work.

4. Meteorological Data Satellite Communication System (BMD Head Office, Dhaka)

Equipment	Specifications	Quantity	Purpose
WAFS-SADIS satellite data Communication System	• All the data delivered from WAFS-SADIS system (GRIB, Charts, OPMET, etc.) shall be received and displayed in this system. • Parabolic antenna; Diameter : approx. 2.4m dia. Design wind velocity: 70 m/s + Safety Factor • VSAT Receiving System (conforming to ICAO Standard) • Data Processing Unit Protocol : X.25 Pentium : 150 MHz or more Memory : 48 Mbyte or more Hard disk : 2GB or more FD Drive : 1.44 MB Memory : 64 Mbyte or more CPT size : 17 " or larger Serial port : Supporting Ethernet Color printer : 1 sheet / minute or more	1	This system will exchange the meteorological data with WAFS system through satellite and display receiving data on the monitor.

5. Video Signal Converting System (Bangladesh TV Centre, Dhaka)

Equipment Designation	Specifications	Quantity	Purpose
Scan Convertr	RGB --> PAL Conversion Input : RGB Signal (VGA) Output : PAL-b 625/50, CCVS(IPP) Input terminal : 2 port or more Output terminal : 5 port or more	1	To convert the RGB video signal from PC to PAL video signal for TV broadcasting.
Wave form Monitor Equipment	Input: PAL - b 625/50, CCVS(IPP)	1	To monitor the wave of the output video signal from the Scan Convertor
Video Monitor Equipment	Input: PAL - b 625/50, CCVS(IPP) CRT: 14 inch or more	1	To monitor the video picture for TV broadcasting.

6. Automatic Meteorological Observation System (Dhaka International Airport)

Equipment	Specifications	Quantity	Purpose
Automatic Meteorological Observation System	•Observation items : atmospheric pressure, temperature, humidity, wind direction & speed and precipitation, RVR, Cloud base height. •Observation method : Comfort to standard of WMO & ICAO.	1	This system will be installed near the landing point of the runway and observes left mentioned items automatically.
Primary Data Processor Unit	Serial port : Supporting Ethernet	1	This unit will be installed in the shed near the AWS and transmit the observing data of AWS to Secondary Data Processor.
Secondary Data Processor Unit	Serial port : Supporting Ethernet CPU performance : Pentium : 150 MHz or more Hard disk : 2GB or more Memory : 128 Mbyte or more Data recorder should be included.	1	This unit will be installed in Met Office of Airport. This unit will receive the observed data of AWS from Primary Data Processor Unit and processes, deplays, archives, transmit those data

7. Communication System

Equipment Designation	Specifications	Quantity	Purpose
Multiplex Radio Equipment	Frequency range : 2 GHz band Line capacity : 2 Mbps Transmitting power (output) : 1W Number of Cnannel : 8 ch or more Modulation method : 4PSK	10	To link up the following stations by microwave radio link; 1.Rangpur Radar Site ~ Rangpur BTTB 2. BMD HQ ~ Dhaka Radar Site 3. BMD HQ ~ Bangladesh TV 4. BMD HQ ~ Dhaka International Airport 5. BMD HQ ~ Prime Minister's Secretariat
Multiplex Carrier Teminal Equipment	Power input and output capacity for at least 4 transmission lines in 1st group (equivalent to 30 CH converted at 64 kb/s) Digital interface (64 kb / s) Digital interface (V. 24) 4W analog interface	7	This equipment will convert the data and audio signals to PCM symbols and multiplex them to 2,048 Mb / s.
DC Power Supply	AC Input : 220V ± 10% Frequency : 50Hz Efficiency : 80% Output power should be enough for installed equipment	6	The UPS is as a backup for the equipment during power stoppage.
Storage Battery	Noise lebel : 100mVp-p or less		At normal times, it will furnish DC power to the load at the rectifier while also recharging the battery. During power stoppage, power will be supplied to the load from the storage battery.
Isolation Transformer	Voltage: 220V, 50Hz Maximum Voltage: AC10kV, 1min.		The isolation transformer will prevent movement of the induced lightning surge to the communication equipment, thereby preventing accidental interference with this equipment.
UHF Data Link Equipment	Frequency range : 400MHz band Line capacity : 1200 bps	4	To link up between AWS beside runway and Control tower at Dhaka International Airport

2. Basic Facility Plan

1) Site Layout Plan

In a weather radar tower building, when radar observers and forecasters work at the display monitors and radar operating consoles, they typically face north, since this direction is considered optimum in terms of operating efficiency and directional sense. This direction clearly facilitates the efficient conduct of radar operations, since the screen surface on which radar images are displayed on monitors and consoles is oriented to the north, which coincides with the facing direction preferred by operators and forecasters. Accordingly, the layout plans for the radar tower building at Rangpur will have the backs of the radar display monitors and operating consoles facing north.

• Rangpur Site

As already noted, Rangpur site is located in the premises of the BMD's Rangpur Observatory. The site is virtually flat and sufficiently large to accommodate a radar tower building construction. Regarding the site infrastructure, power supply and telephone line are available, however, there is no water supply facility, so that the existing facility must presently rely on well water. For this reason, after completion of the building construction, a well for the building construction work will be used as water supply facility for obtaining water for the radar tower building. With regard to drainage (rain water) and sewage disposal in the Project site, rain water will directly be sunk from drainage pit into the ground and also the sewage primarily treated by septic tank will pass into the ground.

2) Architectural Design

a. Floor Plan

The floor plan will be virtually symmetrical, making possible a structural design that is safe and avoids eccentricity. The floor plan for the central portion of the tower building will allow the various rooms to be arranged more flexibility, since all structures such as columns and beams will not protrude into the internal staircase, which is also to serve as evacuation routes. Construction methods and materials have been employed in common local use and the buildings will be of standard grade in Bangladesh.

- Outline of the Room and Equipment Layout for the Radar Tower Buildings

Name of Room	Floor Area (m^2)	No. of staff	Equipment and room function
Radar observation desk	144.00	—	Antenna of microwave system, radar antenna and radome to be installed
Roof floor	121.60	—	Outside unit for AC system (Concrete foundation)
Radar equipment room	34.20	Daytime:4 Night:3	2 AC (15,000 Kcal), radar transmitter/receiver, AVR, UPS, signal processing equipment
Radar observation room	34.20	—	2 AC (15,000 Kcal), radar operating console & display monitor, telecommunication equipment, UPS
Analysis room	22.50	3	Analysis of radar echo sketches for areas unable to receive radar data on-line, preparation of telegraphic messages
Data room	11.70	—	For analyzed data and floppy disk & MO storage
Maintenance room	22.50	—	For storage of spare parts, measuring equipment, and maintenance tools, space for repairing work
Storage room	9.90	—	For storage of oil, grease, other expendables, cleaning gear and spare parts for the building
Electrical room	8.68	—	Main power board, distribution board and cable racks
Generator room	31.92	—	Standby generator, peripheral devices, and service tank
Pump room	6.20	—	Water-intake tank, pumps and inspection space
Tea kitchen	7.50	1~2	Water heater, kitchen facilities, cupboard
Tools room	3.85	—	For storage of maintenance tools
Lavatory	4.50	—	————
Common area	45.55	—	Corridor, Staircase, P.S
TOTAL	**243.20**		

- Calculating Bases for Determining Room Area

Name of room	Room Area (m^2)	Calculation Bases for Room Area
Radar observation deck	144.00	For installation of radar antenna and radome and also for maintenance
Roof floor	121.60	For installation of outside unit for AC system (Concrete foundation) and outside stairs
Radar equipment room	34.20	Installation space for radar systems and working space (7~8m^2/person ×4 persons≒30 m^2).
Radar observation room	34.20	Space for installation of radar systems and working space (7~8m^2/person ×4 persons≒30 m^2).
Analysis room	22.50	Working space (6~7m^2/person ×3 persons≒20 m^2).
Data room	11.70	Storage space for meteorological observation data for 10 years.
Maintenance room	22.50	Storage space for spare parts, special tools, etc. : 10 m^2 Mechanical repairing space : 10 m^2 for 2 persons.
Storage room	9.90	Storage space for spare parts for radar tower building, cleaning things, oil, etc. ≒11m^2
Electricity room	8.68	Installation space for power distribution boards, cable racks, etc. ≒10m^2
Generator room	31.92	Installation space for engine generator, day tank and automatic switch board. ≒30m^2
Pump room	6.20	Installation and maintenance space for pumps, switches, and FRP water tank (0.5 m^3).
Tea kitchen	7.50	Space for kitchen sink and shelf and preparation of drinks. ≒7.0m^2
Tools room	3.85	Storage space for tools. ≒4.0m^2
Lavatory	4.50	
Common area	45.55	Corridor, Staircase, P.S

b) Sectional Plan:

① Height of Tower Building and Floors

- Rangpur Site

There are tall trees reaching a height of 20m in Rangpur project site and 31m high steel towers of electricity transmission adjoining the site. The height of a radar tower building to be constructed, therefore, must be sufficient to clear the tops of those 31m high steel towers and an antenna of the radar system will be 5m in diameter. Since the above conditions, an additional clearance of 1m will be required, and so at least 35m will be necessary for the height of antenna center from the ground level. Regarding calculation of standard height between structural slabs, taking into consideration on proper height and dimensions of each equipment of radar system, wiring and cabling space behind the ceiling, etc., the radar equipment room and observation room should be 3.5 m. This height, therefore, has been made the standard height for the upper floors of the building. Considering protection from high temperature and humidity for power supply system to be installed, the electricity room located on ground floor will be given a slab height of 4m. Finally, considering heavy rainfall and potential flood damage and also due to the flood record, the height from the ground level to ground floor slabs has been set at 1.6m.

② Ceilings

In the radar equipment and observation rooms, the equipment must be protected against dust collecting above the cable rack. In addition, so as to improve the airtightness of these rooms as well as to reduce the equipment noise, the ceilings will be finished with acoustical boards. And, since both of these rooms are to be air-conditioned, the use of ceiling boards will be also be effective in terms of raising the efficiency of both cooling and heating operations. Ceiling height has, accordingly, been set at about 2.7 m, based on the dimensions of the intended equipment.

③ Radome and Rooms for Radar Equipment

Foundation of radome and radar antenna will be made a part of the slab of radar observation deck, so that the weight of the radar antenna will be borne by the beam

located at mid-portion of the slab.

For access to inside of the radome and the radar observation deck, external stairs will be will be provided form the roof floor.

④ Equipment Installation Method

In order to install all the equipment directly from outside into the radar equipment and observation rooms, a large opening will be necessary for bringing the equipment from outside. However, the large opening would be undesirable from the standpoint of airtightness and dust proofing. The equipment will, therefore, be brought in via an unloading balcony at the adjacent staircase landing. For lifting the equipment, 2-tons lifting hook will set at the upper part of this balcony.

c) Elevation Plan

The columns and beans will protrude to the outside, with an appealing elevation plan that enhances the structural design. In this way, since columns and beams will not protrude into the staircase, therefore, the staircase will be able to comfortably handle traffic in both directions.

d) Material Plan

Materials specified for both exterior and interior finishing are all available locally. They have been selected with a view to ease maintenance by BMD.

Exterior	
Roofs	Waterproof mortar t=30mm, Asphalt waterproofing, Insulation boards t=30mm, Protection concrete and Cement tiles
Exterior walls	Burnt clay bricks Cement sand mortar base t=25mm Synthetic resin emulsion spraying tile finish Skirtings : Concrete base, cement sand mortar t=20mm
Interior	
Floors	Porcelain tile Epoxy resin paint (dust-proof) Vinyl tile
Walls	Cement sand mortar Vinyl paint 100 square glazed tiles
Ceilings	Mended fair faced concrete vinyl paint Acoustic mineral board (suspended ceiling system)
Windows and Doors	
Exterior	Aluminum & Steel
Interior	Wooden

In consideration of maintenance by BMD for the radar tower building at Rangpur, all the necessary materials for construction of the building will locally procured in accordance with the following reasons.

External Finish

Roofs : Due to external temperatures are high, reaching 45° C, insulation boards t=30 mm are required.
Asphalt waterproofing is the most reliable waterproofing material which will be protected by protection concrete, mortar and cement tiles.

Exterior walls : Walls will apply cement sand mortar on structural bricks and colored cement splay finish. All materials are generally used locally, they are considered highly reliable in terms of this construction ease and accuracy.

Interior Finish

Floors : Materials have been selected on the basis of superior durability and ease of maintenance.
Porecalain tiles around the entrance hall and vinyl tiles in the other rooms have been selected. In rooms where dust must be avoided, a dust-proof paint finish has been specified.

Walls : Mortar (trowel-coated) has been chosen primarily for its durability. Vinyl paint will be applied for higher walt surfaces. 100 square glazed ceramic tiles will be laid in the rest rooms (1.5 m high from floor level).

Ceilings : In order to enhance the environment in rooms, acoustic mineral boards will be used and other rooms which will not require any ceiling board will be directly applied vinyl paint finish.

Windows and Doors

External : Steel and aluminum has been chosen throughout for reasons of durability, ease of handling, and accuracy and also easy local procurement.

Interior : Wooden with synthetic oil resin paint will be employed throughout for its handling ease during construction and from a maintenance standpoint.

3) Structural Design

a) Structural Design Standards

Constructions codes in Bangladesh have been determined in conformity with U.K. standards (BS), but independent structural standards have not yet been completed. Since British standards do not specifically address seismic considerations, it is recommended that calculations of seismic force be based particularly on U.S design standards, as contained in the UBC (United Building Code, 1982). Accordingly, with respect to seismic force, the structural design for the radar tower building will adopt these UBC standards, in the case of wind pressure and seismic force, exterior force will be determined on the basis of actual records. Moreover, reference has been made, as required, to the Japanese Construction Code as well as the standards of the Architectural Institute of Japan (AIJ).

b) Structural Type

Reinforced concrete has been nominated as structural type for the radar tower building because, locally reinforced concrete is most typical structural type in Bangladesh. The floor slabs are to be reinforced concrete while exterior walls and partition walls are to be burnt clay bricks (with a thickness of 226 mm).

c) Foundations

Large turned moment will occur because the height of radar tower including radome is 40.3m high from the ground level. Based on geological surveys at the proposed site in Rangpur, a suitable foundation bed for this radar tower building is available between 20 ~ 25m in depth form the ground level. Since above these reasons, 25m cast-in-place concrete piles in length will be required safely to support the building.

d) Structural design standards

• Stress calculations

Calculated based on an elasticity analysis

• Section design

The reinforced concrete structural design has been based on the calculation standards established by the Architects Institute of Japan (AIJ), applying the elastic design method.

e) Design loads and external pressure

• Dead load

Dead load calculation will include all of the structural and finishing materials. The estimated combined weight of the radome and radar antenna, which are to be mounted on the observation deck of the radar tower building as a special dead load, is approximately 4.5 tons.

• Live loads

Since virtually all the rooms in the radar tower building will have a storage function, either as equipment room or store room, live loads, with the exception of live loads of the roof and observation deck, will all be uniform. These loads, which are deemed to be identical to those for telecommunication equipment rooms in Japan, have been applied as follows.

Floor slab and small beams	:	500 kg / m^2
Other structure	:	400 kg / m^2
Foe seismic	:	300 kg / m^2

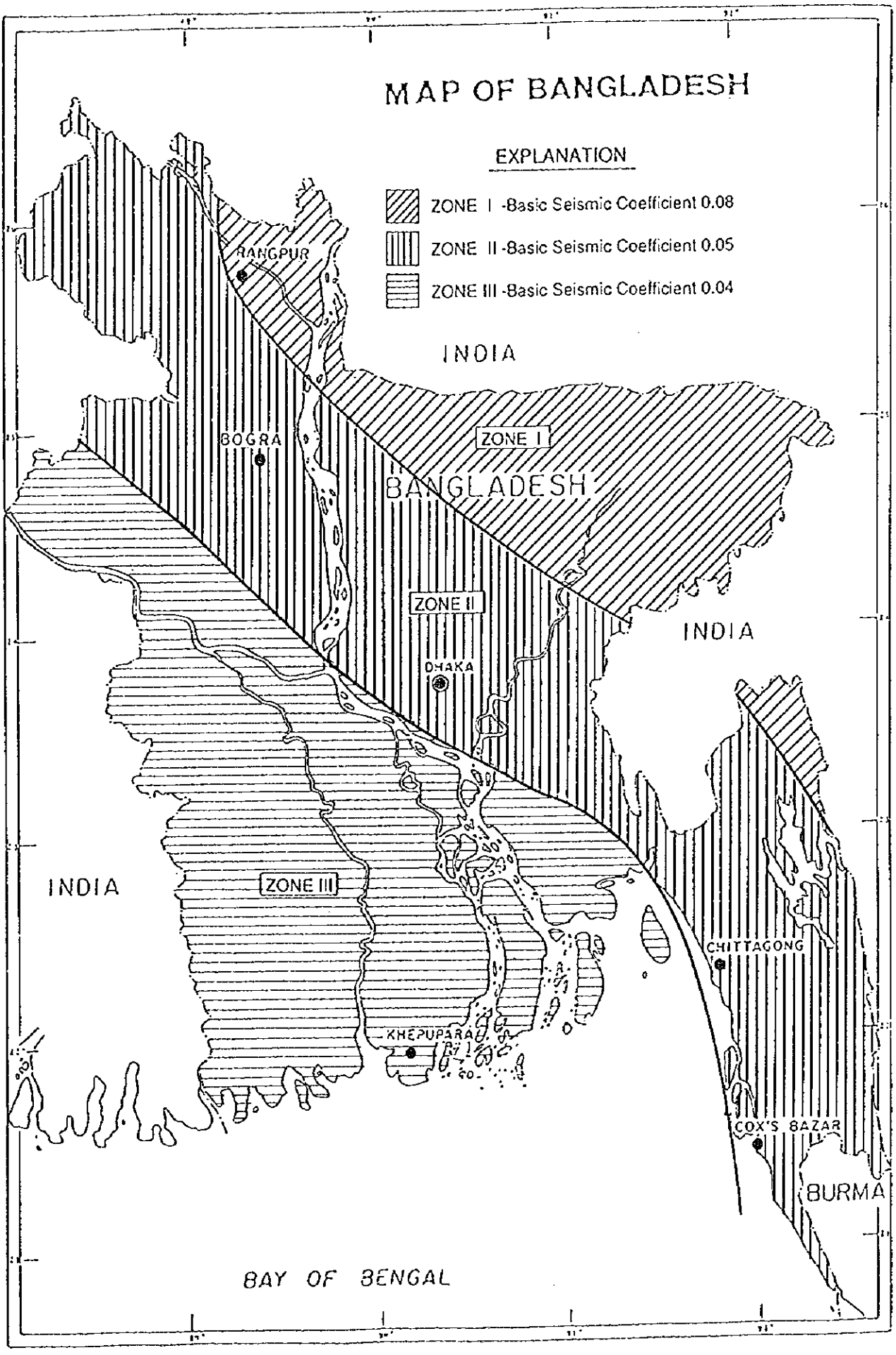
In estimating loads of the radar observation deck, an allowance has been made for the moving space of the maintenance workers servicing the radar radome. Based on the Building Standard Law of Japan, the above values have been reduced to 180, 130, and 60kg / m^2, respectively for these roof surfaces.

• Wind load

Previously, the highest instantaneous velocity of 178m/s was recorded in Dhaka when norwester attacked in Bangladesh. However, this record is very special case, therefore, for appropriate and economical structural design, wind speed of 70m/s using in Bangladesh will be applied as the design wind velocity for the structural design of the radar tower building and radar antenna & radome. In addition, appropriate safety factor shall be added to the structural design.

• Seismic force

Seismic force calculations have been based on American UBC design standards. A chart of the seismic zones of Bangladesh is attached hereinafter as "Seismic Zones of Bangladesh". Rangpur belongs to the "Zone I (Bangladesh major area)", with a seismic acceleration factor of g/5 ~ g/10. Therefore, Zonal Factor of Z = 1 as the seismic force calculation standard and a basic seismic coefficient of Co = 0.08 will be applied for Rangpur project site in accordance with "Seismic Zoning Map of Bangladesh and Outline of a Code for Earthquake Resistant Design of Structures" attached hereunder.



Seismic Zoning Map of Bangladesh and Outline of a Code for Earthquake Resistant Design of Structures

• Soil bearing capacity

Due to the results of the sub-surface soil investigation including boring tests at Rangpur project site, the ground water appeared approximately from depth of 2m form the ground level. Between 20 ~ 25m in depth form the ground level, there is a suitable foundation bed for the radar tower building. The foundation bed is medium dense sand-silt deposit with 18 ~ 20 N value. Since above these reasons, 25m cast-in-place concrete piles in length are essential safely to support the building against large turned moment occurrence due to the height of radar tower including radome.

f) Structural materials and strength

• Concrete

Ordinary concrete will be used, with a design strength of c = 210kg/cm^2 (with a 28-day compression strength).

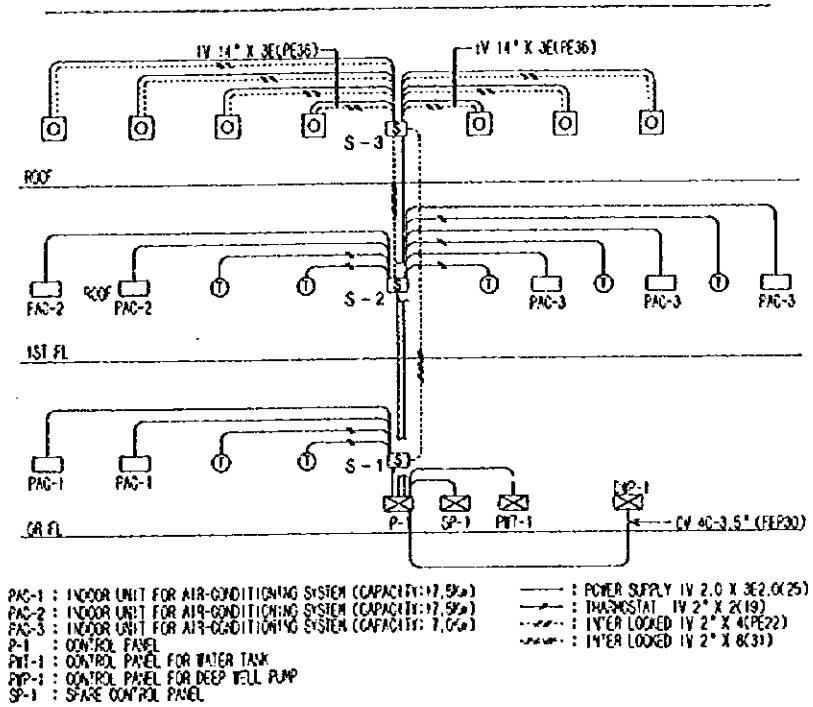
• Reinforced concrete

Reinforcing bars	Standard	Yield strength (MPa)
Deformed bars	Grade 235	235 MPa
	Grade 275	275 MPa

4) Electrical Facilities Design

a) Power intake facility

Power intake up to the project site including wiring and power connection to a low-voltage switch board are major scope of works to be taken by the Government of Bangladesh on his responsibility. In connection with the 415V and 50Hz low-voltage facilities, a hand-hole will be installed at the site, with a 150 mm underground pipe to be laid from this hand-hole to the low-voltage switchboard on the ground floor of the radar tower building.
The required power will be 2 circuit, 3-phase, 4-line, 50 Hz.



POWER WIRING DIAGRAM

b) Generating facility

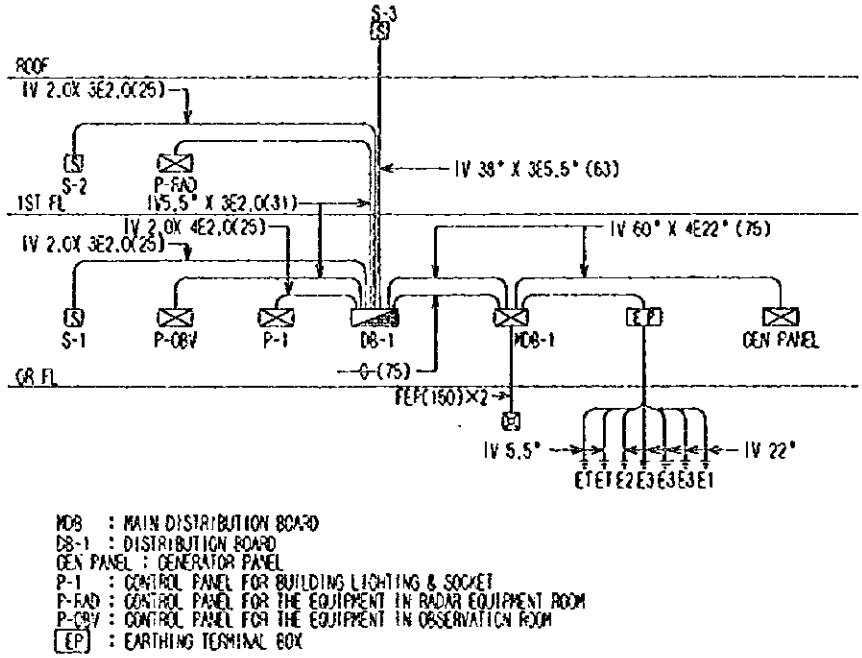
To ensure uninterrupted operation of the radar system, an engine generator will be installed at the site, as follows, as a back-up power source during the commercial power supply failure. For supporting the radar system on 12 hours operation, two service tanks of 400 liters will be supplied at the Rangpur project site

Capacity : 50 KVA

Voltage : 3 PH 4 W, 415V and 50 Hz

c) Trunk line and power facility

Both the exterior and underground pipes will be of polyethylene pipes against saline rot. Inside the building, steel piping will be employed. Air conditioning units will be individually controlled, while ceiling and ventilating fans will be manually operated.



MDB : MAIN DISTRIBUTION BOARD
DB-1 : DISTRIBUTION BOARD
GEN PANEL : GENERATOR PANEL
P-1 : CONTROL PANEL FOR BUILDING LIGHTING & SOCKET
P-FAD : CONTROL PANEL FOR THE EQUIPMENT IN RADAR EQUIPMENT ROOM
P-OBV : CONTROL PANEL FOR THE EQUIPMENT IN OBSERVATION ROOM
EP : EARTHING TERMINAL BOX

POEWR FEEDER DIAGRAM

d) Lighting and wall sockets

Wining work will conform to the Bangladesh technical standards for electrical facilities as well as British Standard and using voltage will be single-phase 240V, with all the equipment to be grounded. Steel pipes will be specified, as generally used in Bangladesh. Lighting fixtures will be mainly fluorescent, for their low power consumption, though incandescent fixtures will also be used to some extent, depending on the particular application. Obstruction lighting system for aviation will be placed on the top of radome.

The illuminance standard in the various rooms will be approximately as shown below.

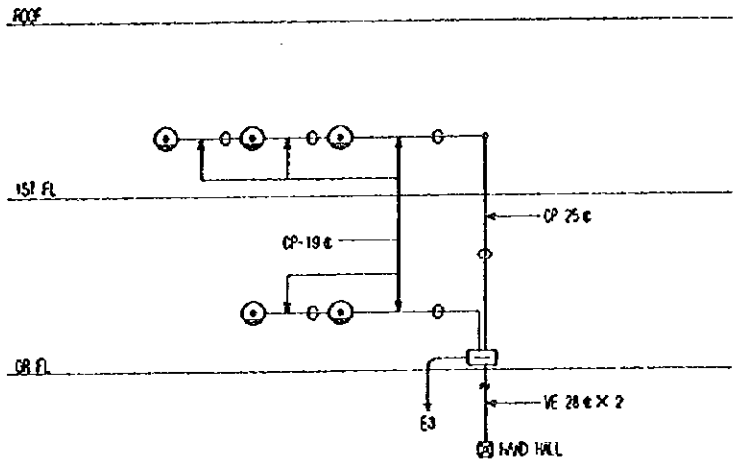
Radar equipment room:		400 lx
Observation room	:	400 lx

Data room	:	350 lx
Analysis room	:	350 lx
Forecasting room	:	400 lx
Generator room	:	250 lx
Pump room	:	300 lx
Electricity room	:	250 lx
Maintenance room	:	350 lx
Other rooms	:	200 lx

General-purpose sockets will be equipped with switches, with a 2-pronged socket to be placed at 8 m ~ 10 m intervals and also a separate socket will be provided for the wall ventilating fan.

e) Hollow pipes for telephone lines:

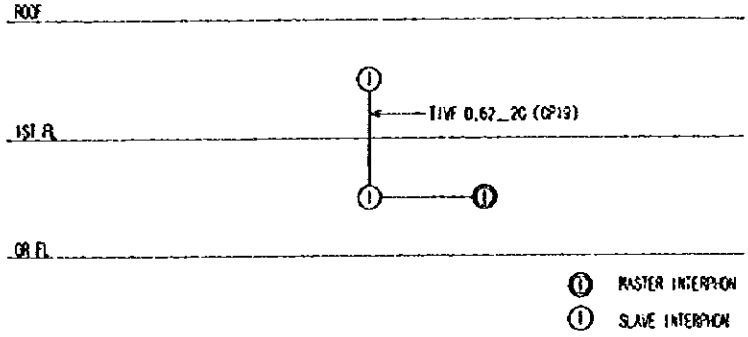
Hollow vinyl piping, with a diameter of at least 28 mm$^{\phi}$, will be installed from the hand-hole to be provided in the project site to the terminal board installed at the building. Hollow steel pipes will be laid between the terminal board and the various telephone outlets, with lead wires to be installed in the pipes. The wirings and related works will be performed by BTTB, with costs to be borne by the Government of Bangladesh.



TELEPHON DIAGRAM

f) Interphone equipment

Interphone equipment will be installed at the ground floor, outside entrance and in the various meteorological operating rooms (radar equipment, observation, etc.) as a security measure to permit night personnel to screen visitors.



INTERPHON DIAGRAM

g) Alarm facilities

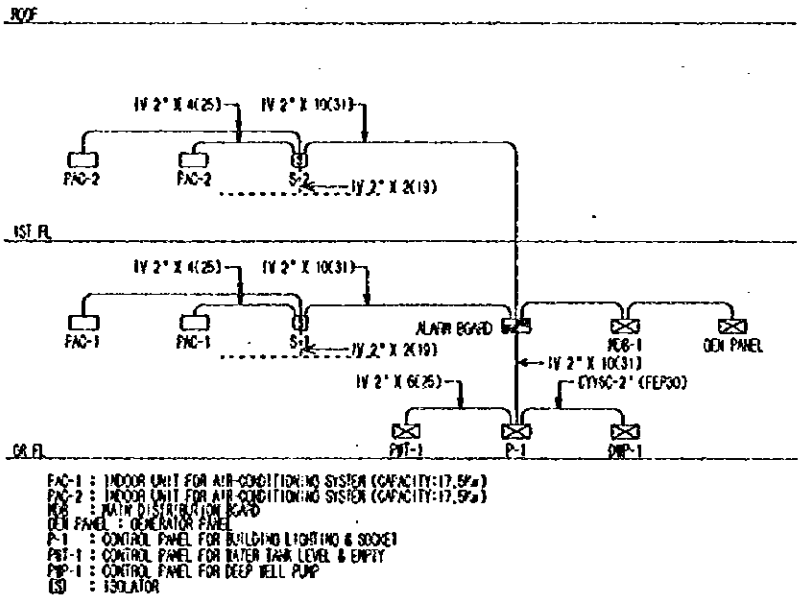
Alarms will be equipped with 20 terminals, the following warnings of the building equipment will be indicated.

No. 1 System failure and overheating of air-conditioning units.

No. 2 System failure and overheating of an engine generator facilities.

No.3 System failure and overheating of the low voltage switch boards.

No.4 Tank water levels at full, low and empty.



ALARM SYSTEM DIAGRAM

h) Grounding facilities

Grounding facility terminals for the equipment will be installed on each floor. PVC grounding wires of at least 5.5 sq. will be connected to the terminal board located on the ground floor. The equipment in the electricity room will be grounded via the terminal board, while the telephone equipment will be grounded by erecting a grounding pole and running a wire from there to the terminal board.

i) Lightning rod facilities

A connection box will be placed on the roof. Inside the building, copper wire 2.6mm$^{\phi}$×17 will be laid in a vinyl pipe VE 28mm$^{\phi}$ and grounded via the test terminal board. The connection from the lighting rod on top of the radome to the grounding box on the radar observation deck will be portion of the equipment installation work.

5) Water Supply, Drainage and Sanitary Fixture Design

a) Water supply system

Water intake into the site will be via a water meter. The Bangladesh government will be responsible for the intake works up to the 3/4" gate valve inside the project site. The water will be raised via a 3/4" water pipe to a FRP water tank located at pump room. The water will then be distributed by the pressure feed system.

b) Drainage system

Drainage will be divided into 2 systems as sewage and miscellaneous drainage. Rainwater drainage work will be included in the portion of building construction work. Sewage will primarily be treated in a septic tank and then permeated by a percolation pit into the ground. Miscellaneous drainage including rain water will be fed directly into a drainage pit.

c) Sanitary fixtures

Toilet seats, washbasins, and other types of sanitary fixtures will be installed where required.

d) Fire-fighting equipment will be installed as required

6) Air-conditioning and Ventilation Facility Design

Large size of air-conditioners will be installed in the radar equipment and radar observation rooms. Air-conditioning system will also be provided in the maintenance, data and analysis rooms.

a) Environmental conditions

- Exterior condition

  Hot season 45 °C D.B MAX

- Interior condition

  Hot season 25 °C D.B 50% R.H.

b) Air-conditioning equipment

The air conditioning equipment to be installed in the radar tower building will be package systems. They can be separately controlled due to the interest of energy conservation and from the standpoint of their intended use. The outside units for the air-conditioning systems will be installed on the roof of the building.

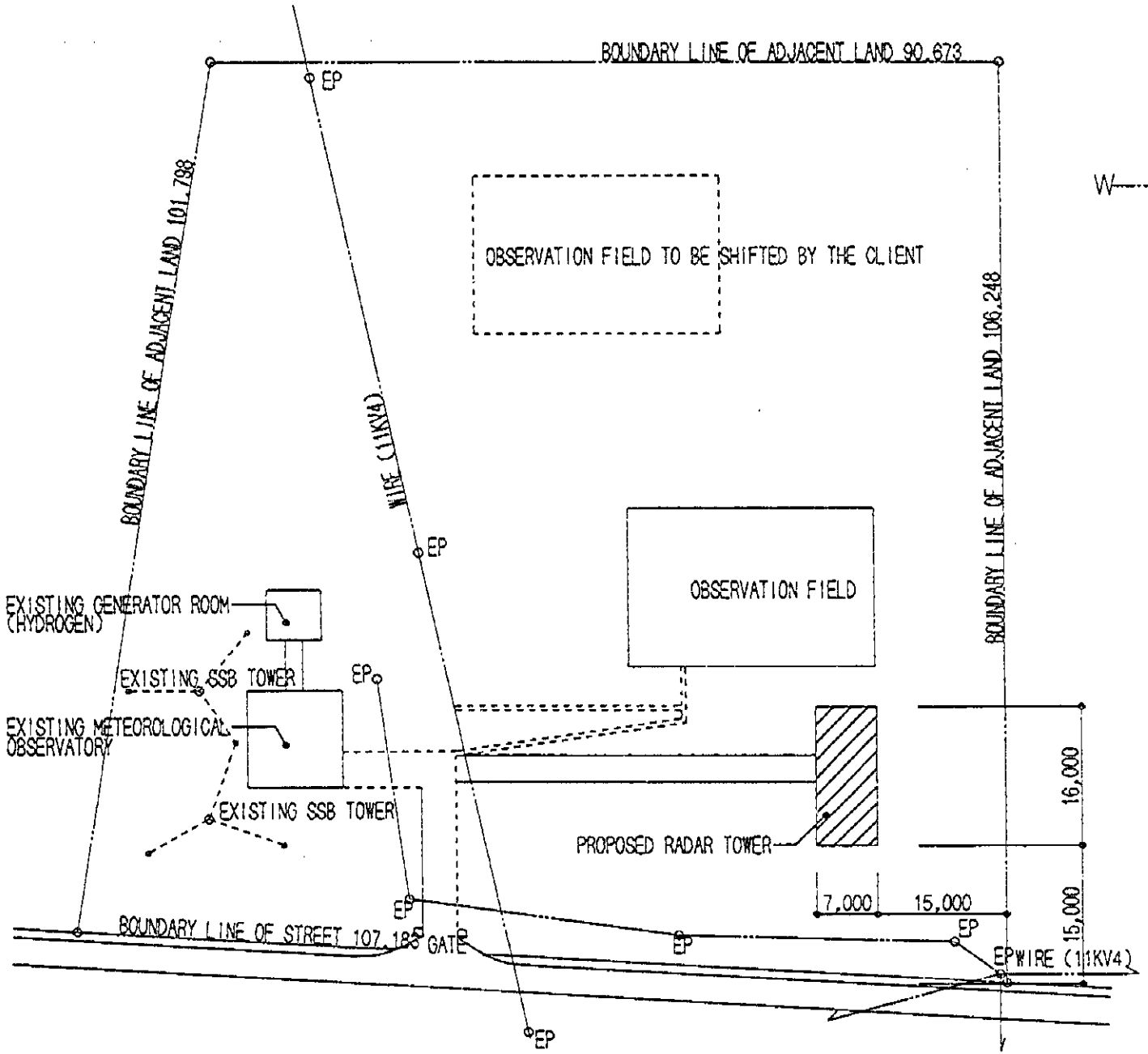
c) Ventilating equipment

Ceiling fans providing forced ventilation will be installed in tea-kitchen, lavatory and other rooms emitting offensive odors. Ventilation systems will also be installed in other rooms where it is deemed necessary to maintain an appropriate environment.

d) Basic Design Drawing

The basic design drawings are as follows.

SITE LAYOUT PLAN	A-01
FLOOR PLAN	A-02
ELEVATION AND SECTION	A-03
EQUIPMENT LAYOUT PLAN	A-04



JWA Japan Weather Association
International Affairs Dept. : Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170 Japan
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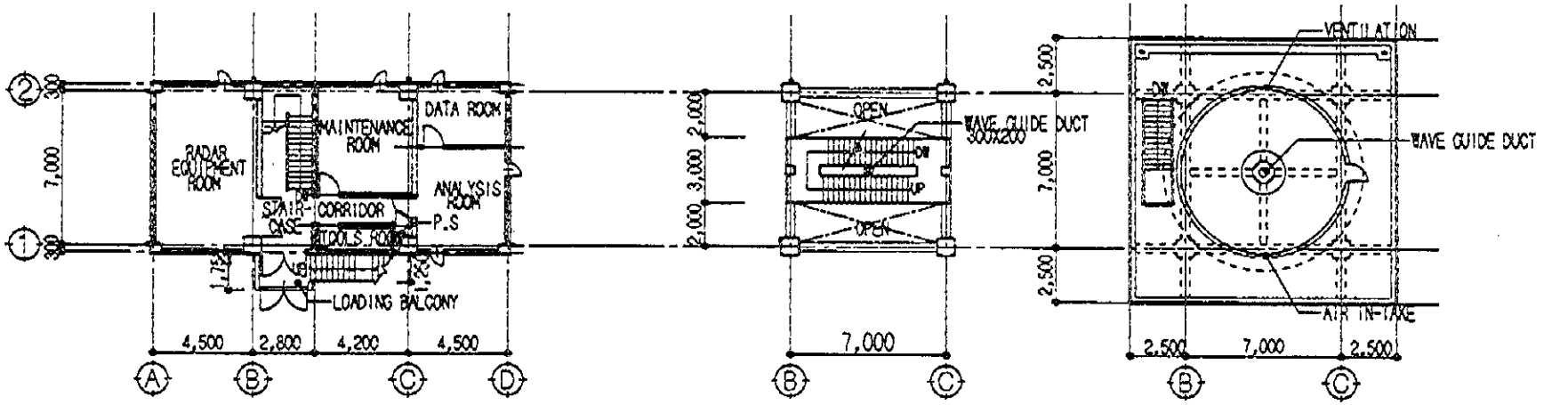
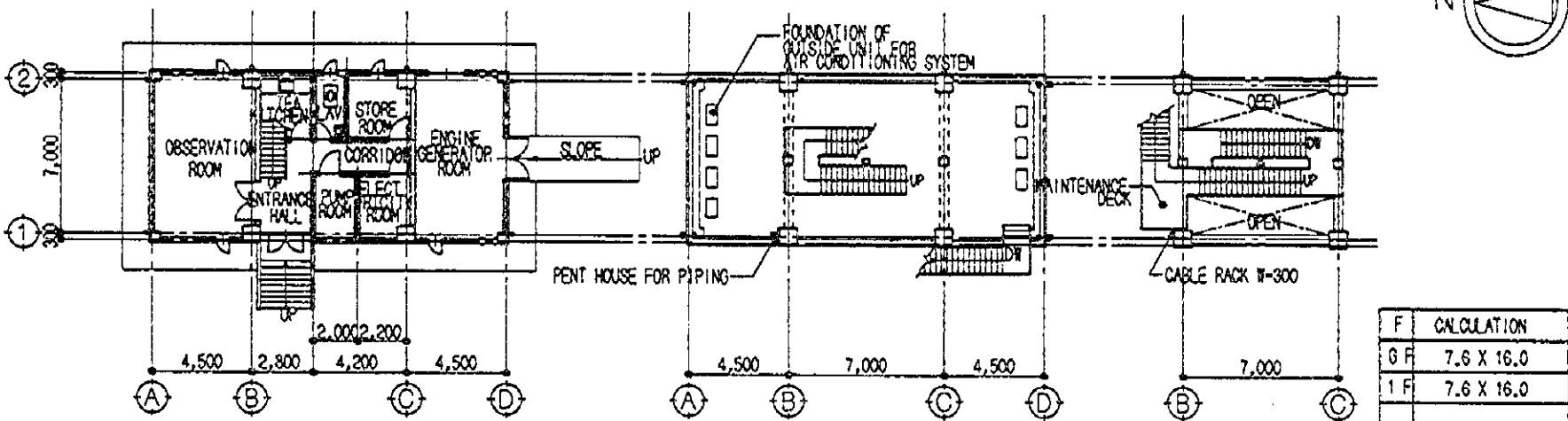
PROJECT:	DRAWING TITLE:	SCALE:	DRAWING No.
RANGPUR RADAR TOWER	SITE LAYOUT PLAN	1:700	A-01



1st.F.PLAN　　ST1.PLAN　　RADAR OBSEVATORY DECK



G.F PLAN　　R.F.PLAN　　2ST.PLAN

F	CALCULATION	AREA
G F	7.6 X 16.0	121.6㎡
1 F	7.6 X 16.0	121.6㎡
TOTAL		243.2㎡

Japan Weather Association
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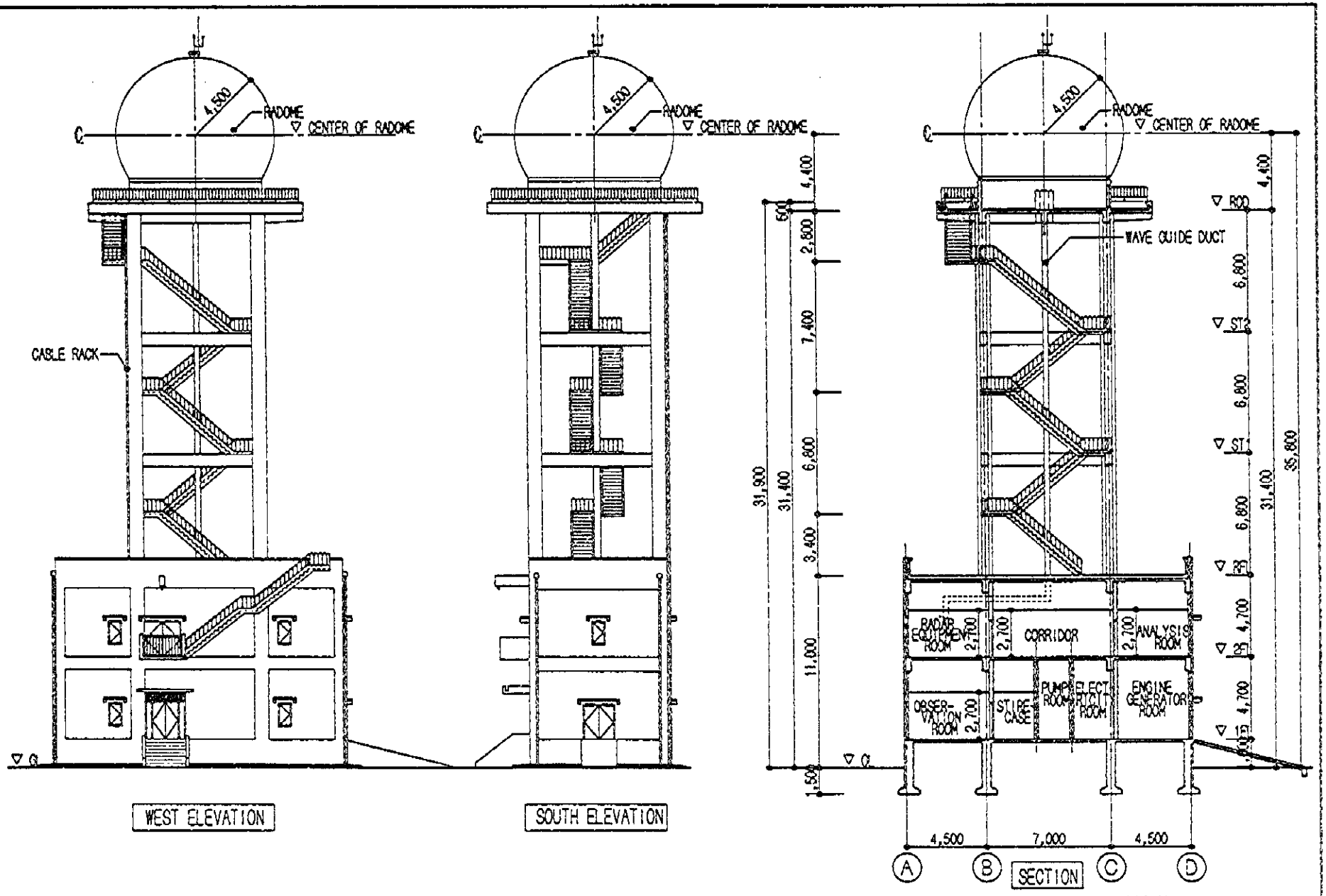
PROJECT: RANGPUR RADAR TOWER

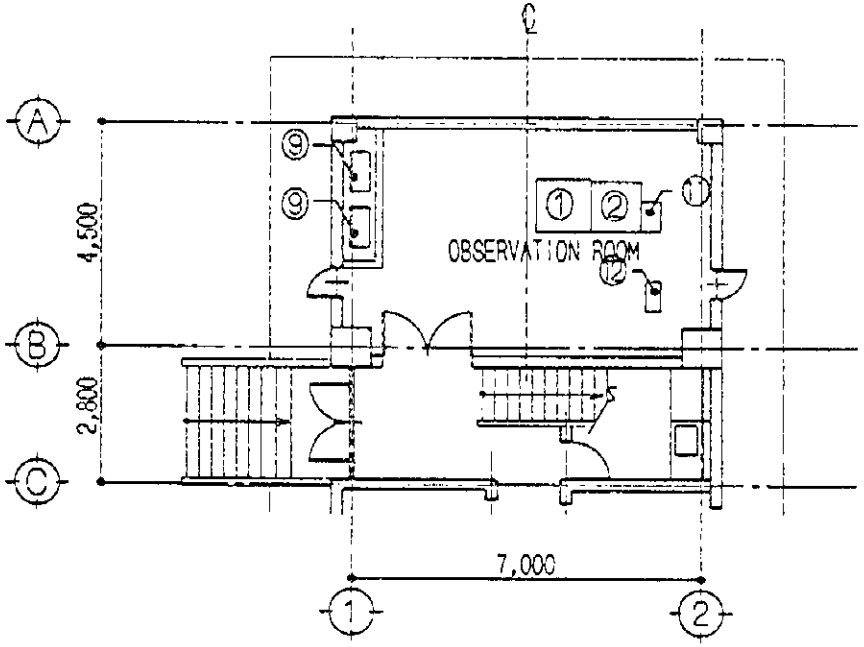
DRAWING TITLE: PLAN

SCALE: 1:300

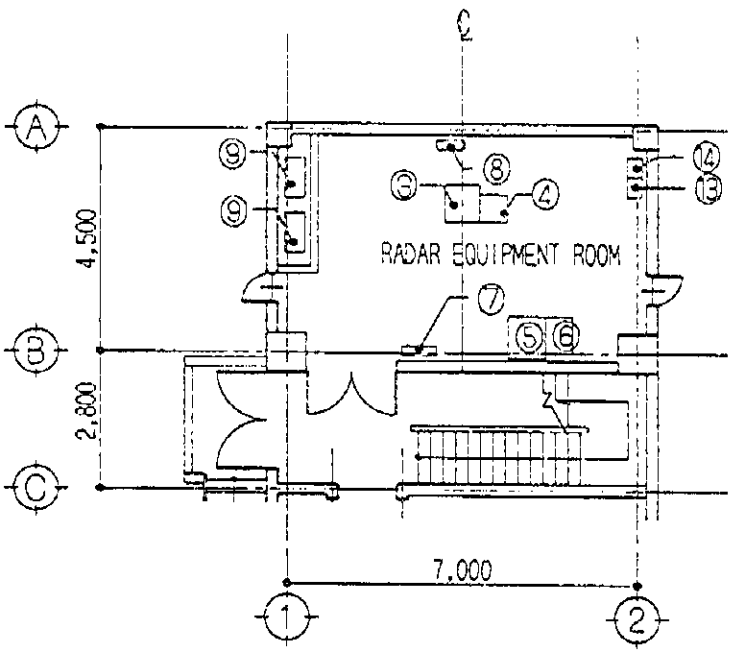
DRAWING No. A-02



Japan Weather Association International Affairs Dept.: Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170 Japan Tel. +81-3-5958-8161 Fax. +81-3-5958-8162 E-mail kokusai@jwa.go.jp	PROJECT: RANGPUR RADAR TOWER	DRAWING TITLE: ELEVATION & SECTION	SCALE: 1:300	DRAWING NO. A-03



GROUND FLOOR



1st FLOOR

① OPERATION CONSOLE
② COLOR MONITOR DISPLAY
③ TRANSMITTER / RECEIVER (TX/RX)
④ ANTENNA SERVO CONTROL
⑤ AUTOMATIC VOLTAGE REGURATOR (AVR)
⑥ UNINTERRUPTED POWER SUPPLY (UPS) FOR RADAR SYSTEM

⑦ POWER DISTRIBUTION BOARD
⑧ DEHYDRATOR
⑨ AIR CONDITIONING SYSTEM
⑩ OUTSIDE UNIT FOR AIR CONDITIONING SYSTEM
⑪ INTER-PHONE & FAX
⑫ UNINTERRUPTED POWER SUPPLY (UPS) FOR TELECOMMUNICATION SYSTEM
⑬ RADIO
⑭ MULTIPLEXER

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PROJECT:	DRAWING TITLE:	SCALE:	DRAWING NO.
RANGPUR RADAR TOWER	EQUIPMENT RAYOUT PLAN	1:150	A-04