Bangladesh Meteorological Department

NO.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
ESTABLISHMENT OF
THE METEOROLOGICAL RADAR SYSTEM
AT MOULVIBAZAR
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

February 2007

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 Establishment of the Meteorological Radar System at Moulvibazar in the People's Republic of Bangladesh and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team from June 21 to July 21, 2006.

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.

February, 2007

Masafumi KUROKI
Vice-President
Japan International Cooperation Agency

February, 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Establishment of the Meteorological Radar System at Moulvibazar in the People's Republic of Bangladesh.

This study was conducted by Japan Weather Association, under a contract to JICA, during the period from June, 2006 to February, 2007. 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,

Yoshihisa UCHIDA
Project Manager
Basic design study team on
the Project for Establishment of
the Meteorological Radar System at Moulvibazar
in the People's Republic of Bangladesh

Japan Weather Association

Summary

Summary

Most of the area of the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh") is a low-lying flat delta, which is the floodplains accounting for 80% of the national land formed with the alluvial soil deposited by the mighty rivers, Ganges, Brahmaputra and Meghna and 50% of the national land is 7m or less above the sea level. Bangladesh is affected seriously by devastating floods and flash floods generated by torrential rains in the pre-monsoon and monsoon seasons every year. The devastating flood and flash floods carry the highest potential for loss of life and property. In the last 15 years, 2,722 were killed or missing, 2,402,020 were injured and the number of flood victim was totally at least 78,923,331.
Bangladesh is quite vulnerable to these natural disasters as the poverty in the flood plains increases due to the extensive damage in the agriculture sector. Regrettably, the extensive damage from floods and flash floods is the determining factor for significant set-back of national economy and living standard of people in Bangladesh.

During the pre-monsoon season (March-May), local severe storms locally called "Nor'wester" (also known as Kalbaishakhi) occur frequently with maximum frequency in the northern part of Bangladesh. Local severe storms are the meso-scale phenomena, which develop from cumulonimbus clouds, mostly originating from neighboring India and are characterized by lightning discharges with a heavy rainfall within a short span of time. They are often accompanied with strong gusts, hail and sometimes become tornadoes. Because of the associated strong gusts and hails with short life period, these storms create hazards to river navigation, cause enormous damage to standing crops, lives and properties every year. In addition, the number of sunken vessels/ships and related casualties due to "Nor'wester" has been increasing.

Disaster management system including early warning is targeted on the recognition of natural disasters such as flood, local severe storms, cyclone etc. are responsible for creating recurrent set-back on the socio-economic conditions of Bangladesh.
The Project has been included in the 'Three years Rolling Investment Program (TYRIP), Financial year 2005-2006 to 2007-2008" by the Ministry of Planning as a part of the Poverty Reduction Strategy Paper (PRSP) on the backdrop of the increasing negative impact of natural disasters, this inclusion indicated the urgent implementation of the project to minimize the economic set-back.
BMD is the sole national meteorological service provider in Bangladesh and is under the administrative supervision of the Ministry of Defence. Its main responsibility as a National Meteorological Service is to record meteorological observations round the clock and to provide weather information, forecasts, advisories and warnings necessary for the mitigation and prevention of natural disasters and improvement of socio-economic conditions.

Due to the present situation, Bangladesh faces the following issues.

[1] BMD is unable to provide the required precipitation data which is indispensable for preparation of

flood forecasts and warning to the Flood Forecasting and Warning Centre (hereinafter referred to as "FFWC") since the existing meteorological radar observation network of BMD is not able to obtain quantitative observational data of precipitation in the northern Sylhet (the wettest area in Bangladesh), the upper river basin of the Meghna and Meghalaya Hills (the world's wettest area) which are located out of the detection range of the existing network.

[2] BMD is unable to provide the required precipitation data to the FFWC and is not also able to issue forecasts and warnings of heavy rainfall causing local rainwater flood the government and to the public for its mitigation. Because the existing Dhaka and Rangpur meteorological radar systems only can only give precipitation intensity, however, these systems do not have functional output of hydrological data required for operation of flood forecasting and warning system.

[3] FFWC is unable to issue flash flood forecasts and warnings since rainfalls in the mountainous areas of the Indian Territory located along the international border at present are not detectable by the existing meteorological radar observation network of BMD.

[4] BMD is unable to observe Nor'wester and associated phenomena like tornadoes, these phenomena are very short lived and occur suddenly but can caused huge damage. To mitigate the related damage and loss, prompt issuance of forecast and warning to public are needed. Due to no Doppler radar in the BMD radar network in the northern part of Bangladesh, BMD is not capable of giving prompt forecast and warning of the above devastating meteorological phenomena.

[5] The existing flood forecasting model (FE2003 Model) of Bangladesh Water Development Board (hereinafter referred to as "BWDB") presently runs on insufficient input data such as observe data of the existing river and rainfall information. Along with these, the longer acquisition time and lock of data over the Indian territory inhibit the accuracy improvement of flood forecasting and warnings.

In order to protect life and property from the natural disasters, it is essential to rectify the current situation as soon as possible and establish the continuous and timely dissemination of flood and local severe storm forecasts and warnings to the public and disaster management agencies. Because of financial problems, the Government of Bangladesh has requested the Government of Japan to procure and install the require equipment and to construct a radar tower building, etc. Japan's Grant Aid Assistance.

In response to the request from the Government of Bangladesh, the Government of Japan decided to conduct a Basic Design Study for the Project and consequently the Japan International Cooperation Agency (JICA) sent the Basic Design Study Team to Bangladesh from June 21, 2004 to July 21, 2006. The team had a series of discussions with Government of Bangladesh officials, conducted surveys and collected necessary information and data for the Project.

After returning to Japan, the team conducted further studies, including a feasibility, justification and scope of the Project, paying particular attention to the present situation in Bangladesh, especially the operation and maintenance capabilities of BMD. From those studies, the team formulated the draft basic design for the Project. JICA then sent the team to Bangladesh again, from November 18 to November 24, 2006, in order to discuss the draft basic design study report, and accordingly the basic design for the Project was finalized.

The finalized components in the basic design for the Project are as follows.

Table 1: Finalized Components for the Project

	Moulviazar Meteorological Radar Observation Station	Storm Warning Centre, Dhaka	Dhaka Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station	Flood Forecasting and Warning Centre
Equipment Procurement and Installation					
Meteorological Radar System	1				
Meteorological Radar Data Display System	1	1			1
Meteorological Data Satellite Communication System	1	1		1	1
Existing Radar System 8 bit Improvement			1	1	
Facility Construction					
Radar Tower Building (including furniture for Equipment)	1				

The required implementation period of the Project, including the detailed design study and the tendering procedures, is approximately 20 months. The total project cost, as estimated in the basic design study, is 1,203 million JP Yen (grant aid: 995 million JP Yen, capital cost for the Project to be borne by Bangladesh: approx. 122,284,500 Taka (208 million JP Yen)).

After completion of the Project, the following benefits and improvements can be expected.

[1] Since rainfalls in the mountainous areas of the Indian Territory located along the international border are detectable by the meteorological radar system, flash flood forecast and warning will be issued every 1 hour to the public and disaster management sector by FFWC after the detection.

[2] Since heavy rainfalls causing local rain water flood in the whole area of Bangladesh are detectable by the meteorological radar observation network consisting of 5 radar systems, heavy rainfall forecast and warning will be issued within 1 hour to the public and disaster management sector by BMD after the detection.

[3] Since the meteorological Doppler radar system will be installed at the northern Bangladesh, Nor'wester forecast and warning will be issued every 1 hour to the public by BMD after its detection by the system.

[4] Since rainfalls in the whole area of Meghna river basin are detectable by the meteorological radar

system, meteorological information will be issued to the organizations concerned with disaster prevention and the public by BMD.

[5] Since precipitation data of 2.5 km mesh in the detection range of the meteorological radar observation network can be inputted to the existing flood forecasting model (FF2003 Model), accuracy of flood forecasts and warnings will be improved.

[6] Since precipitation intensity in the detection range of the meteorological radar observation network will be unified to be 256 gradation level indication, the rainfall observation capability will be upgraded.

BMD, the agency which will implement the Project, has quite a good organizational capability. In addition, BMD's engineers have sufficient experience and knowledge in the operation and maintenance of meteorological radar systems to perform daily operations, maintenance and repair work on the existing systems. Furthermore, BMD's budget is expected to be able to cover Bangladesh's portion of the capital cost and recurrent cost of the Project.

As a consequence of careful and comprehensive evaluation of the Project effects in consideration of the BMD's capabilities in reducing human loss and recurrent economic set-back by the natural disasters, considerable benefits as mentioned above is expected to achieve. The Project would substantially contribute to the mitigation of natural disasters as the basic human needs for the people of Bangladesh, which indicate the appropriateness of carrying out the Project under a grant-aid has been amply confirmed. Therefore, the implementation of the Project is considered rightly advisable.

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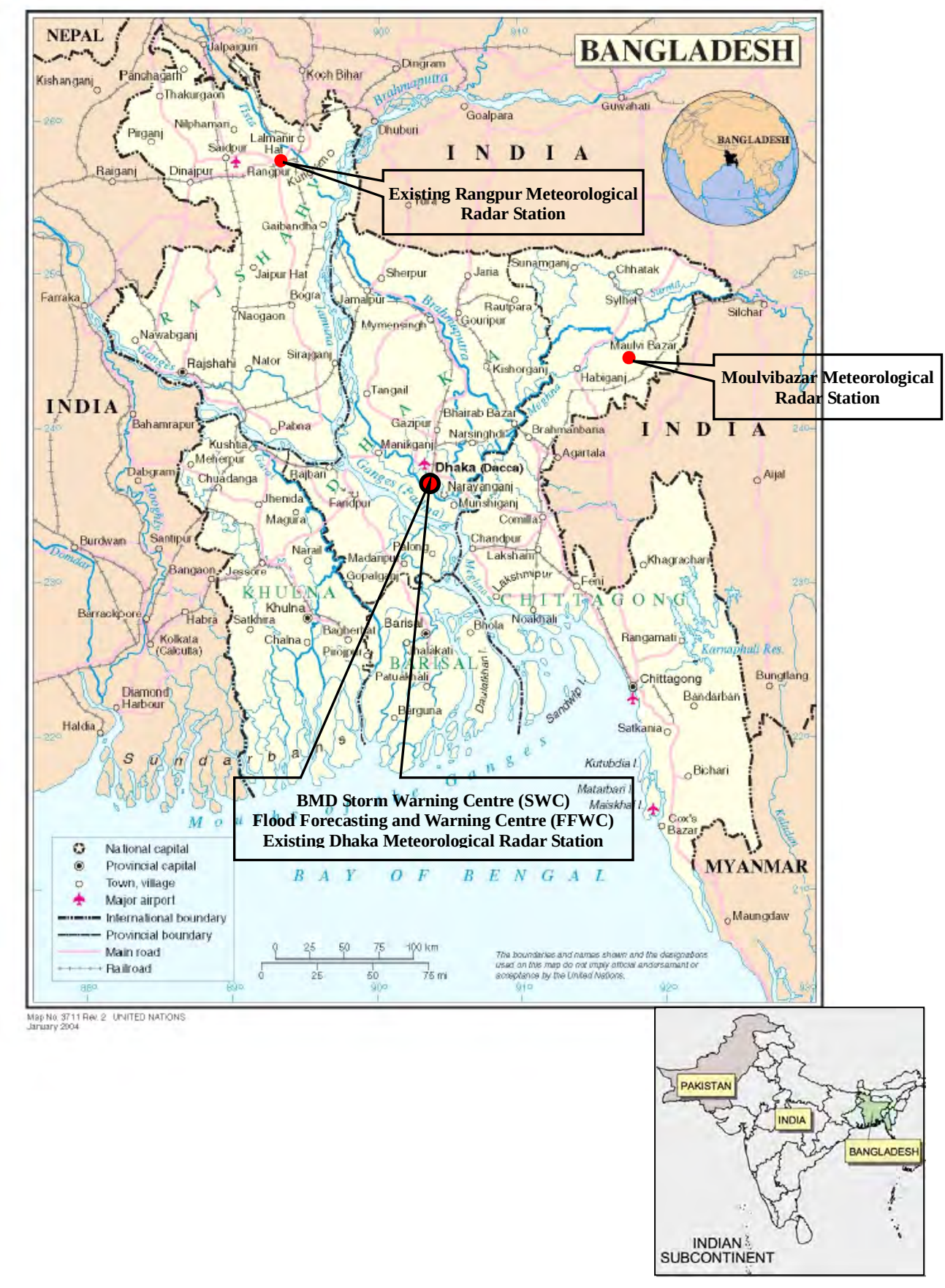
Appendices

■ Bangladesh


BANGLADESH
NEPAL
INDIA
INDIA
INDIA
MYANMAR
BAY OF BENGAL
Existing Rangpur Meteorological Radar Station
Moulvibazar Meteorological Radar Station
BMD Storm Warning Centre (SWC)
Flood Forecasting and Warning Centre (FFWC)
Existing Dhaka Meteorological Radar Station
Dhaka (Dacca)
Rangpur
Moulvi Bazar
Jalpaiguri
Kishanganj
Panchagarh
Thakurgaon
Koch Bihar
Dinajpur
Raiganj
Gaibandha
Jaipur Hat
Sherpur
Jamalpur
Bogra
Naogaon
Farraka
Nawabganj
Rajshahi
Nator
Sirajganj
Tangail
Mymensingh
Gouripur
Rautpara
Sunamganj
Jaria
Cherrapunji
Sylhet
Silchar
Habiganj
Kishorganj
Bhairab Bazar
Gazipur
Narsingdi
Brahmanbaria
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Narayanganj
Munshiganj
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Chandpur
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Bungtlang
Satkania
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Kutubdia I.
Bichari
Maungdaw
Aijal
Pabna
Kushtia
Meherpur
Chuadanga
Bajbari
Faridpur
Jhenida
Magura
Dabgram
Burdwan
Santipur
Bangaon
Jessore
Narail
Madaripur
Gopalganj
Barisal
Bhola
Noakhali
Patuakhali
Barguna
Jhalakati
Pirojpur
Bagherhat
Chalna
Khulna
Satkhira
Habra
Barrackpore
Kolkata (Calcutta)
Diamond Harbour
Haldia
Sundarbans
KHULNA
BARISAL
CHITTAGONG
Ganges
Brahmaputra
Meghna
Karnaphuli Res.
National capital
Provincial capital
Town, village
Major airport
International boundary
Provincial boundary
Main road
Railroad
0 25 50 75 100 km
0 25 50 75 mi
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Map No. 3711 Rev. 2 UNITED NATIONS
January 2004
PAKISTAN
INDIA
BANGLADESH
INDIAN SUBCONTINENT

Moulvibazar Meteorological Radar Tower Building

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Chapter 3 Project Evaluation and Recommendations

ABBREVIATIONS

WMO:	World Meteorological Organization
ASEAN:	Association of Southeast Asian Nations
JICA:	Japan International Cooperation Agency
VSAT:	Very Small Aperture Terminal
IEEE:	Institute of Electrical and Electronic Engineers
MOD:	Ministry of Defence
BMD:	Bangladesh Meteorological Department
SWC:	Storm Warning Centre
BDMB:	Bangladesh Disaster Management Bureau
BWDB:	Bangladesh Water Development Board
FFWC:	Flood Forecasting and Warning Centre
BTTB:	Bangladesh Telegraph and Telephone Board
BTRC:	Bangladesh Telecommunication Regulatory Committee
CPTU:	Central Procurement Technical Unit
TYRIP:	Three Years Rolling Investment Programme
PRSP:	Poverty Reduction Strategy Paper
LLDC:	Least among Less Developed Countries
DANIDA:	Denmark International Development Agency
UNDP:	United Nations Development Program
WMIP:	Water Management Improvement Project
CDMP:	Comprehensive Disaster Management Program
BDRCS:	Bangladesh Red Crescent Society
UNHCR:	The Office of the United Nations High Commissioner for Refugees
IMD:	India Meteorological Department
ECNEC:	Executive Committee for National Economic Council
DPP:	Development Project Proposal
JIS:	Japan Industrial Standard
CPP:	Cyclone Prepardness Programme
BAF:	Bangladesh Air Force

Chapter 1
Background of the Project

Chapter 1 Background of the Project

Bangladesh is a disaster prone country. During the pre-monsoon, monsoon seasons and post monsoon (March-November), it is affected by tropical cyclones, storm surges, local severe storms, heavy rainfall, major floods, flash floods, etc every year. Bangladesh has long been associated with extreme vulnerability to nature disasters. Due to improvement of disaster preparedness including the establishment of early warning systems and a wide meteorological radar network, there has been a significant decrease in the number of lives lost each year. However, natural disasters are still responsible for large amount of property losses with major consequences for the poor. Areas which are prone to natural disasters are found to have higher incidences of poverty. The main reason is that natural disasters have a direct bearing on the rural economy, which has a strong linkage with agricultural production and has resulted in a seriously decreased level of living of resource-poor farmers. Among all the natural disaster's flood itself has caused the largest economic losses. The top 10 causes of the economic losses by the natural disasters are cataloged below.

Table 2: Top 10 of Economic Loses by Natural Disasters

	Natural Disaster	Date of Occurrence	Economic Loses (US$)
1	Flood	June 20,2004	7,000,000,000
2	Flood	August, 1988	2,137,000,000
3	Flood	July 5, 1998	2,000,000,000
4	Cyclone	April 29, 1991	1,780,000,000
5	Cyclone	May15, 1995	800,000,000
6	Flood	August, 1987	727,500,000
7	Flood	July, 1974	579,200,000
8	Flood	September, 2000	500,000,000
9	Flood	July 22, 1987	330,000,000
10	Flood	July 13, 1997	229,000,000

By WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED)
Emergency Events Database (EM-DAT)

<Flood and Flash Flood>

Bangladesh is situated in a heavy rainfall and cyclone prone region as well as in the flood plain of major rivers which are the Ganges, the Brahmaputra and the Meghna. Three major rivers are over running the floodplains every year with huge quantity of water and discharge into the Bay of Bengal. Flooding from river waters overflowing the banks, particularly during monsoon, is an annual phenomenon. In an average year, it is estimated that over one fifth of the country goes under flood water. The people living in the low-lying flood plains have learned to adjust their life styles to this annual flooding. However, floods are still seriously harmful to development of the local industries, improvement of poverty living level, etc.

Floods in Bangladesh are classified into the following four types.

- Monsoon River Flood: a slow rise of water levels in the main rivers caused by heavy rainfall in the upper river basins

- Flash Flood: mainly caused in the pre-monsoon season by intense heavy rainfall generated by the humid south west monsoon in the mountainous area in Indian Territory
- Local Rain Water Flood: flooded by local heavy rainfall in Bangladesh
- Strom Surge: a coastal phenomenon forced by cyclonic storm

Flood is an annual recurring event during the monsoon season in Bangladesh. In an average year, it is estimated that over 20% of the country goes under flood water. But the flood of 1998 was the longest ever unprecedented one in living memory and 68% of the country went under flood water. The extensive damage in the north eastern part of Bangladesh caused by the flood in 2004 was estimated much bigger than the flood in 1998. Over 38% of the country went under the flooded water and the official death toll was 747. Agricultural crops in the affected areas were fully damaged, which has primarily been estimated at 330million US dollars. In addition, the flood created the collapse of health and hygiene situation as a secondary disaster due the flood water remained for a prolonged period.

Table 3: Extent of Damages during Floods in 2004

Human Suffering	Physical Suffering	Others
Affected population: 36,337,944 Human casualty: 747 Affected families: 7,468,128	Affected Districts: 39 Affected Upazilas: 265 Affected Unions: 2,492 Affected Area: 34,583 (Sq. km) Houses Destroyed: 151,142 Houses damaged (partially): 1,223,050 Road network destroyed: 5,000km Road network damaged: 18,400km School destroyed: 458 School damaged (partially):7,582	Death of live stock: 3,919 Crops damaged (fully): 1,605,958 (in acre) Crops damaged (partially):1,038,176 (in acre) Flooded Area : 38% of the country (55,000km^2)

sources: BDMB, FFWC, United Nations Human Settlements Programme

The extent of damages caused by the floods occurred in the past 15 years recorded by BDMB and FFWC is indicated in the table attached in the next page. Those floods totally created 78,923,331 victims, 2,722 dead or missing and 2,402,020 injured.

Table 4: Damage Records caused by Major Floods in Bangladesh (1990-2004)

Date	Killed	Injured	Affected	Damage (US$)	Location	Flooded Area (km^2)	Percentage of Flooded Area in the whole country of Bangladesh (%)
July 24, 2004	747		19,022,600		Kanaighat, Sylhet, Sunamganj, Sherpur, Moulvibazar	55,000	38
April 21, 2004					Sylhet, Gaibandha, Netrokona, Kishorgonj		
July 15, 2003	13				Siragong	21,500	14
June 29, 2003	23				Sylhet		
July 1, 2002	10	0	1,500,000		Mymensingh, Sunamganj, Rangpur, Kurigram, Bhola, Gaibandha, Sherpur, Rajshahi, Barisal, Cox's Bazar	15,000	10
August 31, 2001	0	0	200,000		Sunnamgonj, Sylhet, Nawabgonj, Rajshahi, Kusthia	4,000	3
June 5, 2001	9	0	500,000		Sylhet, Sunnamgonj, Moulvibazar, Brahamanbaria		
August 1, 2000	31	0	2,467,138	$ 500,000	Gangni, Meherpur, Kushtia Sadar, Jibannagar, Alamdanga, Cuadanga, Maheshpur, Pabna, Godagari, Tanor, Mohanpur	35,700	24
June 24, 2000	11	50	200,000		Chittagong, Cowkbazar, Morzapool, Katalganj, Rahmatganj, Chaktai, Halishabr, Bakalia, Chandgaon, Pahartoli, Hathazari, Patiya, Satkania, Keranirhat areas		
August 15, 1999	17	50	0		Chittagong City, Aziz Nagar, Lama Thana	32,000	22
June 30, 1999	31	20	421,250		Chittagong, Cox's Bazar, Chittagong Hill, Comilla		
July 8, 1998	140	50	15,000,000	$2,000,000	Mymensingh, Sherpur, Hobiganj, Rangpur, Sirajang, Rajshahi, Kurigram, Gaibandha, Netore, Chittagong	100,250	68
July 22, 1997	79	30	800,000	$229,000	North, Central North	-	-
September 2, 1996	22		165,000		Chapai Nawabganj	35,800	24
July 1, 1996	33		5,663,319	$150,000	Kurigram, Gaibandha, Bogra, Sirajang, Tangail, Pabna, Manikganj, Dhaka, Narayanganj, Madaripur, Gopalganj, Rajbari, Faridpur, Lalmonirhat, Nilphamari Districts.		
September 1, 1995	400	400,000	175,000		Dinajpur, Panchagarh Rangpur, Nilphamari Joipurhat, Gaibandha, Natore, Naogaon, Bogra	32,000	22
June 15, 1995	250		12,656,006		Sylhet, Moulvibazar, Sunnamgonj, Sirajganj, Gaibandha, Rangpur, Madaripur, Panchagarh		
May 15, 1995	50		351,325		Chittagong, Bhola, Cox's Bazar, Hatiya, Noakhali, Patuakhali		
August 19, 1994	40		300,000		Chapainawabganj, Rajshahi	419	0
June 3, 1994	3		25,000		Sylhet District		
May 19, 1994	12	0	100		North		
April 19, 1994	61				Barisal District and Southern Bangladesh		
August 21, 1993	4	20	1,000,000		Chittagong, Dhaka	28,742	20
July 1, 1993	162	0	11,469,537		Sylhet, Brahmanbaria, Habiganj, Moulvi Bazar, Sunamganj, Sirajganj, Chittagong Hill Districts		
June 1, 1993	28	0	3,207,056		Sylhet, Sunamganj, Hobiganj		
July 11, 1992	0				North-East	2,000	1
June 22, 1992	0				Maheskali, Chittagong, Cox's Bazar		
April 18, 1992	15	200			Kishoreganj, Brahmambaria Districts		
September 10, 1991	100	0	1,000,000	$150,000	Rangpur	28,600	19
July 1, 1991		0	1,590,000		Rajshahi division		
May 1, 1991	200	0	1,200,000		Sylhet		
July 1, 1990	65	2,000,00			Rajshahi division	3,500	2
March 25, 1990	166	1,600	10,000		North Eastern		
Total	2,722	2,402,02	78,923,331				

Flash flood in Bangladesh is an assault of nature in an unpredictable manner. Flsah flood mainly occure in the pre-monsoon season by intense heavy rainfall generated by the humid convective current in the Indian part of the catchments (mountainous areas) as well as inside Bangladesh areas, which are prone to flash floods, in the north eastern part of the country (Figured 1). Flash flood is defined as a flood of short duration with a relatively high peak discharge and featured by small range of occurrence, occurrence in a few hours after the associated intense heavy rainfall and short time between the emergence and the consequent disaster. Therefore, hydro-metrological information for a meaningful flash flood forecast is needed from inside the Indian Territory. Flash flood phenomenon is a hydro-meteorological problem and meteorological forecast especially rainfall forecast as well as real time rainfall measurements can play a significant role in flash flood forecasting.

In April 2004, severe flash floods occurred in the North-eastern region of Bangladesh by intense heavy rainfall which continued for a few days from April 14, 2004 in the Meghalaya Hills in India. The flash flood significantly attacked Sylhet, Moulvibazar and Habiganj areas after 96 hrs.(approx) rain occurred on April 14-15. The flood peak on April 23 was 12.30m high, water flowed 5-6 m above the embankment height and the affected area was estimated 8,000km^2. The flash flood killed 15 person and created over 50,000 victims. This was the ever-worst flash flood in the recorded history of Bangladesh in this region. This part of the country experienced nearly 1.5 times the monthly normal rainfall and caused widespread damages to the standing crops as well as the infrastructure.

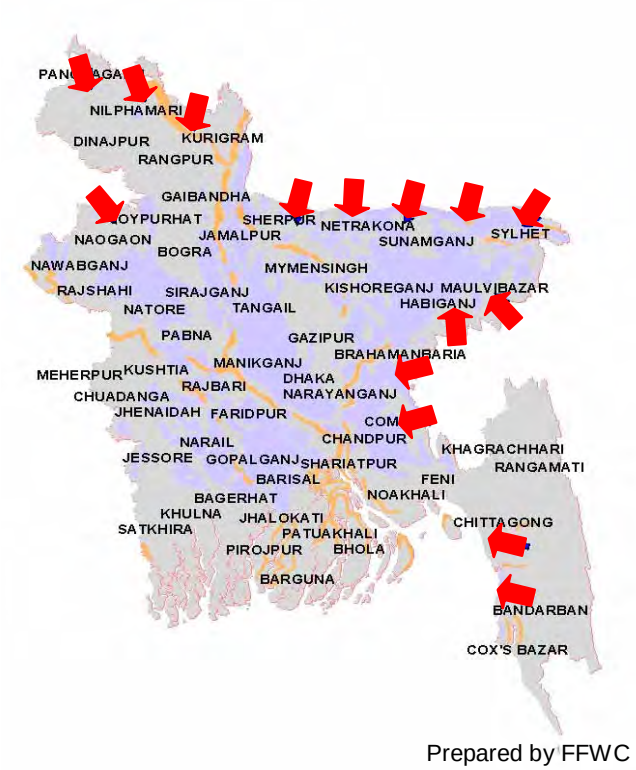
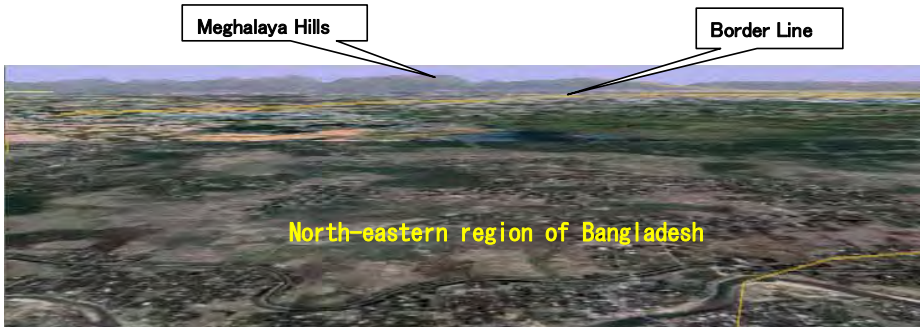


Figure 1: Flash Flood Locations in Bangladesh



For the flash flood forecast another important parameter is the rainfall estimation. However, since the meteorological radar observation network of BMD unfortunately do not cover the northern Sylhet, the Meghna upper river basin and Meghalaya Hills and also BMD only receives precipitation data of 7 synoptic stations located in the Meghna upper river basin in Indian Territory thorough the Global Telecommunication System (GTS) of World Meteorological Organization (WMO), BMD has no precipitation distribution data in those areas. In addition to this, the existing Dhaka and Rangpur radar systems can output precipitation intensity, however, these systems are not capable to output the following hydrological data required for flood forecasting. In fact, these situations indicated above disturb accuracy improvement of flood forecasts and warnings.

- PPI (Plan Position Indicator) Display
- Heavy Rainfall Warning Output
- Accumulated Rainfall
- Rainfall Distribution
- Catchment Area Rainfall Amount Display and Warning

Furthermore, insufficiency of data observed at the existing river and rainfall stations of BWDB for inputting to the existing flood forecasting model (FF2003 Model), longer acquisition time of the required data and lack of data in the Indian Territory inhibit accuracy improvement of flood forecasts and warnings prepared by the existing flood forecasting model (FF2003 Model) of FFWC.

Table 5: Number of Data inputted to FF2003 Model

River Basin	River Station	Rainfall Station
Ganges Basin	29	17
Brahmaputra Basin	23	13
Meghna Basin	22	15
South Eastern Hill Basin	12	11
Total	86	56

< Nor'wester and Tornado>

During the pre-monsoon season (March-May), local severe storms locally called "Nor'wester" (also known as Kalbaishakhi) sometimes associated with tornadoes, occur frequently with maximum frequency in the northern part of Bangladesh. Tornado occur intensively in March (8%), April (36%) and May (22%) mainly in the central and northern areas of Bangladesh. For 30 years between 1967 and 1996, 191 tornadoes occurred and totally killed 5,373 people and frequency of the occurrence is increasing.

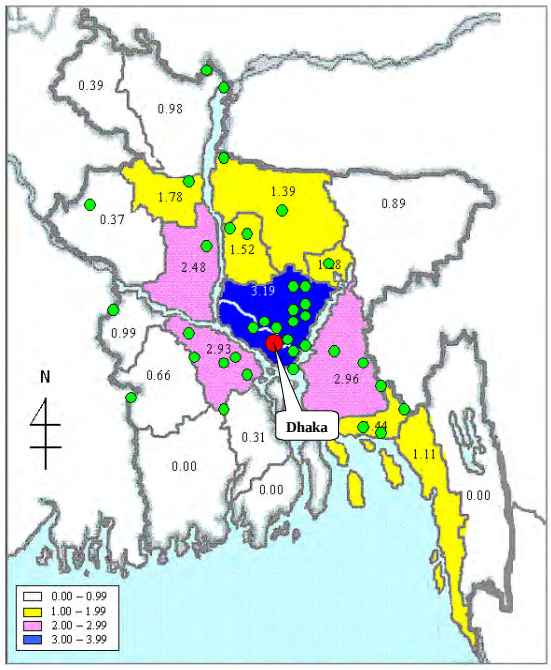


Figure 2: Locations of Tornadoes

Tornado in North-Central Bangladesh by B. K. Paul and R. H. Bhuiyan 2004

Table 6: Tornadoes killed over 100 since Independence in 1971

Date	Place	Dead
April, 1972	Mymensingh	150
April, 1973	Dhaka	681
April, 1977	Faridpur	623
April, 1977	Gopalgangj, Faridpur	111
April, 1978	Mymensingh	150
April, 1989	Manikganj (Saturia)	526
May, 1996	Tangail（North-Central）	605
April, 2004	Mymensingh, Netrokona	111

Tornado in North-Central Bangladesh by B. K. Paul and R. H. Bhuiyan 2004

"Nor'wester" is the meso-scale phenomena, which develop from cumulonimbus clouds, mostly originating from neighboring India and are characterized by lightning discharges. Since the catchment area of the Meghna and Meghalaya Hills are located out of the detection range of the existing meteorological radar observation network of BMD, BMD is not able to detect the severe convective cells of cumulonimbus cloud from the India.

Furthermore, due to no doppler radar system in northern part of Bangladesh, BMD lacks the accurate monitoring and forecast and warning issuance capability of Nor'wester which is required very much in time for related disaster mitigation. Under these situations indicated above for the issuance of Nor'wester forecast and warning, BMD has to depend on the subjective decision of the meteorologist on the basis of the synoptic and climatology. So there is a little scope remains for the meteorologist to address the severe

weather phenomena accurately and timely which greatly undermines the required attention and consideration for safe operation and movement of river vessels by the owner.

The number of sunken vessels/ships has been increasing in current years. 34 vessels/ships were sunken and 958 passengers were killed by “Nor’wester” or severe weather during last 8 years since 1999.

Table 7: List of Sunken Vessels / Ships due to Nor'wester/ Severe Weather during last 8 years since 1999

NO	NAME OF VESSELS	DATE OF SINKING	ACCIDENT PLACE	CAUSE OF SINKING	APPROX. LIGHT WEIGHT	LOSS OF LIVES
1	M. L. Dhip Konn	08-05-1999	Near kalkini Buoy under Laxmipur in the Meghna river	Due to Nor'wester/ Kalboishakhi	60 Tons	23 nos.
2	M.L. Bengal Bird	01-05-2000	Near Mirzar Char under Narshingdi district in the Meghna river	Due to Nor'wester/ Kalboishakhi	50 Tons	27 nos.
3	M.L. Dolphin	01-05-2000	Near Lalpur in the Meghna river	Due to Nor'wester/ Kalboishakhi	100 Tons	73 nos.
4	M. V. Salauddin-2	03-05-2002	Near Shatnal under Matlab Thana of Chandpur	Due to Nor'wester/ Kalboishakhi	200 Tons	245 nos.
5	M. L. Ipti	11-05-2002	Near Banoripara, Barisal	Due to Nor'wester/Kalboishakhi	50 Tons	2 nos.
6	M. V. Subha	24-05-2002	Motbbaria, Pirojpur	Due to Nor'wester/ Kalboishakhi	95 Tons	31 nos.
7	M. V. Amit Express	13-02-2003	Matlab, Chandpur	Due to Nor'wester/ Kalboishakhi	60 Tons	11 nos.
8	M. L. Sharifpur	12-04-2003	Chamta port, Kishorganj	Due to Nor'wester/ Kalboishakhi	60 Tons	21 nos.
9	Passengers Trawler	14-04-2003	Dacope, Chalna, Khulna	Due to Nor'wester/ Kalboishakhi	20 Tons	4 nos.
10	M. V. Mitali-3	21-04-2003	Pagla, Buriganga river, Narayanganj	Due to Nor'wester/Kalboishakhi	115 Tons	131 nos.
11	M. L Majlishpur	21-04-2003	Paneswar, Sarail, B'Baria	Due to Nor'wester/Kalboishakhi	65 Tons	51 nos
12	M.V. Prince of Ekata	21-04-2003	Rajapur- Dilalpur, Kishorganj	Due to Nor'wester/ Kalboishakhi	260 Tons	2 nos.
13	M. V. Mohammadi	21-04-2003	Rajapur Dilalpur, Kishorganj	Due to Nor'wester/ Kalboishakhi	250 Tons	2 nos.
14	M. V. Palash	21-04-2003	Rajapur Dilalpur, Kishorganj	Due to Nor'wester/ Kalboishakhi	230 Tons	2 nos.
15	M. V. Lutfar-2	21-04-2003	Rajapur Dilalpur, Kishorganj	Due to Nor'wester/ Kalboishakhi	250 Tons	2 nos.
16	M. L. Takdir	21-05-2003	Mirzagonj, Patuakhail	Due to Nor'wester/ Kalboishakhi	40 Tons	Nil
17	M. V. Nijamuddin (Trawler)	04-2004	Chandpur	Due to storm	20 Tons	Nil
18	M. V. Tanik	23-05-2004	Aricha	Due to storm	50 Tons	6 nos.
19	M. V. Lighting Sun	23-05-2004	Anandabazar, Chandpur	Due to Nor'wester/ Kalboishakhi	90 tons	61 nos
20	BT-6-238 Tug	21-05-2004	Sadarghat, Dhaka	Due to Nor'wester/ Kalboishakhi	100 Tons	Nil
21	M. V. Diganta Express	23-05-2004	Jahajmara, Chandpur	Due to Nor'wester/ Kalboishakhi	95 Tons	25nos
22	BIWTC- RO-RO Pontoon	23-05-2004	Aricha, Manikganj	Due to Nor'wester/ Kalboishakhi	120 Tons	Nil
23	M. V. Moharaj	20-02-2005	Fatulla, N. Ganj	Due to Nor'wester/ Kalboishakhi	110 Tons	148 nos.
24	M. L. Prince of Patuakhali	15-05-2005	Char Kazol, Patuakhali	Due to Nor'wester/ Kalboishakhi	60 Tons	35 nos.
25	M. L. Raypura	17-05-2005	Aricha, Manikganj	Due to Nor'wester/ Kalboishakhi	97 Tons	54 nos.
26	Engine boat	22-02-2006	Nabinagar, B. Baria	Due to Bad weather	-	2 nos
27	Pontoon no. SP-151	27-05-2006	Ghashiakhali, Bagerhat	Due to bad weather	-	-
28	Crane Dredger M. V. Sagorika	27-05-2006	Kaliganj, Mehandiganj, Barisal	Due to rough weather	100 Tons	Nil
29	Pontoon No- SP-133 (48ft)	27-05-2006	Sherpur, Sylhet	Due to rough weather and old damaged pontoon	30 Tons	Nil
30	Pontoon No- SP- 195 (48ft)	27-05-2006	Taltali, Amtali, Barguna	Due to rough weather and old damaged pontoon	30 Tons	Nil
31	Pontoon No. SP- 240 (48ft)	27-05-2006	Mahipur, Kalipura, Patuakhali	Due to rough weather and old damaged pontoon	30 Tons	Nil
32	Pontoon No- SP- 232 (48ft)	27-05-2006	Shanta, Koyra, Satkhira	Due to rough weather and old damaged pontoon	-	Nil
33	Pontoon No- SP-69 (30ft)	27-05-2006	Pangasia, Kawkhali, Pirojpur	Due to rough weather and old damaged pontoon	30 Tons	Nil
34	Pontoon No-MP-31 (64ft)	27-05-2006	Rampal Launch ghat, Beherhat	Due to rough weather and old damaged pontoon	30 Tons	Nil
35	M. V. IMrul Kayes	08-06-2006	Sandwip, CTG	Due to bad weather and overloading	20 Tons	20 nos.
36	M. V. Sumi-3 (Cargo)	10-06-2006	Bhatiari, Chittagong	Due to bad weather and overloading	1000 Tons	Nil

Bangladesh Inland Water Transport Authority (BIWTA)

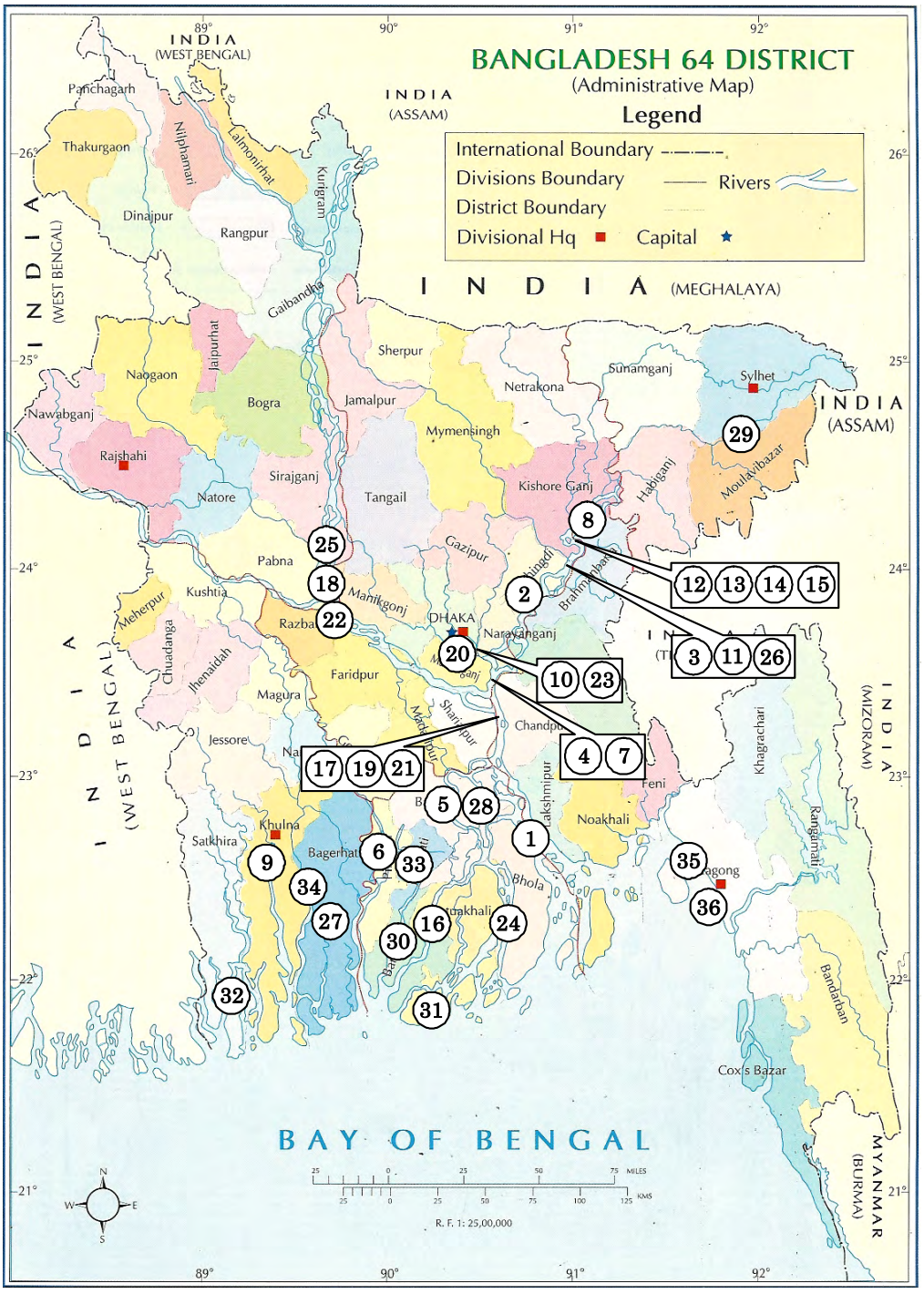


Figure 3: Locations of Sunken Vessels/Ships due to Nor'wester/Severe Weather

<Negative Impact to Development of Bangladesh Economy>

Natural disasters create significant economic losses with major consequences for the poor and have a direct bearing on the rural economy, which has close linkage with agricultural production and has resulted in the marginalization of resource-poor farmers. Most of the population in Bangladesh lives in the low-lying floodplains and 70% of the total population earns a living by agriculture in rural areas. With an increase in population and the growth of physical infrastructure, vulnerability of the society to floods has also

increased. Since most of the total population engaged in agriculture accounting for 21% of GDP, the industrial structure of Bangladesh is quite vulnerable to natural disasters such as floods, flash floods, local severe storms, etc. Consecutive floods at times drastically reduce the GDP growth rate.

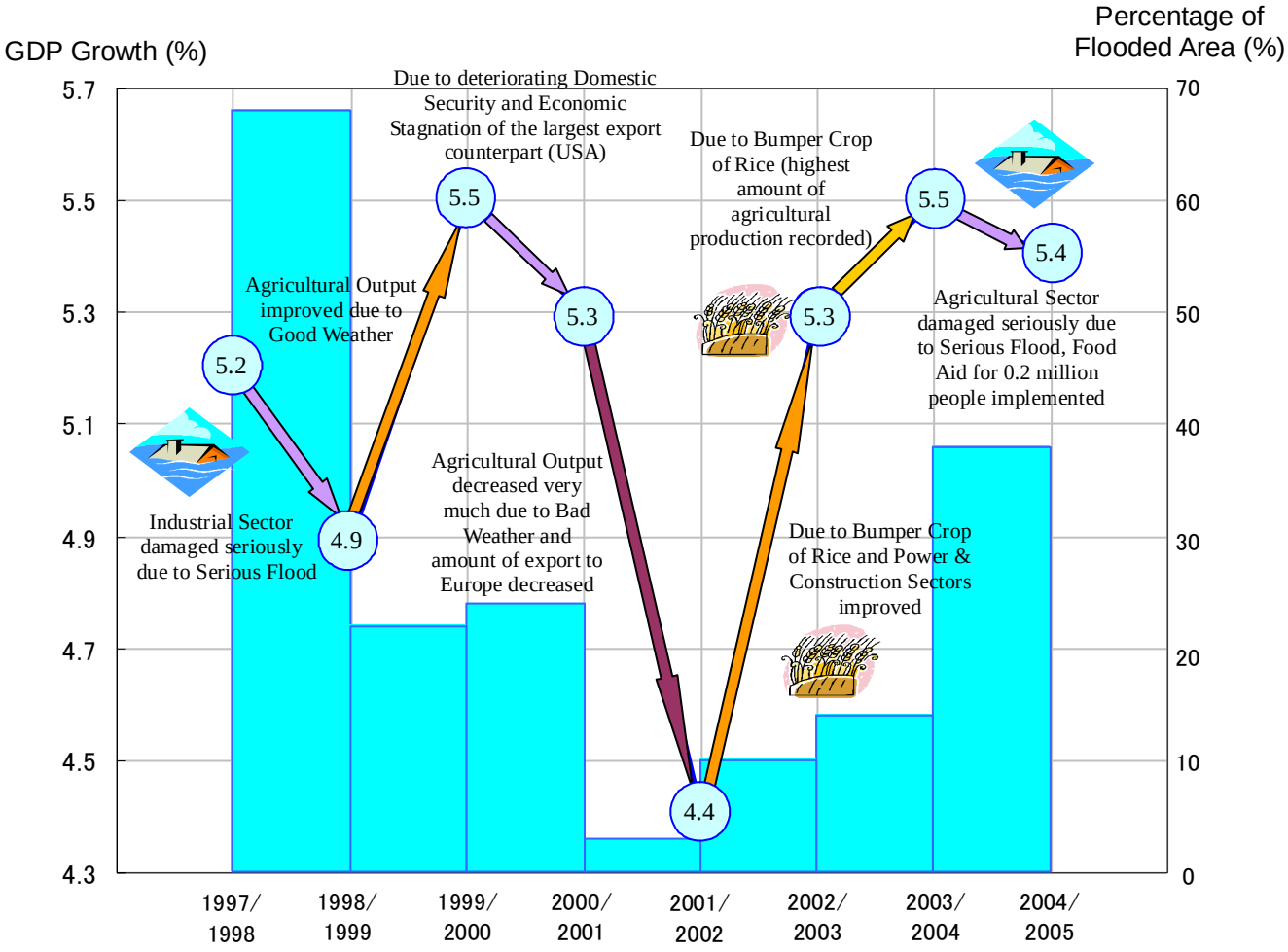


Figure 4: Bangladesh GDP Trends

Since the northern part of the Sylhet District, the catchment area of the Meghna and Meghalaya Hills are located out of the meteorological radar observation network of BMD established by Japan's Grant Aid Assistance consists of the ordinary radar systems of Dhaka and Rangpur (completed in 1999) and the Doppler radar systems of Cox's Bazar and Khepupara (under replacement between 2005 and 2008) and the existing Dhaka and Rangpur radar systems can not output the required hydrological data for flood forecasting in the north western part of Bangladesh, it is essential to improve the current monitoring capability for adequate protection of life and property from natural disasters. There is ample scope for continued improvement in terms of disaster mitigation and recovery. Effective disaster management calls for a reliable and timely disaster warning and dissemination system.

In order to provide continuous and timely monitoring, dissemination and issuance of accurate forecasts and warnings of local severe storms (Nor'westers), tornadoes, floods, flash floods to the public, due to local financial constraints, the Government of Bangladesh requested the Government of Japan to realize the following components using Japan's Grant Aid Assistance.

<Equipment>

[1] Procurement and Installation of Meteorological Doppler Radar System (S-band)

[2] Procurement and Installation of Communication System for Data Transmission

<Facilities>

[3] Construction of Radar Tower Building in the premises of BWDB in Moulvibazar (the ownership of the site has been scheduled to transfer from BWDB to BMD)

As a consequence of the several discussions with BMD and FFWC during the Basic Design Study in Bangladesh, the following components were additionally requested by Bangladesh side to be included in the Project for generating wider project effects effectively.

<Equipment>

[4] Existing Dhaka and Rangpur Meteorological Radar System 8 bit Improvement

[5] Procurement and Installation of Meteorological Radar Data Display Systems for Prime Minister Office, Bangladesh TV Centre and Dhaka International Airport

It was agreed that in accordance with the project implementation schedule, the project component of [5] mentioned above will be procured by BMD as self-reliant efforts of Bangladesh.

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

Bangladesh is affected seriously by devastating floods, flash floods and local severe storms every year which have created disaster-stricken tens of millions people. Regrettably, these disasters have caused significant damage to agriculture as the essential industry of Bangladesh and inflicted suffering on the poverty. The extensive damage from these disasters is the determining factor for significant set-back of national economy and living standard of the poverty in Bangladesh.
Because of the situations indicated above, establishment of disaster management system including early warning is targeted for further reduction of damages created by natural disasters indicated in the Poverty Reduction Strategy Paper 2005.

According to the Paper, the Project aims at upgrading the early-warning information such as accuracy improvement of flood forecasts, timely issuance of flash flood forecasts, and quick issuance of local severe storms and torrential rain through real-time acquisition of i) the precipitation in the whole area of Bangladesh, upper river basins in Indian Territory and mountainous areas located along the international border, ii) actual location of local severe storms and torrential rains; and iii) accumulated rainfall.

Devastating floods and flash floods are generated by torrential rains in the mountainous areas and the upper river basins of the Indian Territory. Local rain water floods are generated by local heavy rainfall in Bangladesh. In addition, local severe storms are developed from cumulonimbus clouds mostly originating from India and sometimes accompanied with tornadoes.
In order to accomplish the target indicated above for reduction of damages created by the natural disasters, establishment of the required equipment and facilities will be implemented in the Project, which makes the followings possible.

- estimation of flooded water volume flowing in Bangladesh from India through monitoring rainfall in the upper river basins
- acquisition of precipitation in the mountainous areas of the Indian side, and
- acquisition of precipitation in the whole area of Bangladesh

Due to the establishment of the required equipment and facilities mentioned above,

① Issuance of a flash flood forecast and warning every 1 hour after detection of heavy rainfall by a meteorological radar system,

② Issuance of a local severe storm forecast and warning every 1 hour after detection of local severe storm by a meteorological radar system,

③ Issuance of a rainfall forecast and warning causing local rain water flood within 1 hour after detection of heavy rainfall by a meteorological radar system, and

④ Accuracy improvement of flood forecasts and warnings,

are expected.

The planned project components are construction of a radar tower building and installation of a meteorological radar system in Moulvibazar, existing Dhaka and Rangpur radar systems 8 bit improvement, installation of meteorological data display systems at SWC and FFWC, and establishment of meteorological data satellite communication systems connecting each project site.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy for the Basic Design of the Project

a) To design a meteorological observation system to contribute to disaster prevention.
b) To enable BMD to contribute effectively to the protection of people's life and property for sustainable socioeconomic activities.
c) To enable BMD to monitor weather condition round-the-clock on a real time basis.
d) To enable BMD and FFWC to issue meteorological and hydrological information and forests/warnings to the public promptly.
e) To set up the size and components of the Project to match the technical, operational and maintenance capabilities of BMD.

(2) Design Policy

[1] Design Policy of the Equipment

a) To design the system so that it is within BMD's capability to operate, maintain and repair.
b) To ensure the equipment is compatible with and meets the technical requirements of the World Meteorological Organization (WMO).
c) To ensure the equipment is suitable for the routine observation and forecasting work of BMD.
d) To select equipment for which spare parts and consumables can be easily procured and replaced.
e) To select reliable and durable equipment suitable for the local environment.
f) To minimize the recurrent costs to BMD of the operation, maintenance and repair of the equipment.
g) To design the equipment by adjusting the accuracy of radar data through calibration.
h) To design the equipment to minimize lightning damage.

i) To design the equipment to operate using 420V±20%, 3 Phase, 50Hz or 220V±20% Single Phase, 50Hz, power.

[2] Design Policy of Radar Tower Building

The design policy is to create a building suitable for use as meteorological radar facility and to become an operational base for weather observation. The plan is to construct meteorological radar tower buildings that will ensure appropriate and effective operations and will accommodate the required systems, equipment and personnel. It is a basic policy that the designed Radar Tower Buildings satisfy the following requirements.

a. To be capable of carrying out a variety of meteorological services as the "Radar Tower Buildings."
b. To provide the necessary environment for meteorological work to be performed effectively and efficiently.
c. To be suitable for BMD's 24hours/day work schedule of observations.
d. To have the necessary power supply back-up equipment (diesel generator, radar power backup unit, auto voltage regulator, etc.) for performing round-the-clock meteorological services 24 hours a day, 365 days a year.
e. To be sufficiently robust to withstand extreme weather and permit the performance of uninterrupted radar observation and the supply of weather forecast & warnings, even during a natural disaster.
f. To be suitable for the installation of a Doppler radar systems and other related equipment supplied under the Project.
g. To make use of local building materials for easy maintenance of the radar tower buildings by BMD.

(3) Design Policy on Environmental Conditions

1) Temperature

Air-conditioning systems are required for rooms where the equipment is to be installed since Moulvibazar has a high temperature and high humid climate.

2) Rainfall

The maintenance stair-case has been located at the center of the building, covered by the upper concrete slab, to enable BMD personnel to easily reach each room for regular maintenance of the radar equipment without getting wet during the Pre-monsoon, Monsoon and Post-monsoon seasons (April-October). These are the busiest periods for the radar system.

3) Flood

Moulvibazar is located in the high risk area of floods and flash foods. Therefore, the ground floor of the radar tower building will be built high enough to minimize any damage by floods/flash foods.

4) Lightning

The frequent lightning occurs especially during the rainy season. A lightning protector is, therefore planned, to prevent damage to the building and to the equipment.

5) Local Severe Storm

To ensure highly accurate radar observations, the maximum horizontal movement angle of the building must be not more than 0.085 degree (5% of the designed radar beam angle) during a local sever storm.

6) Earthquake

According to the "Bangladesh National Building Code 1993", Moulvibazar is located in "Zone 3". The "Basic Seismic Coefficient" of each zone indicated in the Code will be incorporated into the structural design and calculation for the radar tower building.

7) Load Bearing Layer

The suitable load bearing layer (silty, clayey gravel with sand) for the building construction (N value: 50) has been found at a depth of approximately 47m. To prevent differential settlement, cast-in-place concrete piles penetrating at least 0.5-1m into the load bearing layer will be used.

(4) Design Policy for Construction Work

1) Environmental Regulation

Environmental restrictions will not be applied for construction of the radar tower building because the construction work of the Project is not large-scale. However, there must be appropriate consideration given to protecting the environment surrounding the sites of the construction work. Waste water discharged from the radar tower building must undergo initial treatment before filtering treatment into the soil at each site.

2) Use of Locally Procurable Materials

Gravel, sand, cement, blocks, bricks, floor materials, reinforced bars, etc. are produced in Bangladesh while other construction materials are imported from ASEAN (Association of Southeast Asian Nations) countries. Most of the construction materials are procurable in the local market. For the Project, durable maintainable materials will be selected from the locally procurable materials.

3) Use of Local Construction Methods and Local Workers

The common local construction method involves Reinforced Concrete (RC) columns, beams and slabs

and concrete block walls, with a mortar trowel and paint finish. For the Project, this method will be used.

Laborers are classified by their skills, such as carpenters, plasterers, steel fitters, etc. However, there is currently a shortage of skilled laborers and the skill level is variable in Bangladesh. In order to utilize local laborers as much as possible, local construction methods with which local workers are familiar will be used.

(5) Policy for Use of Local Construction Companies

Generally in Bangladesh, the technical skills and competence of the major local construction companies are adequate, so they will effectively be used in construction of the radar tower building.

(6) Design Considerations to Simplify Operation and Maintenance for BMD

1) Easy to operate the equipment

The equipment to be supplied under the Project is to be used to support BMD's routine works as the national meteorological agency for the meteorological disaster prevention. A variety of data processing, analysis, display and communications capabilities must be readily available for BMD, using simple operational procedures.

2) Easy maintenance and affordable recurrent costs of the equipment

The equipment must be designed to minimize the spare parts and consumables required and to simplify regular maintenance. Replacement parts must be quickly and readily available. The biggest recurrent cost of the Project is expected to be electricity, therefore the equipment and facilities should be designed to minimize power consumption.

3) Consideration of minimizing operation & maintenance costs

In order for BMD to meet the increased ongoing costs of the system, such as operation and maintenance costs, after the completion of the Project, the following measures have been included in planning for the equipment and the radar tower building.

- The ability to restrict the operation of air-conditioning systems and the electricity supply to the operational rooms in the radar tower building
- The utilization of natural light to reduce energy requirements by minimizing the hours of artificial lighting required.
- The incorporation of solid-state parts into the radar system as much as possible to reduce the cost and frequency of parts replacement.

(7) Design Policy for Equipment & Building Grade

To allow the supply of uninterrupted forecasts and warnings to the public, even during occurrence of a natural disaster, the equipment and building must be sufficiently robust to withstand floods, local severe storms and lightning strikes and enable the provision of meteorological services 24 hours per day.

(8) Design Policy regarding Construction/Procurement Method and Schedule

Locally procurable materials and the local construction methods must be used in the building design. The equipment to be installed in the radar tower building, such as specialized power backup systems and meteorological equipment, which is not available in the local market, will be mainly procured from Japan. This equipment must be durable, reliable, of a high technical level, and cost effective.

Where possible, outside installation work should not be carried out during the monsoon season (rainy season), which, in Sylhet, is between April and September. Examples of this work include the radar antenna, radome, etc., which will be installed on the top of the radar tower building. In addition, installation of the radar system must also be completed in the dry season to avoid damage from rainwater.

2-2-2 Basic Plan

The finalized components in the basic design for the Project are as follows.

Table 8: Finalized Components for the Project

	Moulviazar Meteorological Radar Observation Station	Storm Warning Centre, Dhaka	Dhaka Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station	Flood Forecasting and Warning Centre
Equipment Procurement and Installation					
Meteorological Radar System	1				
Meteorological Radar Data Display System	1	1			1
Meteorological Data Satellite Communication System	1	1		1	1
Existing Radar System 8 bit Improvement			1	1	
Facility Construction					
Radar Tower Building (including furniture for Equipment)	1				

According to the design policies aforesaid, the basic design plan of the Equipment and the Radar Tower Building are clarified below.

(1) Basic Plan of the Equipment

1) Meteorological Radar System

A meteorological radar system is the only system able to observe in real time the occurrence, movement, distribution and intensity of rainfall, and meteorological phenomena related to rainfall, and to provide quantitative measurements over a large area in real time.

The requested meteorological radar system for Moulvibazar is S band. S band radar system is the most suitable type of radar for the observation of precipitation over a very wide area. S band radar system has several important characteristics, including lower attenuation by rain and the atmosphere than other types of radar, and the ability to transmit at high power, providing a "long range", "real time" system. The real time capability will allow BMD to issue warnings promptly. For these reasons, S band radar has been selected as the most suitable to monitor large-scale and distant phenomena such as monsoons, etc. The Project therefore requires the supply of S band radar system which is the most suitable radar system to monitor the northern-east part of Sylhet being the wettest area in Bangladesh and Meghalaya Hills in Indian Territory being the world wettest area. In addition, the S band radar system must be a Doppler system with a changeable function having quantitative rainfall observation and air-turbulence observation capability in real time.

2,770MHz ±2MHz frequency band will be used for the proposed radar system supplied under the Project. The S band meteorological Doppler radar system is designed to be able to observe rain clouds within a 400km radius and to detect a precipitation rate of 1mm/h or more within a 300km radius. Technical features of the S band meteorological Doppler radar system are as follows.

Table 9: Major Features of Meteorological Radar System

Main Purpose	Rainfall Monitoring
Band	S band
Frequency	2,770MHz
Rainfall Resolution	256 gradation level indication
Detectable Range of Precipitation Intensity 1mm/h or more	300km
Doppler Function	Available
Accumulated Rainfall	Available

In order to accomplish the project targets, the radar system must meet the following requirements.

[1] Doppler Mode

The meteorological radar system is designed to work in Doppler mode, which detects the wind motion and wind patterns of severe weather phenomena such as local sever storms (Nor'wester) and tornadoes within a 160km radius. This will help BMD to monitor the movement and the development of severe

weather system for the preparation of more accurate and timely weather forecasting and warning. The doppler mode is essential to allow for more accurate forecasting and longer forecast prediction times.

[2] CAPPI (Constant Altitude PPI (Plan Position Indicator)) Mode

CAPPI is a horizontal cross-section display at an altitude which can be specified by the user. It is derived from the interpolation of volumetric data. Data from all azimuth and elevation points are used in the calculation of precipitation intensity in order to generate the display for a specified altitude. The product displays constant altitude information from 3-dimensional raw data obtained by scans at multiple elevations. To get 3 dimensional data, the radar antenna can operate in "volumetric scan" mode, changing the antenna elevation at regular time intervals. For the estimation of rainfall from a convective system and the preparation of composite pictures using multiple radar systems, accurate observed data, especially CAPPI data at an altitude of 2km or 3km, is required. An automatic multi-level CAPPI function will be provided with the proposed radar systems.

[3] Required Radar Display and Output Information Functions

The following functionality must be provided by the meteorological Doppler radar system to enable BMD to accomplish its role as a national meteorological service.

Table 10: Required Radar Display and Output Information Functions

	Radar Display and Output Information Functions	**Purpose of Observation**
1	PPI Display	Rainfall
2	RHI Display	
3	JPG Image Output	
4	Heavy Rainfall Warning Output	
5	Accumulated Rainfall	
6	Catchment Area Rainfall Amount Display and Warning	
7	Surface Rain Display	
8	Composite Picture Display	Wind Velocity and Direction
9	Wind Velocity and Direction	
10	Wind Profile of the Upper Layer	
11	Wind Shear Alert	
12	CAPPI Display	3-dimensional
13	Echo Tops Display	
14	Cross Section	
15	Vertical Integrated Liquidation	
16	3-dimensional data Display	

Detection Range of the Meteorological Radar Network in Bangladesh is shown in the drawing attached in the next page.

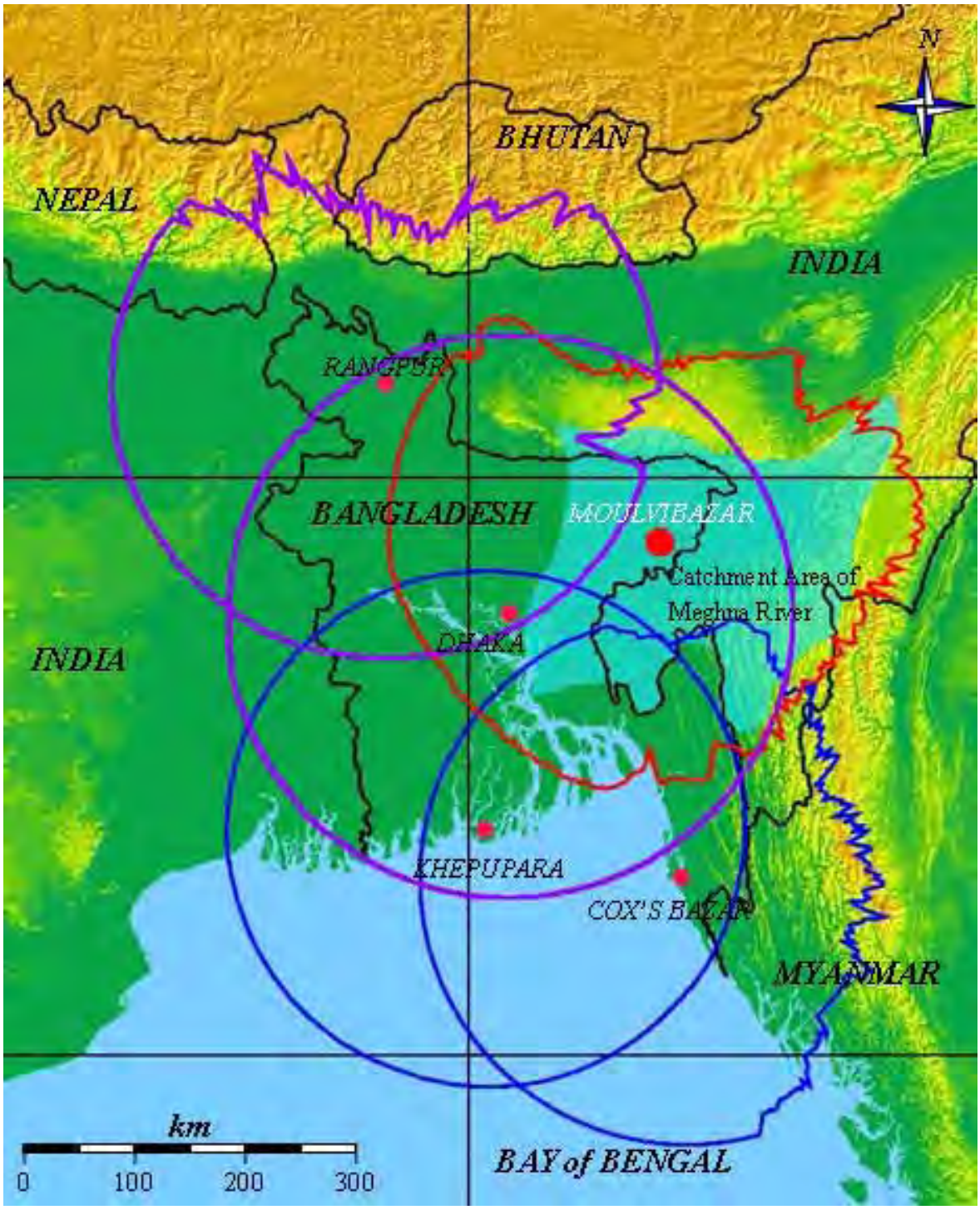


Figure 5: Detection Range of the Meteorological Radar Network
in Bangladesh
(The range indicates beam height of 3000m above sea level)
Note: The line of the range is calculated based on the altitude data of US Geological Survey

2) Meteorological Radar Data Display System

BMD's forecasters are required to do a substantial amount of work, at a number of locations, very rapidly, in order to produce the required outputs, therefore meteorological radar data display systems are to be installed at the following places. In addition, the system must have the ability to receive and display all the meteorological products in real time for routine weather forecasting & warning.

Displays of the system must be minimized heat production for effective room cooling , power-saving type and less screen reflections for smooth and long time operation.

a) Observation Rooms of Moulvibazar Meteorological Radar Tower Building
b) SWC
c) FFWC

<Meteorological Radar Data for FFWC>

A composite radar picture of precipitation intensity in the observation range of five (5) meteorological radar systems will be prepared by a computer system to be installed in SWC. Data file of the composite radar picture will be stored as binary data of hourly accumulated precipitation data of 2.5 km mesh in the detection range shown in the Figure 6.

This data file will be received by the meteorological radar data display system to be installed in FFWC. The meteorological radar data display system will be designed to enable FFWC to manually input the hourly accumulated precipitation data of 2.5 km mesh to the existing flood forecasting model (FF2003).

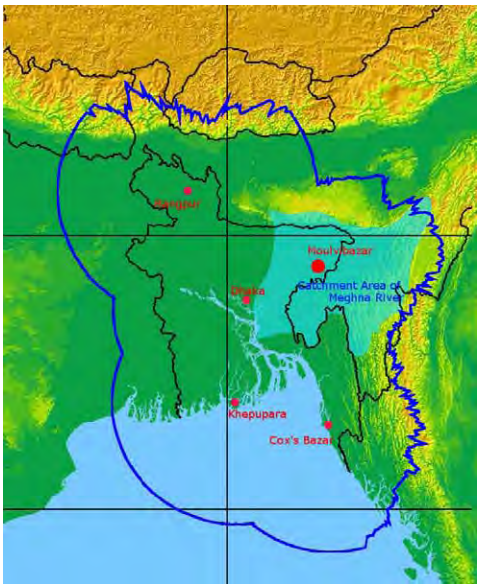


Figure 6: Observation Range of Five Meteorological Radar Systems

3) Meteorological Data Satellite Communication System

Since it has been designed that all of the meteorological radar data produced by the Cox's Bazar and Khepupara Meteorological Radar Systems is delivered to the SWC every 15 minutes, delivery time of the meteorological radar data produced by the Moulvibazar Meteorological Radar System to SWC should be the same for prompt delivery of the required data to FFWC through improvement of rainfall monitoring and forecasting works. To do this, a data transmission speed of the system must be 32kbps or more, between the Moulvibazar Meteorological Radar Observation Station and the SWC; between the exiting Rangpur Meteorological Radar Observation Station and the SWC; and between the SWC and the FFWC.

In order to transmit the meteorological radar data to SWC or FFWC every 15 minutes, currently there are two options, one is the existing BTTB land-line and another one is a satellite communication link. However, it has been finally decided to use the satellite communication link for the Project due to the following reasons.

- Since the satellite communication links have already been used between the Cox's Bazar Meteorological Radar System and SWC; and between the Khepupara Meteorological Radar System and SWC, charge for a communication satellite transponder (space segment) for the Project will be cheaper than the charge for a dedicated line of the existing land-line.
- There are no countermeasures against lightening surge in the existing land-line (high potentiality for the radar system to receive a serious damage).
- Due to the long distance of the existing land-line, it takes long time to identify a specific cause for a technical issue and restore a failed system.
- Since the maintenance of the dedicated line depends on BTTB to a great extent, BMD and FFWC is unable to independently take quick movement in case of emergency.

. The transmission times for the radar data streams to the SWC and FFWC are as follows.

Table 11: Required Transmission Time at Transmission Speed 32kbps (Moulvibazar - SWC)

Moulvibazar Meteorological Radar Data	Transmission Time
Numerical Rainfall and Doppler PPI Data for a Fixed Elevation Angle (240kBytes)	1.3min
Numerical Rainfall and Doppler PPI Data for 10 Elevation Angles (2.4Mbytes)	12.5min

Table 12: Required Transmission Time at Transmission Speed 32kbps (SWC - FFWC)

Meteorological Radar Data	Transmission Time
Precipitation Data of National Composite Picture (360Mbytes)	2.2min

Transmission of all of the radar data from the Meteorological Radar Stations to the SWC and from SWC to FFWC is required, especially during a disaster, therefore, as previously mentioned, the most suitable band for high-speed satellite communication links is C-band, because of the low rain attenuation.

Table 13: Required Conditions of Meteorological Data Satellite Communication System

Bandwidth	C band
Data Transmission Speed	32kbps or more
Required Bandwidth of Transponder	Moulvibazar Radar System - SWC: 100kHz or more
	FFWC - SWC: 100kHz or more
	Existing Rangpur Radar System - SWC: 100kHz or more
	Cox's Bazar Radar System - SWC: 100kHz or more Khepupara Radar System - SWC: 100kHz or more
	Total : 500kHz or more

For transmitting all the meteorological radar data from the Moulvibazar and existing Rangpur Meteorological Radar Observation Stations to SWC and from SWC to FFWC, the transponder to be selected for the Project must satisfy the following requirements as the same as from the Cox's Bazar and Khepupara Meteorological Radar Observation Stations to SWC.

1) Satellite Beam : C band regional beam for Southeast Asia area including Bangladesh
2) Frequency : Up Link 5925 - 6425 [MHz]
3) Down Link : 3700 - 4200 [MHz]
4) Polarizations : Orthogonal Linear
5) Satellite Maximum EIRP : more than 39.5 [dBW]
6) Satellite G/T : more than -2.2 [dB/K]
7) Satellite SFD : less than -86.5 [dBW/m^2]
8) Satellite Orbital Slot (longitude) : 60°E - 140°E

EIRP
Effective Isotropic Radiated Power - This term describes the strength of the signal leaving the satellite antenna or the transmitting earth station antenna, and is used in determining the C/N and S/N. The transmit power value in units of dBW is expressed by the product of the transponder output power and the gain of the satellite transmit antenna.

G/T
Figure of merit of an antenna and low noise amplifier combination expressed in dB. "G" is the net gain of the system and "T" is the noise temperature of the system.

SFD - Saturation Flux Density
The power required to achieve saturation of a single repeater channel on the satellite.

4) Existing Radar System 8bit Improvement

The meteorological radar data (3 bit, 6 gradation level indication) produced by the existing Dhaka and Rangpur Meteorological Radar Systems will be upgraded to 8 bit, 256 gradation level indication. The upgraded meteorological radar data will be combined with the meteorological radar data (precipitation intensity 8 bit data) produced by the Moulvibazar, Cox's Bazar and Khepupara Meteorological Radar Systems to process and make a national composite picture at the SWC. Due to implementation of this 8 bit improvement, resolution of the meteorological radar data (precipitation data) produced by all the Meteorological Radar Systems will be unified.

Table 14: Comparison Table of Before / After Improvement of existing Dhaka and Rangpur Meteorological Radar Stations

	Present	After Improvement
Meteorological Radar Station	・Dhaka ・Rangpur	
Observed Data	Precipitation Intensity Data (3 bit)	Specified vertical angle numeric precipitation data (8 bit)
Data Volume	・orthogonal coordinate format ・240x240 mesh ・3 bit data Total: 30kbyte	・polar coordinate format ・320 rangex360 degree ・8 bit data Total: 240kbyte
Precipitation Intensity Resolution	6 gradation level indication	256 gradation level indication
Display	・Precipitation Intensity	・PPI Display ・Heavy Rainfall Warning Output ・Accumulated Rainfall ・Rainfall Distribution ・Catchment Area Rainfall Amount Display and Warning

Details of the existing Dhaka and Rangpur Meteorological Radar Systems 8 bit Improvement are as follows.

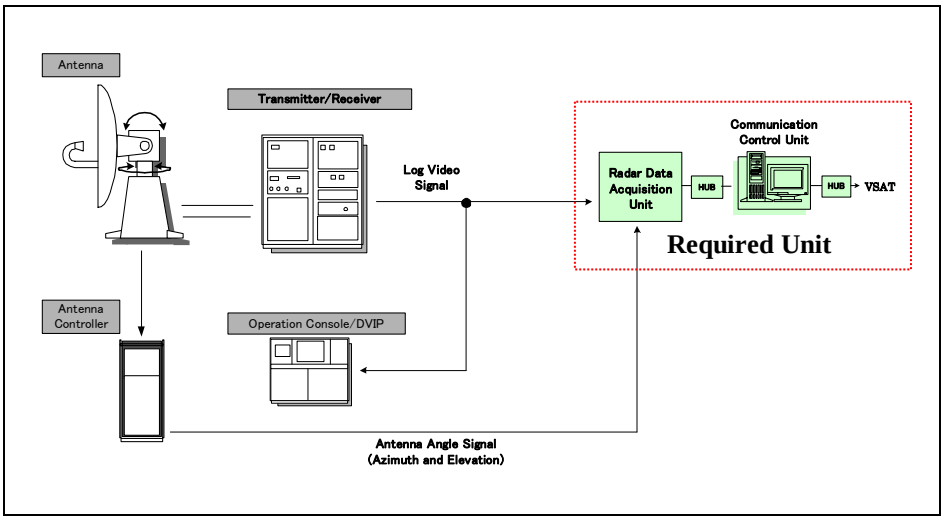


Figure 7: 8bit Modification of Existing Dhaka and Rangpur Meteorological Observation Radar Stations

The “Schematic Diagram for the Project for Establishment of the Meteorological Radar System at Moulvibazar” is attached hereto.

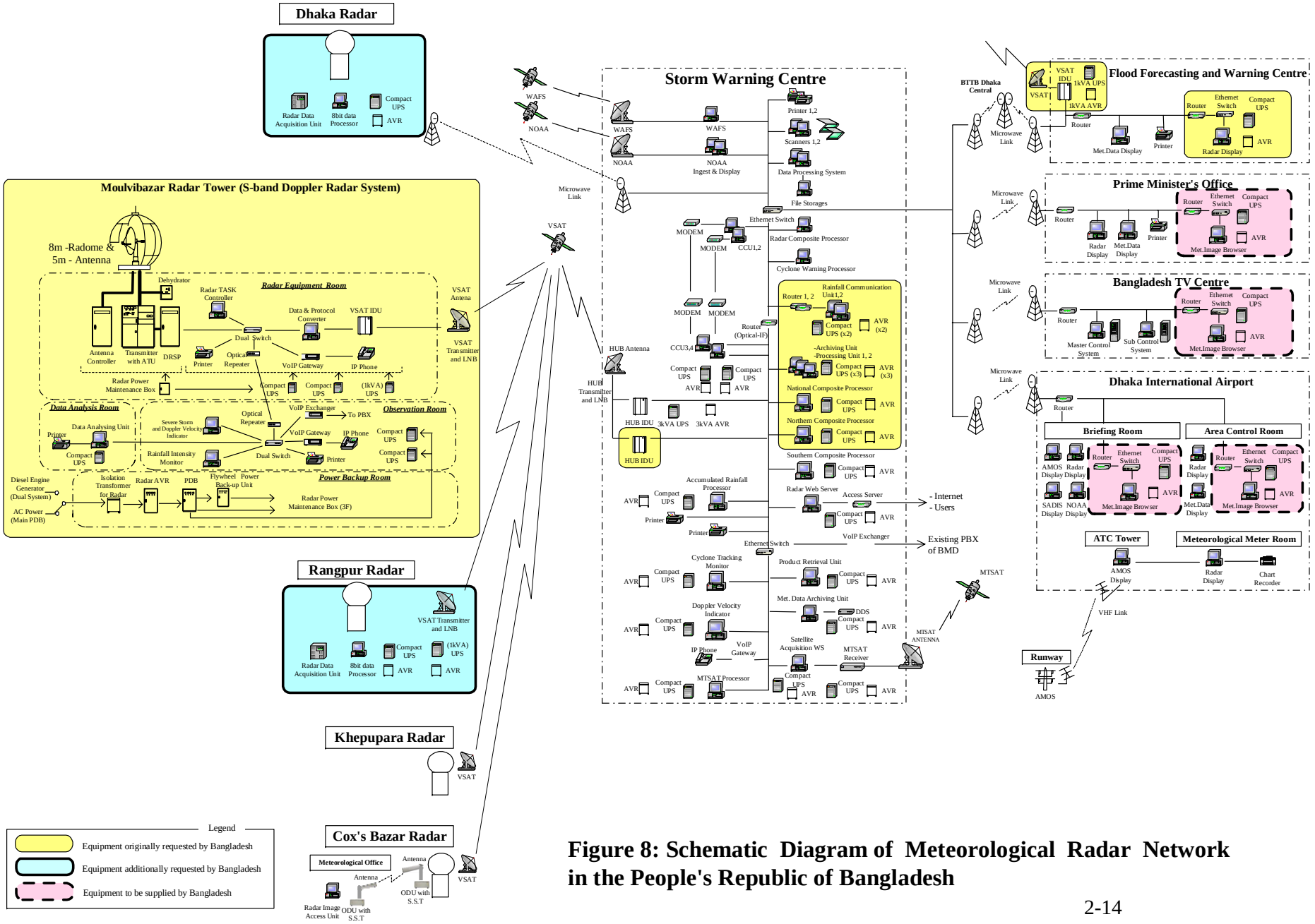


Figure 8: Schematic Diagram of Meteorological Radar Network in the People's Republic of Bangladesh

(2) Major Equipment List

As a consequence of the basic design study, the major components of the Project are described below.

Table 15: Major Components

Name of System	Moulvibazar Meteorological Radar Observation Station	Storm Warning Centre, Dhaka	Dhaka Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station	Flood Forecasting and Warning Centre
Meteorological Radar System	○				
Meteorological Radar Data Display System	○	○			○
Meteorological Data Satellite Communication System	○	○		○	○
Existing Radar System 8bit Improvement			○	○	

Major Equipment List

Meteorological Radar System
(Moulvibazar Meteorological Radar Tower Building)

Name of Site: Moulvibazar Meteorological Radar Tower Building (Radome Floor)			
Equipment	Specification	Quantity	Purpose
Radome	Type: Sandwich Type (Spherical surface) Dimension: Approx. 8m diameter Color: White Suitable non-observant and non-water stickling finish for making smooth surface Allowable velocity pressure: 2600 N/m^2 Suitable Frequency: 2,770MHz (±2MHz) Transmission loss: 0.5dB or less on one way path in dry Lightning Rod: Protecting angles of 60degree Obstruction light: Waterproof lightning system Base ring including necessary installation materials	1	For protecting the radar antenna assembly (a parabolic dish reflector) and maintenance personnel from severe weather conditions and lightning attacks.
Antenna	Type: Horn feed parabolic antenna Reflector: approx. 5m diameter Suitable Frequency: 2,770MHz (±2MHz) Beam width: not wider than 1.7 degree at -3dB point Antenna gain: 39dB or more without Radome Polarization: Linear, horizontal Side lobe level: not more than -25dB without Radome Driving range: Azimuth 360 degree, elevation -2 to +90 degree VSWR: not more than 1.4 without Radome Optical connection box: For converting electric control signal to optical one Directional coupler: Coupling coefficiency: forward –50dB ±2dB backward –35dB ±1dB VSWR: less than 1.10 Rating power: not less than 1MW	1	For radiating radar beam into the atmosphere and receiving scatter waves while rotating the parabola antenna in azimuth and elevation direction.

Name of Site: Moulvibazar Meteorological Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
Antenna Controller	Control mode: Programming mode and manual control mode Driving range: Azimuth 360 degree, elevation –2 to +90 degree Rotation speed Azimuth: 0.5 to 6 rpm (6 rpm in operation) Elevation: not more than 17 second for each way scan between -2 and 60 degree Automatically and manually capable for clockwise and counterclockwise rotation in AZ and up & down in EL Accuracy of specified angle for both antenna calibration and digital readout: Azimuth: not more than ±0.1 degree Elevation: not more than ±0.1 degree	1	For rotation a parabolic dish reflector and for controlling the antenna in azimuth and elevation by both horizontal and vertical drive motor units.
Transmitter	Transmitting frequency: 2,770MHz (S-band) Transmitting power: 500kW peak (at Tx output) Modulator: Solid state type Pulse width: from 0.4 μs to 2.0 μs Pulse repetition frequency (PRF): [Doppler Mode: Dual PRF] From 500Hz to 1,800Hz (Pulse width: 1.0 μs) selectable [Intensity Mode: Single PRF] From 200 Hz to 300Hz (Pulse width: 2.0 μs) selectable Condition Display: Transmission hour, pre-heat hour, status of Local/Remote control	1	For generation and emitting pulse-modulated power with stable frequency and transmitting the power to the antenna.
Amplifier Tube Unit (ATU)	Quadruple transmitting tube: klystron type (including ageing unit x 2) Cooling: Forced air cooling Insulation system: Oil tank Exchange unit of tube system internally mounted	1	For generation pulse-modulated power with stable frequency.

Digital Receiver and Signal Processor (DRSP)	Noise figure of the high frequency circuit: 3dB or better at the input terminal of low noise amplifier (LNA) Receiver type: Coherent IF digitizer Sensitivity: -110dBm or better (at 10us plus) Dynamic range: 80dB or better from noise level to saturated level (depending on matched filter bandwidth) Quantization: 14 bits Range bin: 1024 Processing area: throughout 0 km to 400 km in range and 0 to 360 degree in azimuth Area: 800km x 800km (Intensity Mode) 240km x 240km (Doppler Mode) Data grid or range resolution: 2.5km or more (Intensity Mode) : 1.0km or more (Doppler Mode) Intensity mode Ground clutter suppression: Chebyshev IIR digital high pass filter with minimum influence to precipitation intensity Logarithmic linearity: within ±1dB throughout 80dB Range correction: depending on radar equation Air-attenuation correction: 0.005dB/km in Observation Range Velocity mode Processing type: Pulse Pair, FFT and Random Phase Velocity De-arising: Real-time processing by Dual-PRF Trigger control: PRF selectable (2:3, 3:4, 4:5) Averaging: Block averaging and/or sliding averaging Output data: Reflectivity (Z), Doppler velocity (V), Spectrum width (W) Output data resolution: 8bit or 16bit Output data indicating interval: within 1 minute after automatic scan Time adjustment: Automatically adjustment by GPS NTP server (including antenna)	1	For receiving and processing video echo signal from a RF receiver in the transmitter. For suppressing unnecessary echo such as clutter signals reflected from ground. For sending ingest data to radar TASK controller.
Dehydrator	-Capability of ventilation pressure: 3±1 liter/min, -Normal:200 hPa -Upper limit: 300 ±30 hPa -Lower limit: 70±30 hPa	1	For supplying dried and pressurized air into the wave-guide to reduce wave propagation loss.
Wave-guide Configuration	-Wave-guide Type: S-band wave-guide (conformity with WR-284 or equivalent) -Circulator Allowable maximum power: at least 700 kW -TR limiter (x 6) Type: Dual back up type	1	For feeder line for propagation wave traveling between the antenna and TX/RX.

Radar TASK Controller	CPU: Intel Pentium 4, 3.6GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250GBytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2)ports or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX or LINUX-based Application software: -Radar local control and monitoring -Observation scheduling -Radar echo display -Radar data generation and dissemination	1	For operating the radar system, monitoring condition of the radar system and generating raw product data. Monitoring items: Radiate control/status Azimuth/elevation position control/status TX standby status Pulse width control/status Antenna local/maintenance mode status
Data & Protocol Converter	CPU: Intel Pentium 4, 3.6GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250GBytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2)ports or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX or LINUX-based Application software: -Data receiving, converting and transfer -Parameter setting -Display processing -Web server feature	1	For sending Raw data to Strom Warning Centre according to specified interval.
Peripherals	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	2	For supplying back-up AC power to computing equipment in order to keep the shutdown time of the system in case of power failure.
	1kVA UPS -Capacity: 1kVA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to computing equipment in order to keep the shutdown time of the system in case of power failure.
	Dual Switch -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, eight (8)ports -Input power: AC 220V, single phase, 50Hz -Each ports and power supply shall be duplicated	1	For connecting all the computing equipment on LAN.
	Color printer -Color inkjet type, A3 size -At least 1200 dpi resolution, 7ppm of faster printing speed -Interface USB, SCSI or LAN -Input power: AC 220V, single phase, 50Hz	1	For printing radar image.

	Optical Repeater -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, one (1) port Optical fiber interface one (1) set Multi-mode (100Mbps) -Input power: AC 220V, single phase, 50Hz	1	For converting electrical signal and optical signal on LAN for surge protection.
	Radar Power Maintenance Box -Circuit breaker: no-fuse-breaker type -Main breaker -Power distribution: 5 outputs include 1 spare -Input power: AC 220V, single phase, 50Hz -Output power: AC 220V, single phase, 50Hz	1	For distributing and supplying AC power to radar system.
Name of Site: Moulvibazar Meteorological Radar Tower Building (Electricity Room)			
Equipment	Specification	Quantity	Purpose
Isolation Transformer	Capacity: 35kVA or more Input Power: AC 220V, thee phase, 50Hz Output Power: AC 220V, single phase, 50Hz Insulation: Class B Surge voltage: 30kV or more	1	For protecting each equipment from surge voltage in main power.
Radar AVR	Unit-1(For Radar Equipment) -Capacity: 20kVA or more -Input Power: AC 220V ±20%, single phase, 50Hz -Output Power: AC 220V ±5%, single phase, 50Hz Unit-2(For OA Equipment) -Capacity: 10kVA or more -Input Power: AC 220V ±20%, single phase, 50Hz -Output Power: AC 220V ±5%, single phase, 50Hz	1	For supplying the constant voltage to the radar system.
Name of Site: Moulvibazar Meteorological Radar Tower Building (Radar Power Backup Room)			
Equipment	Specification	Quantity	Purpose
Flywheel Power Backup Unit	-Back up period: 4 minutes or more for radar equipment -Input voltage: AC 220V(single phase 50Hz) -Normal output: Direct output of input voltage -CVCF output: AC 220V ±5%, single phase, 50Hz -Battery less type	1	For supplying the uninterrupted power by flywheel energy to the radar system when power failure is occurred.
Name of Site: Moulvibazar Meteorological Radar Tower Building (Maintenance Room)			
Equipment	Specification	Quantity	Purpose
Test Instruments and Materials	Test signal Generator	1 set	For maintenance of radar system.
	Power Meter	1 set	
	Power Sensor	1 set	
	Frequency Counter	1 set	
	Detector	1 set	
	Attenuator Set	1 set	
	Terminator for Detector	1 set	
	Oscilloscope	1 set	
	Digital Multimeter	1 set	
	CW Converter	1 set	
	Tool Kit	1 set	
	Extension Cable	1 set	
	Leveler	1 set	
	Step Ladder	1 set	
	Clump Current Meter	1 set	
	High Voltage Probe	1 set	
	Vacuum Cleaner	1 set	
	Radar Antenna Maintenance Deck	1 set	

Spare Parts	Timing Belt for Antenna (For Azimuth Angle Signal)	1 set	For maintenance of radar system.
	Timing Belt for Antenna (For Elevation Angle Signal)	1 set	
	Encoder for Antenna (For Azimuth Angle Signal)	1 set	
	Encoder for Antenna (For Elevation Angle Signal)	1 set	
	Motor for Antenna (For Azimuth Angle Signal)	1 set	
	Motor for Antenna (For Elevation Angle Signal)	1 set	
	Servo Unit for Antenna Controller (For Azimuth Angle Signal)	1 set	
	Servo Unit for Antenna Controller (For Elevation Angle Signal)	1 set	
	Power Supply Unit for Antenna Controller	1 set	
	Timer Relay for Transmitter	2 sets	
	Blower Unit for Transmitter	2 sets	
	Fan Unit for Transmitter	1 set	
	Power Supply Unit for Transmitter	1 set	
	Hard Disk Unit for Computer (not less than 250GB)	1 set	
	LAN Arrester	1 set	
	CD-R/W Drive	2 sets	
	MPU (3.8GHz or equivalent)	1 set	
	Memory (not less than 1024MB)	1 set	
	Obstruction Light	2 pcs	
	Grease with Pump and Oil with Jug for Antenna	1 set	
	Carbon Brush for Power	1 set	
	Carbon Brush for Signal	1 set	
	Operation & Maintenance Hand Book	2 sets	
Consumables			For maintenance of radar system.
			For maintenance of radar system.
			For maintenance of radar system.
Service Manuals			For maintenance of radar system.

Meteorological Radar Data Display System
(Moulvibazar Meteorological Radar Tower Building)

Name of Site: Moulvibazar Meteorological Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
Peripherals	VoIP Gateway -Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: phone-line (telephone, fax, etc.) -VoIP port : 4port -WAN interface: 10/100BASE-T	1	For converting voice packet signal. And exchange dial signal for telephone.
	Telephone Type: Analog 2wire, DTMF	1	For voice communication.
Name of Site: Moulvibazar Meteorological Radar Tower Building (Observation Room)			
Equipment	Specification	Quantity	Purpose
Severe Storm and Doppler Velocity Indicator	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX or LINUX-based Application software: -Basic data monitoring feature -Weather product processing -Map projection -Product display & retrieval	1	For monitoring and alerting of severe storm condition by various doppler radar products.
Rainfall Intensity Monitor	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drive Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX, LINUX-based or Microsoft Windows Application software: -Radar local control and monitoring -Observation scheduling -Basic data monitoring feature -Weather product monitoring and display -Map projection -Product display & retrieval	1	For monitoring rainfall intensity.

Peripherals	Color Printer -Color inkjet type, A3 size -At least 1200 dpi resolution, 7 ppm of faster printing speed -Interface USB, SCSI or LAN -Input power: 220V, single phase, 50Hz	1	For printing radar image.
	Dual Switch -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, eight (8) ports -Input power: AC 220V, single phase, 50Hz -Each ports and power supply shall be duplicated	1	For connecting all the computing equipment with LAN.
	Optical Repeater -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, one (1) port Optical fiber interface one (1) set Multi-mode (100Mbps) -Input power: AC 220V, single phase, 50Hz	1	For converting electrical signal and optical signal on LAN for surge protection.
	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	2	For supplying back-up AC power to computing equipment for shutdown the system in case of power failure.
	VoIP Gateway -Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: phone-line (telephone, fax, etc.) -VoIP port : 4port -WAN interface: 10/100BASE-T	1	For converting voice packet signal. Exchange dial signal for telephone.
	VoIP Exchanger -Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: PBX-line (FXO/2W) -VoIP port : 4ports -WAN interface: 10/100BASE-T -IP address: fixed type	1	For converting voice packet signal. Exchange existing PBX interface and LAN interface.
	Telephone Type: Analog 2wire, DTMF	1	For voice communication.
Name of Site: Moulvibazar Meteorological Radar Tower Building (Data Analyzing Room)			
Equipment	Specification	Quantity	Purpose
Data Analyzing Unit	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drive Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 18 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX or LINUX-based Application software: -Basic data monitoring feature -Weather product processing -Map projection -Product display & retrieval	1	For analyzing weather phenomena by observed radar data.

Peripherals	Color Printer -Color inkjet type, A3 size -At least 1200 dpi resolution, 7ppm of faster printing speed -Interface USB, SCSI or LAN -Input power: AC 220V, single phase, 50Hz	1	For printing radar image.
	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to computing equipment for shutdown the system in case of power failure.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	1 set	For maintenance of the system.
	MPU (3.8GHz or equivalent)	1 set	
	Memory (not less than 1024MB)	1 set	
	LAN Arrester	1 set	
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Meteorological Radar Data Display System
(Dhaka Head Office, Storm Warning Centre)

Name of Site: Dhaka Storm Warning Centre			
Equipment	Specification	Quantity	Purpose
Rainfall Communication Unit	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX, LINUX-based or Microsoft Windows Application software -Message Processing -Plotting -Production of Web Pages -WAFS Interface -User Interface	2	For communication processing of rainfall data and weather information.
Archiving Unit	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive DDS: one (1) drive (DDS-3 or more) Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX, LINUX-based or Microsoft Windows Application software -Data Receiving -Display feature -Storing to external storages	1	For storing of radar and weather information to selected media.

Processing Unit	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: LINUX-based and Microsoft Windows Application software (For weather service/Microsoft Windows OS): Microsoft Office Version 2003 or more Application software (For radar observation/UNIX,LINUX or Windows OS): -Data Receiving -Various weather products retrieving -Map edition	2	For retrieving and displaying of radar data.
National Composite Processor	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX, LINUX-based or Microsoft Windows Application software -Data Receiving -Data Dissemination -Display of radar echo -Display of status -National composite processing	1	For creating of national composite image by received data from each radar station.

Northern Composite Processor	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: UNIX, LINUX-based or Microsoft Windows Application software -Data Receiving -Data Dissemination -Display of radar echo -Display of status -Northern composite processing	1	For creating of northern composite image by received data from Dhaka, Rangpur and Moulvibazar radar station.
Peripherals	Router -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, two (2)ports -Routing: IP routing -Input power: AC 220V, single phase, 50Hz	2	For connecting and routing all the computing equipment on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	7	For supplying back-up AC power to computing equipment for shutdown the system in case of power failure.
	AVR -Capacity: 1kVA or more -Input power: AC 220V ±20%, single phase, 50Hz -Output power: AC 220V ±10%, single phase, 50Hz	7	For supplying the constant voltage to the computer.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	4 sets	For maintenance of the system.
	MPU (3.8GHz or equivalent)	4 sets	
	Memory (not less than 1024MB)	4 sets	
	LAN Arrester	4 sets	
	DDS for Data Storage (5)	1 set	For recording of the observed data.
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Meteorological Radar Data Display System (Flood Forecasting and Warning Centre)

Name of Site: Flood Forecasting and Warning Centre			
Equipment	Specification	Quantity	Purpose
Radar Display	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: For surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: LINUX or Microsoft Windows-based Application software: -Data Receiving -Product display & retrieval	1	For displaying of quantitative rainfall data and weather information.
Peripherals	Ethernet Switch -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, eight (8)ports -Input power: AC 220V, single phase, 50Hz -Each ports and power supply shall be duplicated	1	For connecting all the computing equipment on LAN.
	Router -LAN interface: IEEE 802.3 Ethernet -Connection port: 100BASE-T, two (2)ports -Routing: IP routing -Input power: AC 220V, single phase, 50Hz	1	For connecting and routing all the computing equipment on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to computing equipment for shutdown the system in case of power failure.
	AVR -Capacity: 1kVA or more -Input power: AC 220V ±20%, single phase, 50Hz -Output power: AC 220V ±10%, single phase, 50Hz	1	For supplying the constant voltage to the computer.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	1 set	For maintenance of the system.
	MPU (3.8GHz or equivalent)	1 set	
	Memory (not less than 1024MB)	1 set	
	LAN Arrester	1 set	
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Meteorological Data Satellite Communication System
(Moulvibazar Meteorological Radar Tower Building)

Name of Site: Moulvibazar Meteorological Radar Tower Building			
Equipment	Specification	Quantity	Purpose
VSAT Out-door Unit (ODU/Transmitter)	-Output Frequency Range: 5.925GHz～6.425GHz -Input Frequency Range: 950MHz～1450MHz -Output Power Level: +40dBm min -Linear Gain: 64dB nominal -External Reference: 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Input Power]	1	Transmitter for communicating meteorological service and radar data transmission via satellite.
VSAT Out-door Unit (ODU/LNB)	-Input Frequency Range: 3.700GHz～4.200GHz -Output Frequency Range: 950MHz～1450MHz -Noise Temp (Ta: +25 C): 35K typ. 45K max -Conversion Gain (Ta: +25 C): 60 dB min. 66 dB max -External Reference: 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Input Power]	1	Receiver for communicating meteorological service and radar data transmission via satellite.
VSAT Antenna	-Diameter: Approx 2.4m -Tx Frequency Range: 5.925GHz～6.425GHz -Rx Frequency Range: 3.700GHz～4.200GHz -Antenna Drive Method: Manual -Support Structure: Az - El mount	1	Antenna for communicating meteorological service and radar data transmission via satellite.
VSAT In-door Unit (IDU)	-Modulation Method: QPSK -Tx Output Frequency Range: (950MHz～1450MHz) -Rx Input Frequency Range: (950MHz～1450MHz) -Down-link Data Speed: 32kbps or 64kbps -Up-link data Speed: 32kbps or 64kbps -Number of Tx Channel: 1ch (Data, Voice) -Number of Rx Channel: 1ch (Data, Voice) -Output Reference : 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Output Power] (Tx Port) : 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Output Power] (Rx Port) -Output Dc power : +48 V DC (Tx Port) : +15 V DC (Rx Port) -Demodulation Method: Coherent Detection System -Data Interface: 10base-T or 100base-TX (Data, Voice)	1	Modulator/Demodulator for communicating meteorological service and radar data transmission via satellite.
Arrester Box	For 48VDC Power: 1ch Striking Voltage: 88Vmin Response Time: 0.1us Max. Surge current capacity: 2000A (8/20us) For Thermal sensor: 1ch Striking Voltage: ±6Vmin Response Time: 0.1us Max. Surge current capacity: 5000A (8/20us) For High Frequency: 2ch Striking Voltage: 90Vmin Frequency: DC-2.2GHz Max. Surge current capacity: 20KA (8/20us)	1	For protecting of VSAT equipment from lighting.
Maintenance Terminal	OS: Windows XP CPU: Pentium M 1.6GHz or equivalent Memory: 512MB or more VSAT maintenance software Control IDU data and parameter Monitor IDU status, parameter, and health data	1 set	For monitoring and controlling the system.
Spare Unit	Arrester	1 set	For maintenance of the system.
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Meteorological Data Satellite Communication System
(Rangpur Meteorological Radar Tower Building)

Name of Site: Rangpur Meteorological Radar Tower Building			
Equipment	Specification	Quantity	Purpose
VSAT Out-door Unit (ODU/Transmitter)	-Output Frequency Range: 5.925GHz～6.425GHz -Input Frequency Range: 950MHz～1450MHz -Output Power Level: +40dBm min -Linear Gain: 64dB nominal -External Reference: 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Input Power]	1	Transmitter for communicating meteorological service and radar data transmission via satellite.
VSAT Out-door Unit (ODU/LNB)	-Input Frequency Range: 3.700GHz～4.200GHz -Output Frequency Range: 950MHz～1450MHz -Noise Temp (Ta: +25 C): 35K typ. 45K max -Conversion Gain (Ta: +25 C): 60 dB min. 66 dB max -External Reference: 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Input Power]	1	Receiver for communicating meteorological service and radar data transmission via satellite.
VSAT In-door Unit (IDU)	-Modulation Method: QPSK -Tx Output Frequency Range: (950MHz～1450MHz) -Rx Input Frequency Range: (950MHz～1450MHz) -Down-link Data Speed: 32kbps or 64kbps -Up-link data Speed: 32kbps or 64kbps -Number of Tx Channel: 1ch (Data, Voice) -Number of Rx Channel: 1ch (Data, Voice) -Output Reference : 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Output Power] (Tx Port) : 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Output Power] (Rx Port) -Output Dc power : +48 V DC (Tx Port) : +15 V DC (Rx Port) -Demodulation Method: Coherent Detection System -Data Interface: 10base-T or 100base-TX (Data, Voice)	1	Modulator/Demodulator for communicating meteorological service and radar data transmission via satellite.
Arrester Box	For 48VDC Power: 1ch Striking Voltage: 88Vmin Response Time: 0.1us Max. Surge current capacity: 2000A (8/20us) For Thermal sensor: 1ch Striking Voltage: ±6Vmin Response Time: 0.1us Max. Surge current capacity: 5000A (8/20us) For High Frequency: 2ch Striking Voltage: 90Vmin Frequency: DC-2.2GHz Max. Surge current capacity: 20KA (8/20us)	1	For protecting of VSAT equipment from lighting.
Peripherals	1kVA UPS -Capacity: 1kVA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to VSAT equipment.
	AVR -Capacity: 1kVA or more -Input power: AC 220V ±20%, single phase, 50Hz -Output power: AC 220V ±10%, single phase, 50Hz	1	For supplying the constant voltage to the VSAT.

Maintenance Terminal	OS: Windows XP CPU: Pentium M 1.6GHz or equivalent Memory: 512MB or more VSAT maintenance software Control IDU data and parameter Monitor IDU status, parameter, and health data	1 set	For monitoring and controlling the system.
Spare Unit	Arrester	1 set	For maintenance of the system.
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Meteorological Data Satellite Communication System (Flood Forecasting and Warning Centre)

Name of Site: Flood Forecasting and Warning Centre			
Equipment	Specification	Quantity	Purpose
VSAT Out-door Unit (ODU/Transmitter)	-Output Frequency Range: 5.925GHz～6.425GHz -Input Frequency Range: 950MHz～1450MHz -Output Power Level: +40dBm min -Linear Gain: 64dB nominal -External Reference: 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Input Power]	1	Transmitter for communicating meteorological service and radar data transmission via satellite.
VSAT Out-door Unit (ODU/LNB)	-Input Frequency Range: 3.700GHz～4.200GHz -Output Frequency Range: 950MHz～1450MHz -Noise Temp (Ta: +25 C): 35K typ. 45K max -Conversion Gain (Ta: +25 C): 60 dB min. 66 dB max -External Reference: 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Input Power]	1	Receiver for communicating meteorological service and radar data transmission via satellite.
VSAT Antenna	-Diameter: Approx 2.4m -Tx Frequency Range: 5.925GHz～6.425GHz -Rx Frequency Range: 3.700GHz～4.200GHz -Antenna Drive Method: Manual -Support Structure: Az - El mount	1	Antenna for communicating meteorological service and radar data transmission via satellite.
VSAT In-door Unit (IDU)	-Modulation Method: QPSK -Tx Output Frequency Range: (950MHz～1450MHz) -Rx Input Frequency Range: (950MHz～1450MHz) -Down-link Data Speed: 32kbps or 64kbps -Up-link data Speed: 32kbps or 64kbps -Number of Tx Channel: 1ch (Data, Voice) -Number of Rx Channel: 1ch (Data, Voice) -Output Reference : 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Output Power] (Tx Port) : 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Output Power] (Rx Port) -Output Dc power : +48 V DC (Tx Port) : +15 V DC (Rx Port) -Demodulation Method: Coherent Detection System -Data Interface: 10base-T or 100base-TX (Data, Voice)	1	Modulator/Demodulator for communicating meteorological service and radar data transmission via satellite.

Arrester Box	For 48VDC Power: 1ch Striking Voltage: 88Vmin Response Time: 0.1us Max. Surge current capacity: 2000A (8/20us) For Thermal sensor: 1ch Striking Voltage: ±6Vmin Response Time: 0.1us Max. Surge current capacity: 5000A (8/20us) For High Frequency: 2ch Striking Voltage: 90Vmin Frequency: DC-2.2GHz Max. Surge current capacity: 20KA (8/20us)	1	For protecting of VSAT equipment from lighting.
Peripherals	1kVA UPS -Capacity: 1kVA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to VSAT equipment.
	AVR -Capacity: 1kVA or more -Input power: AC 220V ±20%, single phase, 50Hz -Output power: AC 220V ±10%, single phase, 50Hz	1	For supplying the constant voltage to the VSAT.
Maintenance Terminal	OS: Windows XP CPU: Pentium M 1.6GHz or equivalent Memory: 512MB or more VSAT maintenance software Control IDU data and parameter Monitor IDU status, parameter, and health data	1 set	For monitoring and controlling the system.
Spare Unit	Arrester	1 set	For maintenance of the system.
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Meteorological Data Satellite Communication System
(Dhaka Head Office, Strom Warning Centre)

Name of Site: Dhaka Strom Warning Centre			
Equipment	Specification	Quantity	Purpose
HUB In-door Unit (IDU)	-Modulation Method: QPSK -Tx Output Frequency Range: (950MHz～1450MHz) -Rx Input Frequency Range: (950MHz～1450MHz) -Down-link Data Speed: 32kbps or 64kbps -Up-link data Speed: 32kbps -Number of Tx Channel: 3ch (Data, Voice) -Number of Rx Channel: 3ch (Data, Voice) -Connectable with the Dhaka existing Comstream DT-8000 for communicating with Rangpur Meteorological Radar -Output Reference : 10MHz(sin-wave) [Frequency] : -5 to +5 dBm [Output Power] (Tx Port) : 10MHz(sin-wave) [Frequency] : -10 to 0 dBm [Output Power] (Rx Port) -Output Dc power : +48 V DC (Tx Port) : +15 V DC (Rx Port) -Demodulation Method: Coherent Detection System -Data Interface: 10base-T or 100base-TX (Data, Voice) -Equipment Rack: 19 inch Rack -Power Consumption: 800VA or less including ODU	1	Modulator/Demodulator for communicating meteorological service and radar data transmission via satellite.
Maintenance Terminal	OS: Windows XP CPU: Pentium M 1.6GHz or equivalent Memory: 512MB or more VSAT maintenance software Control IDU data and parameter Monitor IDU status, parameter, and health data	1 set	For monitoring and controlling the system.
Spare Unit	Combiner/Divider	1 set	For maintenance of the system.
Service Manuals	Operation & Maintenance Hand Book	1 set	For maintenance of the system.

Existing Meteorological Radar System 8bit Modification
(Dhaka Meteorological Radar Tower Building)

Name of Site: Dhaka Meteorological Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
Radar Data Acquisition Unit	Acquisition data: Existing radar information as follows; -Analog LOG signal -Azimuth angle information -Elevation angle information Quantization: 14 bits or more Range bin: 1024 or more Processing area: throughout 0 km to 400 km in range and 0 to 360 degree in azimuth Processing response: Realtime Output data: LOG data Processing scan mode: PPI Scan Host interface: Serial interface or Ethernet Surge protect: Serial Arrester or LAN Arrester Time adjustment: Automatically adjustment by GPS NTP server (including antenna) Input power: AC 220V, single phase, 50Hz	1	For collecting LOG video signal, azimuth angle signal and elevation angle signal to connect existing radar system.
8bit Data Processor	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2) ports or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: LINUX-based and Microsoft Windows Application software (For weather service/Microsoft Windows OS): Microsoft Office Version 2003 or more Application software (For radar observation/UNIX,LINUX or Windows OS): -LOG data input -8bit data processing -Display processing -8bit data transfer	1	For converting 8bit data by LOG video signal after reject clutter signal.
Peripherals	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to computing equipment in order to keep the shutdown time of the system in case of power failure.
	AVR -Capacity: 1kVA or more -Input power: AC 220V ±20%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz	1	For supplying the constant voltage to the computer.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	1 set	For maintenance of the system.
	LAN Arrester	1 set	
Service Manuals	Operation & Maintenance Hand Book	2 sets	For maintenance of the system.

Existing Meteorological Radar System 8bit Modification
(Rangpur Meteorological Radar Tower Building)

Name of Site: Rangpur Meteorological Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
Radar Data Acquisition Unit	Acquisition data: Existing radar information as follows; -Analog LOG signal -Azimuth angle information -Elevation angle information Quantization: 14 bits or more Range bin: 1024 or more Processing area: throughout 0 km to 400 km in range and 0 to 360 degree in azimuth Processing response: Realtime Output data: LOG data Processing scan mode: PPI Scan Host interface: Serial interface or Ethernet Surge protect: Serial Arrester or LAN Arrester Time adjustment: Automatically adjustment by GPS NTP server (including antenna) Input power: AC 220V, single phase, 50Hz	1	For collecting LOG video signal, azimuth angle signal and elevation angle signal to connect existing radar system.
8bit Data Processor	CPU: Intel Pentium 4, 3.8GHz or equivalent Main memory (RAM): 1024Mbytes or more Hard disk unit: 250Gbytes or more x two (2) drives Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-R/W drive: one (1) drive Monitor display: Color LCD type, 19 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2) ports or more LAN Arrester: for surge protection, RJ45 interface Input power: AC 220V, 50Hz, single phase Software Operation system: LINUX-based and Microsoft Windows Application software (For weather service/Microsoft Windows OS): Microsoft Office Version 2003 or more Application software (For radar observation/UNIX,LINUX or Windows OS): -LOG data input -8bit data processing -Display processing -8bit data transfer	1	For converting 8bit data by LOG video signal after reject clutter signal.
Peripherals	Compact UPS -Capacity: 500VA or more -Input power: AC 220V ±15%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz -Operation time: at least 5 minutes at full load	1	For supplying back-up AC power to computing equipment in order to keep the shutdown time of the system in case of power failure.
	AVR -Capacity:1kVA or more -Input power: AC 220V ±20%, single phase, 50Hz -Output power: AC 220V ±5%, single phase, 50Hz	1	For supplying the constant voltage to the computer.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	1 set	For maintenance of the system.
	LAN Arrester	1 set	
Service Manuals	Operation & Maintenance Hand Book	2 sets	For maintenance of the system.

(3) Basic Plan of the Facility

1) Site and Facility Layout Plan

① Site Features

The site (24°29'08"N, 91°46'30"E) presently belongs to BWDB is sufficiently large and flat to accommodate the radar tower building and the land ownership transfer from BWDB to BMD has officially been proceeding. The shape of the site is elongated extending north and south and the total area is 3,452m^2. The land level is approximately 80 cm lower than the frontal road. The site is located in the center area of the Moulvibazar city and is a quiet neighborhood surrounded by private houses. In the site, the existing decrepit and unusable facilities are available. It has been confirmed that these facilities will be demolished by BWDB after the completion of the land ownership transfer. In the site and the surrounding area, there are many tall native trees which are about 20m high. In addition, to the west border of the site, a 10 storied apartment building is under construction.

② Site Conditions

- Construction site : sufficient flat space is available
- Power supply : 150kVA Transformer (output: AC 415V, 3 phase 4 wires, 50Hz) to be installed by BMD is required
- Water supply : usable water supply pipe for the Project has been laid along with the road on the north side of the premises
- Sewerage : not available (a septic tank and a seepage pit are required)
- Telephone : new lines are to be established

③ Site Layout

The radar tower building is designed to locate about the north-south center and a little east side of the site. In the site, there is a land to be used by BWDB even after the land ownership transfer to BMD and a pound on the south side. In consideration of the future extension of BMD for construction of facilities such as a dormitory office, etc., the west and south sides of the site is designed to be vacant.

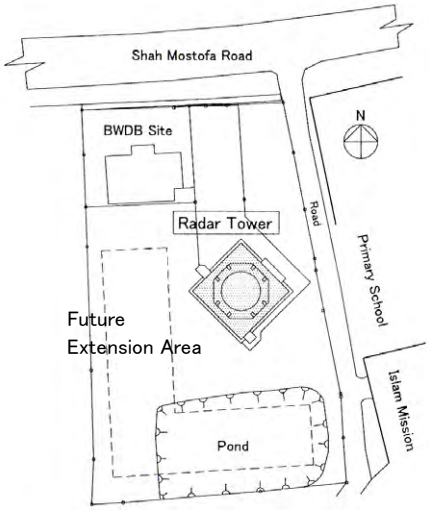


Figure 9: Site Layout Plan

2) Architectural Design

[1] Floor Plan

The floor plan is virtually symmetrical, making possible a structural design that is safe and avoids any

kind of eccentricity. The floor plan for the central portion of the radar tower building allows the various rooms to be arranged with great flexibility, since there are no structures such as columns and beams protruding into the internal staircase (which is also to serve as an evacuation route). Construction methods and materials follow local practice and the building is of standard grade in Bangladesh.

The following table shows total floor area of the radar tower building constructed in recent years by the Japan's Grant Aid and the Moulvibazar which is a standard size.

Table 16: Floor Area of Radar Tower Buildings (by the Japan's Grant Aid Assistance)

Radar Tower Building	Lao, Vientiane	Cox's Bazar	Khepupara	Moulvibazar
Total Floor Area	309.97m^2	323.35 m^2	350.81 m^2	350.06 m^2

The floor area of each room, the number of working staff, the room's function and the method of calculation of the size of each room are shown in the following tables.

Table 17: Calculation Base of Each Room in Proposed Moulvibazar Meteorological Radar Tower Building

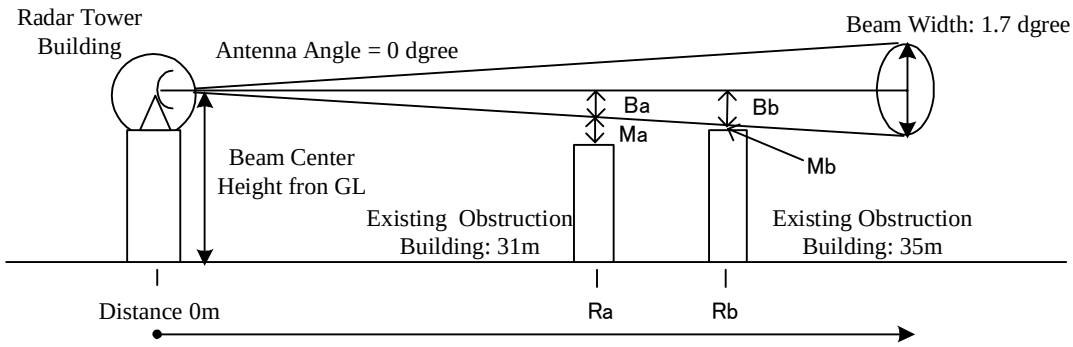
Name of Room	Floor Area (m^2)	Number of Working Staff/Shift	Room Function	Calculation Base
Radome Room	30.2	–	Installation space for radar antenna apparatus.	Maintenance space for radar antenna apparatus. Room area depends upon radome base 6.2m in diameter.
Radar Equipment Room (including Spare Parts Room: 4.2m^2)	53.6	–	Installation space for antenna controller, transmitter, amplifier tube unit, digital receiver, signal processor, dehydrator, wave-guide configuration, radar task controller, power distribution box, optical repeater, VSAT terminal, maintenance box, maintenance cabinet, measuring instrument cabinet, air-conditioning units, etc.	Operation and maintenance space for all the apparatuses described in the left column. For installation of all the required equipment, at least 54m^2 required.
Observation Room	21.9	Shift Schedule Daytime: 3 Night Time: 2	For weather observation terminals (2), VoIP exchange, optical repeater, dual switch, printer, IP telephone, UPS for PCs, filing cabinets, white board, etc.	For radar observation space and installation space for all the equipment described in the left column, 7m^2/person is required. In daytime always 3 persons in operation, approx. 22m^2 is required.
Maintenance Room	16.0	Daytime: 1 Night Time: 1	For maintenance instruments, measuring equipment, cabinets for operation & maintenance manuals and spare parts & consumables.	Maintenance space for various type of the equipment: 5m^2 (5m^2/person). Keeping space for maintenance instruments, measuring equipment: at least 10m^2. Cabinets for operation & maintenance manuals and spare parts & consumables: 6m^2.
Data Analysis Room	13.2	Daytime: 1 Night Time: 1	For data analysis terminal (1), desk for the terminal and data storage cabinets (high type: 3).	Approx. 10m^2 secured as a space for data analysis terminal (1), desk, data storage cabinets and also working space for day time staff.
Data Storage Room	10.7	–	For data storage cabinets (high type: 4) for keeping observation records and observed data of the radar system for analysis.	Necessary space for keeping all data secured.
Engine Generator Room	30.4	–	For 2 engine generators, oil pumps: 2, service tank, accessories, etc	Operation and maintenance space for 75kVA engine generators (2) with 1,000 liter service tank, automatic change-over switch, etc.
Electricity Room	11.7	–	For isolation transformers, power distribution boards, cable rack, test terminals, AVR, etc.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column. Approx. 12m^2 required.
Radar Power Backup Room	11.8	–	For radar power back-up unit and control rack.	Installation, operation and maintenance space for all the apparatuses described in the left column: approx. 12m^2 required.
Toilet	8.2	–	Closet bow: 2, Wash basin: 1, Slop Sink: 1	–
Tea Kitchen	6.0	–	Kitchen: 1	–
Changing Room	2.0	–	Changing space for taking shower	–
Shower Room	1.4	–	Space for taking shower.	–
Storage	3.3	–	Storage space for spare materials and miscellaneous goods.	Approx. 4m^2 secured as a storage space for spare materials and miscellaneous goods.
Pump Room	7.8	–	Well pump: 2 Pump for water reservoir tank: 2	For maintenance space and installation space for pumps: approx. 8 m^2 required.
Guard Room	4.9	–	Working desk for a guard man	For working space for a guard man: approx. 5m^2 required.

[2] Sectional Plan

I. Height of the Radar Tower Building

In Moulvibazar, there are presently two high-rise buildings, BINA hotel building: 31m high, SALEH tower building: 35m high, which may disturb the radar observation. In order to nicely perform the furnished radar functions in the practical radar operation without any technical issues, the antenna center of the radar system must be 46.8m or more, approximately 1m clearance can be secured between the bottom line of the radar beam and the rooftop of the highest building 35m high (SALEH tower building) as indicated in the following table. In accordance with the result of the study, the required height of the radar tower building at the site in Moulvibazar is approximately 52.3m to the top of the lightening rod located on the radome above ground level. In addition, the required height of the ground floor slab from the ground level is 1.6m in consideration of the previous flooded water levels and Moulvibazar being located in the high-risk area of flood disaster.

Table 18: Required Height of Moulvibazar Meteorological Radar Antenna



A Proposed Site for Construction of Moulvibazar Radar Tower Building (Beam Centre Heigh=46.8m)						**B** Existing Obstruction Building in Moulvibazar for Radar Observation									Distance between **A**-**B** (m)	Height of Bottom Line of Beam (m)	Gap between Bottom Line of Beam and Existing Obstruction Building (m)
Latitude			Longitude				Latitude			Longitude			Height (m)				
24	29	08.20	91	46	30.30	Ra: BINA Hotel Building	24	29	26.60	91	46	27.60	31	Ra=571	38.3 Ba=8.5	**Ma=7.3**
						Rb: SALEHTower Building	24	29	21.70	91	46	9.01	35	Rb=729	36.0 Bb=10.8	**Mb=1.0**

II. Ground Level

In the site, there is the existing bench mark (Bangladesh Bench Mark =7.688m) which is the reference ground level of the radar tower building.

III. Equipment Installation

In order to install all the equipment in the radar equipment room, a large opening would be necessary to allow equipment ingress. However, the large opening would be undesirable from the standpoint of air-

tightness and dust proofing. The equipment will, therefore, be brought in via a loading balcony at the adjacent staircase room. For lifting the equipment, a lifting hook with a capacity of 2-tons will be installed on the upper part of this balcony.

[3] Elevation Plan

The structural columns and beams will extend outside the building, enhancing the building design. Because of this, since columns and beams will not intrude into the staircase, the staircase will be able to comfortably handle traffic in both directions.

[4] Construction Method

The structural beams, external stairs, floor slabs, elevated parapet walls (observation deck and radome) will be made by the cast-in-place pre-cast concrete construction method. This construction method will shorten the construction period by 13 months. In case that the normal concrete construction method is applied, the construction period is estimated 14.5 months. Considering 6 months of the equipment installation period, it is rather difficult to complete the Project in the stated implementation period of in the Exchange of Notes to be signed by both Governments. Therefore, use of the cast-in-place pre-cast concrete construction method for the Project is quite important. The structural member size and shape are unified as many as possible for effectively utilizing merits of the cast-in-place pre-cast concrete construction method.

[5] Internal and External Finishing Plan

I. Finishing of Major Rooms (Radar Observation Room and Observation Room)

a) Floor

The radar equipment room and the observation room will have an access floor with a clearance of 15cm for easy wiring of power and signal cables, easy maintenance and easy future expansion. An antistatic, heavy-duty access floor has been selected for the radar equipment room in which a high power radar transmitter weighting about 1 ton is to be installed.

b) External Walls

To combat the effects of local temperature and humidity, the external walls of the radar equipment room are designed as cavity walls in which glass wool is sandwiched for heat insulation. Because of the thermal insulation provided by the building design, the recurrent cost to BMD of power for air-conditioning systems will be minimized.

c) Ceiling

The radar equipment cable rack, which is located in the radar equipment room, and the observation room (the major rooms of the proposed radar tower building), must be protected against dust. In addition, so as to improve the air tightness of these rooms and to reduce equipment noise, the ceilings will be finished with acoustic boards. Since both of these rooms are to be air-conditioned, the use of ceiling boards will also improve the efficiency of this air-conditioning. Based on the dimensions of the intended equipment, the ceiling height of the radar equipment room has been set at 3.0m and the ceiling height of the observation room at about 2.6m.

d) Window

Since the sustained wind pressure to be used for windows of the Radar Observation Room located at the height of 31m is expected to reach approximately 2,600 N/m^2, a laminated glass with a reinforced film will be used. In order to make a double protection for securely keeping wind and rain water from entering into the room, two aluminum windows at inside and outside will be individually installed.

II. Material Plan

Materials specified for both exterior and interior finishing, which are all available locally, have been selected with a view to ease maintenance for BMD as follows.

Table 19: Finishing Materials of Proposed Meteorological Radar Tower Building

		Finishing Materials
Exterior Finishing	**Observation Deck**	Cement sand mortal base, Asphalt waterproofing, Insulation, Protection concrete, Base mortal, Cement tiles
	Roof Floor	Cement sand mortal base, Asphalt waterproofing, Insulation, Protection concrete, Base mortal, Cement tiles
	Walls	Concrete blocks Cement sand mortar base spray tile finish, Porcelain tiles
Interior Finishing	**Floors**	Carpet tiles Vinyl tiles Porcelain tiles Cement sand mortal base, Epoxy resin paint finish
	Skirtings	Wooden skirting, Synthetic resin oil paint finish Cement sand mortar, Vinyl paint finish Cement sand mortar, Epoxy resin paint finish
	Walls	Cement Sand mortal base, Vinyl paint finish Glazed ceramic tiles Glass wool with glass cloth
	Ceilings	Acoustic panels (Grid ceiling system) Cement board (Grid ceiling system) Cement sand mortar base Emulsion paint finish Glass wool with glass cloth
Window and Door	**Exterior**	Aluminum windows and doors Aluminum grilles Aluminum doors, Steel doors
	Interior	Aluminum doors, Steel doors, Wooden doors

Table 20: Bases for Adoption of Materials
of Proposed Meteorological Radar Tower Buildings

		Bases for adoption of materials	Procurement
Exterior Finishing	**Roof Floor**	Due to external temperatures are high, reaching over 35 degrees, insulation board t=30mm will be required. Asphalt waterproofing is the most reliable waterproofing material to be protected by protection concrete, cement sand mortal and cement tiles.	To be procured locally
	Walls	Reinforced concrete blocks will be applied. Concrete blocks are generally used locally and are considered highly reliable in terms of both ease and accuracy of construction.	To be procured locally
Interior Finishing	**Floors**	Materials will be selected on the basis of superior durability and ease of maintenance. Vinyl tiles around offices, corridors and staircases will be applied. In rooms where dust must be avoided, a dust-proof paint finish will be specified.	To be procured locally
		In the offices where computer systems will be installed, access floors shall be applied for cabling under floor.	To be procured from the third countries
	Walls	Cement sand mortal (trowel-coated) will be applied primarily for its durability, and vinyl paint will be applied to avoid dirt. Glazed ceramic tiles will be laid in the toilets and the slop sink booth.	To be procured locally
	Ceilings	In order to enhance the environment and efficiency of air-conditioning, none asbestos acoustic mineral boards will be used. Other rooms which will not require any ceiling board will be directly applied emulsion paint finish on cement and sand mortal.	To be procured locally
Windows and Door	**Exterior**	Aluminum and steel will be chosen throughout for reasons of durability, ease of handling and accuracy.	To be procured overseas
	Interior	Wooden and steel with synthetic oil resin paint will be employed throughout for its handling ease during construction and from a maintenance standpoint.	To be procured locally (partly overseas)

[6] Structural Plan

I. Structural Design Standard

Building standards and fire safety standards have not been firmly established yet in Bangladesh. However, the "Bangladesh National Building Code 1993", based on British Standards (BS) and American Society for Testing and Materials standards (ASTM) has been issued by the Government of Bangladesh. Thereby, it has been decided to design the proposed radar tower buildings in accordance with this code.

II. Soil Condition and Foundation Plan

To ensure radar observation accuracy, building robustness is important and the permissible horizontal deflection of the building must be not more than 0.085 degree. Due to this, the foundation structures must prevent the building differential settlement.

The Bangladesh stratum (diluvial formation: 2 million-10,000 yeas ago, alluvial formation: 20,000 years ago-now) is comparatively younger and the formation accumulated after the last glacial age termination which was 10,000 years ago. Thereby still the soil grain shape is unconsolidated. As a

consequence of the study, there is high possibility of occurrence of consolidation settlement. In fact, many buildings supported by concrete piles driven into intermediate bearing layer have occurred differential settlement. Cast-in-place concrete piles penetrating at least 0.5-1m into the N value 50 load bearing layer located at 47 m deep are needed to meet the maximum permissible horizontal deflection requirement.

III. Structure Type

Reinforced concrete has been selected as the construction material for the proposed radar tower buildings because reinforced concrete construction is the most typical structural type in Bangladesh. The floor slabs are to be reinforced concrete while exterior walls and partition walls are locally made of concrete blocks.

IV. Design Load

a) Dead load

The weight of all the structural and finishing materials has been included in the dead weight calculation for the radar tower buildings. The estimated combined weight of the radome and radar antenna, to be mounted on the top of the radar tower building, is approximately 4.5 tons. The combined weight of the transmitter & receiver units, to be installed in the radar equipment room is approximately 3 tons, as a special dead load.

b) Live load

Since virtually most of all the major rooms in the radar tower building are equipment installation spaces, the live load of the radar tower building is deemed to be identical to that of telecommunication equipment rooms in Japan.

c) Wind load

The following sustained wind pressure to be used for the Project has been calculated in accordance with the "Bangladesh National Building Code 1993".

(Cc) = velocity-to-pressure conversion coefficient: 47.2×10^{-6}
(C1) = structure importance coefficient: 1.25 (essential facilities)
(Cz) = combined height and exposure coefficient: 1.539
(Vb) = basic wind speed in km/h obtained from the following map: 168km/h
(Qz) = sustained wind pressure: $Cc \times C1 \times Cz \times Vb^2 = 2{,}563 N/m^2$

The sustained wind pressure to be used for the Project = $2{,}600\ N/m^2$

d) Seismic load

According to the "Bangladesh National Building Code 1993", Bangladesh is classified into three (3) seismic zones with seismic zone coefficients. Moulvibazar is located in Zone 3. The Basic Seismic Coefficient of Zone 3 is Z=0.25 which is equivalent to C=0.14 of the standardized shear coefficient specified in the Japan Building Code.

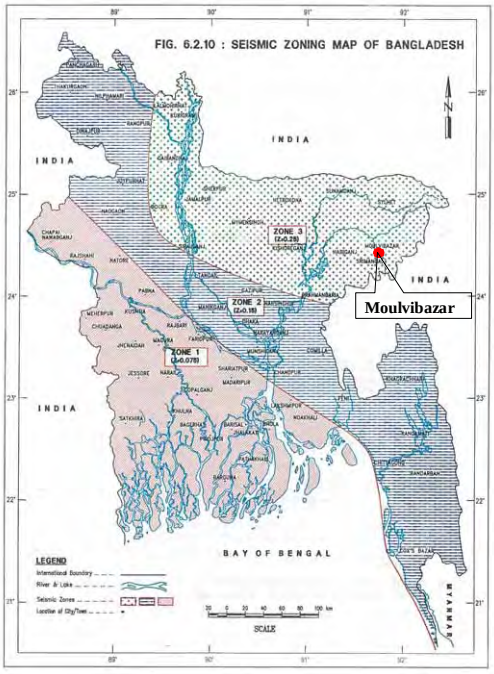


Figure 10: Seismic Zoning Map
"Bangladesh National Building Code 1993"

V. Structural Building Material

All the materials for the building structure will be procured in Bangladesh.

- Concrete : conventional concrete specified concrete strength Fc= 21N/mm^2
- Cement : Japan Industrial Standard (JIS) or equivalent
- Deformed reinforcing bars : ditto

[7] Electrical Facility Design

I. Power intake facility

The required commercial power for the radar tower building will be stepped down to low-voltage by a new transformer (capacity: 150kVA, output: AC 415V, 3 phase 4 wires, 50Hz) to be installed by BMD at the site and will be connected through the existing power meters to the radar tower building. The power inlet to the radar tower building, including wiring and power connection to a low-voltage switchboard, through a hand-hole to be installed under the Project, is one of the major scopes of work to be undertaken by BMD at its own expense.

II. Power generating facility

To ensure uninterrupted operation of the meteorological radar system and the other equipment, two engine generators with the following capacity are required for the radar tower building, as a back-up

power source during commercial power supply failures. During a flood, refueling for the engine generator is difficult. To ensure uninterrupted radar operation for 3 days a 1,000 liter service tank will be installed in the engine generator room of the building.

Capacity : 75 kVA
Output: 415V, 3 phase 4 wire, 50 Hz

III. Trunk line and power facility

Power will be distributed to the switchboard for lighting and to the electricity control panel from the distribution panel in the electrical room. The trunk line for distribution and the power line will use suitable cabling through conduits. An alarm for the power equipment will be shown on an alarm panel in the observation room. The electrical systems for the trunk line and branch circuits are as follows.

- Trunk line for lighting and power : 415V/240V, 3 phase 4 wire
- Branch power circuits : 415V, 3 phase 4 wire
- Branch lighting circuits : 240V, single phase 2 wire
- Branch equipment circuits : 415V, 3 phase 4 wire

IV. Lighting and power outlet

The voltage required for lighting and power sockets is single-phase 240V and all the fixtures must be grounded. Steel pipes will be used for wiring conduits. 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.

The lighting levels in the various rooms will be approximately as shown below.

Radome Room:	200 Lx	Engine Generator Room	200 Lx
Radar Equipment Room:	300 Lx	Electricity Room:	200 Lx
Observation Room:	300 Lx	Pump Room:	200 Lx
Data Analysis Room:	300 Lx	Radar Power Backup Room:	200 Lx
Data Storage Room:	300 Lx	Entrance Hall:	200 Lx
Maintenance Room:	300 Lx	Other Rooms:	200 Lx

General-purpose power outlets will be equipped with switches. Dedicated power outlets are required in the radar equipment room, the observation room, the data analysis room, the data storage room and the maintenance room for the Project computing equipment.

V. Telephone system

The required lines will be extended to each site through the overhead cable lines available in the

premises of each meteorological radar observation station. A service terminal box and a relay terminal box will be installed inside the radar tower building and telephone lines will be installed to outlets in those rooms requiring a telephone. The cabling work to the service terminal box will be conducted by BMD at its own expense. A private branch exchange (PBX) will be installed in the observation room and two telephone lines to be arranged by BMD will be required for the radar tower building.

VI. Intercom system

In order to control night shift personnel and visitors, intercom systems will be installed in the various operating rooms (radar equipment room, observation room, maintenance room, data analysis room and guard room) and outside of the building entrance, as a security measures.

VII. Alarm system

An alarm panel will be installed at the observation room. The following building equipment warnings will be provided.

- System failure of air-conditioning units in the radar equipment room
- System failure of radar power backup unit
- System failure and overheating of the engine generators
- Breaker tripping of the distribution boards

VIII. Grounding system

Grounding cables for the equipment installed on 1st and 6th floors will be connected to the terminal box for earthing. All the equipment to be installed in the electricity room and the radar power backup room will be grounded via the terminal box, while the telephone equipment will be grounded by erecting a grounding electrode and running a wire from there to the terminal box.

IX. Lightning protection system

A lightning rod will be installed on the top of the radome (included in the equipment portion of the Project), with roof conductors on the concrete handrails of parapets, the roof top, and the observation deck, to protect all the equipment and the radar tower building. A connection box will be placed at the radome room for the lightning rod. Inside the building structure, copper tapes will be laid in a vinyl pipe and grounded via the test terminal boxes.

X. Aviation obstruction light

A connection box for two obstruction lights on the top of the radome (which is part of the equipment portion of the Project) will be placed in the radome room. Four obstruction lights, to be installed at the observation deck, will be included in the building portion of the Project. For all of the obstruction lights, two power distribution boards will be installed on the first floor and in the radar equipment room and an automatic blinking switch will be installed on the first floor. All the aviation obstruction lights

will be furnished with surge arresters. Connecting work between the obstruction lights on the top of radome and a connection box placed in the radome will be included in the equipment portion of the Project.

XI. Fire detection and alarm system

Fire detectors will be installed in the radar equipment room, the electricity room, the radar power backup room and the engine generator room, and an alarm system will be installed in the observation room.

[8] Water Supply, Drainage and Sanitary Fixture Design

I. Water supply system

The public water supply pipe has been laid along the frontal road on the north side of the project site in Moulvibazar. For the water intake for the radar tower building, a water supply gate valve will be installed. BMD will be responsible for connecting the plumbing to a gate valve.

II. Drainage system

Drainage will be divided into 2 systems - sewage and miscellaneous drainage. Sewage will primarily be treated in a septic tank and then be permeated by a seepage pit into the ground. Miscellaneous drainage will be fed directly into a seepage pit. A septic tank and a seepage pit must be constructed. The capacity of the septic tank and seepage pit for the radar tower building has been designed for 12 BMD personnel in the operations area and for some visitors.

III. Sanitary fixtures

- Closet bowl: Bangladesh local style and European style individually
- Washbasin: wall-mounted type
- Slop sink: wall-mounted type

IV. Fire extinguisher

Fire extinguishers will be supplied in the following rooms.

Radome Room:	CO_2 type	Engine Generator Room:	ABC type
Radar Equipment Room:	CO_2 type	Electricity Room:	CO_2 type
Observation Room:	CO_2 type	Pump Room:	CO_2 type
Data Analysis Room:	CO_2 type	Radar Power Backup Room:	CO_2 type
Data Storage Room:	CO_2 type	Tea Kitchen:	ABC type
Maintenance Room:	CO_2 type		

[9] Air-conditioning and Ventilation System Design

Air-conditioning systems will be installed in the rooms listed below. It is essential to have a good operating environment, especially for the equipment in the radar equipment room and the observation room; therefore the plural number of air-conditioning systems is indispensable. Package type air-conditioning systems have been selected to minimize any impact to the operation of the radar system if an air-conditioning system fails.

- Radar Equipment Room
- Observation Room
- Data Analysis Room
- Data Storage Room
- Maintenance Room

Ceiling fan forced ventilation will be installed in the tea kitchen and the toilets. Due to the heat generated by the equipment in the radar equipment room, the engine generator room, the radar power backup room, the electricity room, pump room, etc., forced ventilation systems will be adopted. Furthermore, appropriate ventilation systems will be installed in other rooms to meet the following conditions.

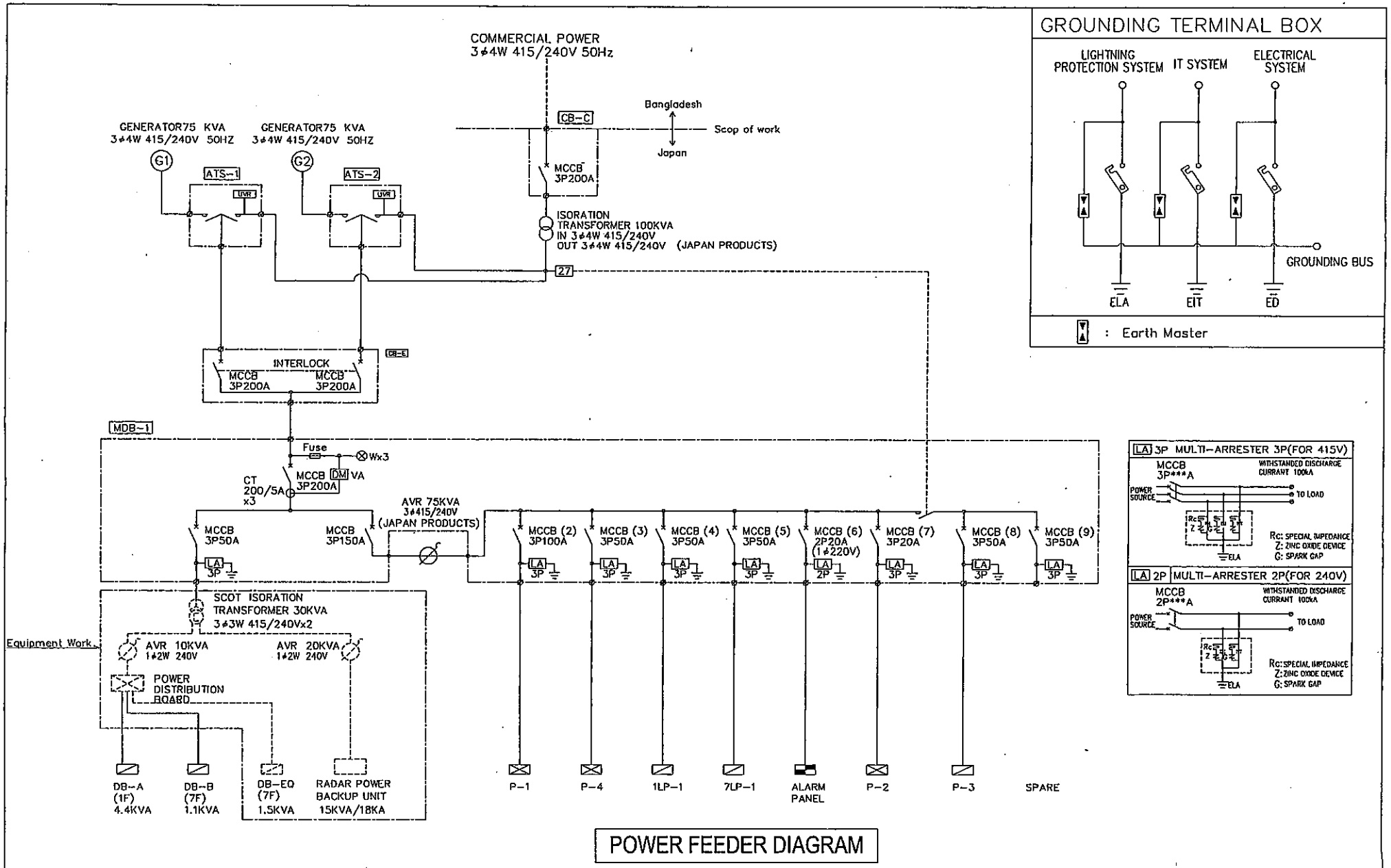
<Environmental conditions>

- Outside condition: 35°C (maximum temperature)
- Indoor condition: temperature 26°C humidity 40-60%
  In the radar equipment room: temperature 25°C humidity 40-60%

The following diagrams of the building equipment plan for the radar tower building are attached from the next page.

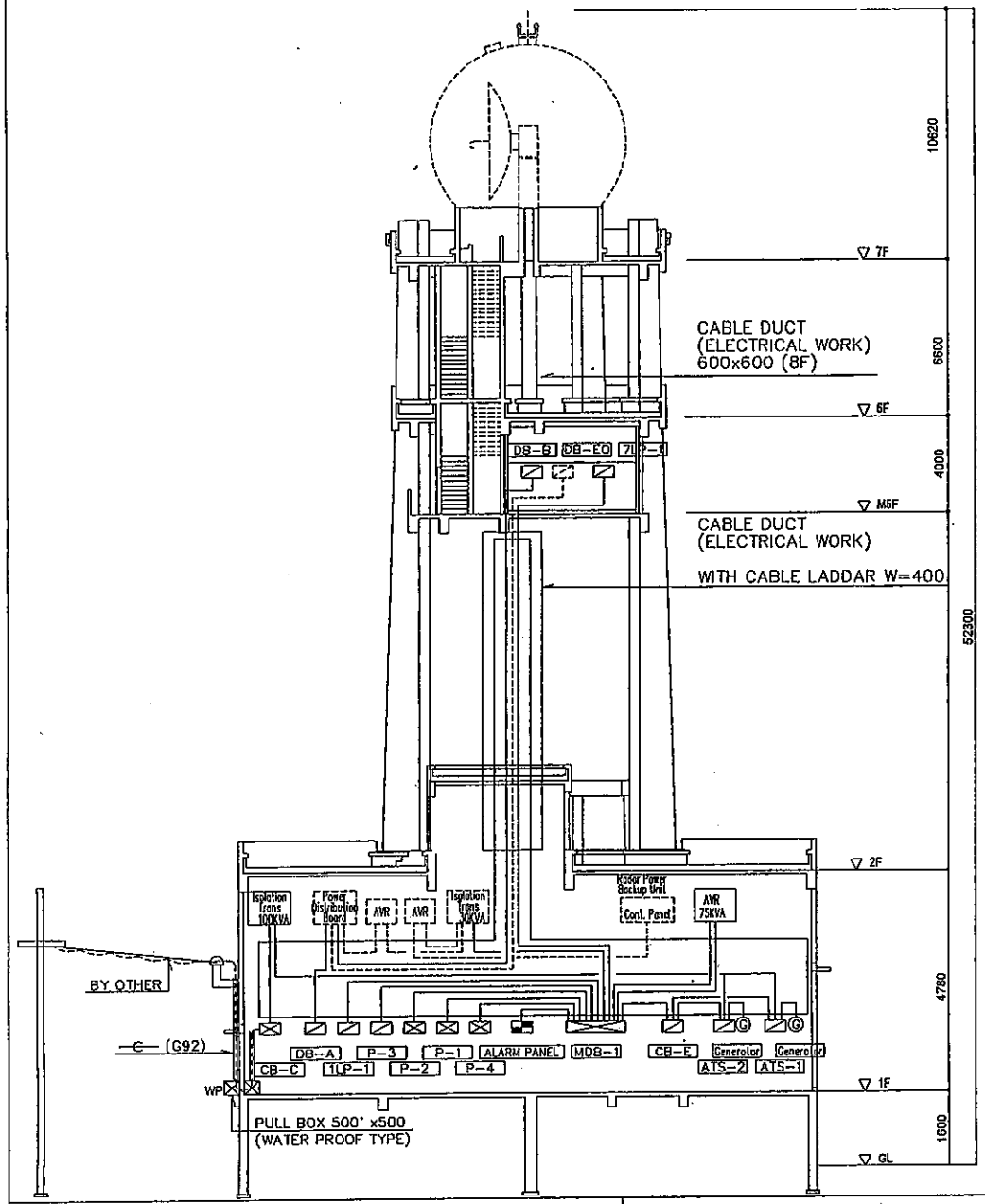
<Moulvibazar Meteorological Radar Tower Building>

- Power Feeder Diagram — System Diagram 1 (SD-01)
- Power Riser System — System Diagram 2 (SD -02)
- Interphone System & Tel Diagram — System Diagram 3 (SD -03)
- Riser Fire Alarm System — System Diagram 4 (SD -04)
- Alarm System Diagram — System Diagram 5 (SD -05)
- Riser Diagram Lightning Protection & Grounding System — System Diagram 6 (SD -06)
- Riser Diagram Obstruction Lighting — System Diagram 7 (SD -07)
- Water Supply & Drainage System — System Diagram 8 (SD -08)
- Air-Conditioning & Ventilation System Diagram — System Diagram 9 (SD -09)



POWER FEEDER DIAGRAM

Japan Weather Association	THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH	DRAWING TITLE: SYSTEM DIAGRAM-1	SCALE: NONE	DRAWING No.: SD - 01



POWER CABLE LIST

FROM	TO	CABLE SIZE	CONDUIT
CB-C	ISOLATION TRANS 100KVA	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ATS-1	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ATS-2	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
CB-E	MDB-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
MDB-1	ISOLATION TRANS 30KVA(EQUIP WORK)	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	P-1	XLPE/PVC 1C-4x50sq +E25sq	(G50) / CABLE LADDAR
MDB-1	P-2	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	P-3	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	P-4	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	1LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	7LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	ALARM PANEL	XLPE/PVC 2C- 6sq +E 6sq	(G32) / CABLE LADDAR
PowerDistributionBoard	DB-A	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDAR
PowerDistributionBoard	DB-B	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDAR
MDB-1	AVR 75kVA	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDAR
AVR 75kVA	MDB-1	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDAR

SPARE PARTS FOR LIGHTNING DAMAGE LIST

ITEM	DESCRIPTION	UNIT
CB-C	MCCB 3P200A	1
ATS-1	UNDER VOLTAGE RELAY	1
	CHANGE OVER SWITCH	1
	RELAY	4
MDB-1	MCCB 3P200A	1
	FUSE	6
	INDICATING LAMP	3
	VOLTAGE AMPERE INDICATOR	1
	ARRESTER 2P	2
	ARRESTER 3P	7
CB-E	MCCB 3P200A	1
	RELAY	4
	FUSE	4
GENERATOR	CONTROL CIRCUIT BOARD	1
	RELAY	4
	FUSE	4
	VOLT METER	1

------ EQUIPMENT WORK

POWER RISER SYSTEM

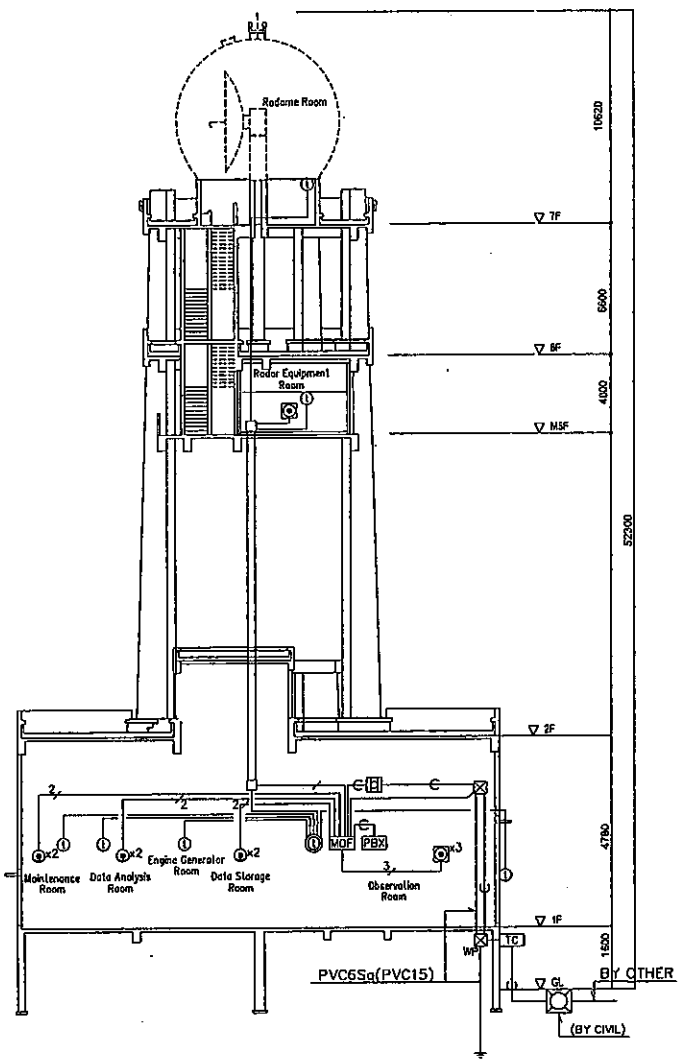
Japan Weather Association
Sunshine 60 Bldg., 66F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-6058-8161 Fax. +81-3-6058-8162

THE PROJECT FOR ESTABLISHMENT OF
THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE: SYSTEM DIAGRAM-2

SCALE: NONE

DRAWING No.: SD - 02

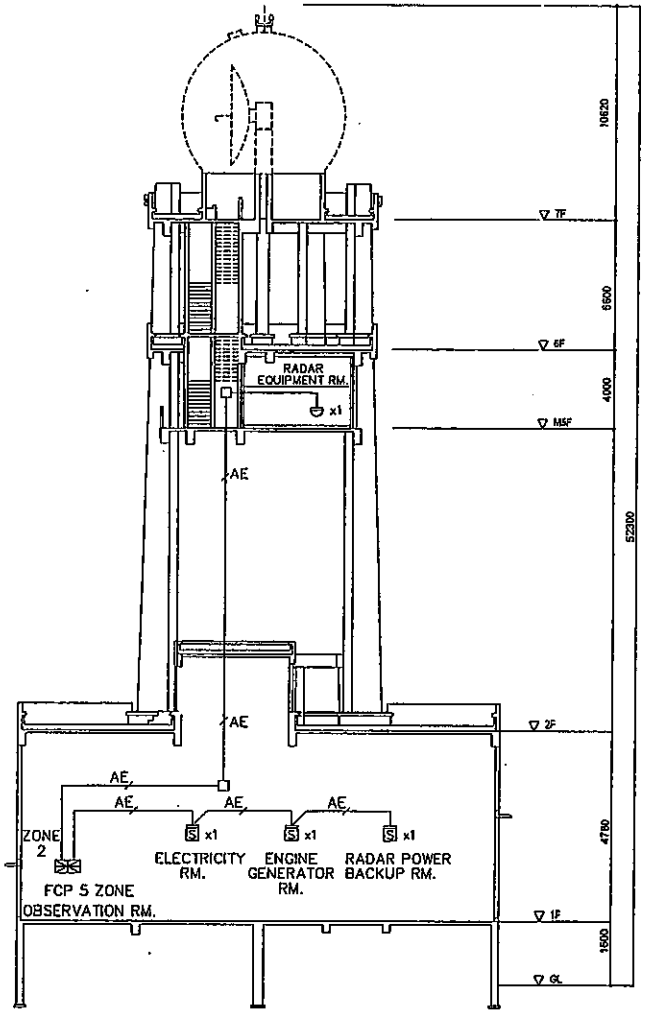


INTERPHONE SYSTEM &TEL DIAGRAM

REMARK

- —C— : —C— (G36)
- —/— : TIEV 0.65-4C (G20)
- —/2— : TIEV 0.65-4Cx2 (G20)
- —/3— : TIEV 0.65-4Cx3 (G25)
- —/— : TIEV 0.65-4C (UNDER THE ACCESS FLOOR)
- —/2— : TIEV 0.65-4Cx2 (UNDER THE ACCESS FLOOR)
- —/3— : TIEV 0.65-4Cx3 (UNDER THE ACCESS FLOOR)
- —— : AE 0.9-2C (G20)
- ---- : AE 0.9-2C (UNDER THE ACCESS FLOOR)
- PBX : PBX COT. 5L , EXT. 15L
- MDF : MAIN DISTRIBUTION FRAME 30P
- ◉ : TELEPHONE OUTLET (MODULAR JACK)
- ◎ : TELEPHONE OUTLET SLAB MOUNT
- E : ARRESTER
- ⓘ : INTERCOM (POWER SUPPLY FOR INTERCOM)
- ① : INTERCOM
- ⊠ : PULL BOX 200x200x200 (WATER PROOF TYPE)
- ▣ : HAND HOLE
- TC : INCOMING TERMINAL FRAME

JWA Japan Weather Association	THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH	DRAWING TITLE: SYSTEM DIAGRAM-3	SCALE: NONE	DRAWING No.: SD - 03



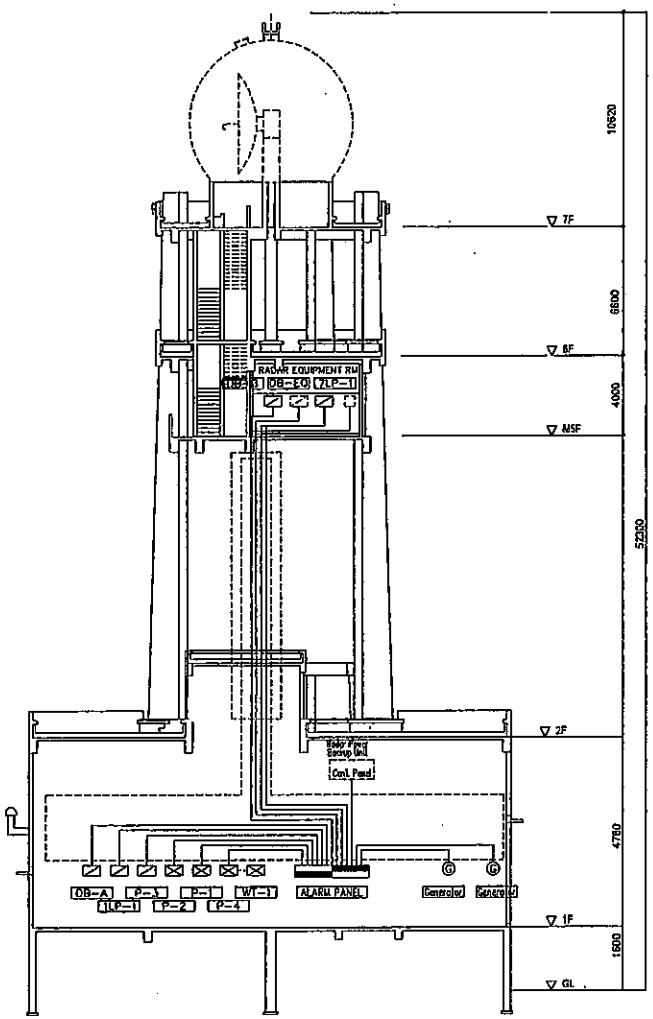
FIRE ALARM CONTROL PANEL 5 ZONE
SMOKE DETECTOR (PHOTO TYPE)
RATE OF RISE HEAT DETECTOR

RISER FIRE ALARM SYSTEM

Japan Weather Association
Sunshine 60 Bldg., 66F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6066 Japan Tel. +81-3-5955-8161 Fax. +81-3-5955-8162

THE PROJECT FOR ESTABLISHMENT OF
THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

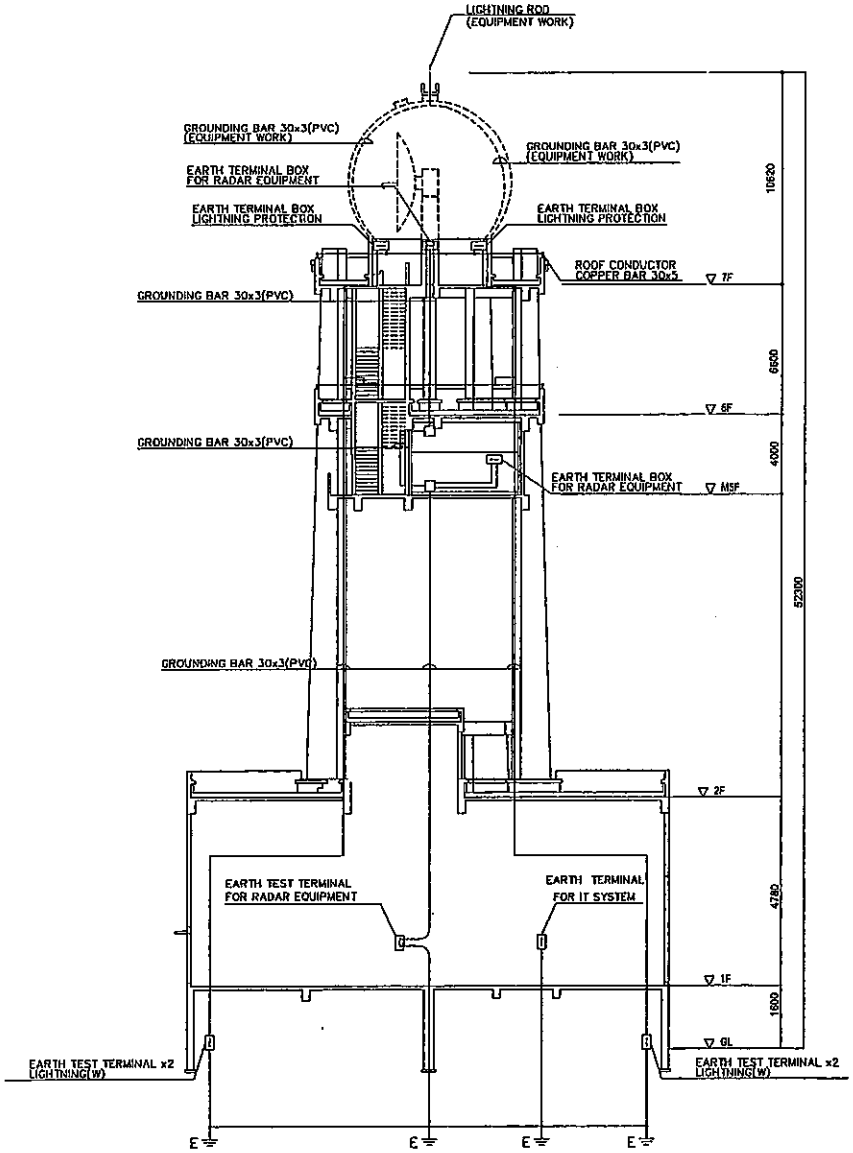
DRAWING TITLE	SCALE	DRAWING No.
SYSTEM DIAGRAM-4	NONE	SD - 04



TEMPERATURE SWITCH
FOR ROOM TEMPERATURE ALARM

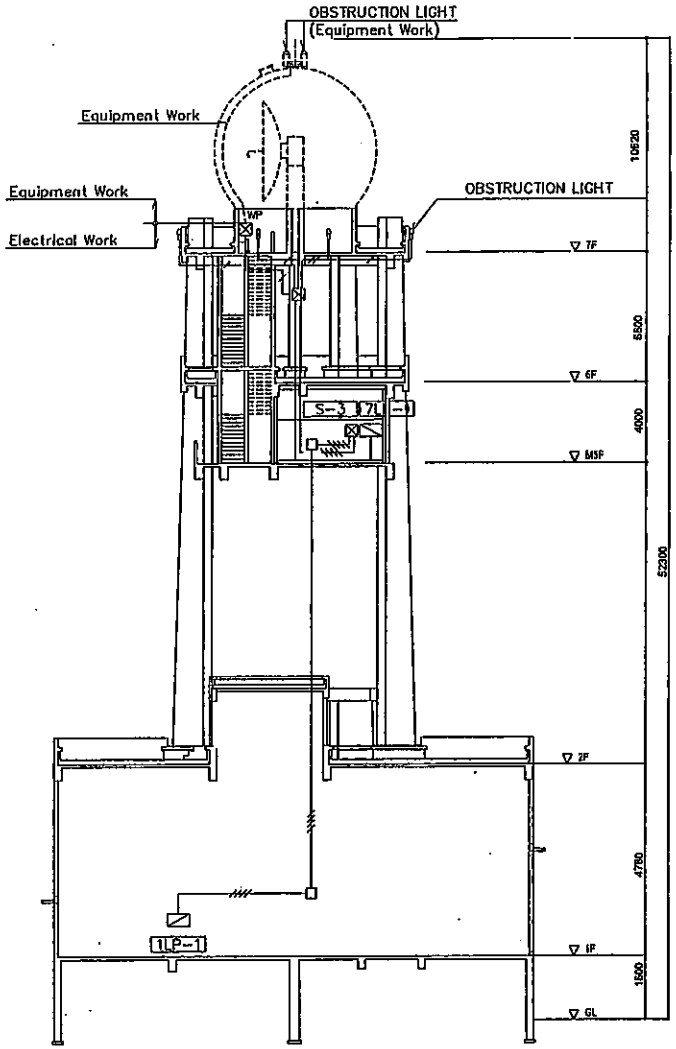
ALARM SYSTEM DIAGRAM

Japan Weather Association	THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH	DRAWING TITLE: SYSTEM DIAGRAM-5	SCALE: NONE / DRAWING No.: SD - 05



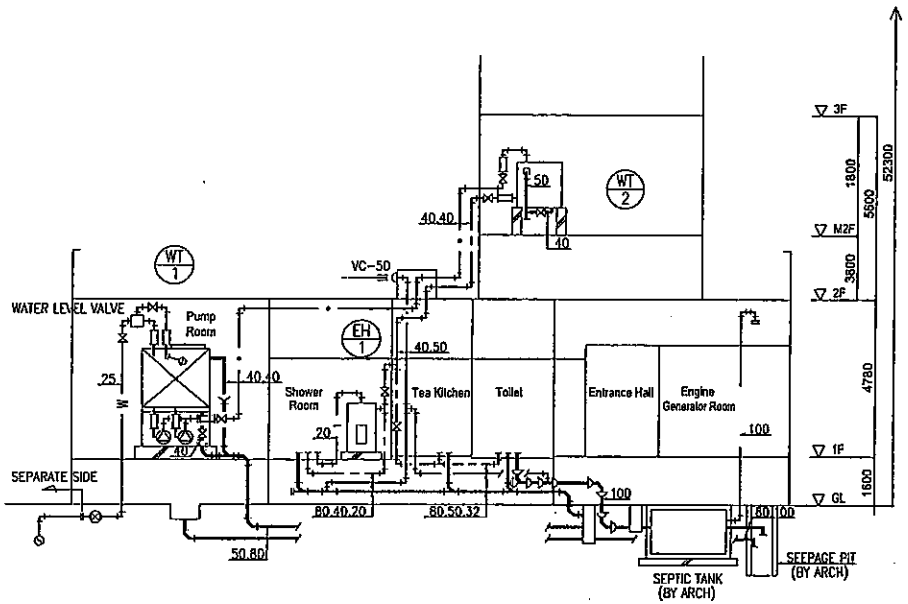
RISER DIAGRAM LIGHTNING PROTECTION AND GROUNDING SYSTEM

Japan Weather Association Bonshine 80 Bldg., 6SF, 3-1-1, Higashi Nakakuru, Toshima-ku, Tokyo, 110-0056 Japan Tel. +81-3-5858-8161 Fax. +81-3-5858-8162	THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH	DRAWING TITLE SYSTEM DIAGRAM-6	SCALE NONE	DRAWING No. SD - 06



RISER DIAGRAM OBSTRUCTION LIGHTING

Japan Weather Association	THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH	DRAWING TITLE: SYSTEM DIAGRAM-7	SCALE: NONE	DRAWING No.: SD - 07



ITEM	DESCRIPTION	GFL	1 FL			TOTAL	REMARK
		PUMP ROOM	TOILET	SHOWER ROOM	TEA KITCHEN		
WATER CLOSET	SQUAT TYPE (EASTERN TYPE)		1			1	
WATER CLOSET	SQUAT TYPE (WESTERN TYPE)		1			1	
LAVATORY	WALL HANG TYPE		1			1	
SERVICE SINK	WALL HANG TYPE		1			1	
PAPER HOLDER	SINGLE		1			1	
FAUCET	SELF CLOSING FAUCET		4			4	
MIRROR	-		1			1	
SHOWER HEAD	(WATER PRESSUE 60Kpa TYPE)			1		1	
SINK					1	1	
FAUCET		1			1	2	

NO.	NAME	SPECIFICATION	Q'TY	POWER SUPPLY					LOCATION	REMARKS
				PHASE	VOLT (V)	FREQUENCY (Hz)	MOTOR (KW)	EMERGENCY POWER SUPPLY		
WT-1	POTABLE WATER	FRP TANK	1					O	PUMP ROOM(1F)	RC FOUNDATION
	TANK /PUMP	RATED CAPACITY 2.5 m^3								(CIVIL WORK)
		DIMENSION 1.0 x 1.5 x 2.0mH								1.8×1.8×0.3mH
		ACCESSORIES MANHOLE 600ϕ, BREATHER,								
		BALL TAP 25A,								
		OVERFLOW AND DRAIN PIPE 40A,								
		ELECTRODE 4P								
		CONSTANT PRESSURE TYPE PUMP	2	3	420	50	1.5			
		40ϕ x 100L/min x 180kpa x 2PCS (1SPARE)			~440					
		ACCESSORIES FLEXIBLE CONNECTOR FOR SUCTION 40A								
WT-2	POTABLE WATER	FRP TANK	1						ROOF (M2FL)	RC FOUNDATION
	GRAVITY TANK	RATED CAPACITY 1.5 m^3								(CIVIL WORK)
		DIMENSION 1.0 x 2.0 x 1.0mH								0.4×1.4×0.5mH
		EARTH QUAKE-PROOF 2.0G (WIND-PROOF TYPE)								
		ACCESSORIES FLAT FRAME 150H, MANHOLE 600ϕ,								
		ELECTRODE 4P								
EH-1	ELECTRIC HOT	WATER STORAGE TYPE FLOOR MOUNTING	1	1	220	50	5.0		1F SHOWER ROOM PS	RC FOUNDATION
	WATER HEATER	STORAGE CAPACITY 99L			~240					(CIVIL WORK)
		STAINLESS STEEL CYLINDER								0.7×0.7×0.3mH
		DIMENSION 460W x 590D x 1035H								
		ACCESSORIES PRESSURE REGULATOR VALVE								
ABC	FIRE EXTINGUISHER	ABC DRY CHEMICAL, WALL HANG	3						EACH ROOM	
		10 Lbs, DISCHARGE TIME 14sec.								
CO2	FIRE EXTINGUISHER	CARBON DIOXICDE, WALL HANG	9						EACH ROOM	
		10 Lbs, DISCHARGE TIME 14sec.								
	SEPTIC TANK (BY ARCH)	SEPTIC TANK & SEEPAGE PIT (RC TYPE, CIVIL WORK)	1						OUT DOOR	

WATER SUPPLY AND DRAINAGE SYSTEM

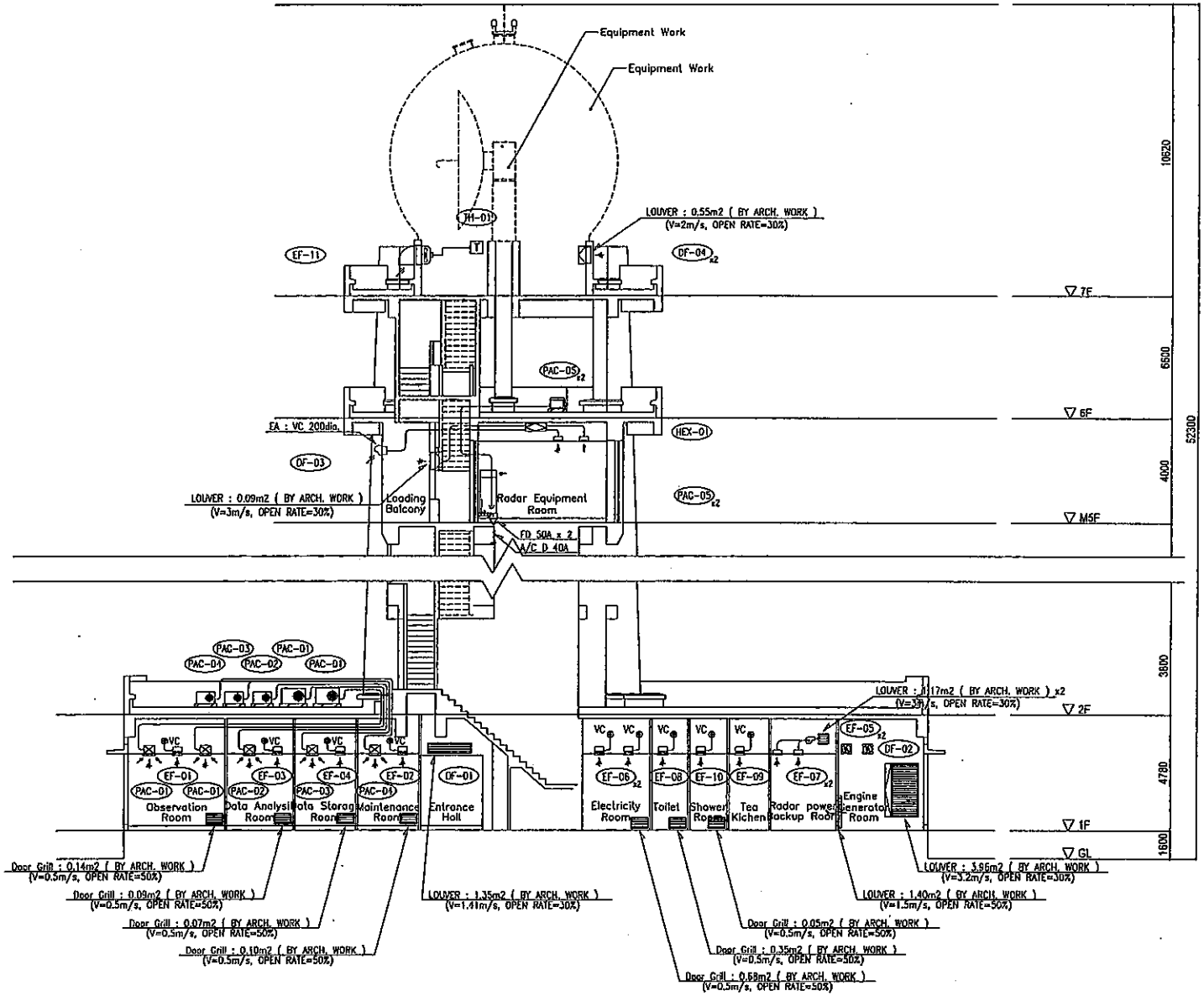
Japan Weather Association
Sunshine 60 Bldg., 58F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6058 Japan Tel. 81-3-6858-8181 Fax. 81-3-6858-8182

THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE: SYSTEM DIAGRAM-8

SCALE: NONE

DRAWING No.: SD - 08



AIR-CONDITIONING & VENTILATION SYSTEM DIAGRAM

Japan Weather Association Sunshine 60 Bldg., 55F, 3-1-1, Higashi Ikebukuro, Toshima-ku, Tokyo, 170-6055 Japan Tel. +81-3-6858-8151 Fax. +81-3-6858-8163	THE PROJECT FOR ESTABLISHMENT OF THE METEOROLOGICAL RADAR SYSTEM AT MOULVIBAZAR IN THE PEOPLE'S REPUBLIC OF BANGLADESH	DRAWING TITLE SYSTEM DIAGRAM-9	SCALE NONE	DRAWING No. SD - 09