

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM
IN
DHAKA AND RANGPUR
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

January 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN WEATHER ASSOCIATION
INTERNATIONAL METEOROLOGICAL CONSULTANT INC.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to consist of Japan Weather Association (JWA) and International Meteorological Consultant Inc. (IMC).

The survey team held a series of discussions with the officials concerned of the Government of the People's Republic of Bangladesh, and conducted field investigations. As a result of further studies in Japan, 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.

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

January, 2015

Masami FUWA
Director General,
Global Environment Department
Japan International Cooperation Agency

Summary

Summary

Bangladesh is located in the delta area consisting of three major rivers, the Ganges River, the Brahmaputra River and the Meghna River, and most of the national land belongs to low-lying areas below altitudes of 10m. The upper river basin of these three major rivers is one of the highest rainfall areas in the world. During the monsoon season, a large amount of rain water, falling in the upper basin, flows into Bangladesh causing extensive floods. Bangladesh is also subject to other meteorological disasters such as storms invading from the northwest, called “Nor’wester,” tornadoes and tropical cyclones approaching from the Bay of Bengal; as a result, the country is considered as one of the most disaster-prone countries in the world. In recent years, the massive flood in 2004 (Estimated total cost: 2.2 billion US dollars) and Tropical cyclone “Sidr” in 2007 (Death and missing: about 4,000 persons, Estimated total cost: 2.3 billion US dollars) caused unimaginable and immense damages in the country which led to a significant set-back in the socio-economic activities of the whole country.

As seen in the figure on the right, there are five meteorological radar systems in Bangladesh established under the grant aid of Japan which are able to monitor meteorological phenomena occurring around the country and the borders shared with neighboring countries. The Bangladesh Meteorological Department (hereinafter referred to as the “BMD”) prepare weather forecasts/warnings based on the data collected on surface weather observation and upper air observation as well as that from these five meteorological radar systems. In order to predict possible disaster risks and adopt the appropriate countermeasures, the timely provision of highly accurate meteorological forecasts/warnings to the public is fundamental. The meteorological radar observation network plays an important role for the realization of this goal.

However, with regard to the existing Dhaka and Rangpur meteorological radar systems, they are dysfunctional or out of operation due to aging as nearly 15 years have passed since their establishments. In addition, the procurement of spare parts from the manufacturer has become difficult. The Dhaka meteorological radar system is still operational with the maintenance, repair and overhaul done by the BMD technicians. However, it cannot fully perform its observation operation capacity since it is now in a critical condition wherein the radar detection area became narrower due to a reduction in transmission power. In addition, it is having trouble in conducting its observation operation due to the construction of skyscrapers and radio jamming in association with rapid industrial development in Dhaka. The Rangpur meteorological radar system, on the other hand, proved to be impossible to resume operation as a result of a re-examination done in 2012 despite repeated recovery works. Thus, it is strongly required to replace the existing Dhaka and Rangpur meteorological radar systems. However, due to a lack of financial and technical capabilities, the Government of Bangladesh, in 2013, has requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities under Japan’s Grant Aid Assistance scheme.

In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Establishment of S-band Doppler Radar Systems at Dhaka and Rangpur (hereinafter referred to as the “Preparatory Survey”). The Japan International Cooperation Agency (hereinafter referred to as “JICA”) sent the Preparatory Survey Team to Bangladesh in order to conduct the Preparatory Survey from March 24 to April 24, 2014. The Team had a series of discussions with the officials concerned from the Government of Bangladesh, conducted surveys and collected the necessary and pertinent information and data for the Project. In addition, the Team conducted further studies, including a feasibility, justification and scope of the Project, paying particular attention to the present situation in Bangladesh from various perspectives such as the operational & maintenance capabilities of the BMD, best equipment arrangement plan, etc.

JICA sent the Preparatory Team again to Bangladesh from September 8 to September 23, 2014 in order to explain and discuss the outline design & draft survey report. In the course of the discussions and field survey, it was confirmed that the requested items are required for the Project in consideration of the Project’s objectives and effects. As a consequence of further studies on the requested items in Japan, it has been decided that the following components indicated in the table attached hereunder are the objective items of the Preparatory Survey for the Project.

Table 1: Objective Items of the Preparatory Survey

Component	BMD Joydevpur Observatory (Dhaka Radar Observation Station)	BMD Rangpur Observatory (Rangpur Radar Observation Station)	Storm Warning Centre (SWC) at BMD Head Office	BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)
Procurement and Installation of Equipment				
S-Band Doppler Pulse Compression Solid State Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	1	-	-
Meteorological Rader Data Display System	1	1	1	1
Meteorological Data Satellite Communication System (VSAT)	1	1	-	-
Modification of the existing Meteorological Data Satellite Communication System (Hub VSAT System)	-	-	1	-
Construction of Radar Tower Building				
Radar Tower Building	1	1	-	-
Technical Training	Initial operation guidance in the contract of manufacturer			
Soft Component				

The key objective of the Project is the effective mitigation of the devastation caused by meteorological disasters such as floods, tropical cyclones and tornados through the re-strengthening of the radar

observation network of the five meteorological radar systems through the replacement of the existing Dhaka and Rangpur meteorological radar systems with state-of-the-art S-band Doppler pulse compression solid state radar system.

The Ministry of Planning, in charge of formulating the national development plan, incorporated this Project as an urgent undertaking under the poverty reduction strategy of the “Sixth Five-Year Plan, Financial Year 2011-2015” since it plays an important role in the establishment of an early warning system against natural disasters and the reduction of economic losses. Moreover, the BMD Strategic Plan includes the implementation of this Project, which was approved by the Ministry of Defence and submitted to the Ministry of Planning. The implementation of this Project which is in accordance with Japan’s aid policy, “Overcoming social vulnerability,” is expected to greatly contribute to achieving the goal of the development plan in Bangladesh.

Moreover, in order to reduce the BMD’s operational and maintenance costs, the equipment was designed to minimize spare parts and consumables. Since the biggest expected recurrent cost of the Project is electricity, the equipment and facilities were designed in such a way so as to minimize power consumption. As a result, the BMD’s budget is expected to be able to cover the Bangladeshi portion of the capital and recurrent costs of the Project.

In conclusion, the implementation of the Project is considered to be an appropriately suitable and worthwhile endeavor.

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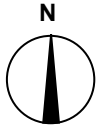
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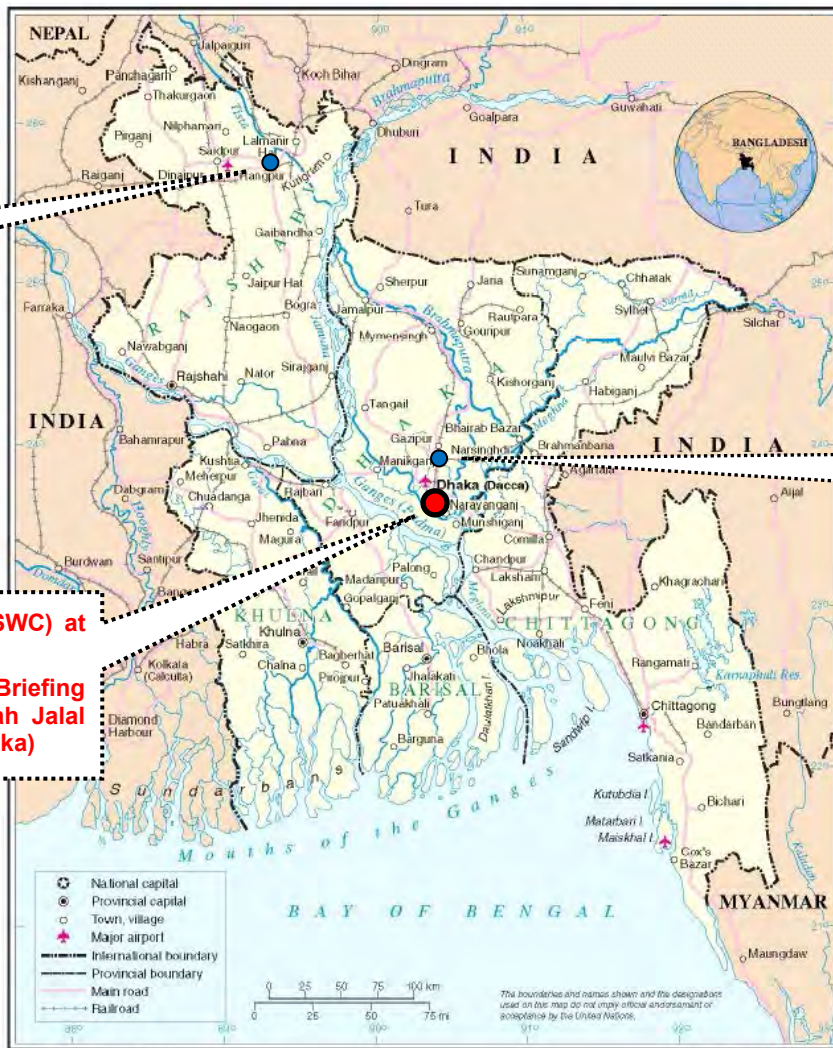
■ The People's Republic of Bangladesh



Rangpur Meteorological Radar Station

Dhaka (Joydevpur) Meteorological Radar Observation Station

Storm Warning Centre (SWC) at BMD Head Office
 BMD Meteorological Briefing Room in the Hazrat Shah Jalal International Airport (Dhaka)



Map No. 3711 Rev. 2 UNITED NATIONS January 2004

Department of Resurveying Operations Cartographic Section



Dhaka (Joydevpur) Meteorological Radar Tower Building



Rangpur Meteorological Radar Tower Building

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ABBREVIATIONS

ASEAN : Association of Southeast Asian Nations
AVR : Automatic Voltage Regulator
BTRC : Bangladesh Telecommunication Regulatory Commission
AWS : Automatic Weather Observation System
BMD : Bangladesh Meteorological Department
CAPPI : Constant Altitude Plan Position Indicator
CPTU : Central Procurement Technical Unit
CDVAT : Custom Duty Value Added Tax
DPP : Development Project Proposal
EIA : Environmental Impact Assessment
JICA : Japan International Cooperation Agency
SWC : Storm Warning Centre
DDN : Digital Data Network
MTBF : Mean Time Between Failure
MTTR : Mean Time To Repair
OJT : On-the-Job Training
VSAT : Very Small Aperture Terminal
VAT : Value Added Tax
NRB : National Board of Revenue
ECNEC : Executive Committee for the National Economic Council
UNDP : United Nations Development Programme
WMO : World Meteorological Organization

Chapter 1

Background of the Project

Chapter 1 Background of the Project

1-1 Background of the Project

Bangladesh is located in the delta area consisting of three major rivers, the Ganges River, the Brahmaputra River and the Meghna River, and most of the national land are in low-lying areas below altitudes of 10m. The upper river basin of these three major rivers is one of the highest rainfall areas in the world. During the monsoon season, a large amount of rain water, falling in the upper basin, flows into Bangladesh causing extensive floods. Bangladesh is also subject to other meteorological disasters such as storms invading from the northwest, called “Nor’wester,” tornadoes and tropical cyclones approaching from the Bay of Bengal; as a result, the country is considered as one of the most disaster-prone countries in the world. In recent years, the massive flood in 2004 (Estimated total cost: 2.2 billion US dollars) and Tropical cyclone “Sidr” in 2007 (Death and missing: about 4,000 persons, Estimated total cost: 2.3 billion US dollars) caused unimaginable and immense damages in the country which led to a significant set-back in the socio-economic activities of the whole country.



Figure 1: Three Major Rivers in Bangladesh

As seen in the figure on the right, there are five meteorological radar systems in Bangladesh established under the grant aid of Japan which are able to monitor meteorological phenomena occurring around the country and along the borders shared with neighboring countries. The Bangladesh Meteorological Department (hereinafter referred to as the “BMD”) prepare weather forecasts/warnings based on the data collected on surface weather observation and upper air observation as well as those from these five meteorological radar systems. In order to predict possible disaster risks and adopt the appropriate countermeasures, the timely provision of highly accurate meteorological forecasts/warnings to the public is fundamental. The meteorological radar observation network plays an important role for the realization of this goal.

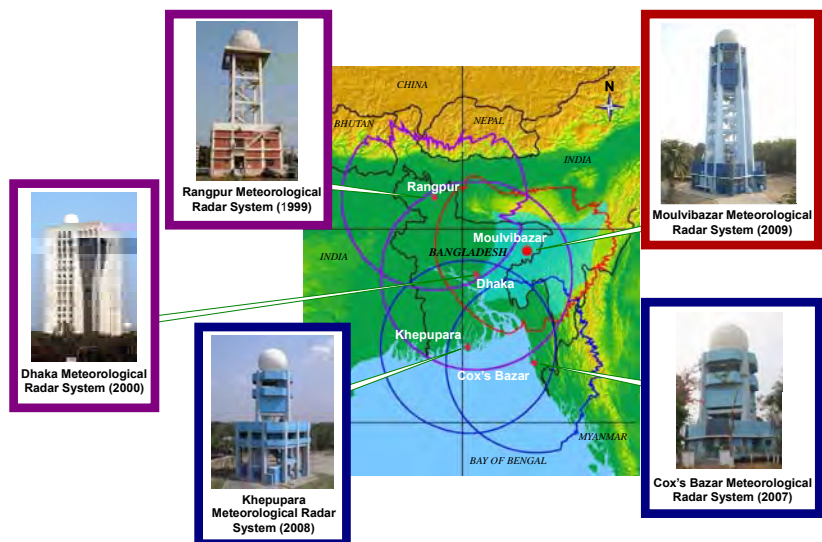


Figure 2: Meteorological Radar Observation Network in Bangladesh

However, with regard to the existing Dhaka and Rangpur meteorological radar systems, they are dysfunctional or out of operation due to aging as nearly 15 years have passed since their establishment. In addition, the procurement of spare parts from the manufacturer has also become difficult. The Dhaka meteorological radar system is still operational with the maintenance, repair and overhaul done by the BMD technicians. However, it cannot fully perform its observation operation capacity since it is now in a critical condition wherein the radar detection area became narrower due to a reduction in transmission power. The Rangpur meteorological radar system, on the other hand, proved to be impossible to resume operation as a result of a re-examination done in 2012 despite repeated recovery works.

The table below indicates the role played by each of the five meteorological radar systems in Bangladesh.

Table 2: Roles of the Five Meteorological Radar Systems in Bangladesh

	Name of Site	Role
1	Rangpur	Surveillance of a storm called “Nor’wester” invading from the northwest and precipitation in the Meghalaya Mountains and the foot of the Himalayan Mountains
2	Moulvibazar	Surveillance of precipitation in the Meghalaya Mountains which brings about flashfloods or floods
3	Dhaka	Wide range observation of the country, Disaster prevention in the Dhaka Capital Territory, Aviation Security in the international airport
4	Khepupara	Surveillance of a tropical cyclone approaching from the Bay of Bengal
5	Cox’s Bazar	Surveillance of a tropical cyclone approaching from the Bay of Bengal

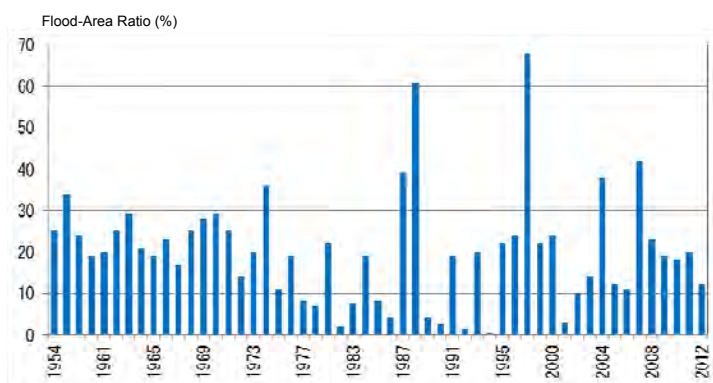
The Dhaka meteorological radar system, which is located in the center of Bangladesh and is able to cover about 80 % of the national land, plays a major role in disaster prevention in the Dhaka Capital Territory and the aviation security of the international airport. The role of the Rangpur meteorological radar system is to monitor storms invading from the northwest called Nor’wester and precipitation in the Meghalaya Mountains and the foot of the Himalayan Mountains which results in higher levels of flooding. It is an urgent task to replace both radar systems and develop these facilities since they are extremely important for the mitigation of damages caused by natural disasters in Bangladesh. Furthermore, as a result of economic growth, more and more skyscrapers which can be obstacles for radar observation have been constructed around the Dhaka meteorological radar system situated on the top of the twenty-story building (Islamic Development Bank-Bangladesh Islamic Solidarity Educational Wakf: IDB-BISEW). Therefore, it is strongly desired that the existing Dhaka and Rangpur meteorological radar systems be replaced and its facilities developed at the earliest possible time.



1-2 Characteristics of Meteorological Disasters in Bangladesh

<Flood>

In Bangladesh where three major rivers are flowing through, floods happen almost every year and it is not uncommon for most of the country to be, at some point in time, inundated. The figure on the right shows the “Annual change of Flood Area in Bangladesh.” The flood area has varied greatly from year to year since 1980 while the flood-area ratio remained at the 20% level before 1970. In recent years, the flood-area ratio of 2007 was



Source: Annual Flood Report 2012 by Flood Forecasting and Warning Centre

Figure 3: Annual Change of Flood Area in Bangladesh

42%, the third largest recorded flood-area ratio in Bangladesh, while that of 2001 was only 2.8%. It has been analyzed by the BMD that due the monsoon season irregular and increase of the frequency of extreme heavy rain and drought, there is a high possibility that the damages caused by floods will intensify and worsen. The annual precipitation in Dhaka in the past for 55 years (1953-2008), it was recorded about 1,500mm in the lowest year, and 3,000mm in the highest year. The annual mean temperature is also rising 0.6 degree C. For flood monitoring and forecasting, the surveillance of precipitation in the high rainfall areas of the upper river basins is indispensable. Thus, the Rangpur meteorological radar system, whose detective area includes the Meghalaya Mountains and the foot of the Himalayan Mountains, will be more important in the future.

<Flash Flood>

A flashflood occurs when torrential rain falls in the mountainous areas within a very short time and rain water rapidly flows into the downstream basin. In Bangladesh, it frequently happens in the northern and eastern areas surrounded by mountains. The surveillance of torrential rain causing flashfloods by a meteorological radar system is effective and efficient for the following reasons.



Source: Floods in Bangladesh by Thomas Hofer and Bruno Messerli 2006

Figure 4: Inflow of Flash Flood

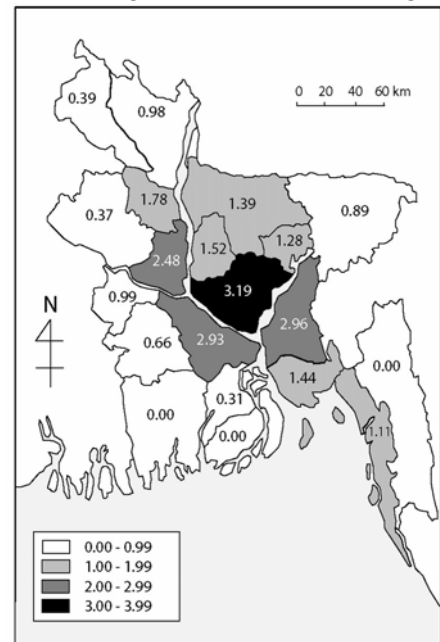
- A rain gauge network is not able to catch localized torrential rainfall.
- The time interval between the occurrence of torrential rain in the mountainous areas and its flow into the downstream basin is very short, thus, an immediate grasp of the occurrence of torrential rain is

important.

- Since the torrential rain occurs on the Indian side, there is no alternative way to obtain rainfall data but through a meteorological radar system.

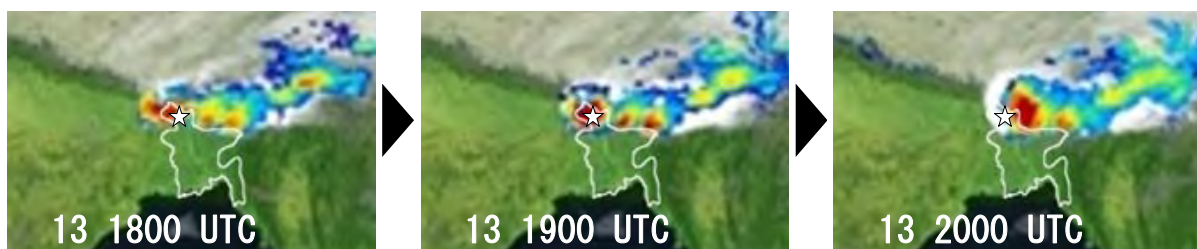
<Nor'wester and Tornado>

During the pre-monsoon period, the storm called “Nor’wester” sometimes causes tremendous damages, associated with a tornado. The figure on the right shows the annual average tornado occurrence per 100,000 square miles between 1967 and 1996. Central Bangladesh including Dhaka, receives a higher frequency of tornadoes than the other regions of the country because the cumulonimbi coming from the northwest tend to develop rapidly in the central plain. On April 13, 2010, tornadoes occurred in northern Bangladesh and eastern India where more than one hundred people lost their lives. The figure below shows the time-series precipitation observed by the satellite. It can be seen that the cumulonimbi moved eastward while developing rapidly. The Rangpur meteorological radar system can cover the invasion pathway of the cumulonimbi and the Dhaka meteorological radar system can monitor its rapid development in the central area. In addition, a Doppler radar system is able to detect a vortex called meso-cyclone existing in developed cumulonimbus, thereby, becoming an effective measure in monitoring the development of cumulonimbus and the occurrence of the associating tornado. Therefore, the replacement of two meteorological radar systems with an S-band Doppler pulse compression solid state radar system is deemed to be quite effective.



Source: Design and Adoption of Household Tornado Shelters to Mitigate the Tornado by Y. Ono 2001

Figure 5: Distribution of the Annual Average Tornado Occurrence per 10,000 square miles (1967-1996)



Source: JAXA

Figure 6: Precipitation observed by the Satellite (18:00-20:00 UTC, April 13, 2010)
(☆: Location of the Rangpur Meteorological Radar System)

<Tropical Cyclone>

Tropical Cyclones in the Bay of Bengal are usually generated during the pre-monsoon season (April-May) and the post-monsoon season (October-November). Although the damages caused by storm surges in the coastal areas are outstanding in Bangladesh, many tropical cyclones intrude into the inland with greater intensity after their landfalls. Four out of eight tropical cyclones moved inland during 2000-2013. In particular, Tropical cyclone Sidr in 2007 traveled through the country with great intensity and caused extensive damages including in the capital, Dhaka. The total number of dead/missing persons amounted to 4,407, most of which were from the coastal areas (3,280 in Barisai district and 854 in Khulna district), but even the Dhaka district had 142 dead/missing persons. As seen in the figure on the right, the areas receiving heavy rain of more than 100mm extended to the inland. The meteorological radar systems in Khepupara and Cox's Bazar obviously play the main roles in monitoring tropical cyclones. However, depending on a tropical cyclone's course, it can be said that a wide-area monitoring of a tropical cyclone by five meteorological radar systems is also significant.



Figure 7: Tracks of Tropical Cyclones making landfall in Bangladesh (2000-2013)

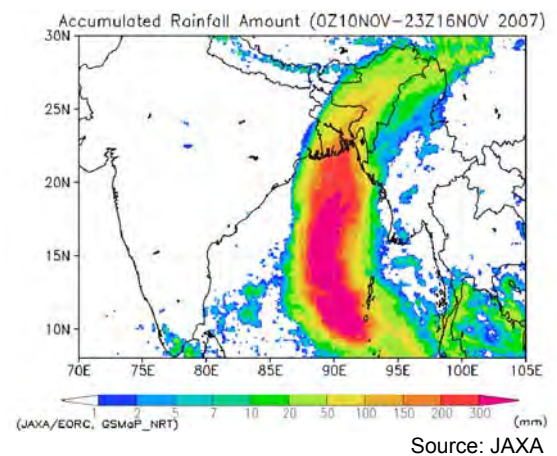


Figure 8: Amount of Rainfall caused by Tropical Cyclone Sidr in 2007

1-3 Negative Impact on the Development of the Bangladesh Economy

The figure below is a graph showing the growth rate of the GDP in Bangladesh. Bangladesh has maintained a steady economic development with the recent growth rate of the GDP of around 6%. The growth rate of the GDP, however, declined in 2001/2002 and 2004/2005 when severe floods occurred and brought about extensive damages all over the country. In 2008/2009, due to the attack of Cyclone "AILA" whose estimated damage was worth 2.7 billion US dollars, the growth rate of the GDP fell below 6% after four years. Thus, it can be said that these natural disasters have serious negative impacts on the economic development of the whole country.

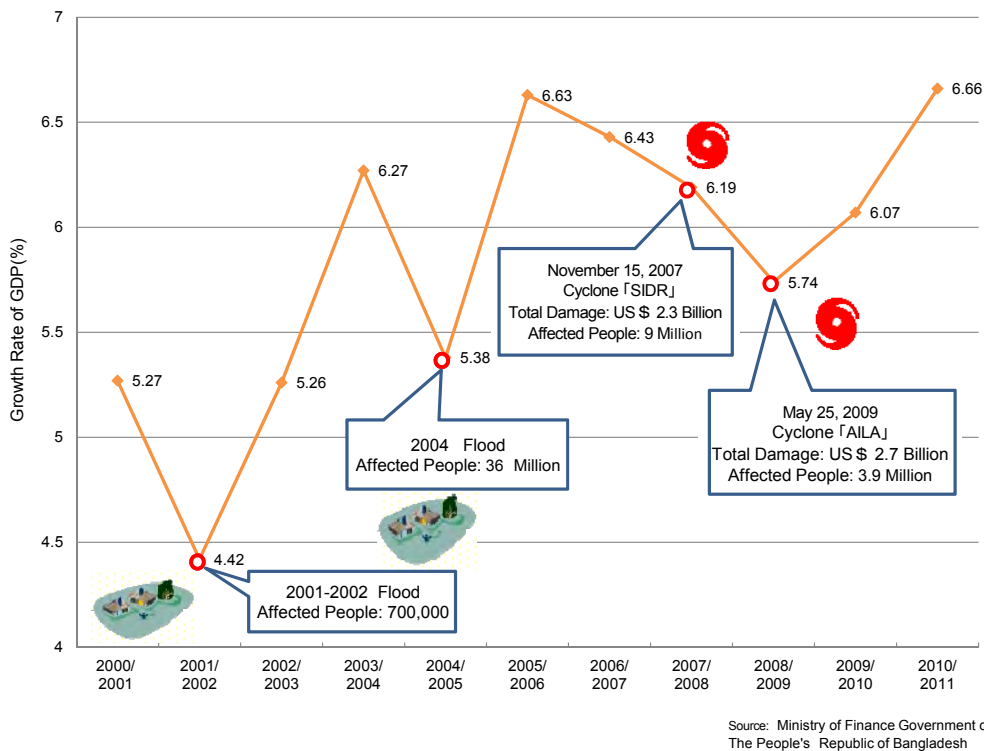


Figure 9: Growth Rate of GDP and Meteorological Disaster

1-4 Brief Summary on the Request for the Project by Bangladesh

As indicated above, the Dhaka meteorological radar system, which covers about 80% of the national land, is regarded as the most important meteorological radar system in Bangladesh in terms of the protection of the Dhaka Capital Territory from meteorological disasters and the secure landing and take-off of civil aviation aircrafts at the Hazrat Shah Jalal International Airport (Dhaka). The Rangpur meteorological radar system is in charge of monitoring precipitation around the border shared with India, storms invading from the northwest called Nor'wester, precipitation in the Meghalaya Mountains and the foot of the Himalayan Mountains which may be a trigger of flooding. However, both meteorological radar systems are dysfunctional or out of operation due to aging as nearly 15 years have passed since their establishment which interferes with weather observation operation. In addition, the Dhaka meteorological radar system is having trouble in conducting its observation operation due to the construction of skyscrapers and radio jamming in association with rapid industrial development in Dhaka. Thus, it is strongly required to replace the existing Dhaka and Rangpur meteorological radar systems. Due to a lack of financial and technical capabilities, the Government of Bangladesh, in 2013, has requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities under Japan's Grant Aid Assistance scheme.

In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Establishment of S-band Doppler Radar Systems at Dhaka and Rangpur (hereinafter referred to as the

“Preparatory Survey”). The Japan International Cooperation Agency (hereinafter referred to as “JICA”) sent the Preparatory Survey Team to Bangladesh in order to conduct the Preparatory Survey from March 24 to April 24, 2014. The Team had a series of discussions with the officials concerned from the Government of Bangladesh, conducted surveys and collected the necessary and pertinent information and data for the Project. In addition, the Team conducted further studies, including a feasibility study focusing on the justification and scope of the Project, paying particular attention to the present situation in Bangladesh from various perspectives such as the operational & maintenance capabilities of the BMD, best equipment arrangement plan, etc.

JICA sent the Preparatory Team again to Bangladesh from September 8 to September 23, 2014 in order to explain and discuss the outline design & draft survey report. In the course of the discussions and field survey, it was confirmed that the requested items are required for the Project in consideration of the Project’s objectives and effects. As a consequence of further studies on the requested items in Japan, it has been decided that the following components indicated in the table attached hereunder are the objective items of the Preparatory Survey for the Project.

Table 3: Objective Items of the Preparatory Survey

Component	BMD Joydevpur Observatory (Dhaka Radar Observation Station)	BMD Rangpur Observatory (Rangpur Radar Observation Station)	Storm Warning Centre (SWC) at BMD Head Office	BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)
Procurement and Installation of Equipment				
S-Band Doppler Pulse Compression Solid State Radar System (including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System, Measuring Equipment and Spare Parts)	1	1	-	-
Meteorological Radar Data Display System	1	1	1	1
Meteorological Data Satellite Communication System (VSAT)	1	1	-	-
Modification of the existing Meteorological Data Satellite Communication System (Hub VSAT System)	-	-	1	-
Construction of Radar Tower Building				
Radar Tower Building	1	1	-	-
Technical Training	Initial operation guidance in the contract of manufacturer			
Soft Component				

1-5 Project Site Location Information

Table 4: Project Site Location Information

Name of Site	BMD Joydevpur Observatory (Dhaka Radar Observation Station)	BMD Rangpur Observatory (Rangpur Radar Observation Station)	Storm Warning Centre (SWC) at BMD Head Office	BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)
Latitude	N 23° 59' 13.5"	N 25° 43' 59.5"	N 23° 46' 46.7"	N 23° 51' 02.1"
Longitude	E 90° 24' 17.7"	E 89° 15' 10.1"	E 90° 22' 43.3"	E 90° 24' 12.5"
Altitude	15m	36m	8m	36m

1-6 Stability of Commercial Power

Stability measuring tests of commercial power by a power quality analyzer were conducted at each project site (SWC at the BMD Head Office, Joydevpur Observatory and Rangpur Observatory) with the results indicated in the following table. As a consequence of these tests, it was confirmed that power back-up systems such as engine generators, automatic voltage regulators, etc. are indispensable for the proposed Joydevpur and Rangpur Meteorological Radar Observation Stations.

Table 5: Stability of Commercial Power (Measured by Power Quality Analyzer)

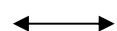

Name of Site	BMD Joydevpur Observatory (Dhaka Radar Observation Station)	BMD Rangpur Observatory (Rangpur Radar Observation Station)	Storm Warning Centre (SWC), at BMD Head Office
Commercial Power (Voltage: Nominal)	230V, 50Hz, single phase 2-wire	400V, 50Hz, 3-phase 4-wire	400V, 50Hz, 3-phase 4-wire
Voltage (Nominal: 230V)*	253.0	243.0	243.0
	177.0	206.0	206.0
Frequency (Hz)	51.5	51.4	51.4
	48.9	48.8	48.8
Frequency of Electric Outage	1-3 times/day (approx. 10 minutes - 2 hour/time)	2-3 times/day (approx. 10 minutes - 2 hours/time)	Not available due to the existing engine generator system

*Result of measuring that nominal 400V 3-phase power divided into 3 lines × 230V Single-phase

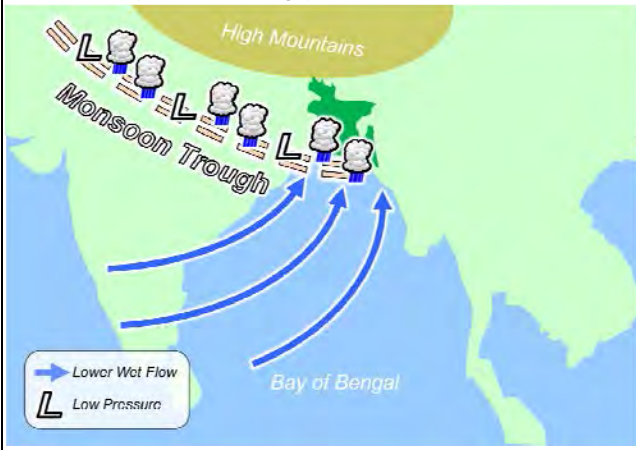
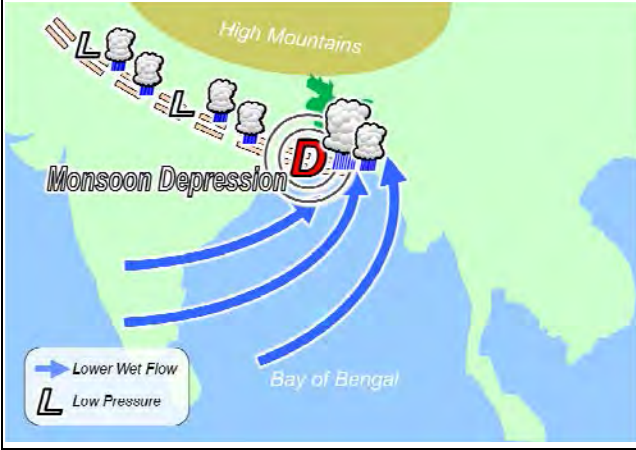
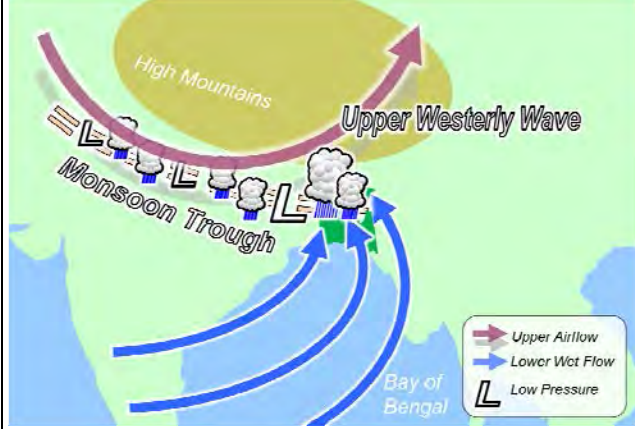
1-7 Natural Conditions of Bangladesh

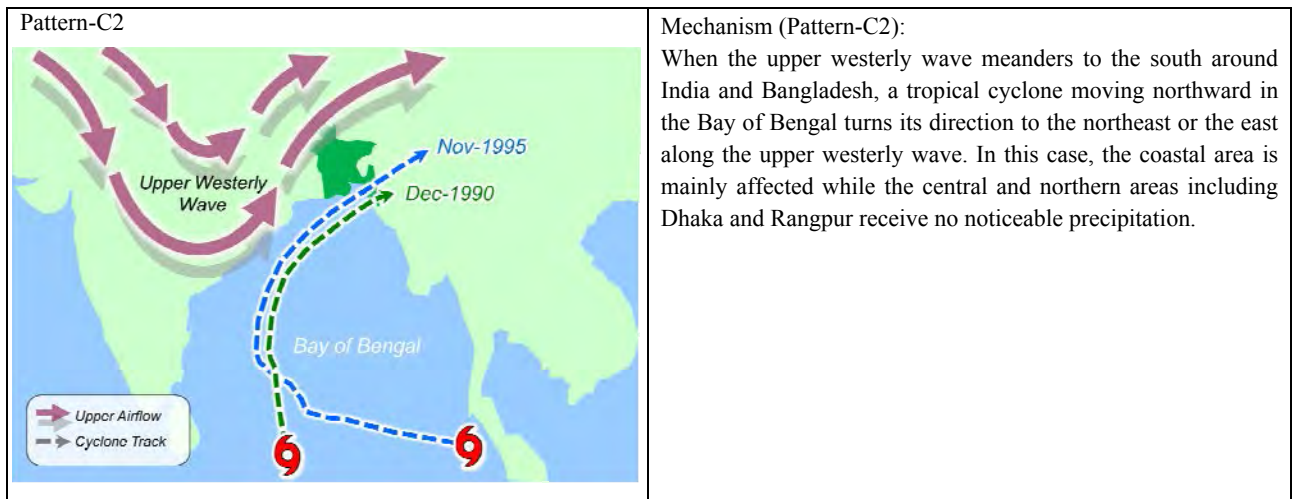
The following tables show the period of typical precipitation events and their details including their mechanism and influence on Bangladesh.

Table 6: Calendar of Typical Precipitation Events in Bangladesh

 Season of each Event
 Peak Season of each Event

Monsoon

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					←	←	←	←			
<p>Pattern-M1 (Monsoon Trough)</p> 						<p>Mechanism: The monsoon period (rainy season) in Bangladesh is from June to September and the total rainfall during this period accounts for 71 % of the average annual rainfall of the country. The distribution of rainfall greatly depends on the position and movement of the axis of the monsoon trough, which extends from the northwestern part of India to the north of the Bay of Bengal. The zone of heavy rainfall shifts north and south along with the movement of the trough.</p>					
<p>Pattern-M2 (Monsoon Depression)</p> 						<p>Mechanism: During the monsoon season, monsoon depressions normally form in the monsoon trough over the Bay of Bengal, north of latitude 18°N. Although many monsoon depressions move westward for India, some stay in the Bay of Bengal or move northward for Bangladesh and affect Bangladesh. In this case, the affected area is mostly the southern part of Bangladesh.</p> <p>Observed Rainfall in the Event: Dhaka: 497mm/48h (13-14 September, 2004) Rangpur: 120mm/24h (14 Jul, 2007)</p>					
<p>Pattern-M3 (Monsoon Trough + Upper Westerly Wave)</p> 						<p>Mechanism: In addition to Pattern-M1, when the Upper Westerly Wave at 500hPa level moves toward Bangladesh, the monsoon trough staying around Bangladesh tends to be intensified and affects mainly the northern part of Bangladesh.</p> <p>Observed Rainfall in the Event: Dhaka: 190mm/24h (5 Jun, 2008) Rangpur: 478mm/72h (17-19 Aug, 2009)</p>					



1-8 Topographic and Geotechnical Surveys

At the proposed BMD Joydevpur Observatory (Dhaka Radar Observation Station) and BMD Rangpur Observatory (Rangpur Radar Observation Station), which are the proposed sites for the construction of the new radar tower buildings, the topographic and geotechnical surveys indicated in the following tables were implemented by a local contractor consigned by the Preparatory Survey Team.

Table 7: Topographic Survey

Required Works	<ul style="list-style-type: none"> • Position of the existing building, observation facility, observation field • Bearing survey of the magnetic north • Calculation of the area planned • Plane surveying (0.5m contour line) <ul style="list-style-type: none"> - Position of the existing facilities (electrical lines, water lines, telephone lines, sewage, public roads, fences, vegetation, trees: more than 4m height, streetlights, manholes and other features) • Longitudinal profile and cross section <ul style="list-style-type: none"> - Indication of ground level at intervals of 10m - Public roads, ponds, river and each water level - Setting bench marks
Required Products	<ul style="list-style-type: none"> • Plane surveying map • Longitudinal profile and cross section • AutoCAD data file in CD-ROM

Table 8: Geotechnical Survey

Boring (All core boring)	Required number of borings: 3 Maximum depth of borings: 50m (Borings shall be extended to a more suitable bearing layer for a building construction even if borings have reached more than a depth of 50m. After reaching the bearing layer, borings shall be continued to a depth of at least 5m.)
Collecting soil samples	<ul style="list-style-type: none"> • Undisturbed soil sampling: 3 samples (at different levels) × 3 holes • Disturbed soil sampling: 3 samples (at different levels) × 3 holes • Adoption of standard: ASTM or JGS-Japanese geotechnical society
Standard Penetration Test	At intervals of every 1m till the bottom of each borehole
Laboratory Testing	Density Test of Soil Particle, Particle Size Distribution, Specific Gravity, Water Content , Liquid Limits, Plastic Limits, Unconfined Compression Test and Consolidation Test
Required Products	Geotechnical Survey Report: expected soil bearing capacity and calculation of consolidation coefficient

**Table 9: Geotechnical Survey Result of
BMD Joydevpur Observatory (Dhaka Radar Observation Station)**

Boring No.	Depth (m)	Soil Type	N-value	Gravity (g/cm ³)	Moisture Content (%)
BH-1	1.0 - 3.5	Clayey Silt	9 - 11	-	-
	3.5 - 4.5	Silty Sand	10	-	22
	4.5 - 16.5	Clayey Silt	9 - 30	2.71	28 - 30
	16.5 - 25.5	Silty Sand	19 - 49	-	-
	25.5 - 28.5	Clayey Silt	36 - 50	-	-
	28.5 - 30.0	Silty Sand	50	-	-
	30.0 - 36.5	Clayey Silt	23 - 42	2.79	-
	36.5 - 40.5	Silty Sand	30 - 50	-	-
	40.5 - 42.5	Clayey Silt	29 - 30	2.75	-
42.5 - 50.0	Silty Sand	50	2.68	-	
BH-2	1.0 - 9.5	Clayey Silt	6 - 18	2.76	21 - 25
	9.5 - 12.5	Silty Sand	16 - 30	-	-
	12.5 - 15.5	Clayey Silt	12 - 15	-	-
	15.5 - 18.5	Silty Sand	33 - 50	-	-
	18.5 - 30.0	Clayey Silt	22 - 49	2.74	-
	30.0 - 42.5	Clayey Silt	11 - 50	2.70	-
	42.5 - 50.0	Silty Sand	33 - 50	2.68	-
BH-3	1.0 - 3.5	Clayey Silt	5 - 10	-	-
	3.5 - 4.5	Silty Sand	8	-	25
	4.5 - 7.5	Clayey Silt	10 - 14	-	26
	7.5 - 17.5	Silty Sand	9 - 39	2.72	31
	17.5 - 30.0	Clayey Silt	11 - 37	2.72	-
	30.0 - 35.5	Clayey Silt	21 - 45	-	-
	35.5 - 50.0	Silty Sand	31 - 50	2.69 - 2.73	-

**Table 10: Geotechnical Survey Result of
BMD Rangpur Observatory (Rangpur Radar Observation Station)**

Boring No.	Depth (m)	Soil Type	N-value	Gravity (g/cm ³)	Moisture Content (%)
BH-1	1.0 - 7.5	Clayey Silt	2 - 5	2.75	24 - 34
	7.5 - 21.5	Silty Sand	3 - 27	2.69	-
	21.5 - 30.0	Silty Sand	30 - 46	-	-
	30.0 - 36.5	Silty Sand	36 - 50	-	-
	36.5 - 50.0	Silty Sand	50	2.67 - 2.70	-
BH-2	1.0 - 7.5	Clayey Silt	2 - 6	2.74	12 - 34
	7.5 - 21.5	Silty Sand	10 - 32	2.71	-
	21.5 - 30.0	Silty Sand	25 - 40	-	-
	30.0 - 36.5	Silty Sand	43 - 50	-	-
	36.5 - 50.0	Silty Sand	50	2.69 - 2.70	-
BH-3	1.0 - 8.5	Silty Sand	2 - 6	-	26 - 31
	8.5 - 20.5	Silty Sand	12 - 30	2.73	-
	20.5 - 30.0	Silty Sand	31 - 50	2.68	-
	30.0 - 36.5	Silty Sand	50	-	-
	36.5 - 50.0	Silty Sand	50	2.68 - 2.70	-

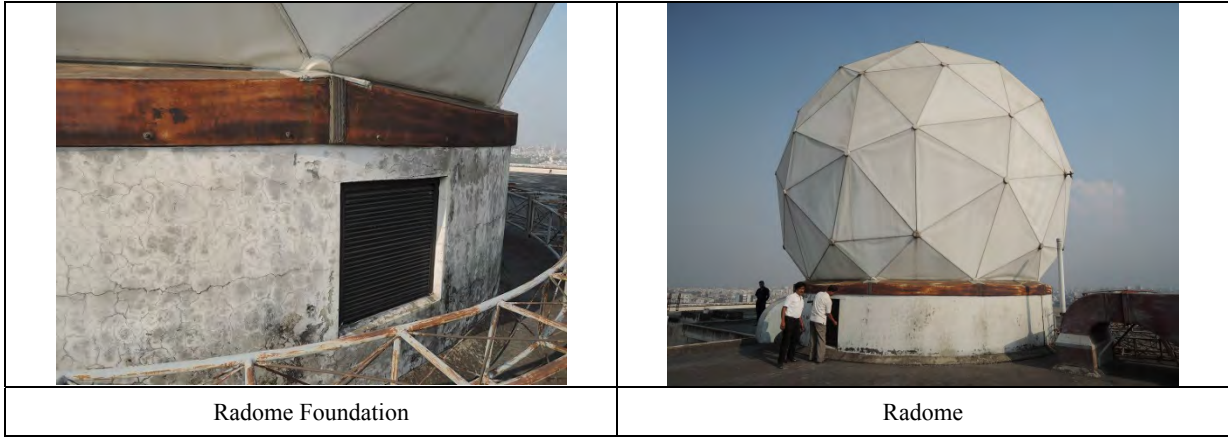
1-9 Existing Facility and Equipment

<Existing Dhaka and Rangpur Radar Tower Buildings>

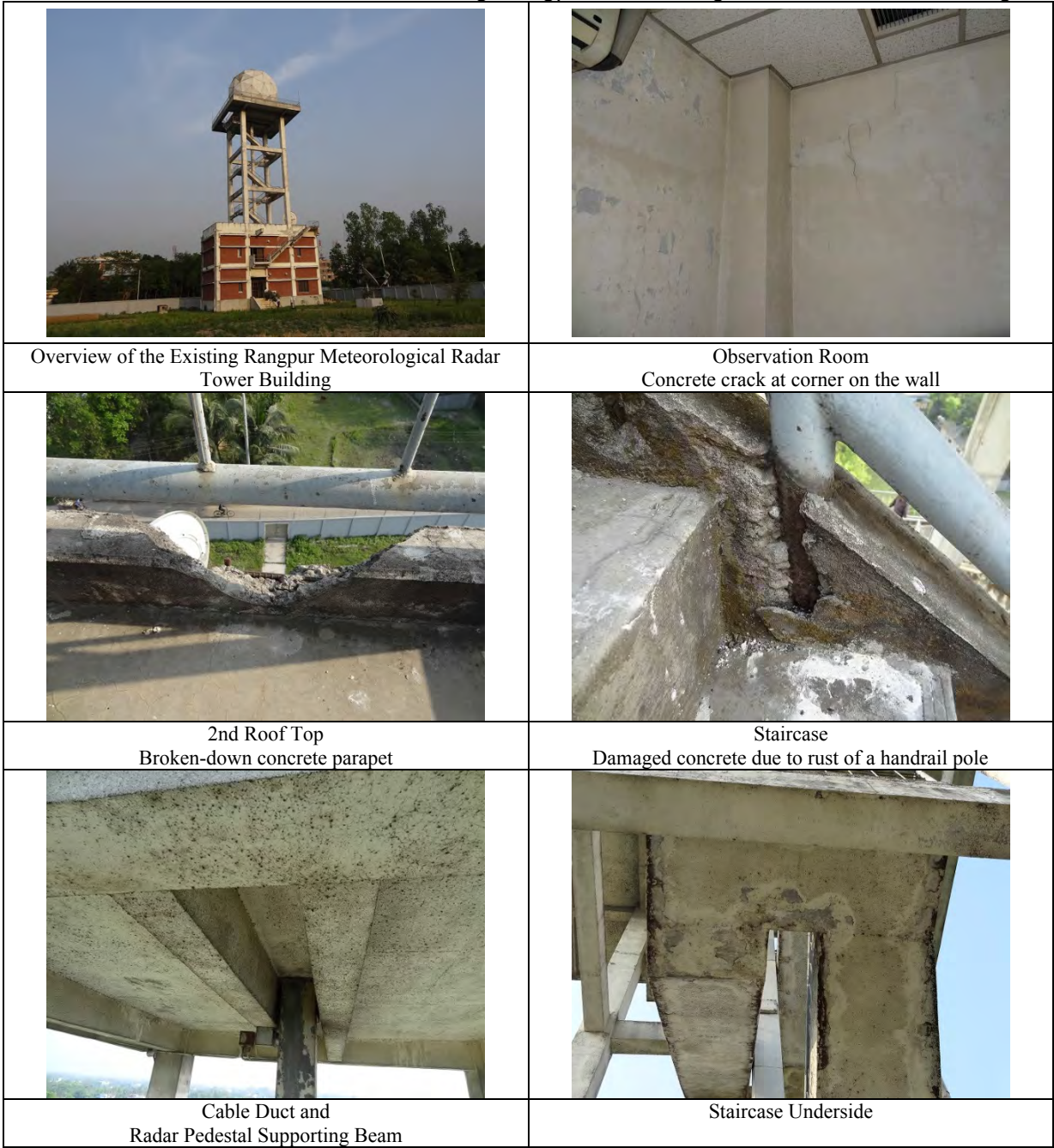
Pictures of the existing Dhaka and Rangpur Radar Tower Buildings are attached hereunder.

Picture: Current Situation of the Existing Dhaka Meteorological Radar System









	
Operation PPI Console	Transmitter/Receiver and Antenna Control Units
	
2GHz Microwave Data Communication System	Uninterrupted Power Supply Unit
	
Radar Antenna and Pedestal Radome Room	Auto Voltage Regulator and Power Distribution Board

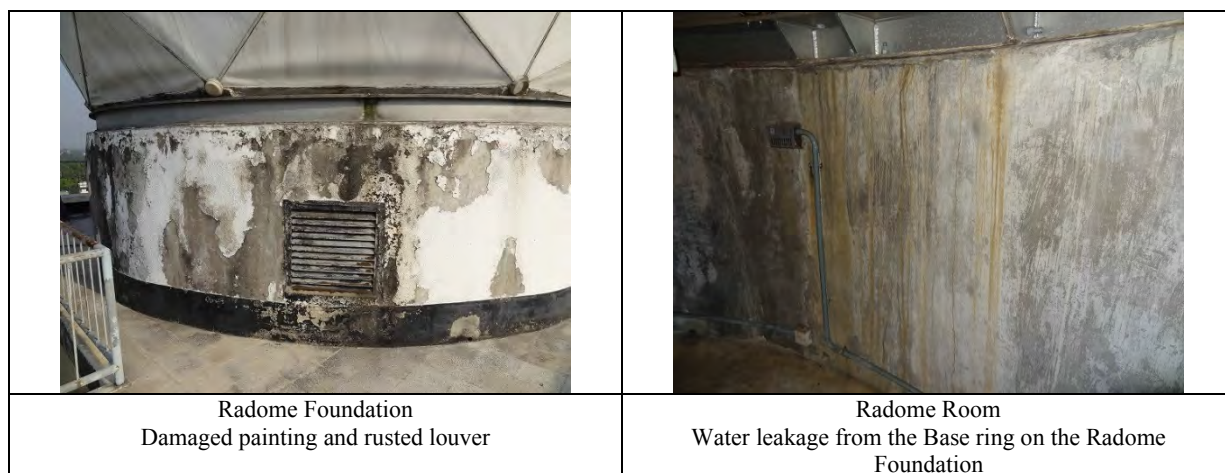


Picture: Current Situation of the Existing Rangpur Meteorological Radar Tower Building



Picture: Current Situation of the Existing Rangpur Meteorological Radar Equipment

	
<p>Operation PPI Console</p>	<p>Transmitter/Receiver and Antenna Control Units</p>
	
<p>Uninterrupted Power Supply Unit and Auto Voltage Regulator</p>	<p>Radar Data Acquisition Unit and 8bit Data Processor</p>
	
<p>VSAT In-Door Unit</p>	<p>VSAT Antenna & Out-Door Unit</p>
	
<p>Radome Room Radar Antenna and Pedestal</p>	<p>Radome External view</p>



The result of the Schmidt Hammer Test for concrete compressive strength and Comprehensive Structural Evaluation for the existing Rangpur Radar Tower Building is attached hereunder.

Table 11: Result of Schmidt Hammer Test for Concrete Compressive Strength of the Rangpur Existing Meteorological Radar Tower Building

Location	Schmidt Hammer Test			Rejection/Acceptance Region	Average of Acceptance Value (R)	Concrete Compressive Strength (F) of the existing Rangpur Radar Tower Building		
	No.	Rebound Value	Average					
Slab	1	47	49.7	Rejection Region: $\geq +20\%$ of Average $=49.7 \times 2 = 99.4$ Acceptance Region	52.3	coefficient angle of inclination $+90^\circ \rightarrow 52.3 - 3.1 = 49.2$ $F = \alpha \times (13R - 184) / 9.8$ $\alpha = \text{coefficient of concrete age}$ concrete age $\leq 1,000$ days: $\alpha = 0.6$	27.9N/mm ²	
	2	56						47
	3	60						56
	4	56						60
	5	56						56
	6	55						56
	7	47						55
	8	62						47
	9	38						62
	10	49						38
	11	31		49				
	12	52		31				
	13	50		52				
	14	28		50				
	15	48		28				
	16	51		48				
	17	57		51				
	18	57		57				
	19	50		57				
	20	43		50				
		43	Rejection Region: $\leq -20\%$ of Average $=49.7 \times 0.8 = 39.7$					

Concrete Compressive Strength for Structural Design: 21N/mm²

Concrete Compressive Strength for Quality Management according to Standard of Architectural Institute of Japan (AIJ): 24N/mm²

Table 12: Comprehensive Structural Evaluation for the Existing Rangpur Meteorological Radar Tower Building

Current Situation on the Main Structures	
Column	Not found concrete cracks
Girder	Not found concrete cracks
Floor	Not found concrete cracks
Wall	Not found concrete cracks
Roof Slab	Not found concrete cracks and water leakage
Re-bar	Not found exposed re-bar.

Result of structural calculation. (Replace radar equipment)		
Allowable load capacity was calculated after removal of the existing radar system due to 3-dimensional modeling of the existing Islamabad Radar Tower Building		
Condition for structural calculation	Live load (during radar operation): 3.0kN/m ² (300kg/m ²)	
	Wind speed : 36m/s (during storm)	
	Seismic coefficient : C0=0.1 C0 '= 0.125 (1.25 importance factor to consider)	
	Concrete compression strength: FC=21N/mm ² Re-bar : SD295	
Main Structure	Analysis result	Pass-Fail
Column: 400mmx400mm	Out of range for allowable stress (during seismic)	Fail (Danger)
Girder: 350mmx450mm	Out of range for allowable stress (during seismic)	Fail (Danger)
Grade Beam: 400mmx2500mm	Within the allowable stress	Pass
Slab: 150mm	Out of range for allowable stress (over load)	Fail (Danger)
Foundation slab	Out of range for allowable stress	Fail (Danger)
The result of Schmidt Hammer Test for Concrete Compressive Strength		
Girder	Current concrete compression strength: 27.9N/mm ² (Design concrete compression strength : 21N/mm ²)	
Synthetic judgment	As a consequence of the Comprehensive Structural Evaluation, it was confirmed that an additional load of 11tons on the roof top poses a distinct danger (destruction) to the existing radar tower building (11tons is the equivalent weight of a new meteorological radar system including a new power back-up system and a new radar data display system). For the installation of the new system, a new radar tower building is required.	

1-10 Consideration for Environmental Conservation

In order to implement the Project, it was confirmed by the BMD that an Environmental Impact Assessment (EIA) permit is not required.

Chapter 2

Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

Bangladesh is one of the most disaster-prone countries in the world. During the monsoon season from June to September, heavy rain causes floods in the three major rivers almost every year. In the pre-monsoon (April and May) and the post-monsoon (October and November) seasons, the country is affected by a tropical cyclone approaching from the Bay of Bengal and also Bangladesh experiences storm called Nor'wester and tornado as well as flash flood caused by

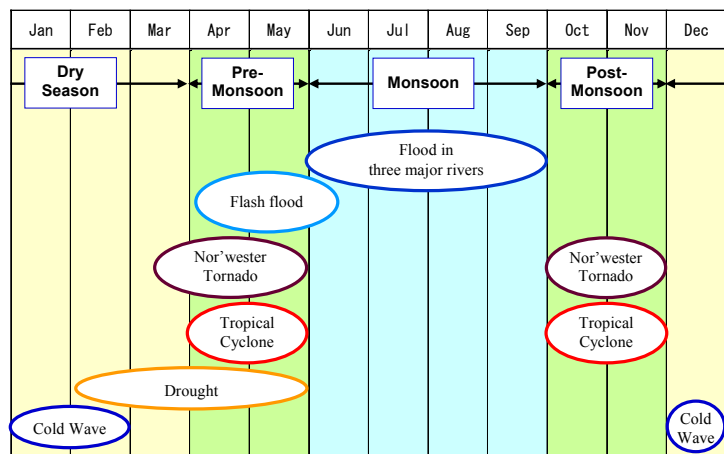


Figure 10: Meteorological Disaster Calendar in Bangladesh

torrential rain. The Bangladeshi socioeconomic structure, which relies heavily on agriculture wherein most of the poor population is engaged in, is extremely vulnerable to natural disasters. The damages caused by these natural disasters make their lives much harder and, thus, cause the significant set-back of the country's socio-economic activities.

Since meteorology has indeed become a matter of life or death in Bangladesh, the role of the BMD, the only meteorological organization in the country, is crucial and important. In order for the BMD to mitigate the damages caused by natural disasters, it is a priority issue to disseminate highly accurate forecasts/warnings to the public more appropriately and promptly through making good use of the equipment and facilities for disaster prevention including the meteorological radar systems established under Japan's Grant Aid.

However, the Dhaka and Rangpur meteorological radar systems are dysfunctional or out of operation due to aging for nearly 15 years have passed since their establishment. In addition, the procurement of spare parts from the manufacturer has become difficult. The Dhaka meteorological radar system is still operational with the maintenance, repair and overhaul work done by the BMD technicians. However, it cannot perform its full observation operation capacity since it is now in a critical condition wherein radar detection became narrower due to a reduction in transmission power. The Rangpur meteorological radar system, on the other hand, proved to be impossible to resume its operation as a result of a re-examination done in 2012 despite repeated recovery works.

Given the situation indicated above, the key objective of the Project is to effectively mitigate the devastation caused by natural disasters by the re-strengthening of the radar observation network of the five meteorological radar systems in Bangladesh through the replacement of the existing Dhaka and Rangpur meteorological radar systems with state-of-the-art S-band Doppler pulse compression solid state radar systems.

2-2 Outline Design of Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Policy of the Project

- a) To design a meteorological observation system that can contribute to disaster prevention in Bangladesh.
- b) To enable the BMD to provide weather information, forecasts, advisories and warnings necessary for the protection of people's lives and properties from natural disasters and the improvement of socio-economic conditions in Bangladesh.
- c) To enable the BMD to monitor weather conditions around-the-clock on a real time basis.
- d) To enable the BMD to promptly issue a weather information and/or a warning to the public.
- e) To ensure the improvement of the BMD's overall function and capacity in reducing human loss and economic setback brought about by tropical cyclones through the upgrading of the BMD's monitoring capabilities of meteorological phenomena including tropical cyclones.
- f) To determine and establish the size and components of the Project to match with the technical, operational and maintenance capabilities of the BMD.

[1] Design Policy of the Equipment

- a) To ensure that the equipment is compatible with and meets the technical requirements of the World Meteorological Organization (WMO).
- b) To ensure that the equipment is suitable for the routine observation and forecasting work of the BMD.
- c) To design the Dhaka (Joydevpur) and Rangpur Meteorological Radar Systems with functions relevant to quantitative rainfall observation and air-turbulence observation capabilities that enhances and upgrades the accuracy of the weather forecasts made by the BMD.
- d) To design the Meteorological Radar Systems to acquire constant altitude information from 3-dimensional raw data obtained by scans of the radar system at multiple elevations to ensure wider coverage and detection of rainfall distribution at each altitude.

- e) To design the system in such a way that all the data produced by the Dhaka (Joydevpur) and Rangpur Meteorological Radar Systems are delivered to the SWC at the BMD Head Office every 15 minutes.
- f) To install a new radome strengthened with a honeycomb structures core-mat in the interlayer which can withstand a survival wind speed of 90m/s.
- g) To design the system so that it is within the BMD's capability to operate, maintain and repair.
- h) To select equipment for which spare parts and consumables can be easily procured and replaced.
- i) To select reliable and durable equipment suitable for the local environment.
- j) To minimize the recurrent costs of the BMD for the operation, maintenance and repair of the equipment.
- k) To ensure the accuracy of radar data through meticulous adjustment and proper calibration (optimization of radar ZR relation parameter for rainfall calculation).
- l) To design the equipment so as to minimize lightning damage.
- m) To have the necessary power supply back-up equipment (diesel generator, radar power backup unit, auto voltage regulator, etc.) for performing around-the-clock meteorological services 24 hours a day, 365 days a year.
- n) To design the equipment to operate using 230V Single Phase 2-Wire /400V 3-Phase 4-Wire $\pm 20\%$, 50Hz power.

[2] Design Policy of the Radar Tower Building

The aim is to construct a meteorological radar tower building that will ensure the appropriate and effective operation of the system as well as accommodate the required systems, equipment and personnel. It is basic policy that the designed Radar Tower Buildings satisfies the following requirements:

- a) To ensure, as much as possible, that the height of the radar tower buildings is free of obstructions (e.g. surrounding mountains, existing facilities) to avoid blind areas during radar observations.
- b) To select the most suitable foundation structures to ensure that the permissible horizontal deflection of the radar tower buildings is not more than 0.075 degree (approx. 5% of beam angle of an antenna to be manufactured).
- c) To ensure that the working environment for the BMD's 24-hour/day work schedule of observations is conducive to ensuring effective and efficient performance.
- d) To be sufficiently robust enough to withstand extreme weather and ensure uninterrupted radar observation and continuous provision of weather forecasts & warnings to the public, even during the occurrence of a natural disaster.
- e) To make use of local building materials for the easy maintenance of the radar tower buildings by the BMD.

f) To design the equipment so as to minimize lightning damage.

(2) Design Policy on Environmental Conditions

1) Temperature/Humidity

Air-conditioning systems are required for the rooms (radar equipment room, radar observation room, spare parts room, electricity room, etc.) where the equipment is to be installed since Bangladesh has a hot and humid climate throughout the year.

2) Rainfall

The meteorological data should be transmitted and received even during the occurrence of very heavy rains. A maintenance staircase is located at the center of the building, covered by an upper concrete slab, to enable the BMD personnel to easily reach each room for the regular maintenance of the radar equipment without getting wet during the pre-monsoon, monsoon and post-monsoon seasons (April-October).

3) Flood

Dhaka (Joydevpur) and Rangpur are located in areas which are subject to high risks of flooding. Therefore, the ground floor of the radar tower buildings will be built high enough to minimize any possible damage due to flooding.

4) Lightning

Frequent lightning occurs especially during the rainy season. A lightning protection and grounding system (see Page 2-42, Lightning Protection & Grounding System) are, therefore, indispensable to prevent damage to the building and to the equipment.

5) Wind

For calculating the design wind load of the proposed Radar Tower Buildings, the basic wind speed (66m/s) for Dhaka (Joydevpur) and Rangpur indicated in the Bangladesh National Building Code 2012 will be applied.

6) Earthquake

According to the Bangladesh National Building Code 2012, in order to calculate the seismic zone factor: $Z=0.28$ for Dhaka (Joydevpur) and Rangpur will be applied.

7) Load Bearing Layer

The structural design of the radar tower building is to be implemented according to the results of the geotechnical survey done by a local contractor consigned by the Preparatory Survey Team. Foundation type of the radar tower buildings are as follows:

Table 13: Foundation of the Dhaka (Joydevpur) and Rangpur Meteorological Radar Tower Buildings

	Dhaka (Joydevpur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Foundation	Pile foundation (cast in site concrete)	Pile foundation (cast in site concrete)

(3) Design Policy for Construction Work

1) Environmental Regulation

Waste water discharged from the radar tower building must undergo initial treatment before filtering the treatment into the soil at the 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 the Association of Southeast Asian Nations (ASEAN) countries. Most of the construction materials are procurable in the local market. For the Project, durable materials will be selected from locally procurable materials.

3) Use of Local Construction Methods and Local Workers

The common local construction method involves reinforced concrete (RC) structure 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 labors and the skill level is variable in Bangladesh. In order to utilize local labors as much as possible, local construction methods with which local workers are familiar with will be used.

(4) Policy for Use of Local Construction Companies

1) Construction Work of the Radar Tower Building

Generally, in Bangladesh, the technical skills and competence of the major local construction companies are adequate enough. Thus, they will be used for the construction of the radar tower buildings.

2) Equipment Installation Work

Under the supervision of a Japanese engineer, a local electrical work contractor will be consigned in the installation work of the equipment.

(5) Design Considerations to Simplify Operation and Maintenance for the BMD

1) User-friendly equipment

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

2) Easy maintenance and affordable recurrent costs of the equipment

The equipment must be designed in such a way so as 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 facility should be designed to minimize power consumption.

3) Consideration of minimizing operational & maintenance costs

In order for the BMD to meet the increased operational and maintenance costs of the system, the following measures have been included in the plan for the equipment and the radar tower buildings:

- The ability to restrict the operation of the air-conditioning systems and the electricity supply in the operational rooms within the radar tower buildings only.
- The utilization of natural light to reduce energy requirements by minimizing the hours of artificial lightening required.
- Usage of LED for artificial lightening.
- Incorporation of solid-state parts into the radar system to reduce the cost and frequency of parts replacement.

(6) Design Policy for Equipment & Building Grade

To ensure the uninterrupted dissemination of forecasts and warnings to the public, the equipment and the radar tower buildings must be sufficiently robust enough to withstand very heavy rains, local severe storms and flooding to enable the provision of meteorological services 24 hours per day.

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

Locally procurable materials and local construction methods must be used in the building design. The equipment to be installed in the radar tower buildings, such as the specialized power backup systems and meteorological equipment, which are not available in the local market, will be procured mainly 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 is between June 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 due to rainwater. The equipment for the Project must be durable, reliable, of high technical level and cost effective.

Though the equipment to be installed in the radar tower buildings, such as the specialized power backup systems and meteorological equipment are not available in the local market, locally procurable materials and local construction methods must be used in the building design. The pulse compression solid state Doppler radar system to be procured under the Project, which has already been put into practical use for meteorological observation and has confirmed its reliability, durability, accuracy and performance, is only available and made in Japan.

2-2-2 Basic Plan

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

Table 14: Objective Equipment and Facilities of the Preparatory Survey

Component	BMD Joydevpur Observatory (Dhaka Radar Observation Station)	BMD Rangpur Observatory (Rangpur Radar Observation Station)	Storm Warning Centre (SWC) at BMD Head Office	BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)
Procurement and Installation of Equipment				
S-Band Doppler Pulse Compression Solid State Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	1	-	-
Meteorological Rader Data Display System	1	1	1	1
Meteorological Data Satellite Communication System (VSAT)	1	1	-	-
Modification of the existing Meteorological Data Satellite Communication System (Hub VSAT System)	-	-	1	-
Construction of Radar Tower Building				
Radar Tower Building	1	1	-	-

(1) Equipment Plan

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 is of the S band type (wave length: approx. 10cm). An 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 the BMD to issue warnings promptly. For these reasons, an S band radar has been selected as the most suitable radar system to monitor large-scale and distant phenomena such as monsoons, etc. Thus, the S band radar system is to be installed as requested by the BMD. The S band radar system must be a pulse compression solid state Doppler radar system with a changeable function accurately having quantitative rainfall observation and air-turbulence observation capability for monitoring rapidly changing weather conditions in real time.

2,800MHz of the existing Dhaka and Rangpur Meteorological Radar Systems (as the center frequency) ± 5 MHz frequency band will be used for the proposed Doppler radar systems supplied under the Project.

Table 15: Major Features of Meteorological Radar Systems in Bangladesh

Specifications	Existing Dhaka and Rangpur Ordinary Radar Systems	Existing Cox’s Bazar, Khepupara and Moulvibazar Doppler Radar Systems	Planned Dhaka (Joydevpur) and Rangpur Pulse Compression Solid State Doppler Radar Systems
Radar Type	Magnetron Radar	Klystron Radar	Solid State Radar
Operating Frequency	2.7 - 2.9 GHz	2.7 - 2.9 GHz	2.7 - 2.9 GHz
Occupied Frequency Bandwidth	60MHz (Center Frequency +/-30MHz)	20MHz (Center Frequency +/-10MHz)	10MHz (Center Frequency +/-5MHz)
Observation Data	Precipitation Intensity	Precipitation Intensity, Doppler Velocity, Spectrum Width	Precipitation Intensity, Doppler Velocity, Spectrum Width
Maximum Observation Range for 1mm/h Detection	Radius 300km	Radius 440km	Radius 450km
Maximum Doppler Observation Range	Not Available	Radius 200km	Radius 200km
Data Mesh Size	2.5km mesh	0.625km mesh	0.625km mesh
Precipitation Intensity Quantitative Estimation Data	0 - 128 mm/h (qualitative)	0 - 250 mm/h (quantitative)	0 - 250 mm/h (quantitative)
Precipitation Intensity Display Level	6 levels	16 levels	16 levels
Hourly rainfall accumulation	Not Available	Available	Available
Maximum Doppler Velocity	Not Available	More than +/-70 m/s	More than +/-70 m/s
Doppler Processing Function	Not Available	Available	Available
Survival Wind Speed of the Radome	More than 75m/s	More than 90m/s	More than 90m/s
Antenna Diameter	4 m	5 m	5 m
Transmission Power	500kW (peak power)	500kW (peak power)	10kW (peak power)
Transmission Tube (Unit)	Magnetron (Tube)	Klystron (Tube)	GaAs/GaN FET (Semi-conductor)
Life of the Transmission Tube (Unit)	About 3,000 hours	About 20,000 hours	More than 100,000 hours
Replace Interval of the Transmission Tube (Unit)	1 to 2 years	3 to 4 years	More than 10 years
Ease of Transmission Tube Handling	Difficult	Very difficult	Easy
Cautions for Storage of the Transmission Tube (Unit)	Periodical Maintenance for Aging	Periodical Maintenance for Deionization and Aging	Not Need of Periodical Maintenance
Switching Device of the Modulator	Thyratron (Tube)	FET Switch (Semi-Conductor)	—
Replace Interval of the Switching Device	1 to 2 years	More than 10 years	—
Transmitter Power Supply Voltage	High Voltage (about 30kV)	High Voltage (about 40kV)	Low Voltage (DC 24V)
Power Consumption	About 8kVA	About 10kVA	About 8kVA

Amount of Heat Generation (Relative)	middle	high	low
Running Cost including Consumables (Relative)	middle	high	low
Vibration, Noise (relative)	middle	high	low

[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 tropical cyclones, local severe storms and tornadoes within a 200km radius. This will help the BMD to monitor the movement and development of severe weather systems in preparation for a more accurate and timely weather forecast 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

In order to obtain accurate observation rainfall data during meteorological radar observation, it is recommended to conduct radar observations at lower antenna angles closer to the ground surface. The continuous automatic observation done in multiple elevations during a CAPPI observation enable the collection of echo intensity data in three different dimensions. It is possible to eliminate the disadvantages described above by converting the data observed from a constant altitude surface and the data obtained from CAPPI observation into rainfall data. In order to be able to produce an estimation of heavy rain amounts, it is especially necessary to use a high degree of 2km or 3km CAPPI product. Therefore, in this Project, it will be necessary to provide for a CAPPI function with automatic multiple elevation angle observation for CAPPI product creation.

Figure of the “Composite Picture of the Proposed Meteorological Radar Observation Network in Bangladesh” after completion of the Project are attached hereunder.

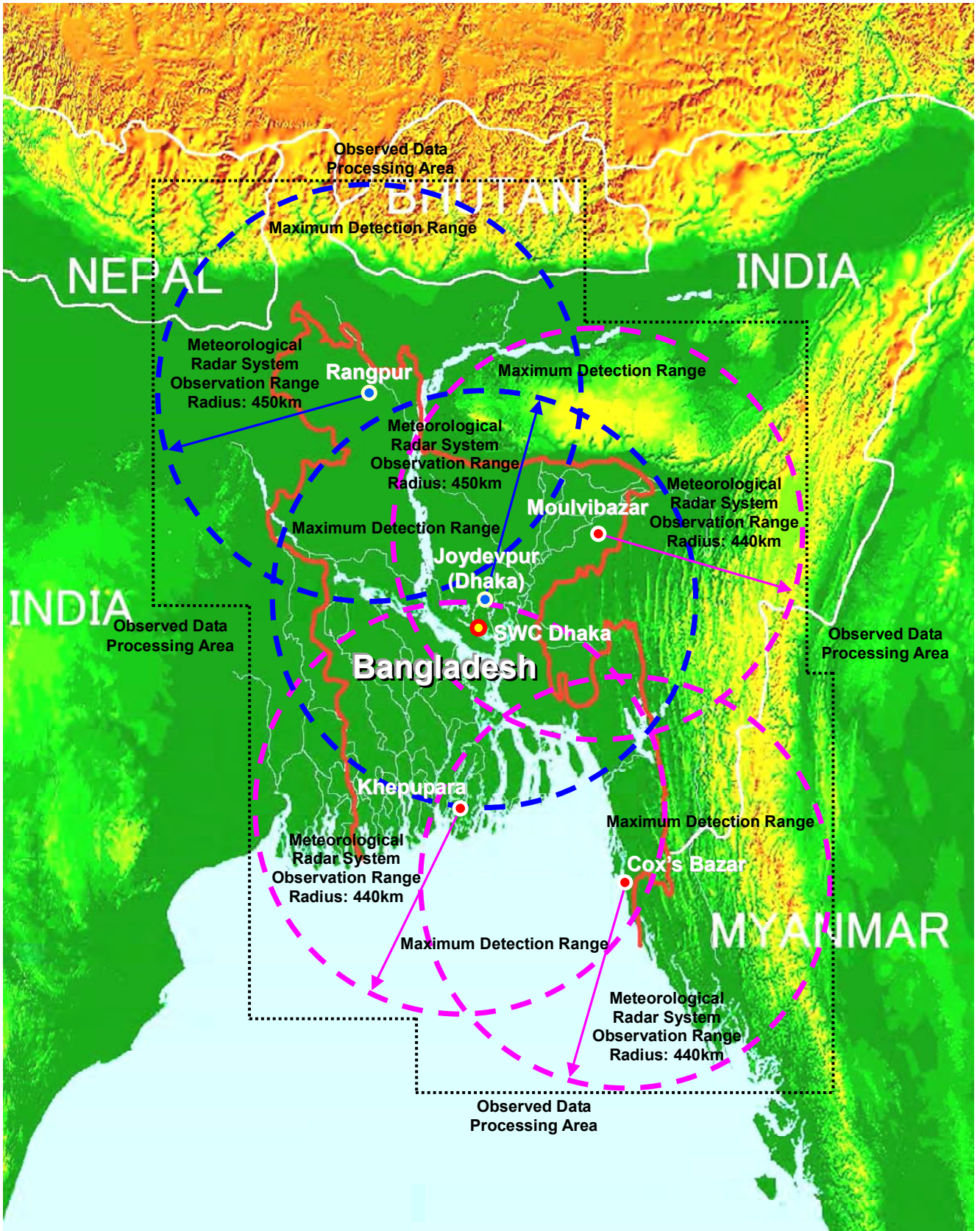


Figure 11: Composite Picture of the Proposed Meteorological Radar Observation Network in Bangladesh

2) Meteorological Radar Data Display System

A meteorological radar data display system must have the ability to receive and display all meteorological products in real time because the BMD’s forecasters must obtain the meteorological radar data in real time for routine weather forecasting & warning. In addition, the BMD’s forecasters are required to do a substantial amount of work in a short period of time so the meteorological radar data display systems are to be installed in the SWC at the BMD Head Office, the proposed Radar Tower Buildings and the BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka) so that they do not need to leave the area. Displays of the system must have minimized heat production for effective room cooling, are of the power-saving type and have less screen reflections for a smoother and long time operation. The meteorological radar data display system will be designed to store data files of the radar pictures as binary data of hourly accumulated precipitation data of 2.5 km mesh.

3) Meteorological Data Satellite Communication System (VSAT)

In order to improve the tropical cyclone monitoring and forecasting work and to enable the timely dissemination of products, all of the meteorological radar data produced by the proposed Dhaka (Joydevpur) and Rangpur Meteorological Radar Systems must be delivered to the SWC at the BMD Head Office, every 15 minutes in view of the CAPPI mode observation. The required data transmission speed is 64kbps between each Meteorological Radar Systems and the SWC. To facilitate this, a data acquisition system is required, employing the most suitable band for high-speed satellite communication links using C-band, because of its low attenuation by rain.

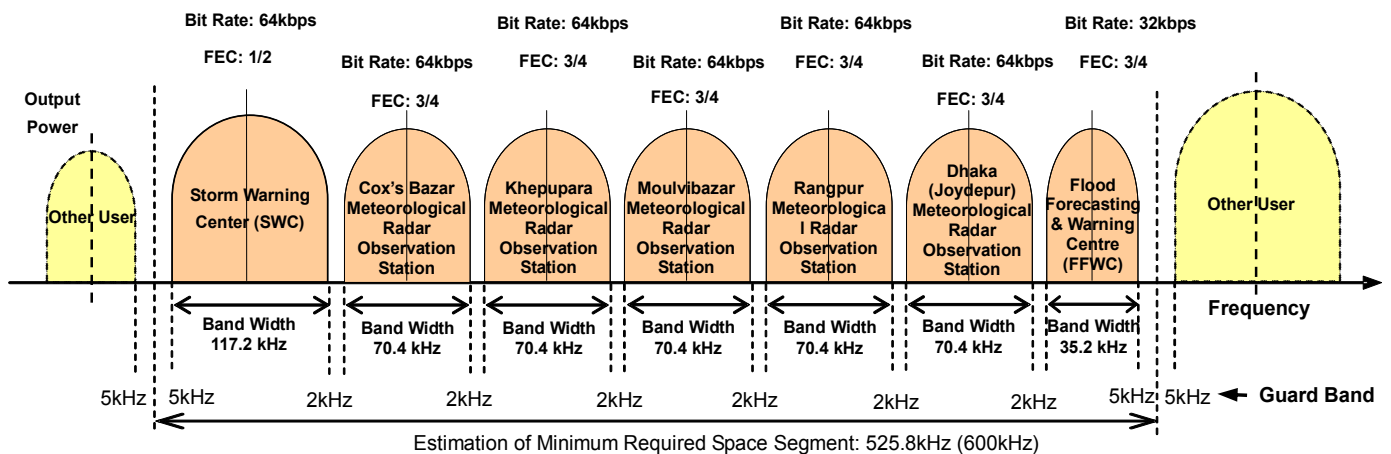


Figure 12: Estimation of Minimum Required Space Segment

The data transmission speed of the Meteorological Data Satellite Communication System (VSAT) higher than 64kbps is not required in actuality due to the characteristic features of a meteorological radar observation indicated in the following table/figure.

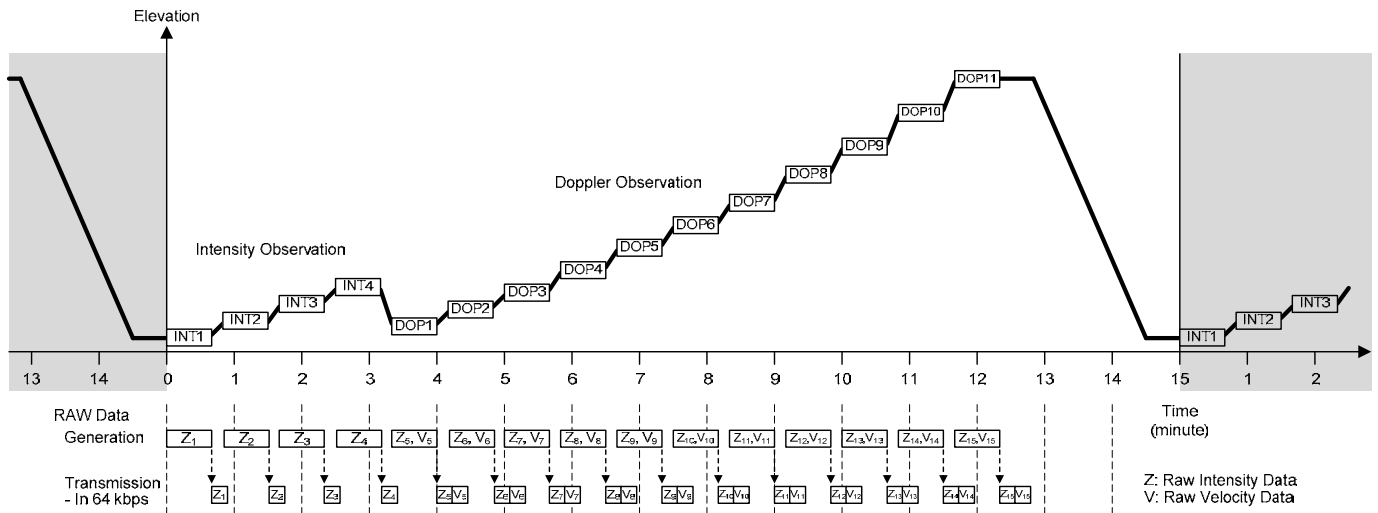

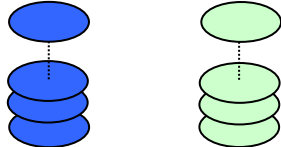


Figure 13: Meteorological Radar Observation Schedule

Table 16: Data Volume and Products of the Proposed Meteorological Radar Systems

Descriptions of Data	Data Volume of Single Observation	Radar Display
4 Elevation Angles: Long Range Observation (450km radius) Intensity RAW Data [Intensity (8bit)] 	<ul style="list-style-type: none"> • Polar coordinate format • 320 range×360 angle • 8bit data (Intensity) • 4 elevation angles Total: 480kbytes	<Radar Products> <ul style="list-style-type: none"> • PPI/RHI Display • Location Manual Data Input and Low Pressure Track Display • Heavy Rainfall Warning Output • N-hour Accumulated Rainfall • Surface Rain Indication • Composite Display • Catchment Area Rainfall Amount Display
11 Elevation Angles: Short Range Observation (200km radius) Intensity RAW Data and Doppler RAW Data [Intensity (8bit)] [Doppler (8bit)] 	<ul style="list-style-type: none"> • Polar coordinate format • 320 range×360 angle • 8bit data (Intensity/Doppler) • 11 elevation angles Total: 2.64Mbytes	<Radar Products indicated above + below> <ul style="list-style-type: none"> • CAPPI Display • Echo Top Display • Vertical Cross Section • Vertical Integrated Liquidation • 3-Dimensional Data Display • Wind Velocity and Direction • Wind Profile of the Upper Layer • Wind Shear Alert

For transmitting all the meteorological radar data from each Meteorological Radar System to the SWC, the transponder to be selected for the Project must satisfy the following requirements.

- Geographic Coverage: Southeast Asia area including Bangladesh
- Satellite Beam: C band beam
- Frequency
 - ✧ Up Link : 5,925 – 6,425 [MHz]
 - ✧ Down Link : 3,700 – 4,200 [MHz]
- Polarizations: Orthogonal Linear
- Satellite Maximum EIRP: more than 38.0 [dBW]
- Satellite G/T: more than 2.1 [dB/K]
- Satellite SFD: less than 83.0 [dBW/m²]

✦ 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.

The “Schematic Diagram of the Meteorological Observation Network in the People’s Republic of Bangladesh” is attached hereto.

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

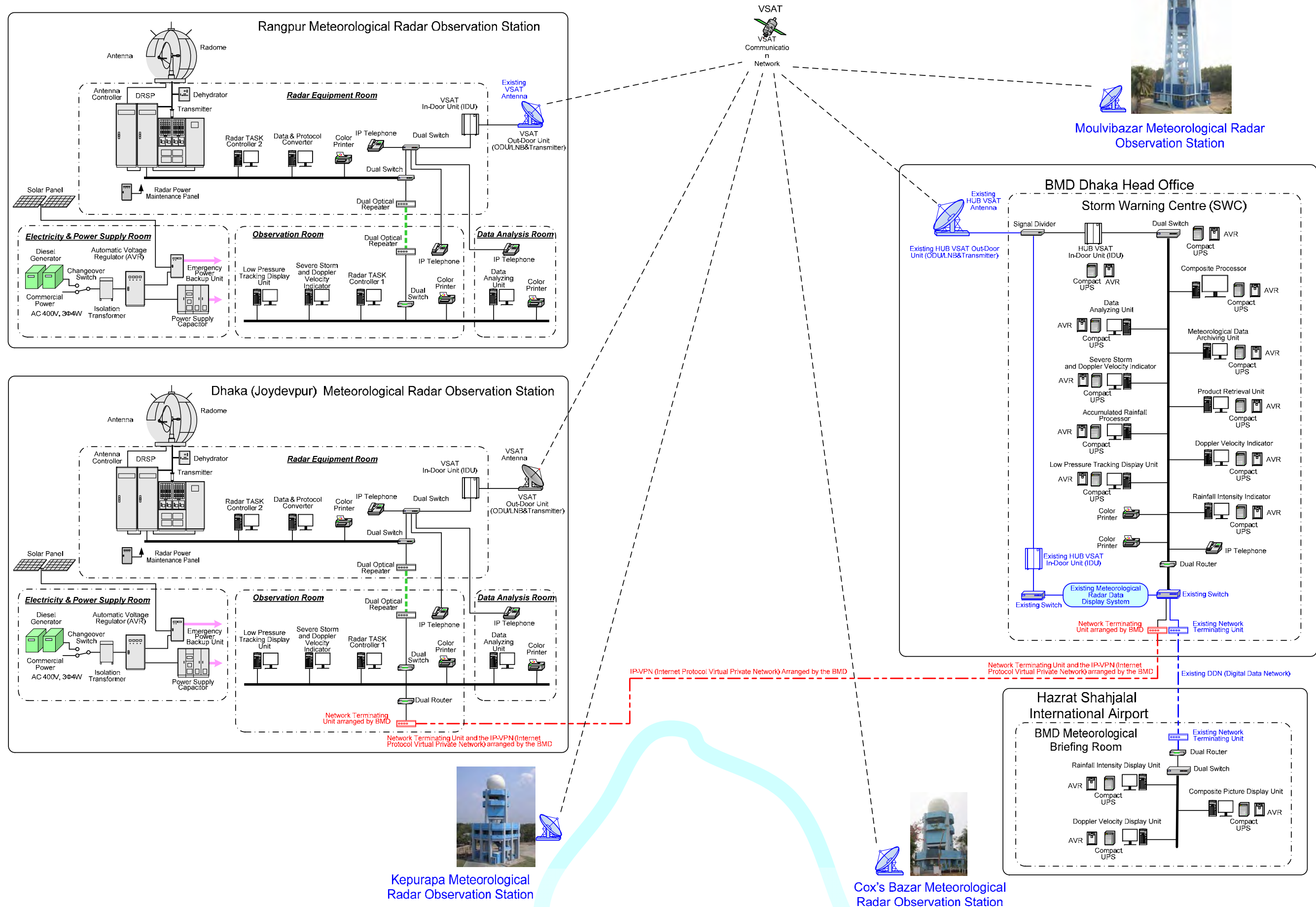


Figure 14: Schematic Diagram of Meteorological Radar Observation Network in Bangladesh

(2) Major Equipment List

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

Table 17: Main Equipment Components

Component	BMD Joydevpur Observatory (Dhaka Radar Observation Station)	BMD Rangpur Observatory (Rangpur Radar Observation Station)	Storm Warning Centre (SWC) at BMD Head Office	BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)
Procurement and Installation of Equipment				
S-Band Doppler Pulse Compression Solid State Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	1	-	-
Meteorological Rader Data Display System	1	1	1	1
Meteorological Data Satellite Communication System (VSAT)	1	1	-	-
Modification of the existing Meteorological Data Satellite Communication System (Hub VSAT System)	-	-	1	-

Major Equipment List

S-Band Doppler Pulse Completion Solid State Radar System

Name of Site: Dhaka (Joydevpur) Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
Radome	1 set	For protecting the radar antenna assembly (a parabolic dish reflector) and the maintenance personnel from severe weather conditions and lightning attacks.
Antenna	1 set	For radiating radar beam into the atmosphere and receiving scatter waves while rotating the parabola antenna in azimuth and elevation direction.
Antenna Controller	1 set	For rotating the parabolic dish reflector and for controlling the antenna in azimuth and elevation by both horizontal and vertical drive motor units.
Transmitter	1 set	For amplifying pulse-modulated power with stable frequency and transmitting the power to the antenna.
Digital Receiver and Signal Processor (DRSP)	1 set	For receiving, pulse compression and processing echo signal from the Antenna. For suppressing unnecessary echo such as clutter signals reflected from the ground. For sending ingest data to the radar TASK controller.
Dehydrator	1 set	For supplying dried and pressurized air into the wave-guide to reduce wave propagation loss.
Wave-guide Configuration	1 set	For feeder line propagation of the wave traveling between the antenna and TX/RX.

Radar TASK Controller	2 sets	For operating the radar system, monitoring the condition of the radar system and generating raw product data. Control and monitoring items: Radiate control/status, Azimuth/elevation position control/status, TX standby status, Pulse width control/status and Antenna local/maintenance mode status.	
Data & Protocol Converter	1 set	For sending raw data to the central system according to specified intervals.	
Radar Power Maintenance Panel	1 set	For distributing and supplying AC power to the radar system.	
Dual Switch	1 set	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.	
Color Printer	1 set	For printing radar image.	
Dual Optical Repeater	1 set	For converting electrical signal and optical signal on LAN for protection against surges.	
Isolation Transformer	1 set	For protecting each equipment from surges in voltage in the main power.	
Automatic Voltage Regulator (AVR)	1 set	For supplying constant or regulated voltage to the radar system.	
Power Supply Capacitor	1 set	For supplying uninterrupted power by Electric Dual Layer Capacitor energy to the radar system when power failure occurs.	
Spectrum Analyzer	1 set	For maintenance of the system.	
Test signal Generator	1 set		
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		
Network Camera	1 set		
Tool Kit	1 set		
Extension Cable	1 set		
Leveler	1 set		
Step Ladder	1 set		
Clump Current Meter	1 set		
Vacuum Cleaner	1 set		
Radar Antenna Maintenance Deck	1 set		
Spare Parts	Timing belt for antenna (for azimuth drive)		1 set
	Timing belt for antenna (for elevation drive)	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 drive)	1 set	
	Motor for antenna (for elevation drive)	1 set	
	Servo unit for antenna controller (for azimuth drive)	1 set	
	Servo unit for antenna controller (for elevation drive)	1 set	
	Power supply unit for antenna controller	1 set	
	Power supply unit for transmitter	1 set	
	Power supply unit for digital receiver and signal processor	1 set	
	Fan unit for radar equipment	2 sets	
	LAN Arrester	2 sets	
Obstruction light	2 sets		
Consumables	Grease with pump and oil with jug for antenna	1 set	For maintenance of the system.
	Antenna carbon brush for power	1 set	

	Antenna carbon brush for signal	1 set	
Service Manuals		2 sets	For maintenance of the system.

S-Band Doppler Pulse Completion Solid State Radar System

Name of Site: Rangpur Meteorological Radar Observation Station			
Equipment	Quantity	Purpose	
Radome	1 set	For protecting the radar antenna assembly (a parabolic dish reflector) and the maintenance personnel from severe weather conditions and lightning attacks.	
Antenna	1 set	For radiating radar beam into the atmosphere and receiving scatter waves while rotating the parabola antenna in azimuth and elevation direction.	
Antenna Controller	1 set	For rotating the parabolic dish reflector and for controlling the antenna in azimuth and elevation by both horizontal and vertical drive motor units.	
Transmitter	1 set	For amplifying pulse-modulated power with stable frequency and transmitting the power to the antenna.	
Digital Receiver and Signal Processor (DRSP)	1 set	For receiving, pulse compression and processing echo signal from the Antenna. For suppressing unnecessary echo such as clutter signals reflected from the ground. For sending ingest data to the radar TASK controller.	
Dehydrator	1 set	For supplying dried and pressurized air into the wave-guide to reduce wave propagation loss.	
Wave-guide Configuration	1 set	For feeder line propagation of the wave traveling between the antenna and TX/RX.	
Radar TASK Controller	2 sets	For operating the radar system, monitoring the condition of the radar system and generating raw product data. Control and monitoring items: Radiate control/status, Azimuth/elevation position control/status, TX standby status, Pulse width control/status and Antenna local/maintenance mode status.	
Data & Protocol Converter	1 set	For sending raw data to the central system according to specified intervals.	
Radar Power Maintenance Panel	1 set	For distributing and supplying AC power to the radar system.	
Dual Switch	1 set	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.	
Color Printer	1 set	For printing radar image.	
Dual Optical Repeater	1 set	For converting electrical signal and optical signal on LAN for protection against surges.	
Isolation Transformer	1 set	For protecting each equipment from surges in voltage in the main power.	
Automatic Voltage Regulator (AVR)	1 set	For supplying constant or regulated voltage to the radar system.	
Power Supply Capacitor	1 set	For supplying uninterrupted power by Electric Dual Layer Capacitor energy to the radar system when power failure occurs.	
Spectrum Analyzer	1 set	For maintenance of the system.	
Test signal Generator	1 set		
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		
Network Camera	1 set		
Tool Kit	1 set		
Extension Cable	1 set		
Leveler	1 set		
Step Ladder	1 set		
Clump Current Meter	1 set		
Vacuum Cleaner	1 set		
Radar Antenna Maintenance Deck	1 set		

Spare Parts	Timing belt for antenna (for azimuth drive)	1 set	For maintenance of the system.
	Timing belt for antenna (for elevation drive)	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 drive)	1 set	
	Motor for antenna (for elevation drive)	1 set	
	Servo unit for antenna controller (for azimuth drive)	1 set	
	Servo unit for antenna controller (for elevation drive)	1 set	
	Power supply unit for antenna controller	1 set	
	Power supply unit for transmitter	1 set	
	Power supply unit for digital receiver and signal processor	1 set	
	Fan unit for radar equipment	2 sets	
	LAN Arrester	2 sets	
	Obstruction light	2 sets	
Consumables	Grease with pump and oil with jug for antenna	1 set	For maintenance of the system.
	Antenna carbon brush for power	1 set	
	Antenna carbon brush for signal	1 set	
Service Manuals	2 sets	For maintenance of the system.	

Meteorological Radar Data Display System

Name of Site: Dhaka (Joydevbpur) Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
Severe Storm and Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Low Pressure Tracking Display Unit	1 set	For tracking cyclone course and predicting cyclone course and time.
Color Printer	2 sets	For printing radar image.
Dual Switch	1 set	For connecting all the computer equipment with LAN.
Dual Optical Repeater	1 set	For converting electrical signal and optical signal on LAN for surge protection.
Data Analyzing Unit	1 set	For analyzing weather phenomena by observed radar data.
IP Telephone	3 sets	For voice communication through IP network.
Spare Parts LAN Arrester	3 sets	For maintenance of the system.
Service Manuals	2 sets	For maintenance of the system.

Meteorological Radar Data Display System

Name of Site: Rangpur Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
Severe Storm and Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Low Pressure Tracking Display Unit	1 set	For tracking cyclone course and predicting cyclone course and time.
Color Printer	2 set	For printing radar image.
Dual Switch	1 set	For connecting all the computer equipment with LAN.
Dual Optical Repeater	1 set	For converting electrical signal and optical signal on LAN for surge protection.
Data Analyzing Unit	1 set	For analyzing weather phenomena by observed radar data.
IP Telephone	3 sets	For voice communication through IP network.
Spare Parts LAN Arrester	3 sets	For maintenance of the system.
Service Manuals	2 sets	For maintenance of the system.

Meteorological Radar Data Display System

Name of Site: Storm Warning Centre (SWC) at BMD Head Office		
Equipment	Quantity	Purpose
Composite Processor	1 set	For the generation of composite pictures from incoming data of all the radar stations.
Data Analyzing Unit	1 set	For analyzing weather phenomena by using observed radar data.
Meteorological Data Archiving Unit	1 set	For storing of radar and weather information to a selected media.
Severe Storm and Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Product Retrieval Unit	1 set	For retrieving and displaying radar data.
Accumulated Rainfall Processor	1 set	For generating and sending accumulated rainfall data.
Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Rainfall Intensity Indicator	1 set	For generating rainfall intensity and related data
Low Pressure Tracking Display Unit	1 set	For tracking cyclone course and predicting cyclone course and time.
Color Printer	2 sets	For printing radar image.
Dual Router	1 set	For forwarding data packets between computer networks.
Dual Switch	1 set	For connecting all the computer equipment with LAN.
IP Telephone	1 set	For voice communication through IP network.
Compact UPS	10 sets	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.
Automatic Voltage Regulator (AVR)	10 sets	For supplying constant or regulated voltage to the radar system.
Spare Parts LAN Arrester	9 sets	For maintenance of the system.
Service Manuals	2 sets	For maintenance of the system.

Meteorological Radar Data Display System

Name of Site: BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)		
Equipment	Quantity	Purpose
Composite Picture Display Unit	1 set	For displaying composite pictures generated by Composite Processor.
Rainfall Intensity Display Unit	1 set	For displaying rainfall intensity generated by Rainfall Intensity Indicator.
Doppler Velocity Display Unit	1 set	For displaying horizontal wind distribution (wind direction and speed) generated by Doppler Velocity Indicator.
Dual Router	1 set	For forwarding data packets between computer networks.
Dual Switch	1 set	For connecting all the computer equipment with LAN.
Compact UPS	3 sets	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.
Automatic Voltage Regulator (AVR)	3 sets	For supplying constant or regulated voltage to the radar system.
Spare Parts LAN Arrester	3 sets	For maintenance of the system.
Service Manuals	2 sets	For maintenance of the system.

Meteorological Data Satellite Communication System

Name of Site: Dhaka (Joydevbpur) Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
VSAT Out-door Unit (ODU/Transmitter)	1 set	Transmitter for radar data transmission via satellite.
VSAT Out-door Unit (ODU/LNB)	1 set	Receiver for radar data transmission via satellite.
VSAT Antenna	1 set	Antenna for radar data transmission via satellite.
VSAT In-Door Unit (IDU)	1 set	Modulator/Demodulator for radar data transmission via satellite.
Arrester Box	1 set	For protection of VSAT equipment from lightning.
Emergency Power Backup Unit	1 set	For supplying back-up AC power to VSAT equipment for uninterrupted or continued VoIP communication to Head Office in case of power failure.
Dual Switch	1 set	For connecting all the computer equipment with LAN.
Maintenance Terminal	1 set	For maintenance of the system.
Directional Coupler	1 set	
Spare Parts Arrester Terminal Set	1 set	For maintenance of the system.
Service Manuals	2 sets	For maintenance of the system.

Meteorological Data Satellite Communication System

Name of Site: Rangpur Meteorological Radar Observation Station			
Equipment	Quantity	Purpose	
VSAT Out-door Unit (ODU/Transmitter)	1 set	Transmitter for radar data transmission via satellite.	
VSAT Out-door Unit (ODU/LNB)	1 set	Receiver for radar data transmission via satellite.	
VSAT Antenna	1 set	Antenna for radar data transmission via satellite.	
VSAT In-Door Unit (IDU)	1 set	Modulator/Demodulator for radar data transmission via satellite.	
Arrester Box	1 set	For protection of VSAT equipment from lightning.	
Emergency Power Backup Unit	1 set	For supplying back-up AC power to VSAT equipment for uninterrupted or continued VoIP communication to Head Office in case of power failure.	
Dual Switch	1 set	For connecting all the computer equipment with LAN.	
Maintenance Terminal	1 set	For maintenance of the system.	
Directional Coupler	1 set		
Spare Parts	Arrester Terminal Set	1 set	For maintenance of the system.
Service Manuals	2 sets	For maintenance of the system.	

Meteorological Data Satellite Communication System

Name of Site: Storm Warning Centre (SWC) at BMD Head Office			
Equipment	Quantity	Purpose	
HUB VSAT In-Door Unit (IDU)	1 set	Transmitter for radar data transmission via satellite.	
Signal Divider	1 set	For Dividing a signal from VSAT antenna	
Compact UPS	1 set	To supply uninterrupted power to VSAT system in case of power failure.	
Compact Automatic Voltage Regulator (AVR)	1 set	To supply constant or regulated voltage to the system.	
Spare Parts	Transmitter (10W)	1 set	For maintenance of the system.
	LNB	1 set	
	Modem (for HUB IDU)	1 set	
	Modem (for VSAT IDU)	1 set	
	Signal Divider	1 set	
	Arrester Terminal Set	1 set	
	Battery (for 3kVA UPS)	1 set	
Service Manuals	2 sets	For maintenance of the system.	

(3) Basic Plan of the Facility

1) Site and Facility Layout Plan

The outline and current situation of infrastructures in the proposed Meteorological Radar Observation Stations are as follows.

Table 18: Outline and Current Situation of Infrastructures at the Proposed Project Sites for the Establishment of Meteorological Radar Observation Stations

	Dhaka (Joydepur) Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station
Latitude(N) Longitude(E)	N 23° 59' 13.5" E 90° 24' 17.7"	N 25° 43' 59.5" E 89° 15' 10.1"
Altitude	15m	36m
Site Status	Existing Weather Observation Station	Existing Meteorological Radar Observation Station
Area of Property (Inside of the existing fence/boundary wall)	15,194m ²	9,953m ²
Space availability for the construction of the proposed radar tower building	Enough space is available	Enough space is available
Access Road	Poses no problem for the construction of the proposed radar tower building.	Poses no problem for the construction of the proposed radar tower building.
Description/Outline of the Premises	Land cleared and leveled	Land cleared and leveled
Commercial Power	230V, Single-phase 2-wire, 50Hz	400V, 3-phase 4-wire, 50Hz
Water Supply	Deep well water	Deep well water
Waste water and Sewage	Septic tank and seepage pit are required	Septic tank and seepage pit are required
Telephone	Available	Available
Internet Connection	Available (Mobile Telephone Network)	Available (Mobile Telephone Network)
Mobile phone in the property area	Service is available	Service is available

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 obstructing structures such as columns and beams protruding into the internal staircase (which will also serve as an evacuation route). Construction methods and materials follow local practice and the building is of standard grade in Bangladesh.

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 presented in the following tables.

Table 19: Calculation Base of Each Room in the Proposed Meteorological Radar Tower Building

Name of Room	Dhaka (Joydevpur) Meteorological Radar Tower Building Floor Area (m ²)	Rangpur Meteorological Radar Tower Building Floor Area (m ²)	Room Function	Calculation Base
Radome Room	30.18	30.18	Installation space for radar antenna apparatus.	Maintenance space for radar antenna apparatus. Room area depends upon

				radome base of 6.2m in diameter.
Radar Equipment Room (including Spare Parts Room)	86.49	86.49	Installation space for antenna controller, transmitter, solid state power amplifier, digital receiver, signal processor, dehydrator, wave-guide configuration, radar task controller, power distribution box, optical repeater, compact link transmitter/receiver, 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 77m ² is required.
Observation Room	155.31	155.31	For the following equipment and furniture. <ul style="list-style-type: none"> ➤ weather observation terminals ➤ data analysis terminal, ➤ VoIP exchange ➤ optical repeater ➤ dual switch ➤ printer ➤ IP telephone ➤ UPS for PCs ➤ desk for the terminal ➤ filing cabinets ➤ white board ➤ data storage cabinets ➤ data storage cabinets for keeping observation records and observed data of the radar system for analysis ➤ cabinets for maintenance instruments and operation & maintenance manuals Space for keeping spare parts & consumables.	For radar observation space and installation space for all the equipment described in the left column. A space for data analysis terminal, desk, data storage cabinets and also working space. Necessary space for keeping all data secured. Maintenance space for various type of the equipment and keeping space for maintenance instruments, measuring equipment.
Electricity Room	45.12	44.82	For isolation transformers, power distribution boards, cable rack, test terminals, AVR, etc. For radar power back-up unit and control rack.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column.
Toilet (1FL)	15.45	15.45	European Style Commode: M1+F1, Wash Basin: M1+F1, Urinal: 1, Slop Sink: 1	—
Toilet (GFL)	3.4	—	Local Style Commode:1,Wash Basin: 1	—
Tea Kitchen	6.49	6.49	Kitchen: 1	—
Changing Room	2.21	2.21	Changing space for taking shower	—
Shower Room	2.29	2.29	Space for taking shower	—

Storage (1FL)	3.67	3.67	Storage space for spare materials and miscellaneous goods.	—
Storage (GFL)	—	2.01	Storage space for spare materials and miscellaneous goods.	—
Engine Generator Room	68.76	68.12	Operation and maintenance space for 75kVA engine generators: 2, oil tank & oil pump: 1, automatic change-over switch, etc.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column.
Pump Room	10.72	11.27	Pump for water reservoir tank: 1 Well pump: 2	For maintenance space and installation space for pumps: approx. 7 m ² is required.
Security Office	6.71	4.48	Working space for security guard.	Working space for 1 security personnel.
Meteorological Surface Observation & Data Management Room	13.31	—	Working space for meteorological surface observation and data management.	Necessary space for the routine work of 1 observer estimated according to the existing facility as reference.
Agro-meteorological Observation & Data Management Room	11.24	—	Working space for agro-meteorological observation and data management.	Necessary space for the routine work of 1 observer estimated according to the existing facility as reference.
Recording & Reporting Room	11.24	—	Working space for observation data recording and reporting.	Necessary space for the routine work of 1 observer estimated according to the existing facility as reference.

[2] Sectional Plan

I. Height of the Radar Tower Buildings

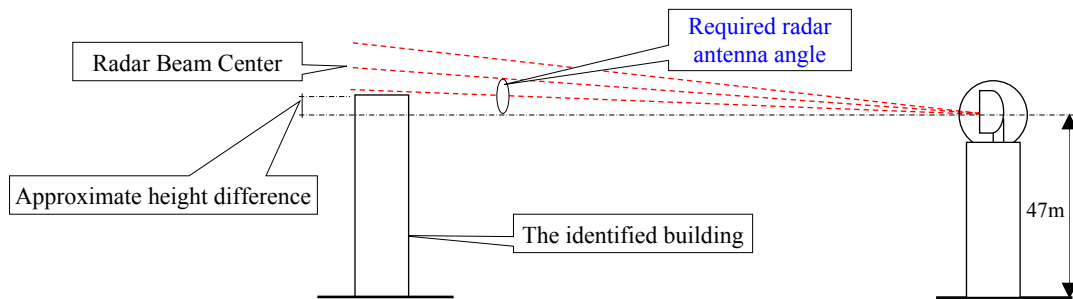
◆ Proposed Dhaka (Joydevpur) Meteorological Radar Tower Building

The existing obstructive buildings/facilities (Location Map No. 2, 3 & 4) around the proposed Dhaka (Joydevpur) Meteorological Radar Observation Station are indicated in the following table. The required radar antenna center height for the proposed radar system in the Dhaka (Joydevpur) Meteorological Radar Observation Station is at least 47m. In case that the radar antenna center height is 47m and the radar antenna angle is 0.5 degree, the high-rise buildings adjacent to the BMD Joydevpur can be captured. The existing obstructive buildings/facilities around the proposed Dhaka (Joydevpur) Meteorological Radar Observation Station currently do not pose a serious problem. In addition, several self-standing and guided telecommunication steel towers which are unsurpassable and unavoidable obstructions for radar observation can be found in Joydevpur (Gazipur). Since these telecommunication steel towers are not completely solid structures, they are not considered major obstructions in radar observation.

As a result of the discussions with the Gazipur City Corporation and the Rajdhani Unnayan Karttripakkha (RAJUK), it was confirmed that there is no plan to construct a high rise building, which will be an unavoidable obstruction for radar observation, around the proposed Dhaka (Joydepur) Meteorological Radar Observation Station.

Table 20: Existing Obstructive Buildings to the Radar Observation in Joydepur (as of April, 2014)

Location Map No.	1	2
Name of Building	National University, Gazipur	Sewing Factory Building (under construction)
Picture		
Number of Stories	16	12
Height	59m	40m
Latitude(N)	N23° 57'02.19"	N23° 59'40.28"
Longitude(E)	E90° 22'47.69"	E90° 24'21.83"
Altitude	14m	13m
Distance from the BMD Joydepur	approx. 4.8km	approx. 0.8km
Direction from the BMD Joydepur	212°	8°
Approximate height difference (Existing obstructive building height – planned height of radar antenna center: 47m + Ground level difference)	59m-47m-1m=11m Ground level is 1m lower than the BMD Joydepur	40m-47m-2m=-9m Ground level is 2m lower than the BMD Joydepur
Required radar antenna angle to eliminate the shadow area caused by the identified buildings	+0.9°	+0.4°
Location Map No.	3	4
Name of Building	Apartment Building (under construction)	Apartment Building (IBRAHIM Tower)
Picture		
Number of Stories	11	9
Height	34m	32m
Latitude(N)	N23° 59'34.43"	N23° 59'28.37"
Longitude(E)	E90° 23'44.76"	E90° 23'40.76"
Altitude	14m	15m
Distance from the BMD Joydepur	approx. 1.1km	approx. 1.1km
Direction from the BMD Joydepur	305°	294°
Approximate height difference (Existing obstructive building height – planned height of radar antenna center: 47m + Ground level difference)	34m-47m-1m=-14m Ground level is 1m lower than the BMD Joydepur	32m-47m=-15m Ground level is the same as the BMD Joydepur
Required radar antenna angle to eliminate the shadow area caused by the identified buildings	+0.1°	±0°



Since it is technically possible to complement the shadow area created by the existing obstructive building (National University, Gazipur) indicated in the above table in the radar detection range with CAPPI data, it does not pose a serious problem for radar observation.

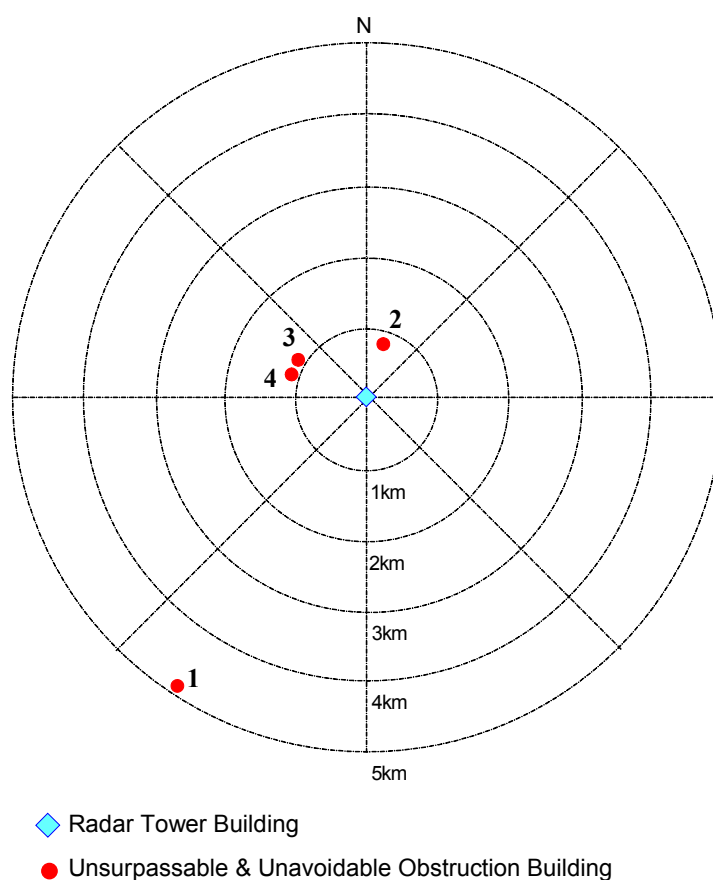


Figure 15: Location Map of the Existing Obstructive Buildings around the BMD Joydevpur


◆ Proposed Rangpur Meteorological Radar Tower Building

The required radar antenna center height for the proposed radar system in the Rangpur Meteorological Radar Observation Station is at least 47m as shown in the figure below. In case that the radar antenna center height is 47m and the radar antenna angle is 0.5 degree, the roof top of the highest building (Hotel North View) in the Rangpur city can be captured. The existing obstructive building (Hotel North View) currently does not pose a serious problem. Several self-standing and guided telecommunication steel towers which are unsurpassable and unavoidable obstructions for radar observation can be found in Rangpur as seen in the picture shown below. Since these telecommunication steel towers are not completely

solid structures, they are not considered as major obstructions in radar observation.

As a result of the discussions with the Rangpur City Corporation, it was found out that there are currently 4 plans to construct high rise buildings, which will become unavoidable obstructions for radar observation, that have been specially approved by the Rangpur City Mayor. Since it is technically possible to complement the shadow areas created by the 4 obstructive buildings in the radar detection range with CAPPI data, they do not pose a serious problem for radar observation.

Table 21: Obstructive Buildings to the Radar Observation in Rangpur

Existing Obstructive Building to the Radar Observation in Rangpur (as of April, 2014)				
Name of Building	Hotel North View			
Picture				
Number of Stories	11			
Height	38m			
Latitude(N)	N25° 44' 59.80"			
Longitude(E)	E89° 15' 20.85"			
Altitude	38m			
Distance from the BMD Rangpur	approx. 1.9km			
Direction from the BMD Rangpur	9°			
Approximate height difference (Existing obstructive building height –planned height of radar antenna center: 47m + Ground level difference)	38m-47m+1m=-8m Ground level is 1m higher than the BMD Rangpur			
Required radar antenna angle to eliminate the shadow area caused by the identified building	+0.5°			
High Rise Building Construction Plans specially approved by the Mayor of Rangpur City (as of September, 2014)				
Location Map No.	1 ●	2 ●	3 ●	4 ●
Name of Building	Zilla Parishad Community Super Market	Almi Bhaban	A.R City	Islami Bank Community Hospital
Number of Stories	18	1	17	18
Height	55m	52m	52m	55m
Altitude	37m	37m	37m	37m
Distance from the BMD Rangpur	approx. 2.1km	approx. 3.8km	approx. 3.7km	approx. 3.8km
Direction from the BMD Rangpur	358°	332°	330°	329°
Approximate height difference (Existing obstructive building height –planned height of radar antenna center: 47m + Ground level difference)	55m-47m=8m	52m-47m=5m	52m-47m=5m	55m-47m=8m
Required radar antenna angle to eliminate the shadow area caused by the identified building	+1.0°	+0.8°	+0.8°	+0.9°

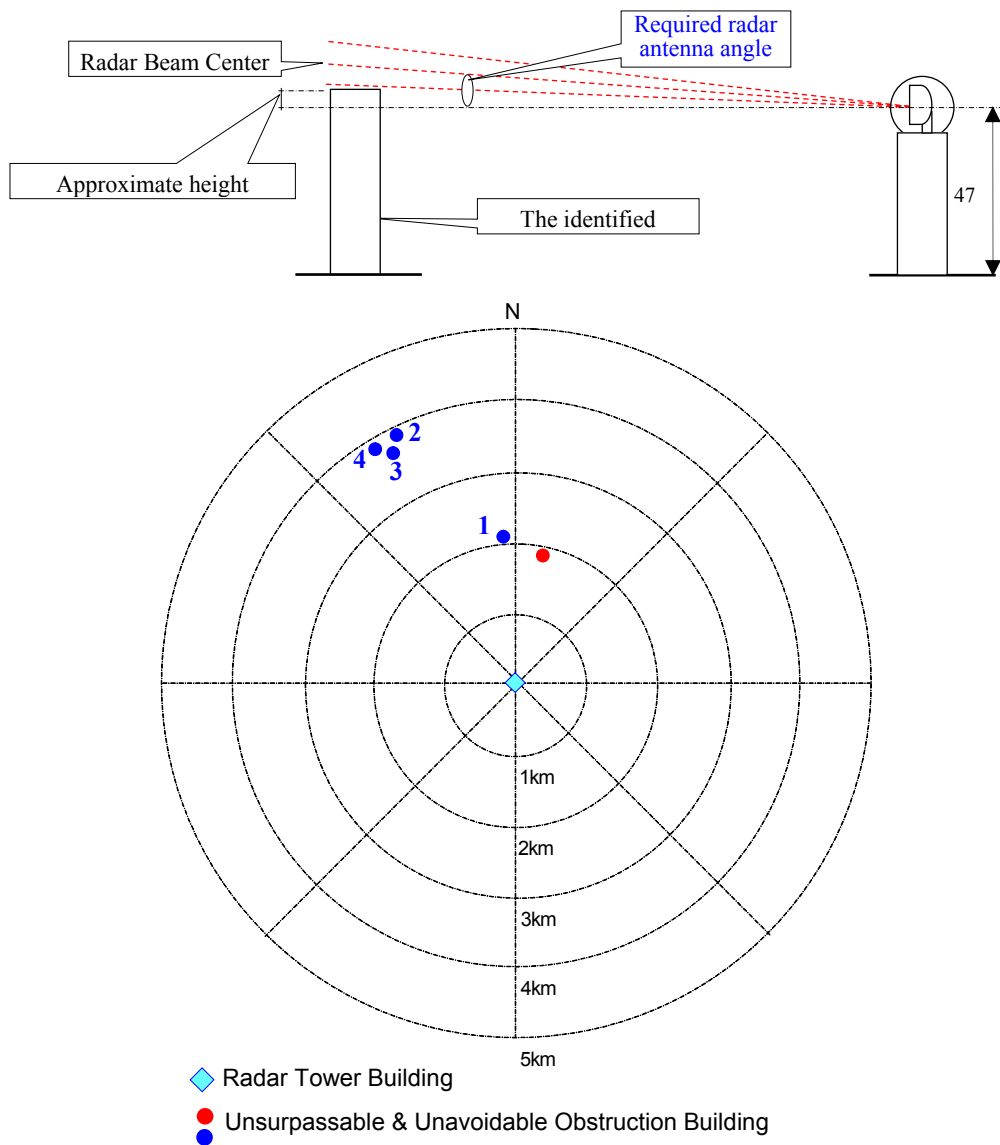


Figure 16: Location Map of the Obstructive Buildings around the BMD Rangpur

Since the Project is planned to be implemented under Japan's Grant Aid and as one of the National Projects of Bangladesh, the Preparatory Survey Team recommended that it is necessary to design and establish a restrictive framework on the construction of high rise buildings, which are unsurpassable and unavoidable obstructions for radar observation, around the Meteorological Radar Observation Stations (at least within a 5km radius from the Stations) in Joydevpur and Rangpur and the Bangladesh side understood the necessity.

II. Ground Level

During the course of the topographic survey work at the project site, a benchmark was identified to be the reference ground level. Such reference will be used for the construction of the radar tower buildings.

III. Equipment Installation

In order to install all the equipment inside the radar equipment room, a large opening would be needed 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 through 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 buildings, enhancing the building design. Given that the columns and beams will not intrude into the staircase, the staircase will be able to comfortably handle traffic in both directions.

[4] Internal and External Finishing Plan

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

a) Floor

The radar equipment room and the observation room will have an access floor with a clearance of 150mm for easy wiring of power and signal cables, trouble-free maintenance and simple future expansion. An anti-static, heavy-duty access floor has been selected for the radar equipment room in which a high power radar transmitter weighing about 1 ton would 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 with a glass wool sandwiched in between for heat insulation. Because of the thermal insulation provided by the building design, the recurrent cost to the BMD 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 in the proposed radar tower buildings), 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 air-conditioning.

d) Window

The sustained wind pressures of the Radar Tower Buildings are as follows. A laminated glass with

reinforced film will be used. In order to ensure double protection from wind and rain water entering into the room, two aluminum windows will be individually installed inside and outside.

- ◆ Dhaka (Joydevpur) Meteorological Radar Tower Building: 5,700N/m² (Height of windows of the Radar Observation Room from the ground level: approx. 32m)
- ◆ Rangpur Meteorological Radar Tower Building: 5,700N/m² (Height of windows of the Radar Observation Room from the ground level: approx. 32m)

II. Material Plan

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

Table 22: Finishing Materials of the Proposed Meteorological Radar Tower Buildings

		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
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 Porcelain tiles
	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 Aluminum grilles Aluminum doors, Steel doors
	Interior	Aluminum doors, Steel doors, Wooden doors

Table 23: Bases for Adoption of Materials of the Proposed Meteorological Radar Tower Buildings

		Bases for adoption of materials	Procurement
Exterior Finishing	Roof Floor	Since external temperatures are high (reaching over 35 degrees), an 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.	
	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.	
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.	

		In the offices where computer systems will be installed, access floors shall be applied for cabling under the floor.	To be procured locally
	Walls	Cement sand mortar (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.	
	Ceilings	In order to enhance the environment and efficiency of air-conditioning, non-asbestos acoustic mineral boards will be used. Other rooms which will not require any ceiling board will be directly applied with emulsion paint finish on the cement and sand mortar.	
Window and Door	Exterior	Aluminum and steel will be chosen all throughout for reasons of durability, ease of handling and accuracy.	
	Interior	Wooden and steel with synthetic oil resin paint will be employed all throughout for its handling ease during construction and from a maintenance standpoint.	

[5] Structural Plan

I. Structural Design Standard

In order to formulate and develop the structural design of the proposed radar tower buildings, the Bangladesh National Building Code is mainly applied and the Building Standard Law of Japan, the Standard of Architectural Institute of Japan (AIJ) and the Uniform Building Code (UBC) of the USA are used as references, if so required.

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 0.075 degree. Due to this, the foundation structures must prevent the building differential settlement. The bearing layer and foundation of the Proposed Meteorological Radar Tower Buildings are indicated in the following table.

Table 24: Bearing Layer, Pile and Foundation of the Proposed Meteorological Radar Tower Buildings

	Dhaka (Joydevpur) Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station
Depth of Bearing Layer	GL-46.6m	GL-47.6m
N value of Bearing Layer	50	50
Piling	Required	Required
Designed Pile Length	42.97m	43.97m
Required Number of the Designed Pile	22 pcs	24 pcs
Diameter of the Designed Pile	1.2m	1.2m
Foundation type	Pile foundation (cast in site concrete)	Pile foundation (cast in site concrete)

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 the exterior walls and partition walls are made out of locally procured 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 following combined weight as a special dead load will be considered.

Table 25: Weight of Meteorological Radar System Unit

Installation Place (Room Name)	Name of Meteorological Radar System Unit	Weight
Roof Top	Radom, Antenna and Pedestal	4.5 tons
Radar Equipment Room	Transmitter/Receiver, Signal Amplifier, etc.	3.0 tons
	Signal Processor, Antenna Controller, etc.	2.0 tons
Electricity Room	Isolation Transformer, Auto Voltage Regulator (for Equipment and Building) and Capacitor	6.0 tons

b) Live load

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

c) Wind load

The Basic Wind Speed of Dhaka (Joydevpur) and Rangpur indicated in the Bangladesh National Building Code 2012 (Table 2.4.1: Basic Wind Speeds for Selected Locations in Bangladesh) are as follows.

Basic Wind Speed (m/s)

✦ Dhaka (Joydevpur): 65.7

✦ Rangpur: 65.3

Therefore, to calculate the wind load of the proposed Radar Tower Building, the Basic Wind Speed 66m/s will be applied. Regarding the Importance Factor, the Category IV factor which is for the most important facility $I = 1.15$ will be used.

d) Seismic load

For the calculation of the seismic load, the seismic zone factor in Dhaka (Joydevpur) and Rangpur, as indicated in in the Bangladesh National Building Code 2012, is applied.

✦ Dhaka (Joydevpur) and Rangpur: Zone 3 $z = 0.28$

Regarding the Importance Factor, the Category IV factor which is for the most important facility $I = 1.5$ will be used.

V. Structural Building Material

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

- Concrete (conventional concrete): specified concrete strength $F_c = 21 \text{ N/mm}^2$
- Cement: American Society for Testing and Materials (ASTM) or equivalent
- Deformed reinforcing bars : ASTM A615 Grade 60 or equivalent

[6] Electrical Facility Design

I. Power intake facility

Table 26: Power Intake Facility

	Dhaka (Joydevpur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Intake Power (Nominal Voltage)	400V, 3-phase 4-wire, 50Hz	400V, 3-phase 4-wire, 50Hz

II. Power generating facility

Table 27: Power Generating Facility

	Dhaka (Joydevpur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Number of Engine Generator	2	2
Capacity	75KVA	75KVA
Output	400V, 3-phase 4-wire, 50Hz	400V, 3-phase 4-wire, 50Hz
Fuel Tank Capacity	1,000 liters	1,000 liters

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.

Table 28: Trunk Line and Power Facility

	Dhaka (Joydevpur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Trunk line for power and lighting	400V/230V, 3-phase 4-wire	400V/230V, 3-phase 4-wire
Branch power circuits	400V, 3-phase 4-wire	400V, 3-phase 4-wire
Branch lighting circuits	230V, single-phase 2-wire	230V, single-phase 2-wire
Branch equipment circuits	400V, 3-phase 4-wire	400V, 3-phase 4-wire

IV. Lighting and power outlet

The voltage required for lighting and power sockets is a single-phase 230V 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 a particular situation. The lighting levels in the various rooms will be approximately as shown below.

Table 29: Approximate Lighting Levels in the Various Rooms

	Dhaka (Joydevpur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Radome Room	200 Lx	200 Lx
Radar Equipment Room	300 Lx	300 Lx
Observation Room	300 Lx	300 Lx
Engine Generator Room	200 Lx	200 Lx
Electricity & Power Supply Room	200 Lx	200 Lx
Pump Room	200 Lx	200 Lx
Entrance Hall	200 Lx	200 Lx
Other Rooms	200 Lx	200 Lx

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

V. Telephone system

A service terminal box, a relay terminal box and telephone sets will be installed inside the radar tower buildings and telephone lines will be installed to outlets in those rooms requiring a telephone.

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 and observation room) and outside of the building entrance, as a security measure.

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 the 2nd floor will be connected to the terminal box for earthing. All the equipment to be installed in the electricity room and the power supply 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 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 buildings. 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 (LED), to be installed at the radome roof floor, 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 top of the 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 & power supply room and the engine generator room, and an alarm system will be installed in the observation room.

[7] Water Supply, Drainage and Sanitary Fixture Design

I. Water supply system

Public water supply is unavailable. As such, the construction of a well is required for the construction work of the radar tower building at each site. After the construction work, this well would be used as the water supply facility for the radar tower buildings. For the well water intake for the radar tower buildings, a water supply gate valve will be installed.

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
- Urinal: stall type
- Washbasin: wall-mounted type

- Slop sink: wall-mounted type

IV. Fire extinguisher

Fire extinguishers will be supplied in the following rooms.

Table 30: Fire Extinguisher

	Dhaka (Joydevpur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Radome Room	CO ₂ type	CO ₂ type
Radar Equipment Room	CO ₂ type	CO ₂ type
Observation Room	CO ₂ type	CO ₂ type
Engine Generator Room	ABC type	ABC type
Electricity & Power Supply Room	CO ₂ type	CO ₂ type
Pump Room	CO ₂ type	CO ₂ type
Tea Kitchen	ABC type	ABC type

[8] 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, the observation room and the electricity & power supply room. Therefore, a substantial 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.

Table 31: Air-conditioning and Ventilation System

	Dhaka (Joydepur) Meteorological Radar Tower Building	Rangpur Meteorological Radar Tower Building
Radome Room	Fan forced ventilation	Fan forced ventilation
Radar Equipment Room	Air-conditioning system Heat exchange system	Air-conditioning system Heat exchange system
Observation Room	Air-conditioning system Fan forced ventilation	Air-conditioning system Fan forced ventilation
Engine Generator Room	Fan forced ventilation	Fan forced ventilation
Electricity & Power Supply Room	Air-conditioning system Fan forced ventilation	Air-conditioning system Fan forced ventilation
Pump Room	Fan forced ventilation	Fan forced ventilation
Shower Room	Fan forced ventilation	Fan forced ventilation
Toilet (M & F)	Fan forced ventilation	Fan forced ventilation
Tea Kitchen	Fan forced ventilation	Fan forced ventilation

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 electricity room, pump room, etc., forced ventilation systems will be adopted. Furthermore, appropriate ventilation systems will be installed in the other rooms to meet the following conditions.

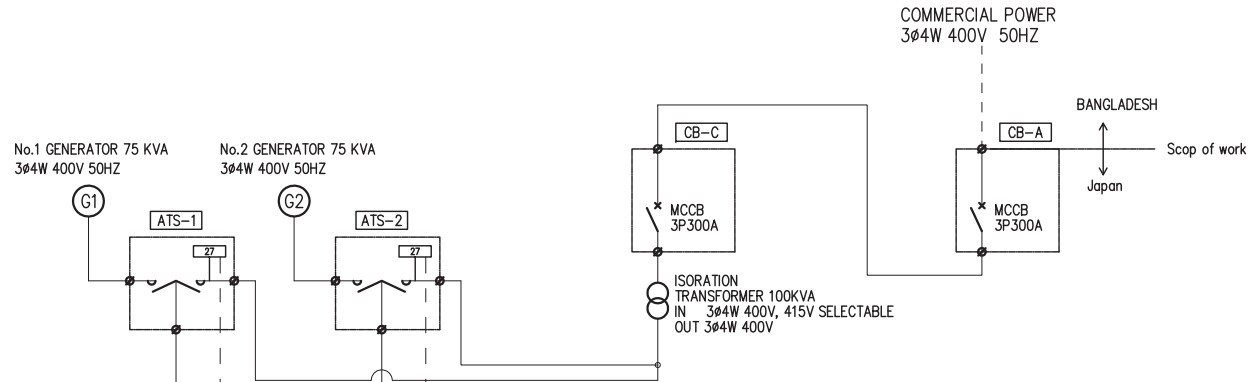
<Environmental conditions>

- Outside condition: 31°C (maximum temperature: 40°C)
- Indoor condition: temperature 26°C humidity 40-60%

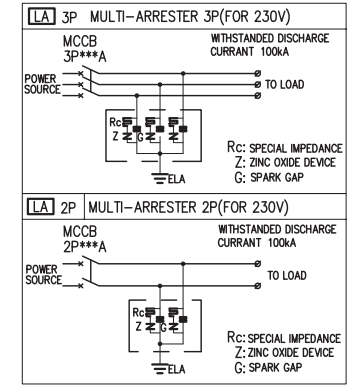
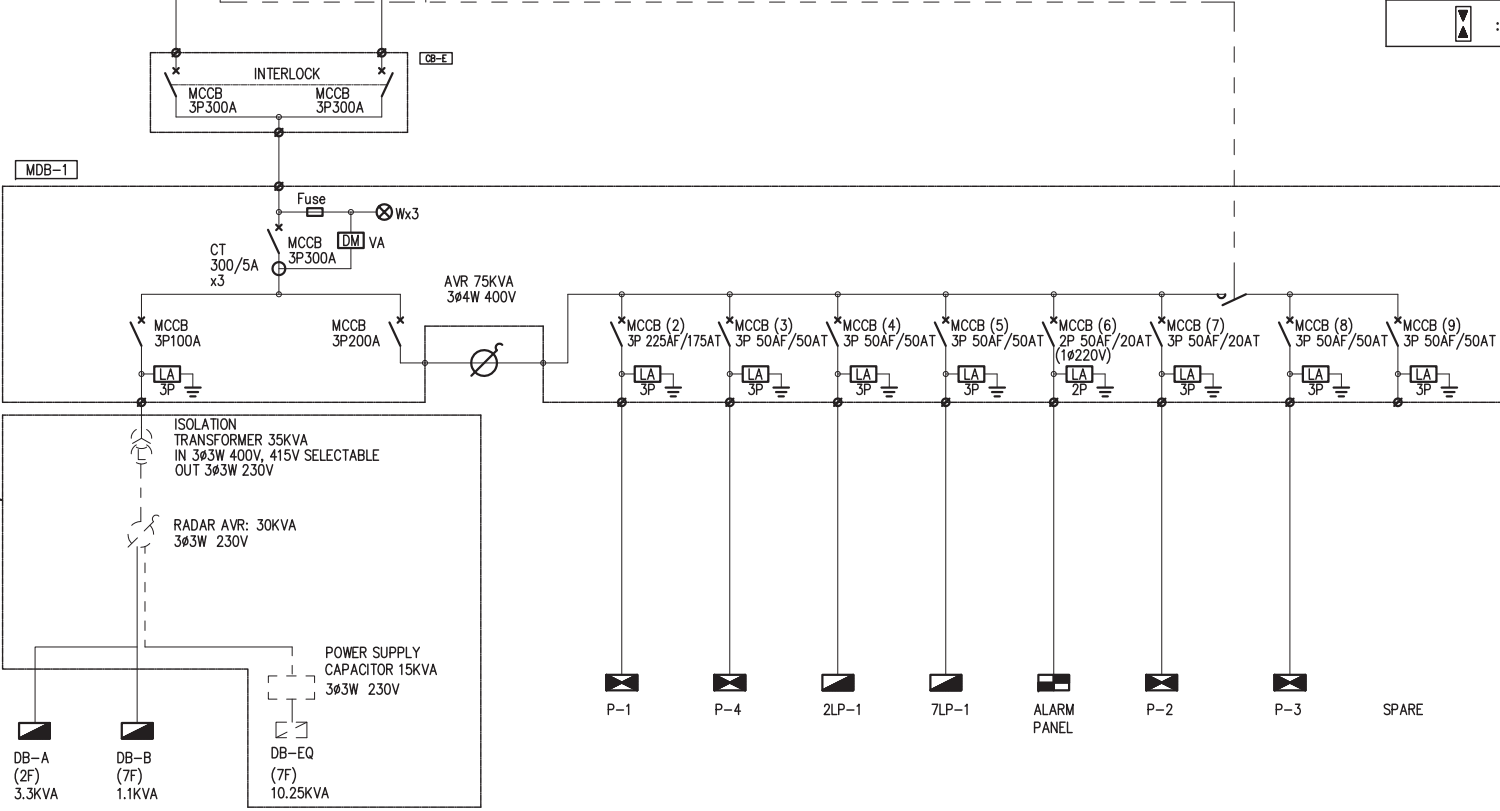
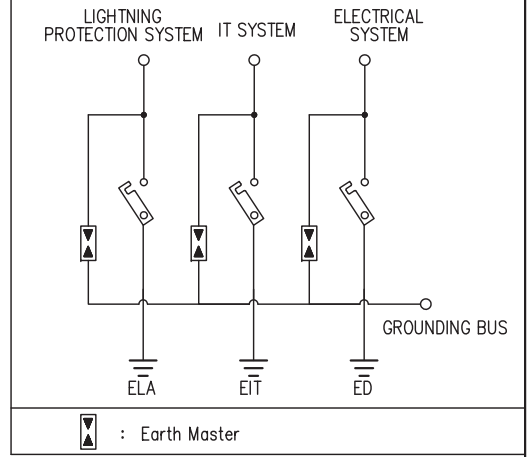
The diagrams of the building equipment plan for the radar tower buildings can be found in the subsequent pages immediately hereafter.

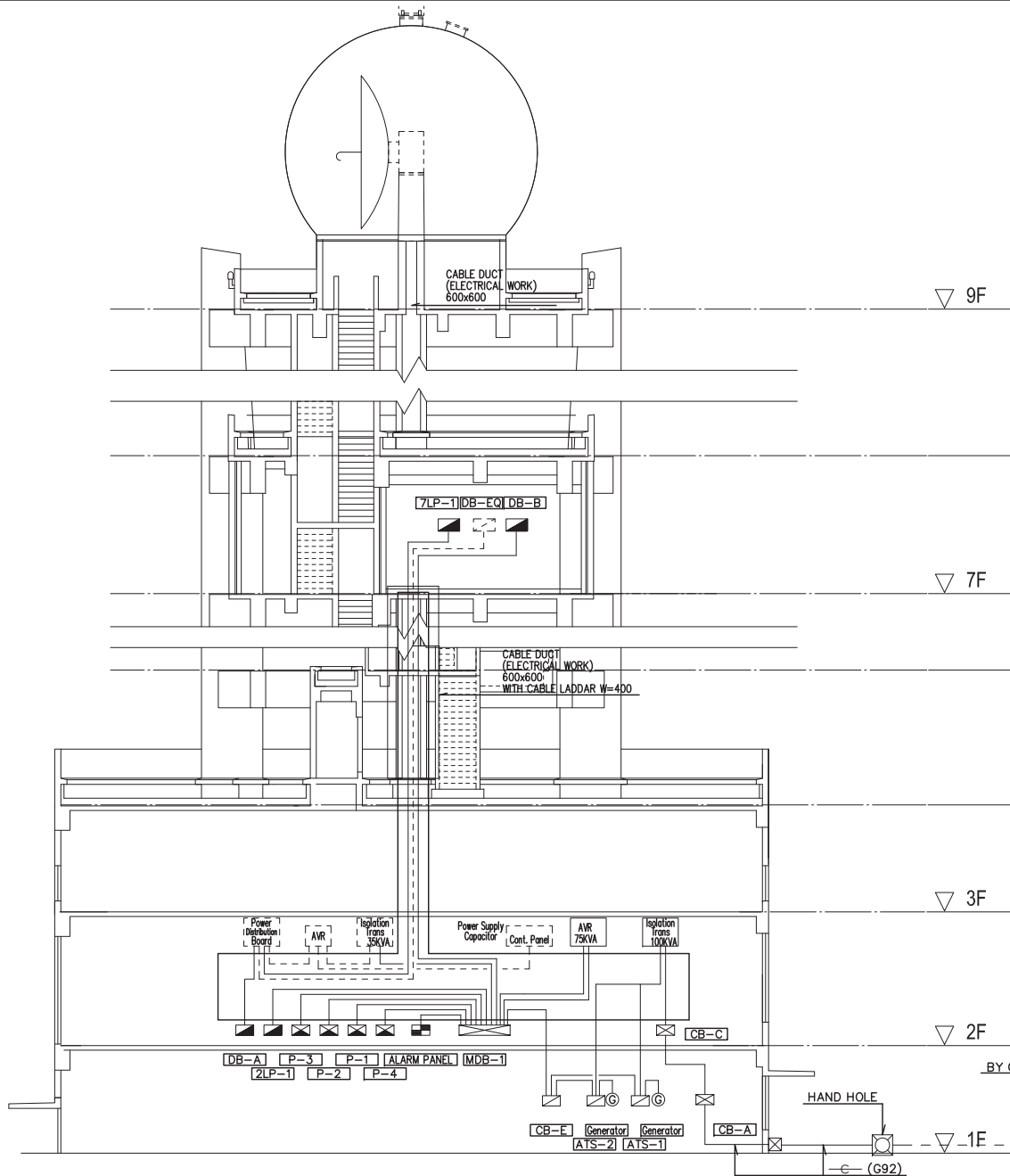
< Meteorological Radar Tower Building >

- Power Feeder System : SD-01
- Power Riser System : SD-02
- Interphone & Tel. System : SD-03
- Fire Alarm System : SD-04
- Alarm System : SD-05
- Lightning Protection & Grounding System : SD-06
- Obstruction Lighting System : SD-07
- Water Supply & Drainage System : SD-08
- Air-Conditioning & Ventilation System : SD-09



GROUNDING TERMINAL BOX





POWER CABLE LIST

FROM	TO	CABLE SIZE	CONDUIT
CB-A	CB-C	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
CB-C	ISOLATION TRANS 100KVA	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
ISOLATION TRANS	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
ISOLATION TRANS	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
GENERATOR	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
GENERATOR	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
ATS-1	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
ATS-2	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDER
CB-E	MDB-1	XLPE/PVC 1C-4x120sq +E22sq	(G80) / CABLE LADDER
MDB-1	ISOLATION TRANS 35KVA(EQUIP WORK)	XLPE/PVC 4C-30sq +E22sq	(G50) / CABLE LADDER
MDB-1	P-1	XLPE/PVC 1C-4x70sq +E50sq	(G70) / CABLE LADDER
MDB-1	P-2	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDER
MDB-1	P-3	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDER
MDB-1	P-4	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDER
MDB-1	2LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDER
MDB-1	7LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDER
MDB-1	ALARM PANEL	XLPE/PVC 2C- 6sq +E 6sq	(G32) / CABLE LADDER
PowerDistributionBoard	DB-A	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDER
PowerDistributionBoard	DB-B	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDER
MDB-1	AVR 75kVA	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDER
AVR 75kVA	MDB-1	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDER

SPARE PARTS FOR LIGHTNING DAMAGE LIST

FROM	DESCRIPTION	UNIT
CB-A	MCCB 3P300A	1
CB-C	MCCB 3P300A	1
ATS-1	UNDER VOLTAGE RELAY	1
	CHANGE OVER SWITCH	1
	RELAY	4
MDB-1	MCCB 3P300A	1
	FUSE	6
	INDICATING LAMP	3
	VOLTAGE AMPERE INDICATOR	1
	ARRESTER 2P	2
	ARRESTER 3P	7
CB-E	MCCB 3P300A	1
	RELAY	4
	FUSE	4
GENERATOR	CONTROL CIRCUIT BOARD	1
	RELAY	4
	FUSE	4
	VOLT METER	1

- - - EQUIPMENT WORK



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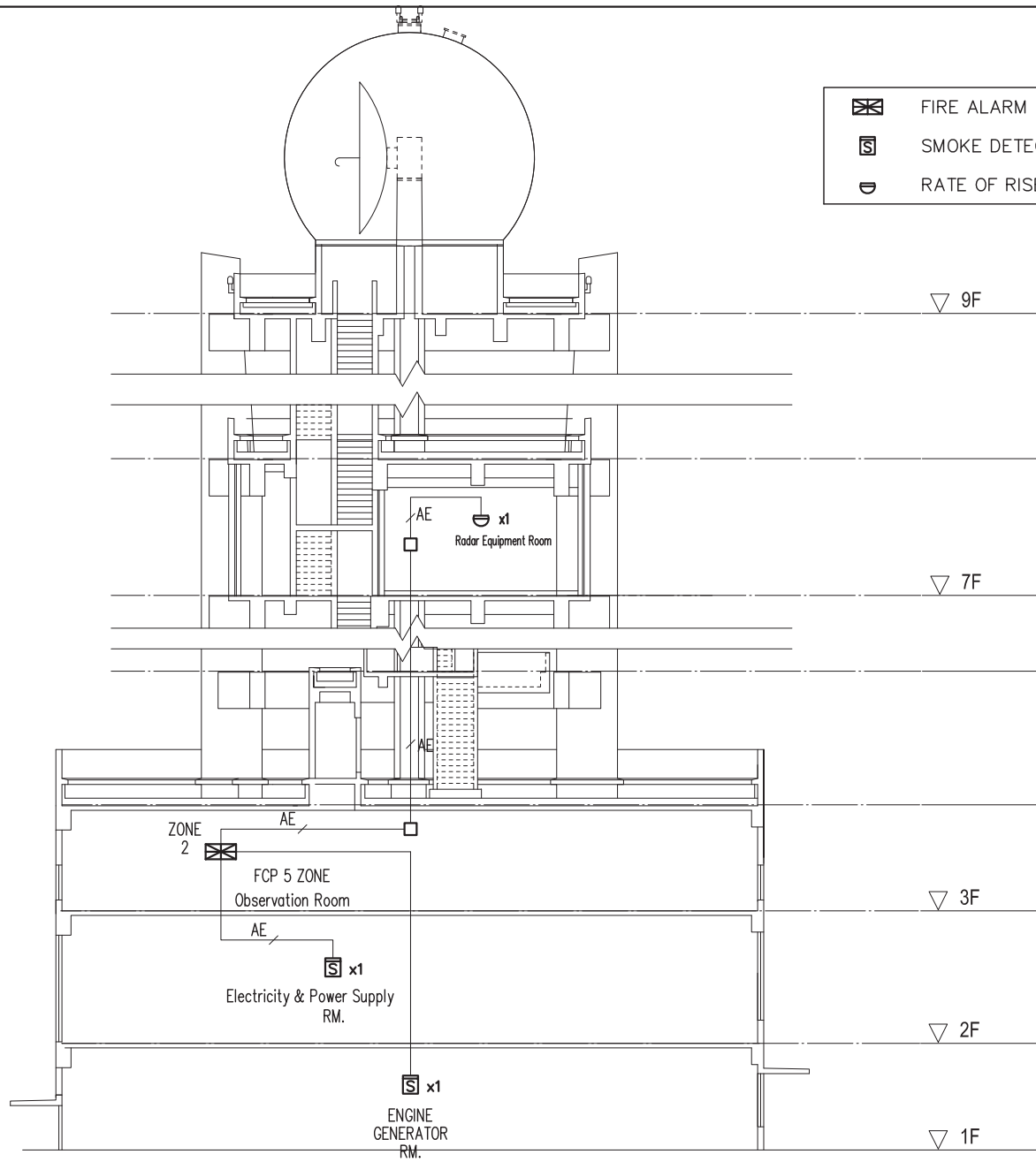





THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
Meteorological Radar Tower Building
POWER RISER SYSTEM

SCALE
NONE

DRAWING No.
SD - 02



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



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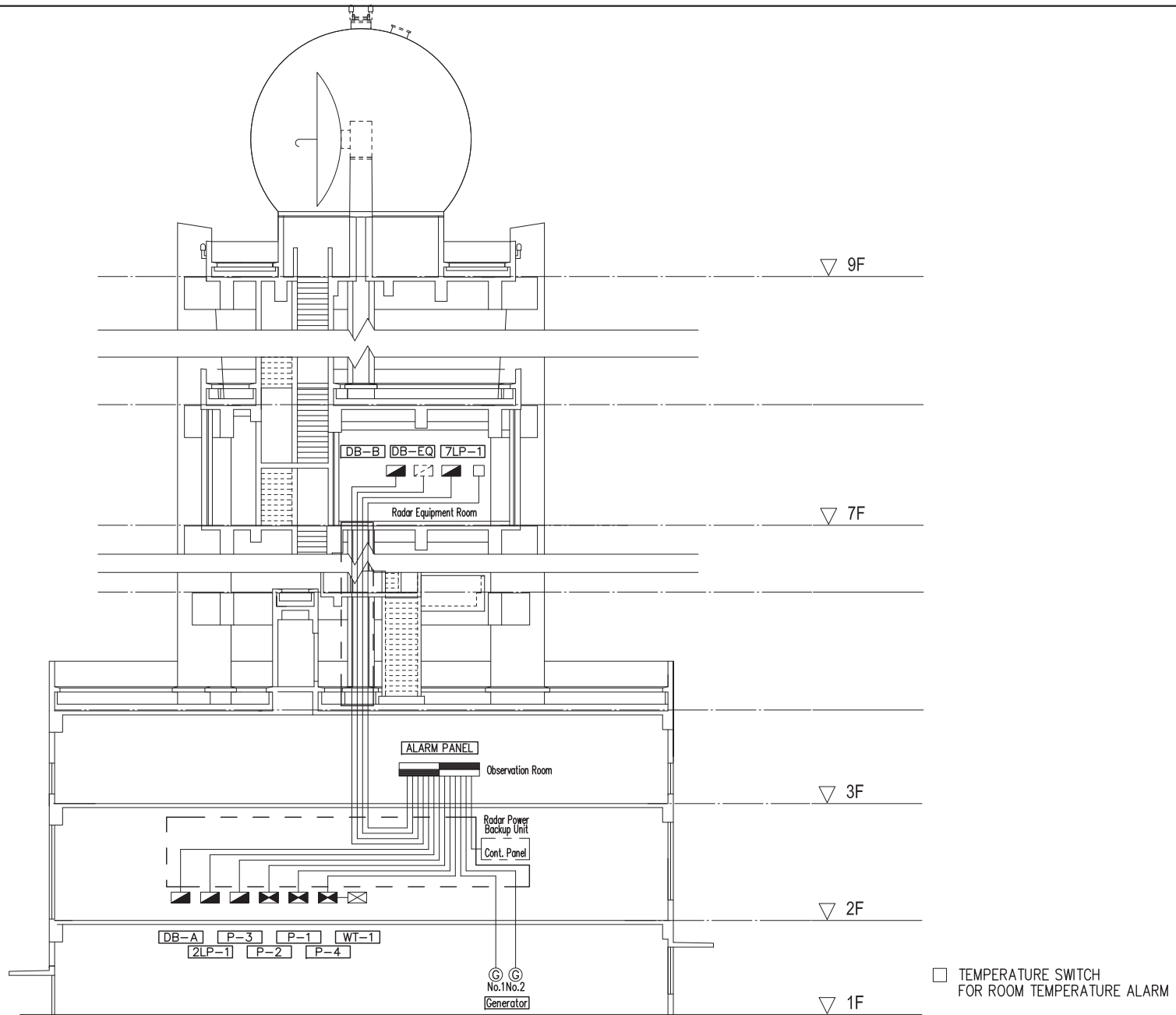


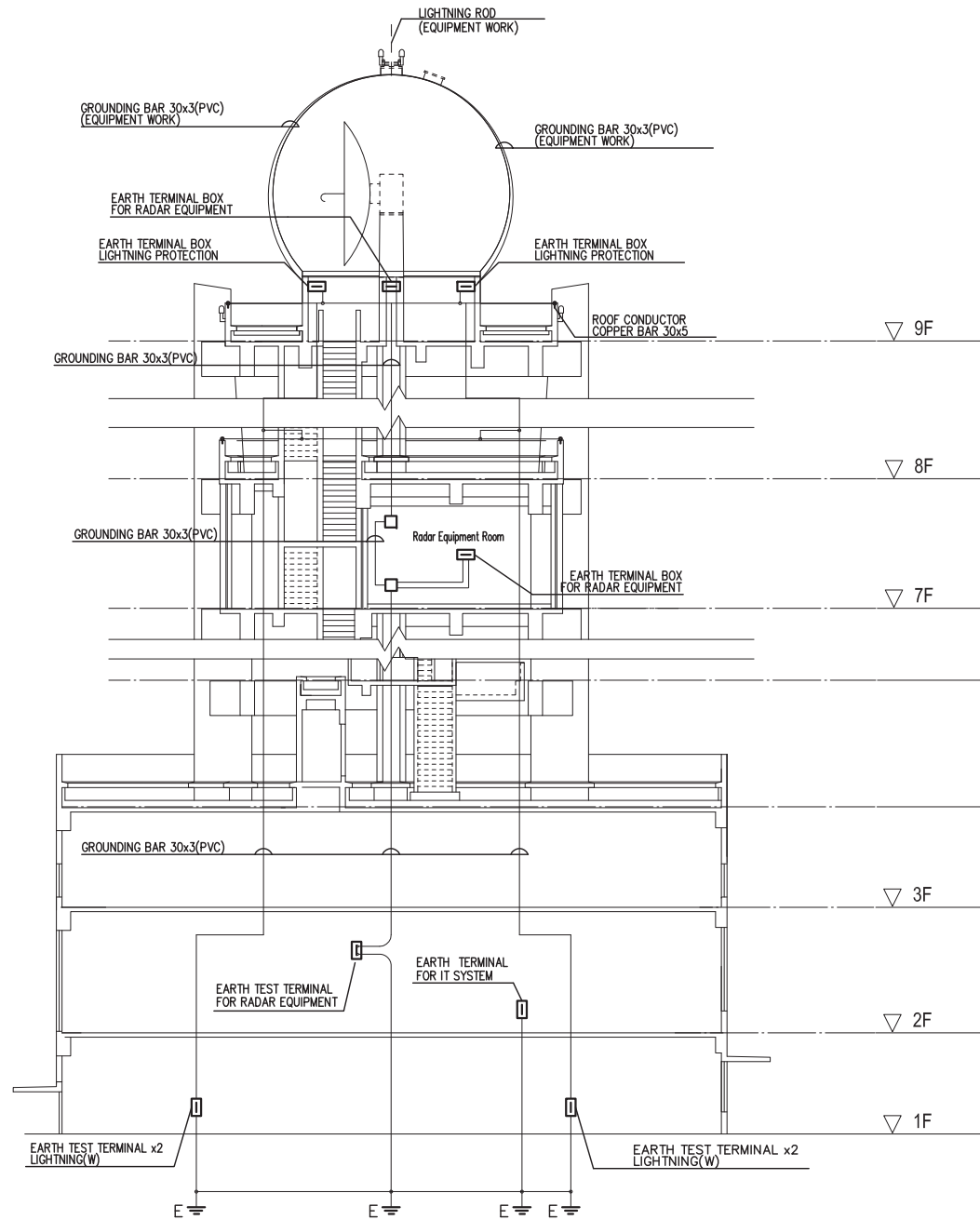
THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
Meteorological Radar Tower Building
FIRE ALARM SYSTEM

SCALE
NONE

DRAWING No.
SD - 04





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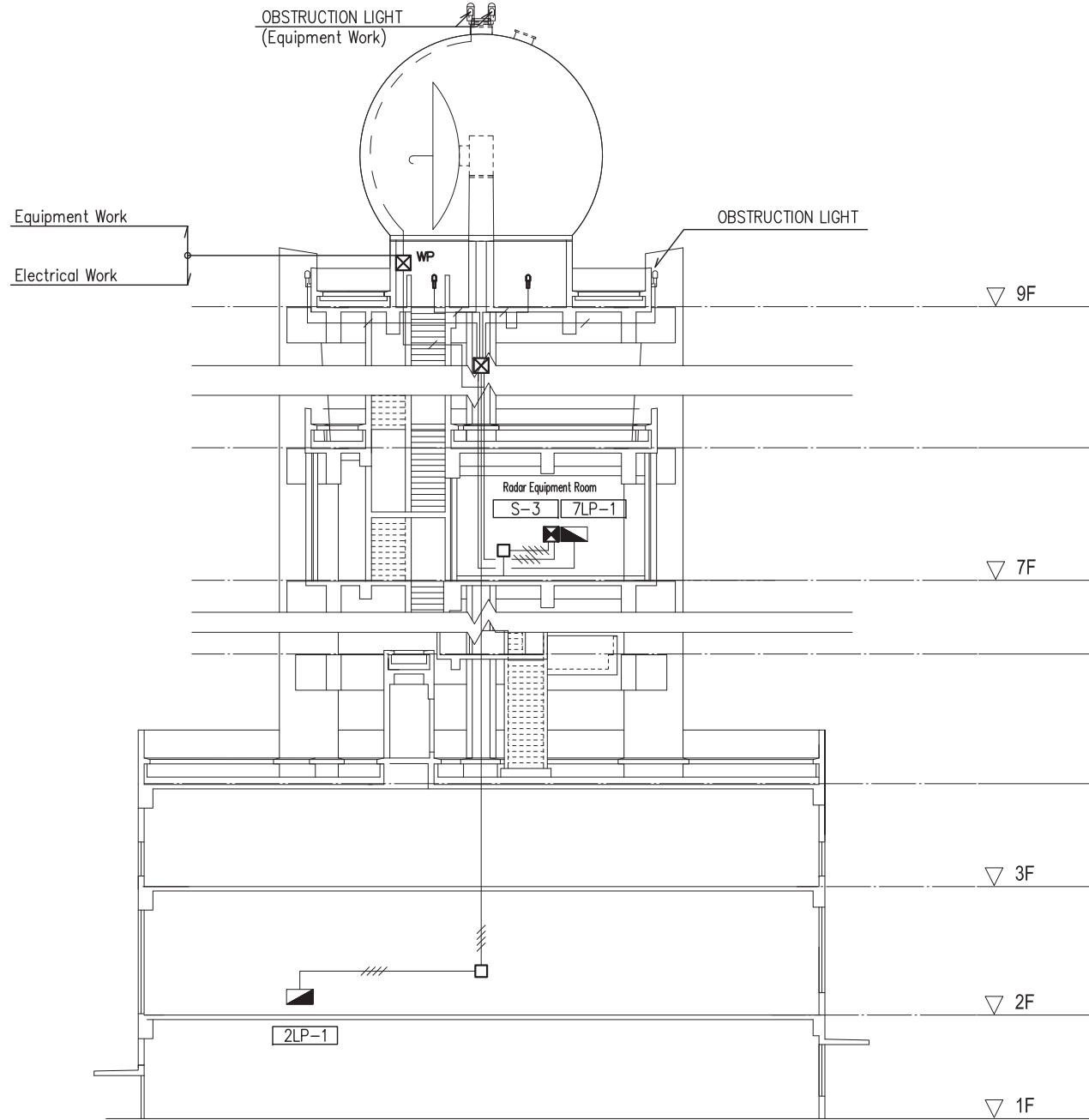


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
Meteorological Radar Tower Building
LIGHTNING PROTECTION &
GROUNDING SYSTEM

SCALE
NONE

DRAWING No.
SD - 06



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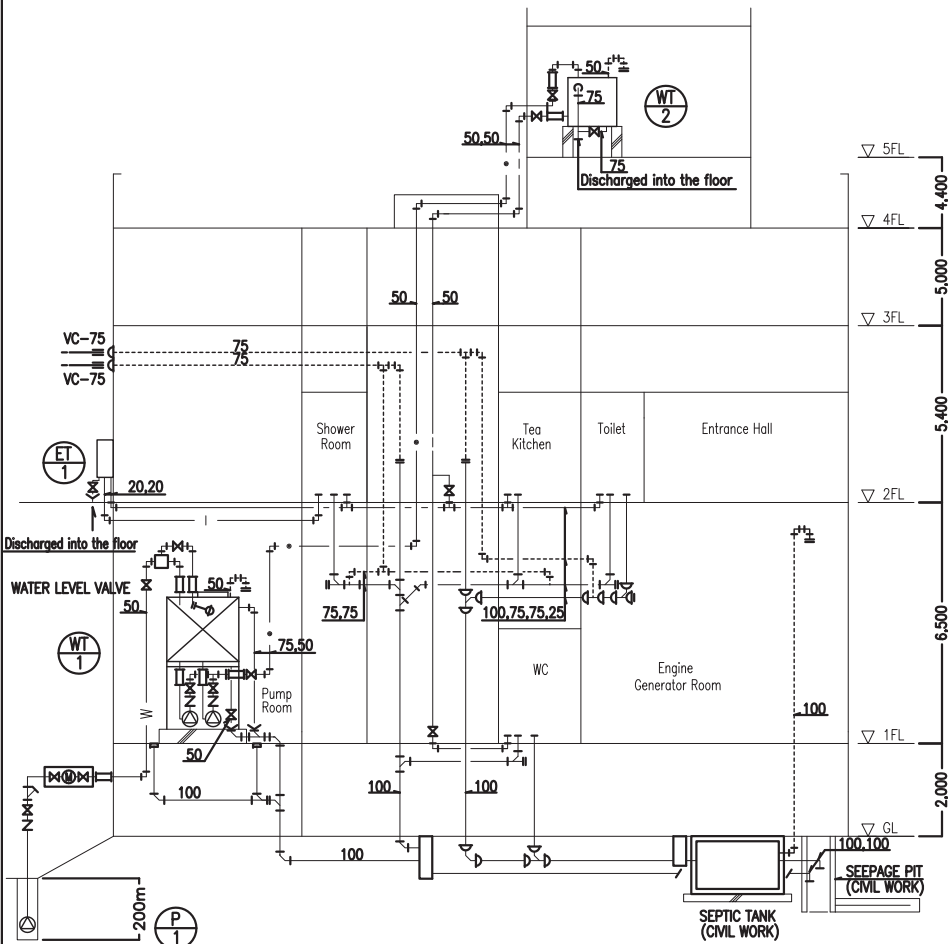
THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
Meteorological Radar Tower Building
OBSTRUCTION LIGHTING SYSTEM

SCALE
NONE

DRAWING No.
SD - 07

2-44



ITEM	1F		2F				TOTAL	REMARK
	TOILET(DHAKA)	PUMP ROOM	TOILET(M)	TOILET(F)	SHOWER ROOM	TEA KITCHEN		
WATER CLOSET	1		1	1			2	
LAVATORY	1		1	1			2	
PAPER HOLDER	1		1	1			2	
FAUCET	1	1	1	1		1	5	
MIRROR	1		1	1			2	
SHOWER HEAD					1		1	
KITCHEN SINK						1	1	
URINAL			1				1	
SERVICE SINK						1	1	

NO.	NAME	SPECIFICATION	Q'TY	POWER SUPPLY				LOCATION	REMARKS
				PHASE	VOLT (V)	FREQUENCY (Hz)	MOTOR (KW)		
P-1	PUMP	Model: Deep Well Submersible Pump Product made in stainless steel 100mm 32φ x 40 l/min x 2340 kpa Accessories: Panel, Ball valve, Check valve	1	3	440	50	3.7	Out door	
WT-1	POTABLE WATER TANK / PUMP	FRP Tank Rated capacity 2.5 m ³ Dimension 1,000 x 1,500 x 2,000H Accessories Manhole 600φ Breather Ball tap 25A , overflow and drain pipe 40A Electrode 4P Constant pressure type pump 40 φ x 100 l/min x 270 kpa x 2 pcs (1 spare) Accessories Flexible connector for suction 40A	1					Pump Room	RC FOUNDATION (CIVIL WORK) 1.8x1.8x0.3mH
WT-2	POTABLE WATER GRAVITY TANK	FRP tank Rated capacity 1.5 m ³ Dimension 1,000 x 1,500 x 1,500H Earth quake proof 2.0G(Wind -Proof type) Accessories Flat frame 150H, manhole 600 φ Electrode 4P	1					5FL Roof	RC FOUNDATION (CIVIL WORK) 0.4x1.4x0.5mH
ET-1	INSTANTANEOUS WATER HEATER	Model: Outdoor location type Dimension: 336x200x200 Gas consumption: 38.7kW , 2.78kg/h Product weight : 18kg	1	1	230	50	0.112	2F Out door	
ABC	FIRE EXTINGUISHER	ABC Dry chemical, wall hang 10 Lbs Discharge time 14 sec	2					Each room	
CO2	FIRE EXTINGUISHER	Carbon dioxide, wall hang 10 Lbs Discharge time 14 sec	9					Each room	
	SEPTIC TANK (CIVIL WORK)	Septic tank & Seepage pit (RC type, Civil work) Blower pump (Civil work)	1					Out door	



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DRAWING TITLE
Meteorological Radar Tower Building

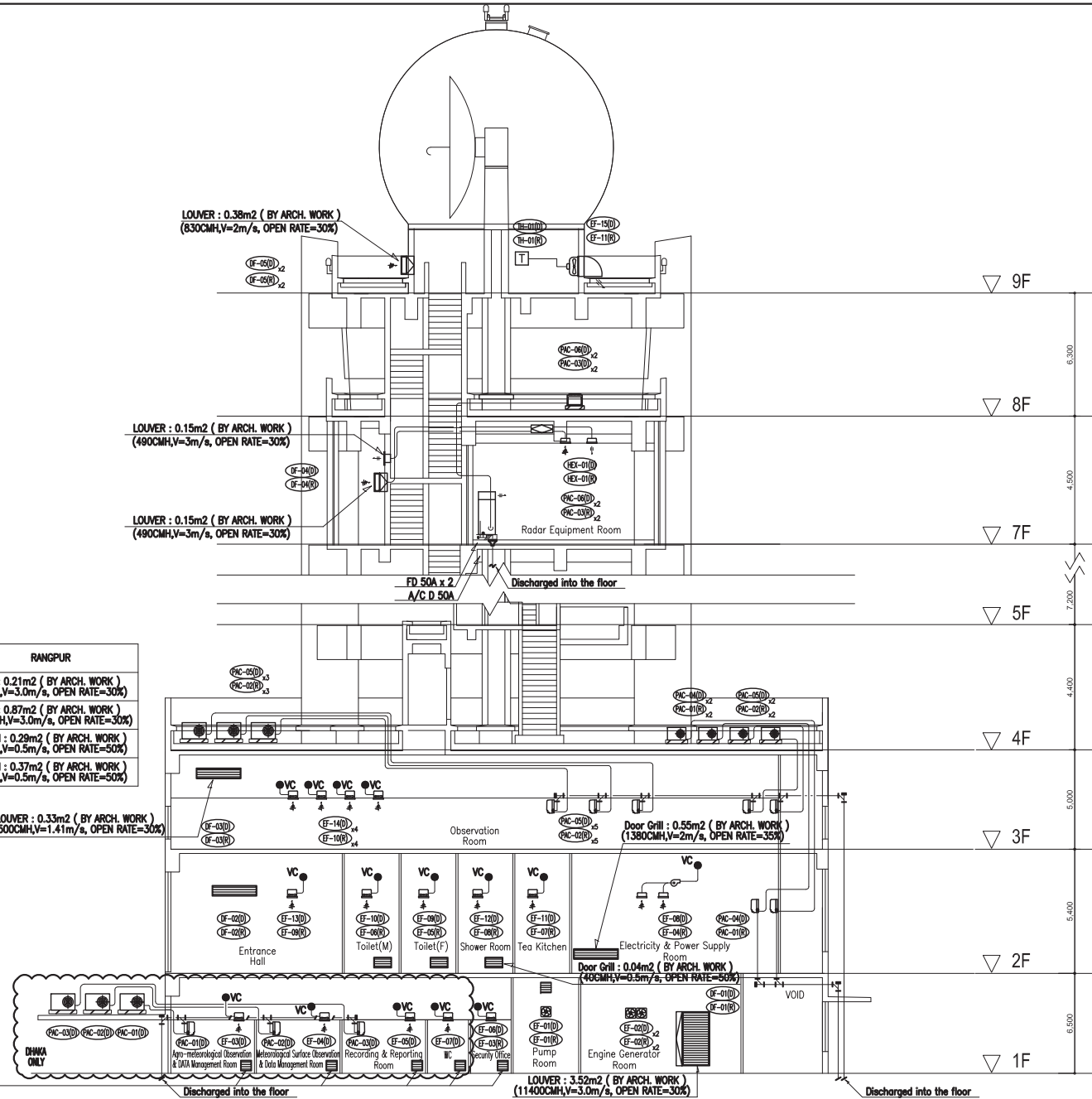
WATER SUPPLY & DRAINAGE SYSTEM

SCALE

NONE

DRAWING No.

SD - 08



	DHAKA	RANGPUR
Pump Room	LOUVER : 0.20m ² (BY ARCH. WORK) (650CMH,V=3.0m/s, OPEN RATE=30%)	LOUVER : 0.21m ² (BY ARCH. WORK) (670CMH,V=3.0m/s, OPEN RATE=30%)
Entrance Hall	LOUVER : 0.87m ² (BY ARCH. WORK) (2820CMH,V=3.0m/s, OPEN RATE=30%)	LOUVER : 0.87m ² (BY ARCH. WORK) (2830CMH,V=3.0m/s, OPEN RATE=30%)
Toilet (M)	Door Grill : 0.3m ² (BY ARCH. WORK) (270CMH,V=0.5m/s, OPEN RATE=50%)	Door Grill : 0.29m ² (BY ARCH. WORK) (260CMH,V=0.5m/s, OPEN RATE=50%)
Toilet (F)	Door Grill : 0.36m ² (BY ARCH. WORK) (320CMH,V=0.5m/s, OPEN RATE=50%)	Door Grill : 0.37m ² (BY ARCH. WORK) (330CMH,V=0.5m/s, OPEN RATE=50%)

Agro-meteorological Observation & DATA Management Room	Door Grill : 0.28m ² (BY ARCH. WORK) (250CMH,V=0.5m/s, OPEN RATE=50%)	DHAKA ONLY
Meteorological Surface Observation & DATA Management Room	Door Grill : 0.28m ² (BY ARCH. WORK) (250CMH,V=0.5m/s, OPEN RATE=50%)	
Recording & Reporting Room	Door Grill : 0.28m ² (BY ARCH. WORK) (250CMH,V=0.5m/s, OPEN RATE=50%)	
WC	Door Grill : 0.17m ² (BY ARCH. WORK) (150CMH,V=0.5m/s, OPEN RATE=50%)	
Security Office	Door Grill : 0.08m ² (BY ARCH. WORK) (50CMH,V=0.5m/s, OPEN RATE=50%)	

2-2-3 Outline Design Drawing

The following outline design drawings for the Project are attached hereunder.

< Dhaka (Joydevpur) Meteorological Radar Tower Building >

- Site Plan : A-01(D)
- Floor Plan 1 : A-02(D)
- Floor Plan 2 : A-03(D)
- Floor Plan 3 : A-04(D)
- Floor Plan 4 : A-05(D)
- Floor Plan 5 : A-06(D)
- Floor Plan 6 : A-07(D)
- Floor Plan 7 : A-08(D)
- Elevation 1 : A-09(D)
- Elevation 2 : A-10(D)
- Section : A-11(D)

- Equipment Layout Plan 1 : EQ-01(D)
- Equipment Layout Plan 2 : EQ-02(D)
- Equipment Layout Plan 3 : EQ-03(D)
- Equipment Layout Plan 4 : EQ-04(D)

< Rangpur Meteorological Radar Tower Building >

- Site Plan : A-01(R)
- Floor Plan 1 : A-02(R)
- Floor Plan 2 : A-03(R)
- Floor Plan 3 : A-04(R)
- Floor Plan 4 : A-05(R)
- Floor Plan 5 : A-06(R)
- Floor Plan 6 : A-07(R)
- Floor Plan 7 : A-08(R)
- Elevation 1 : A-09(R)
- Elevation 2 : A-10(R)
- Section : A-11(R)

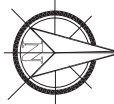
- Equipment Layout Plan 1 : EQ-01(R)
- Equipment Layout Plan 2 : EQ-02(R)
- Equipment Layout Plan 3 : EQ-03(R)

< Storm Warning Centre (SWC) at BMD Head Office >

- Floor Plan and Section : EQ-01(SWC)
- Floor Plan and Details : EQ-02(SWC)
- Equipment Layout Plan : EQ-03(SWC)

< BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport >

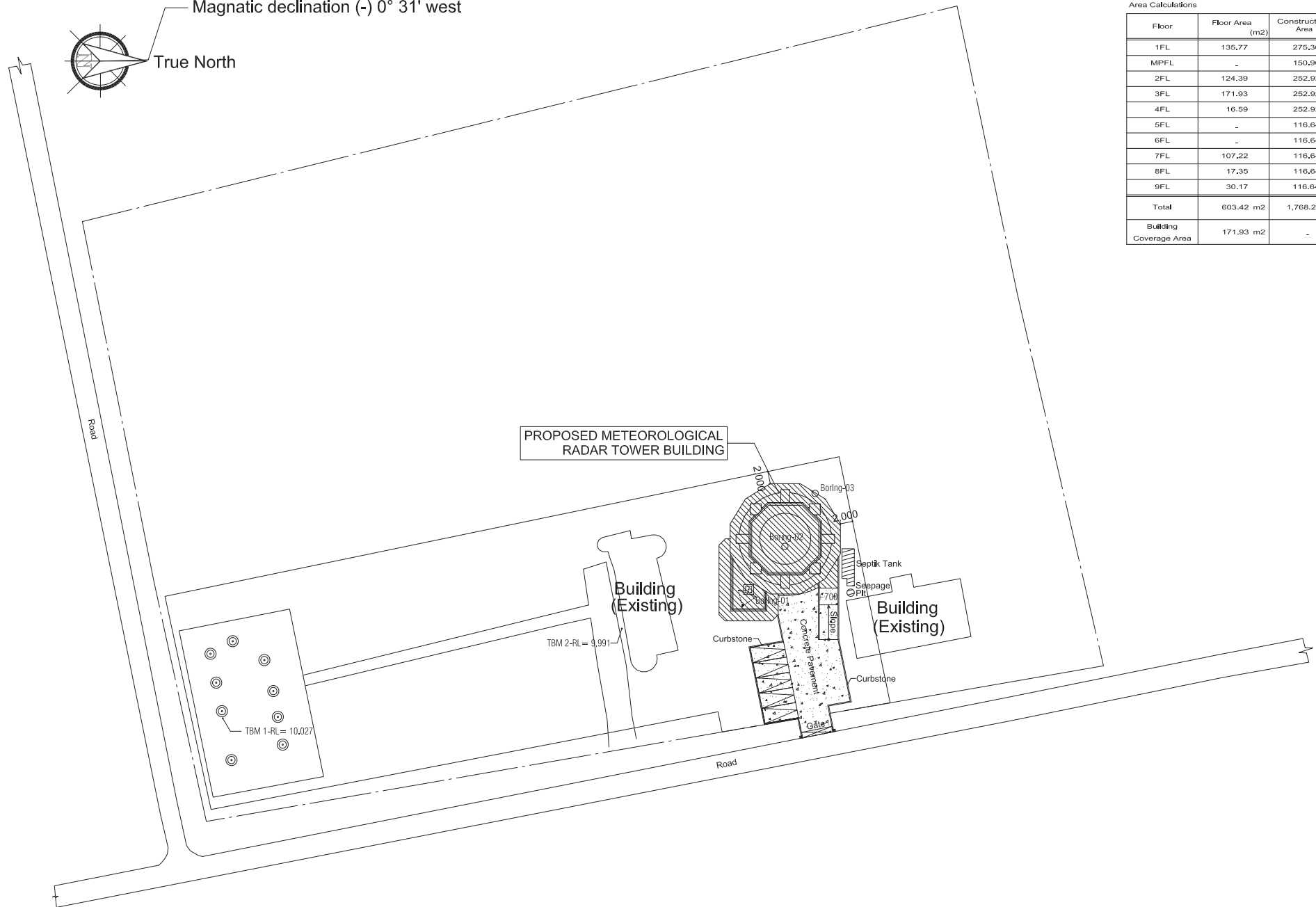
- Equipment Layout Plan : EQ-01(DIA)



Magnetic declination (-) 0° 31' west
True North

Area Calculations

Floor	Floor Area (m2)	Construction Area (m2)
1FL	136.77	275.36
MPFL	-	150.96
2FL	124.39	252.92
3FL	171.93	252.92
4FL	16.59	252.92
5FL	-	116.64
6FL	-	116.64
7FL	107.22	116.64
8FL	17.35	116.64
9FL	30.17	116.64
Total	603.42 m2	1,768.28 m2
Building Coverage Area	171.93 m2	-



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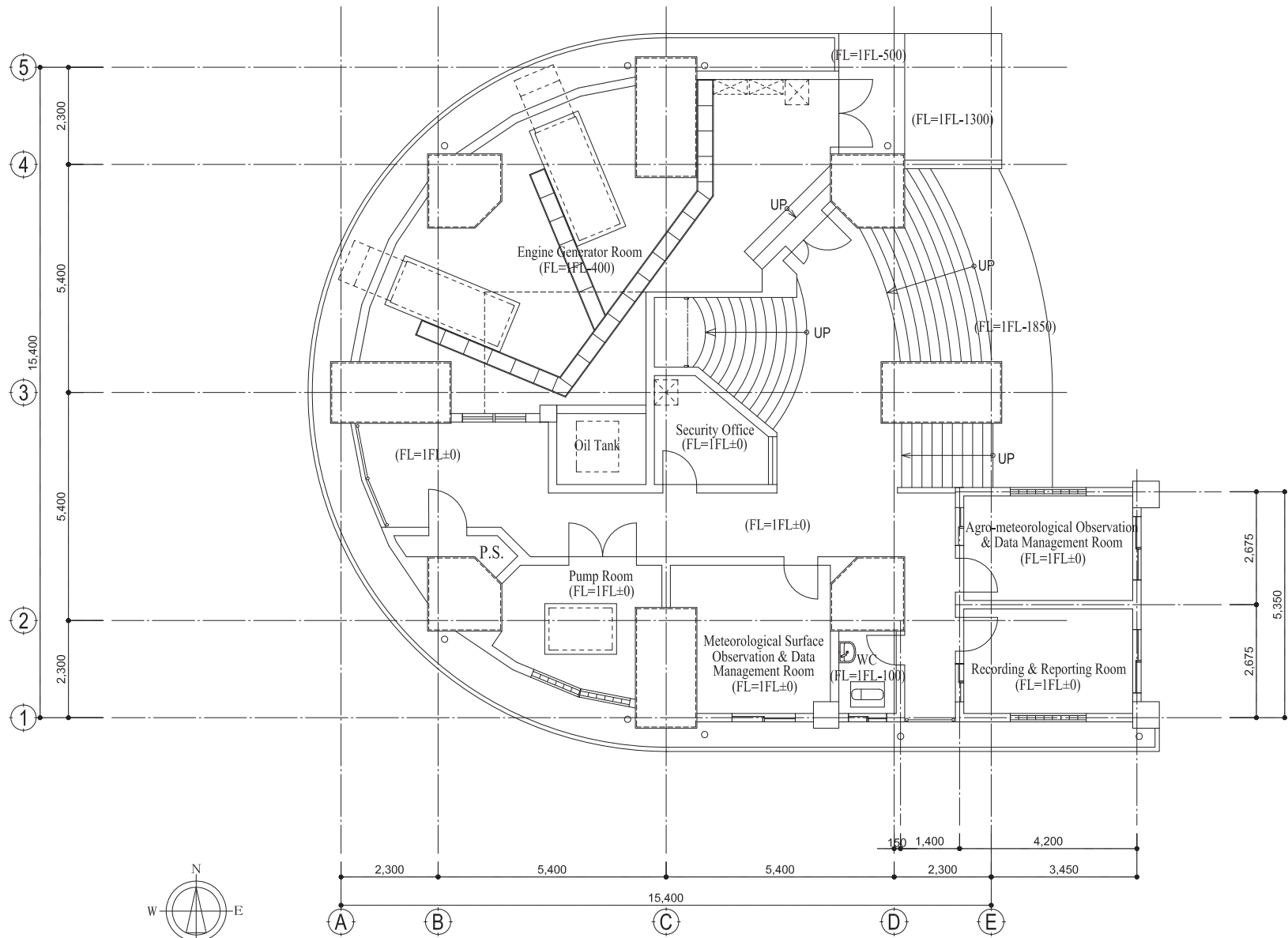


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

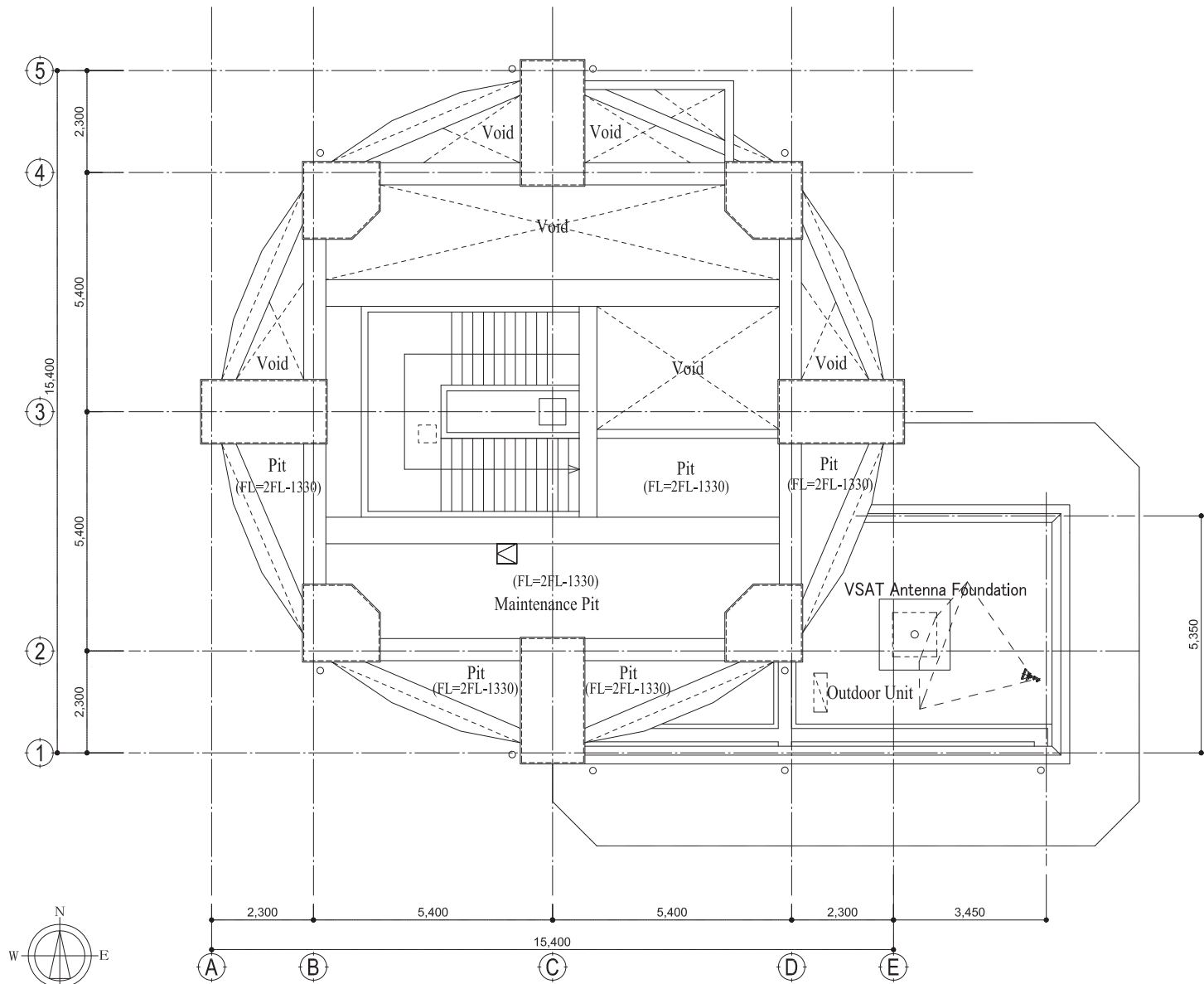
DRAWING TITLE
DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
Site Plan

SCALE
1:600

DRAWING No.
A - 01 (D)



1FL PLAN



MPFL PLAN



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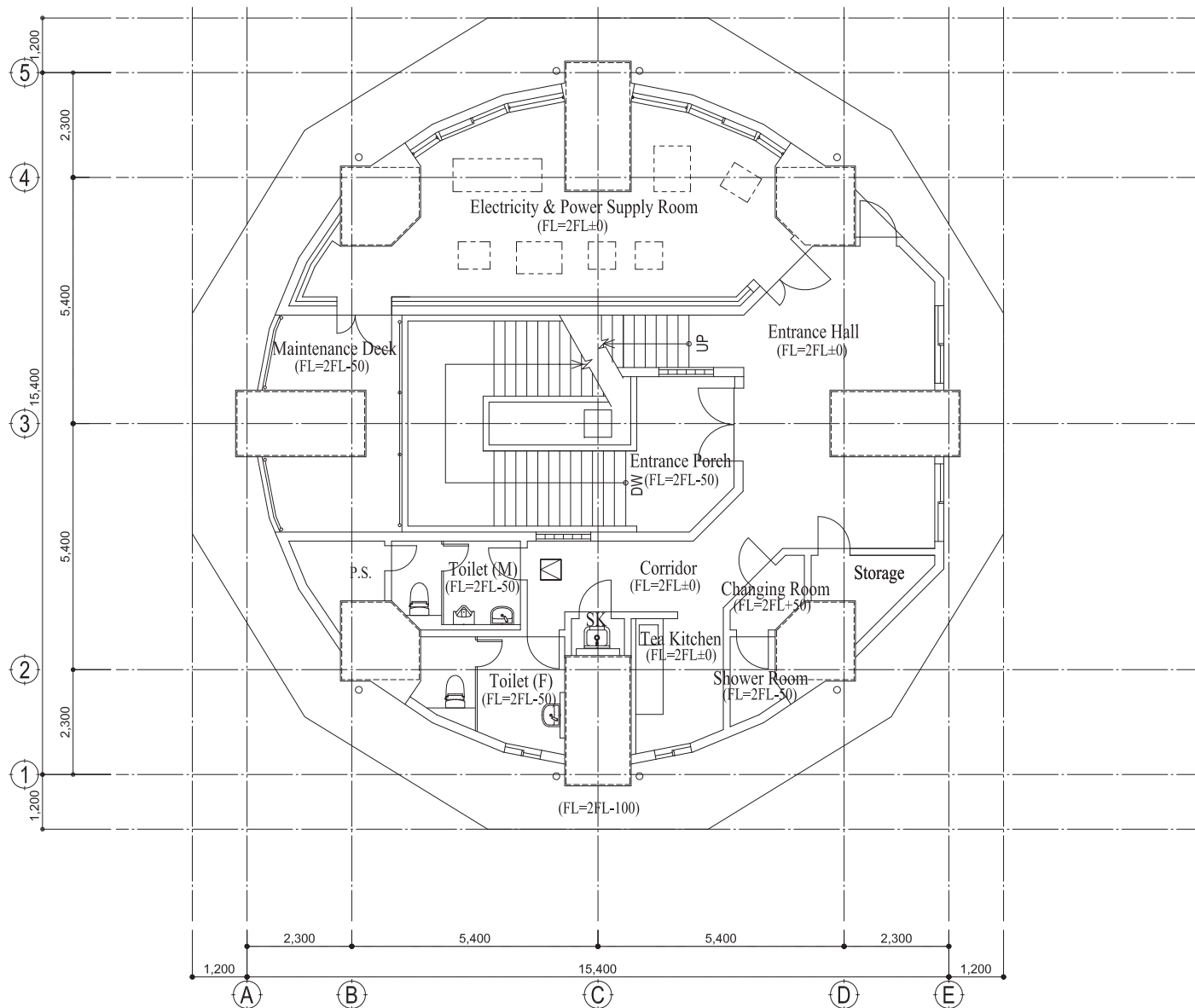


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 2

SCALE
1:100

DRAWING No.
A - 03 (D)



2FL PLAN



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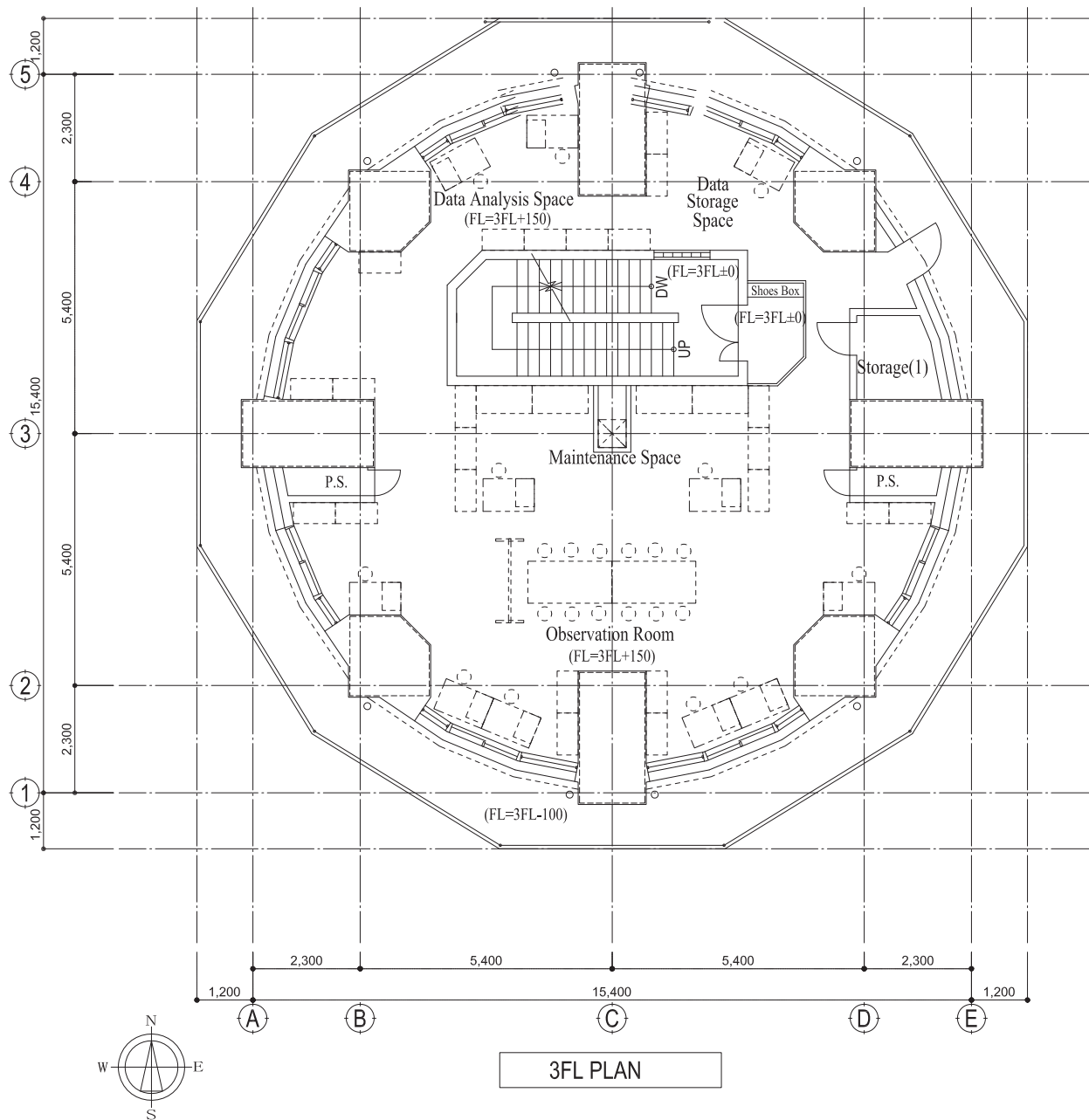


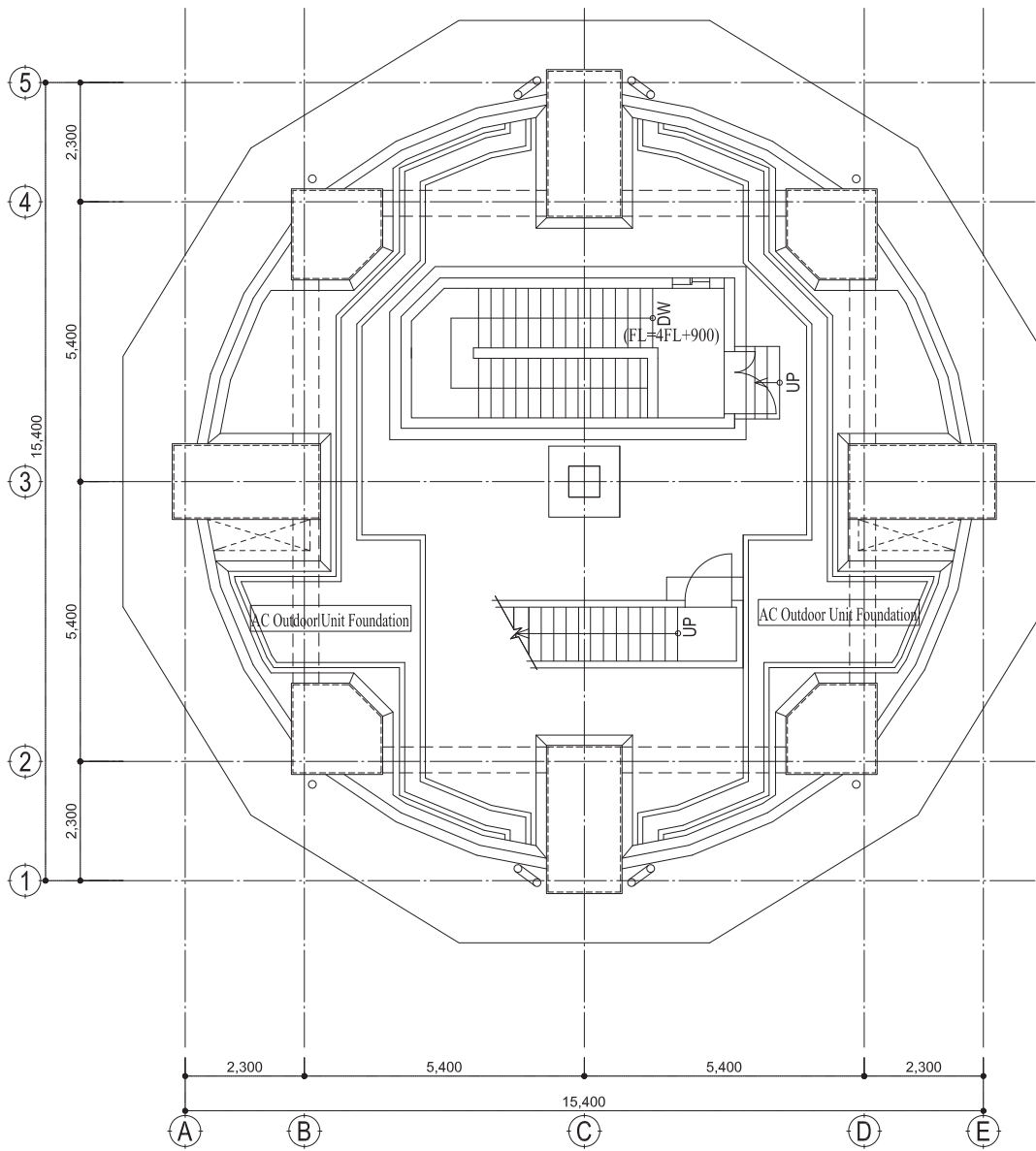
THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 3

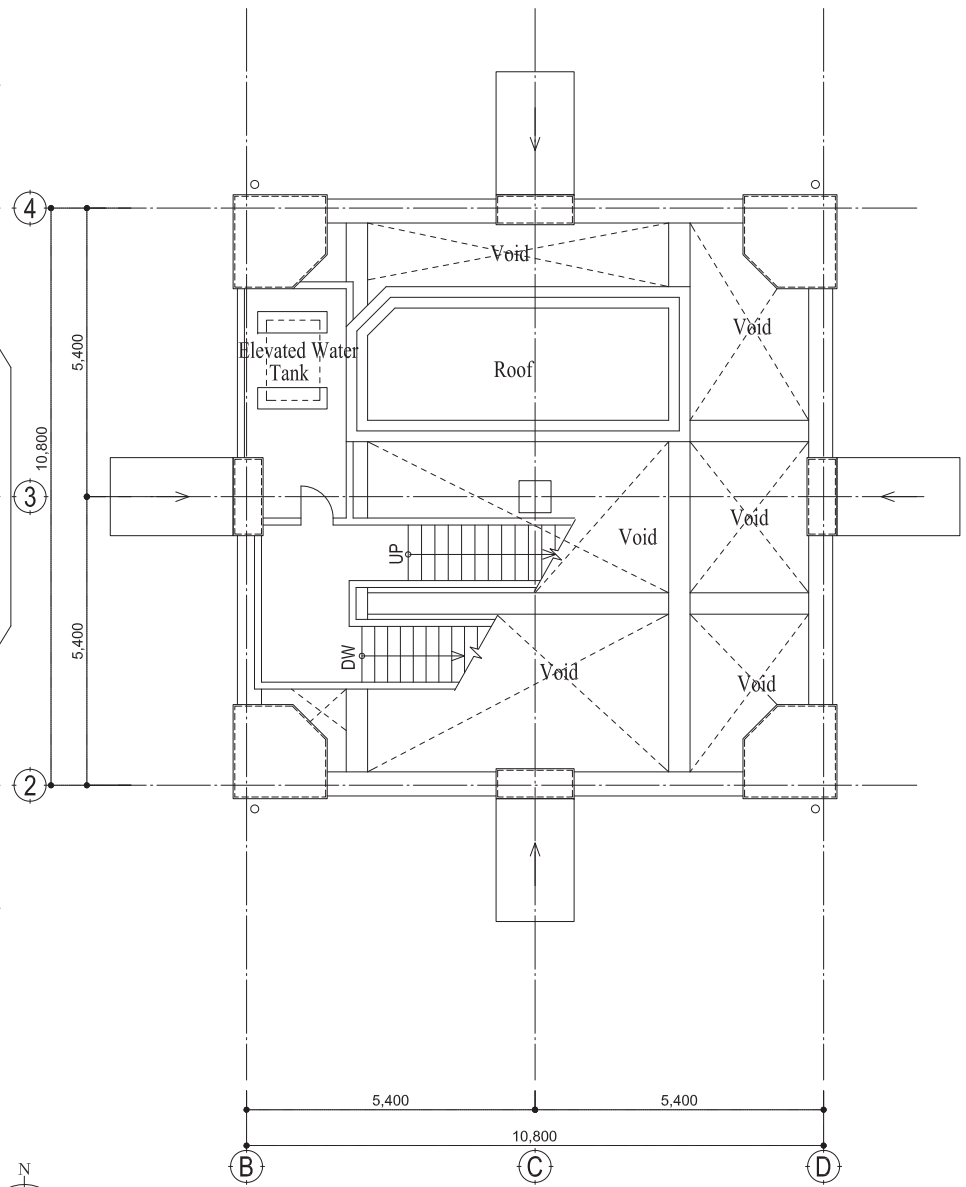
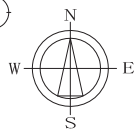
SCALE
1:100

DRAWING No.
A - 04 (D)





4FL PLAN



5FL PLAN



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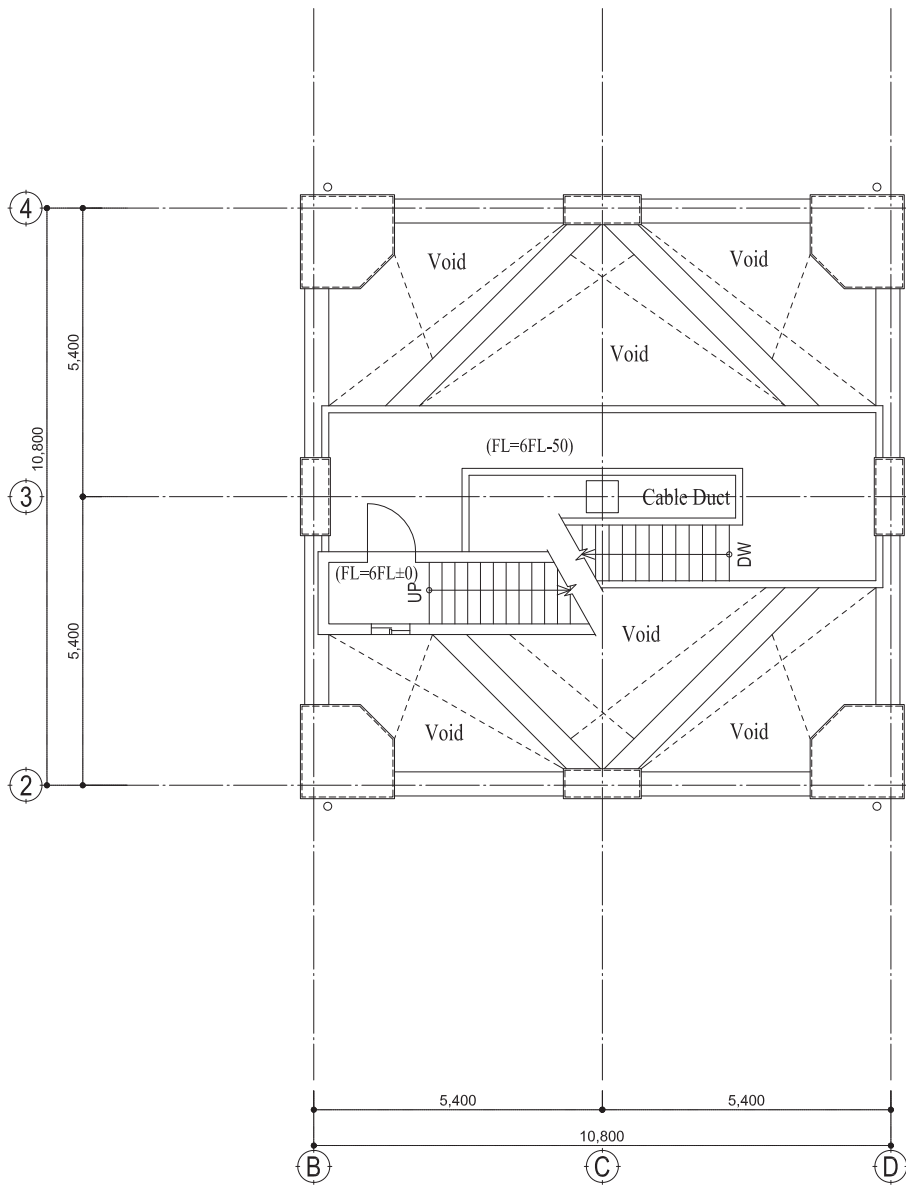


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

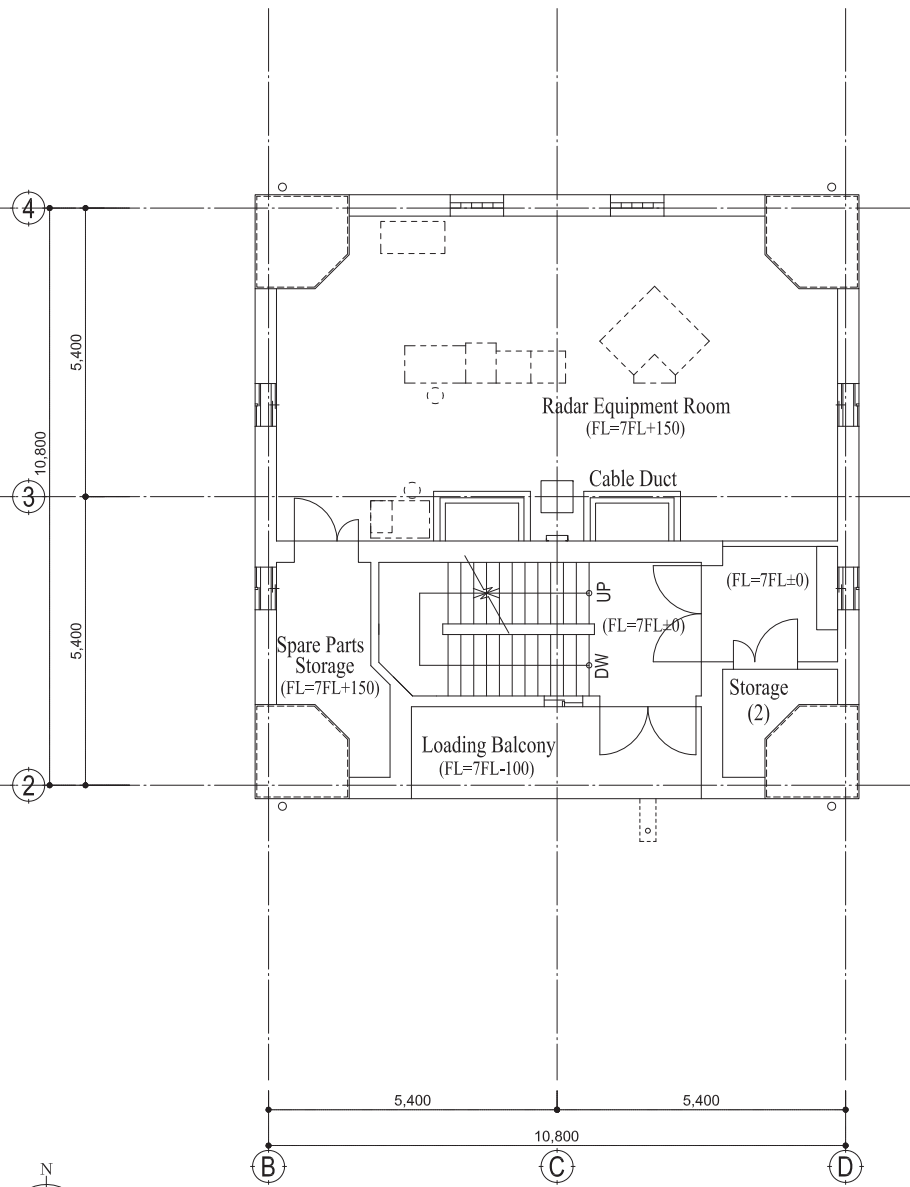
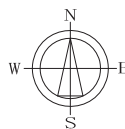
DRAWING TITLE
DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 5

SCALE
1:100

DRAWING No.
A - 06 (D)



6FL PLAN



7FL PLAN



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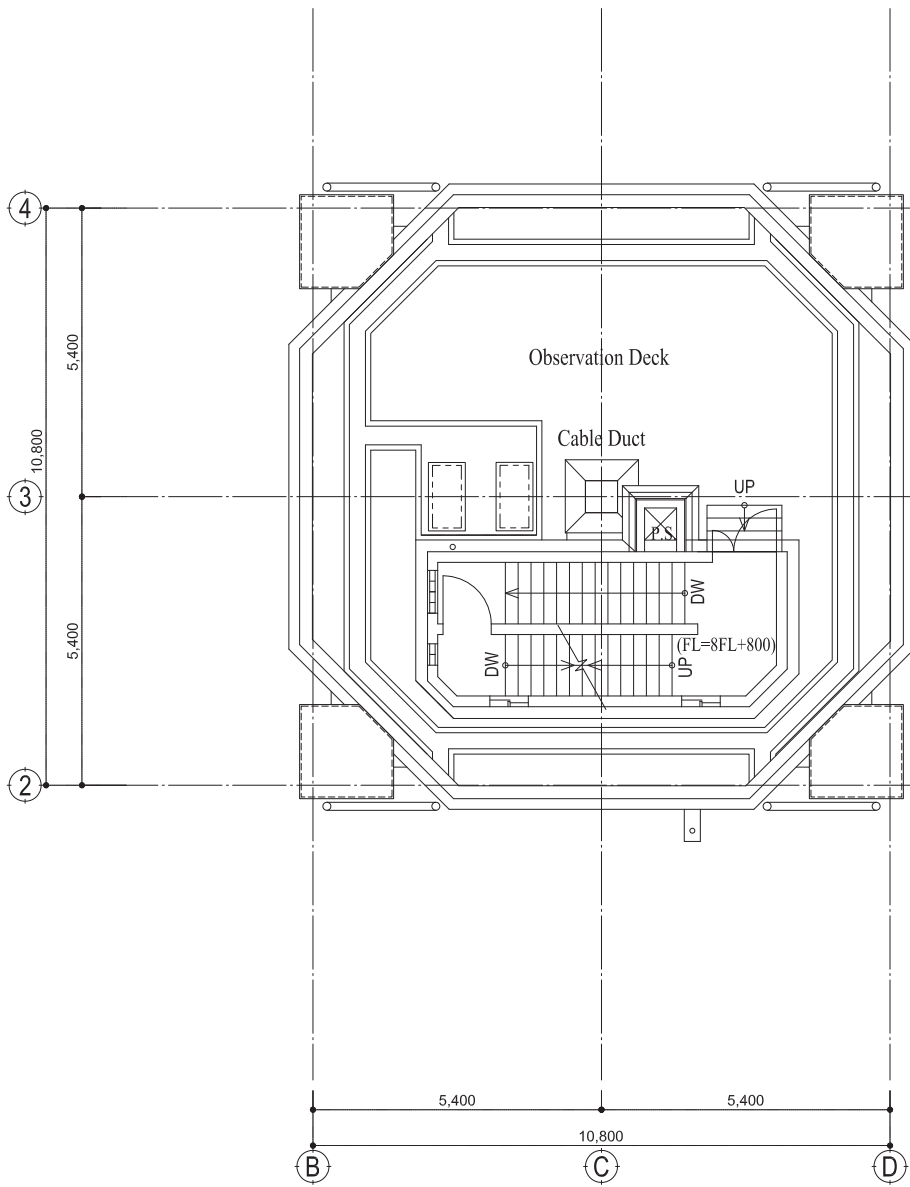


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

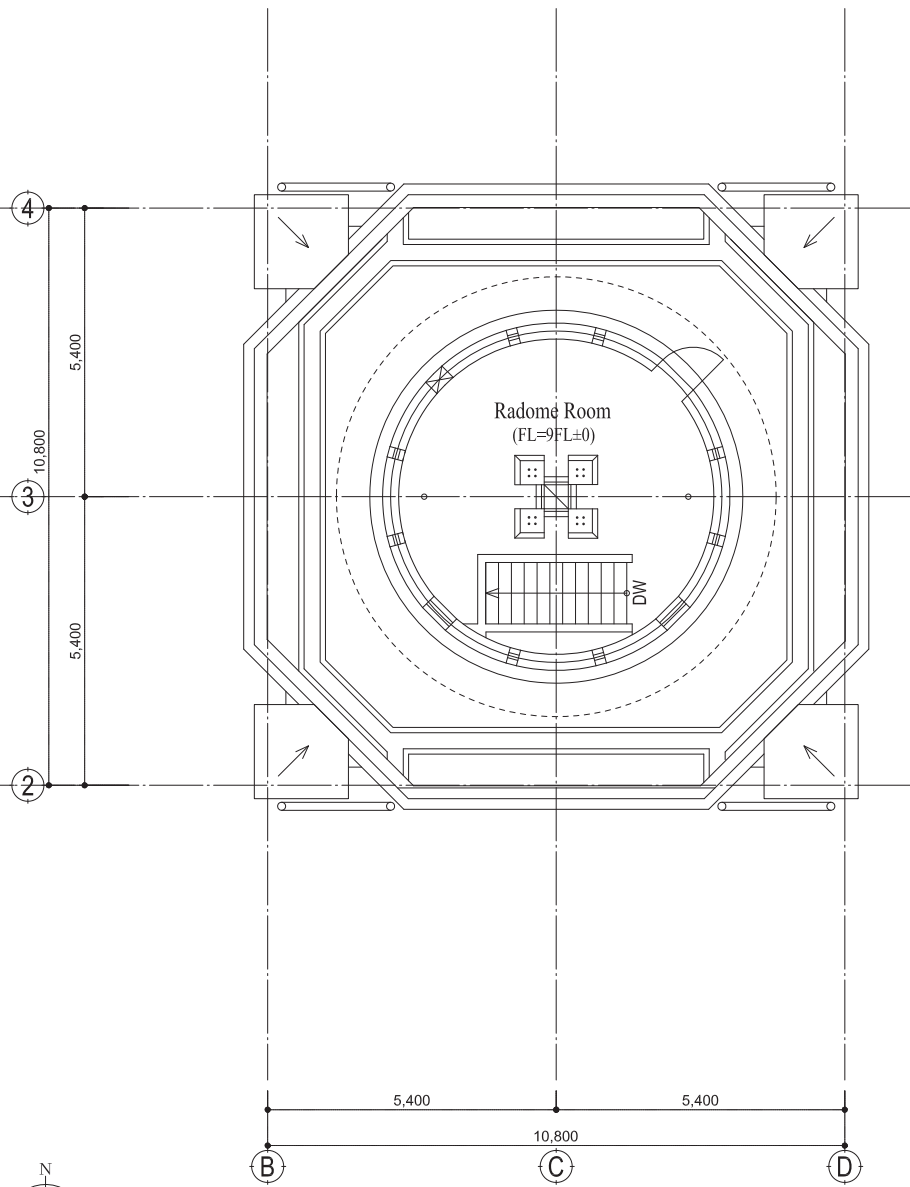
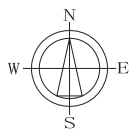
DRAWING TITLE
DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 6

SCALE
1:100

DRAWING No.
A - 07 (D)



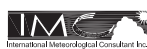
8FL PLAN



9FL PLAN



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THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

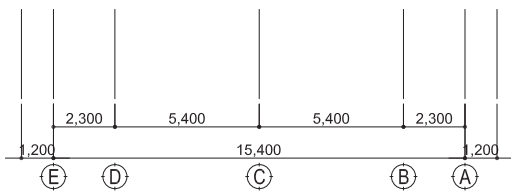
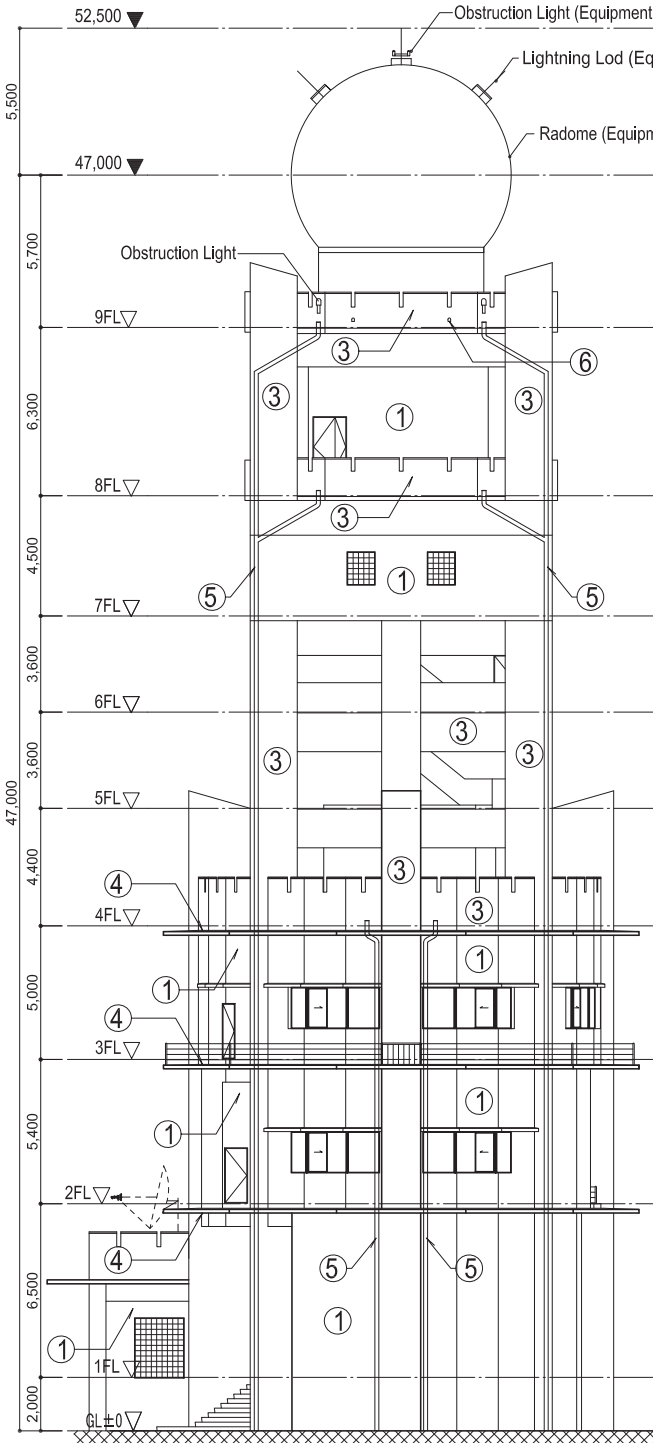
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DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 7

SCALE
1:100

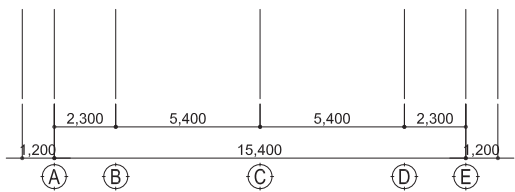
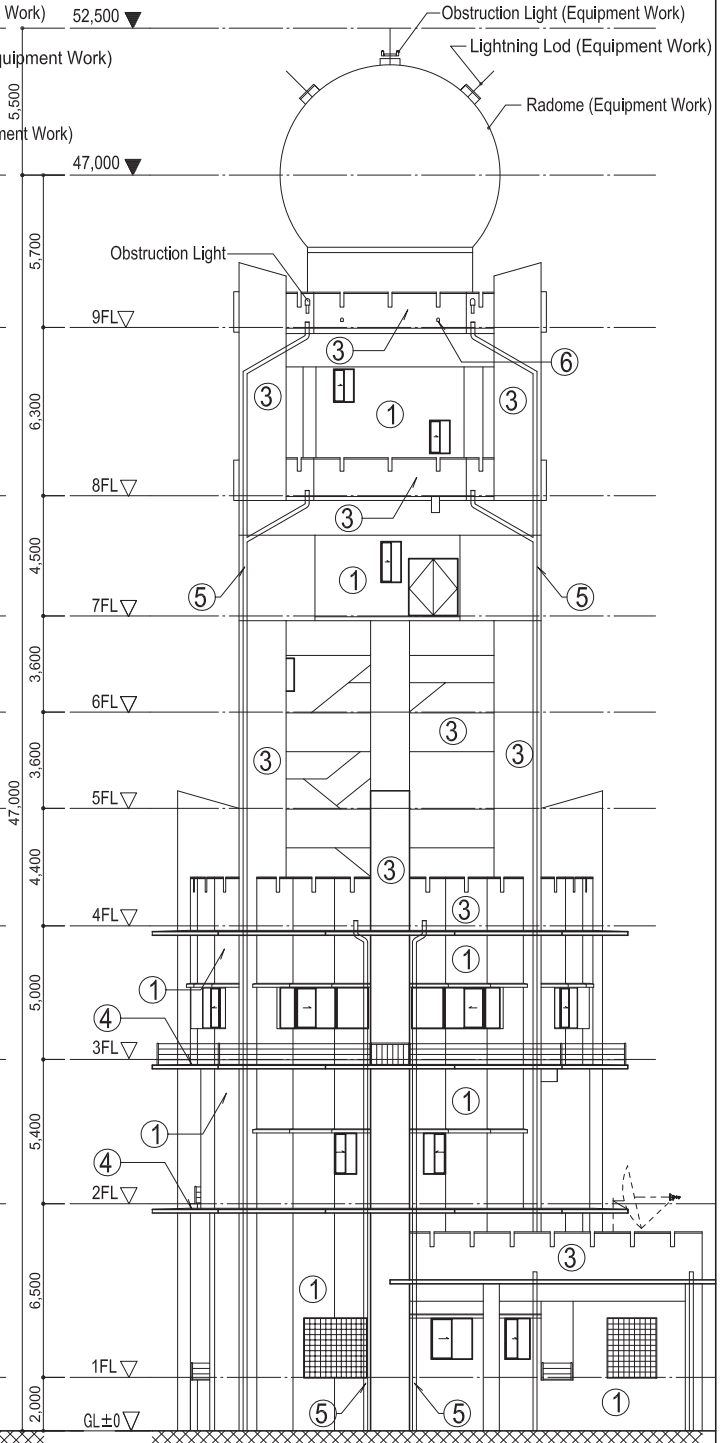
DRAWING No.
A - 08 (D)

LEGEND

①	C.S. Mortar t=25 Spray Tile
②	C.S. Mortar t=25
③	Fair-faced Concrete, Mortar Mending, Spray Tile
④	Waterproof Mortar t=30, ERP
⑤	Rain Leader Pipe: Galvanized Steel Pipe 150A, Spray Tile
⑥	Overflow Pipe: Galvanized Steel Pipe 100A, Spray Tile



NORTH ELEVATION



SOUTH ELEVATION



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THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLES REPUBLIC OF BANGLADESH

DRAWING TITLE
DHAKA (JOYDEVPUR) METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 2

SCALE
1:200

DRAWING No.
A - 10 (D)

LEGEND

①	C.S. Mortar t=25 Spray Tile
②	C.S. Mortar t=25
③	Fair-faced Concrete, Mortar Mending, Spray Tile
④	Waterproof Mortar t=30, ERP
⑤	Rain Leader Pipe: Galvanized Steel Pipe 150A, Spray Tile
⑥	Overflow Pipe: Galvanized Steel Pipe 100A, Spray Tile



WEST ELEVATION

EAST ELEVATION



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THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLES REPUBLIC OF BANGLADESH

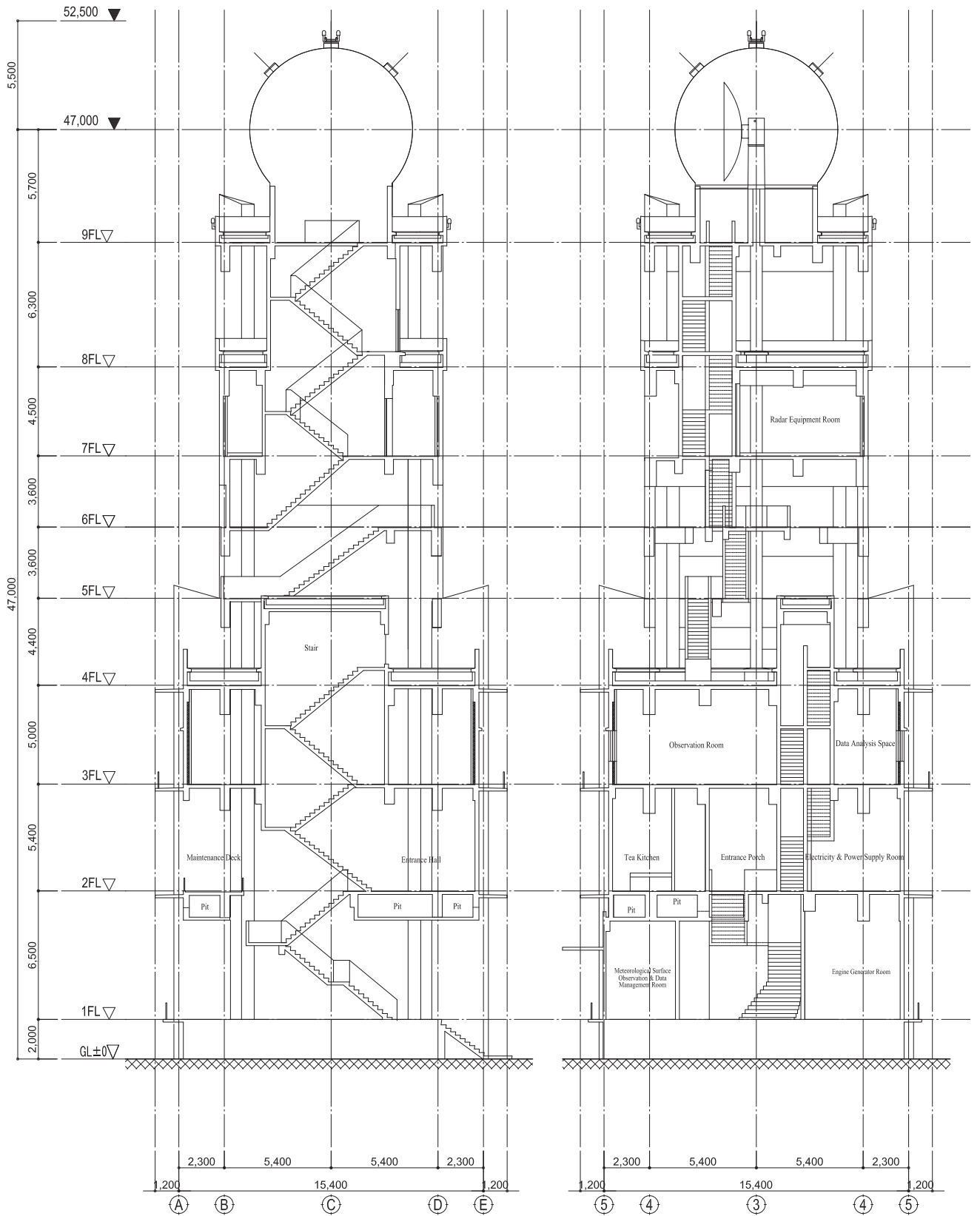
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DHAKA (JOYDEBPUR) METEOROLOGICAL RADAR TOWER BUILDING
SECTION

SCALE

1:200

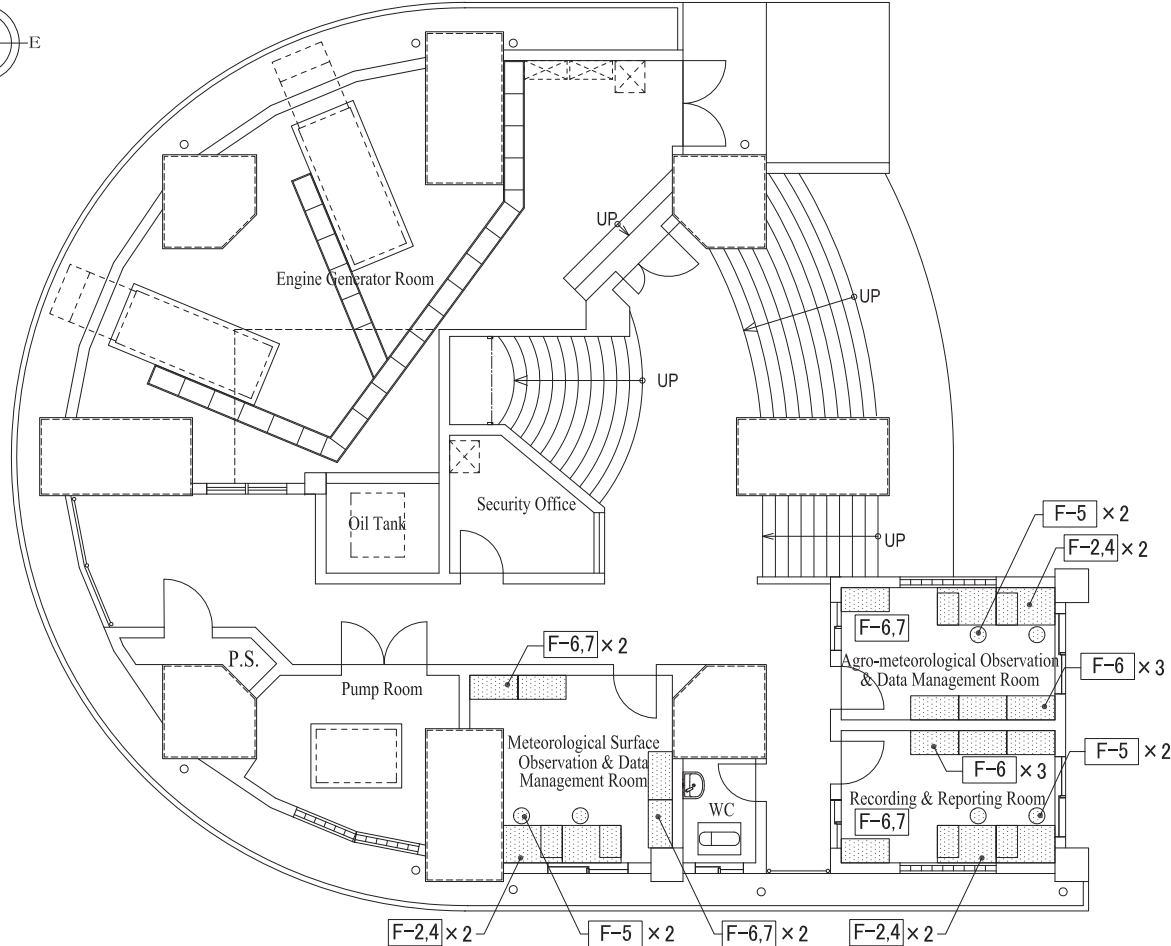
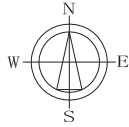
DRAWING No.

A - 11 (D)



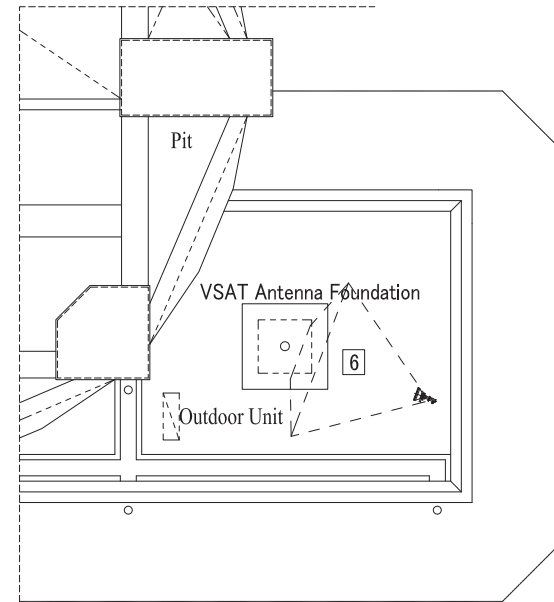
SECTION 1

SECTION 2

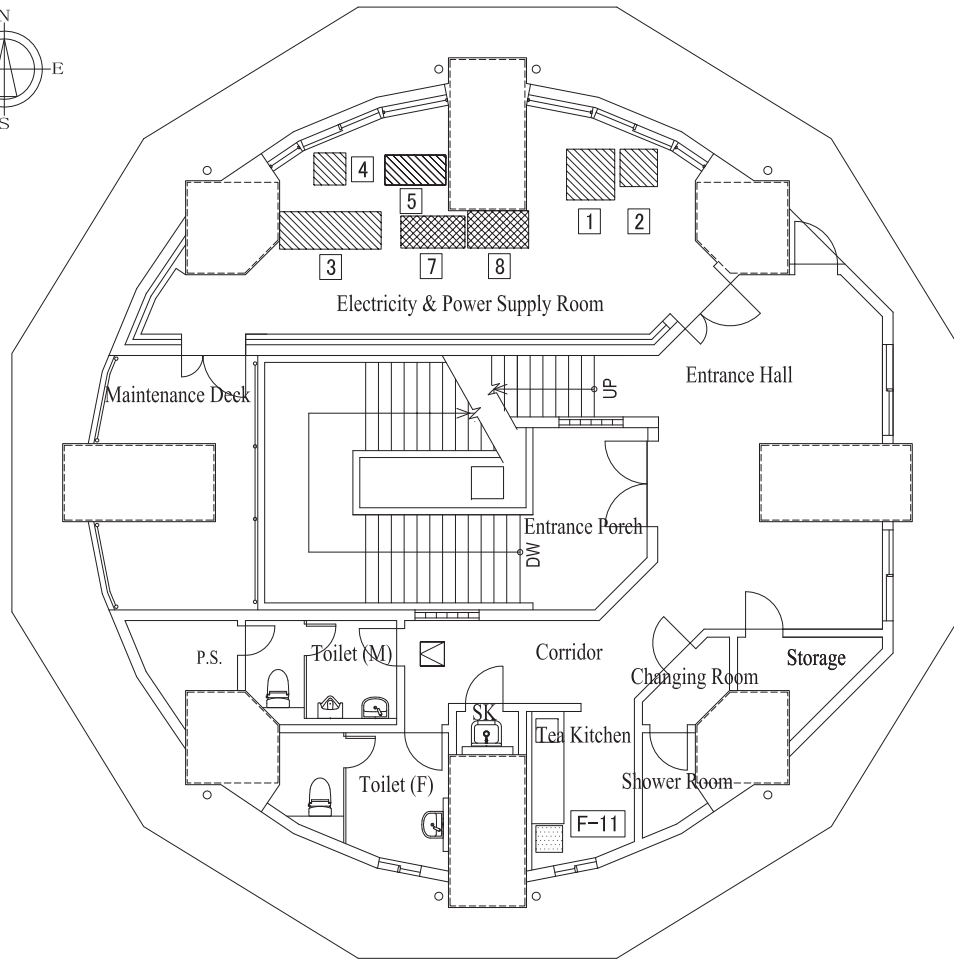
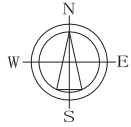


1FL PLAN

- FURNITURE (CONSTRUCTION WORK)
 - F-2** Pedestal-free Desk (W1,100 × D700)
 - F-4** Drawer Unit with Casters
 - F-5** Chair
 - F-6** Lateral Filling Cabinet H1,100
 - F-7** Cabinet (Double Hinged Doors) H1,000
- EQUIPMENT (EQUIPMENT WORK)
 - 6** USAT Antenna



MPFL PLAN



2FL PLAN

EQUIPMENT (EQUIPMENT WORK)

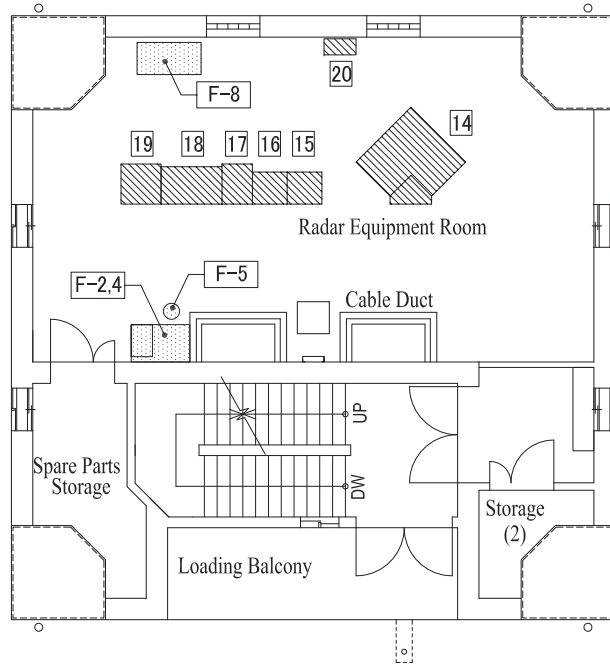
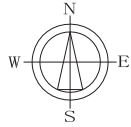
- 1 Radar AVR
- 2 Radar IT
- 3 Power Supply Capacitor
- 4 Emergency Power Backup Unit
- 5 Emergency Power Backup Battery

EQUIPMENT (CONSTRUCTION WORK)








- 7 AVR
- 8 Isolation Transformer

FURNITURE (CONSTRUCTION WORK)





- F-11 Water Dispenser



 EQUIPMENT (EQUIPMENT WORK)

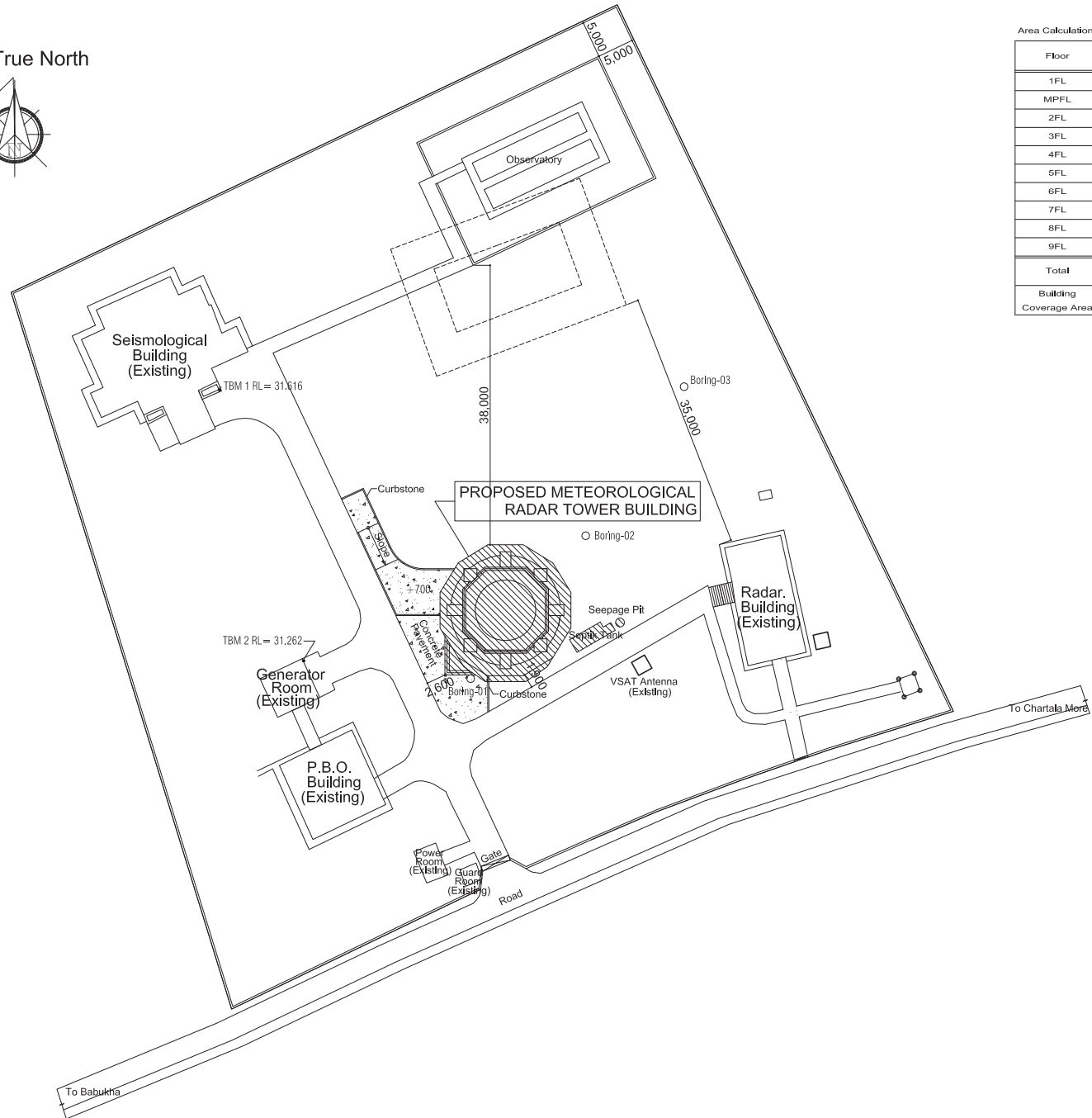
-  14 Transmitter
-  15 Antenna Controller & Dehydrator
-  16 DRSP
-  17 Data & Protocol Converter
-  18 Radar TASK Controller
-  19 VSAT In-Door Unit (IDU)
-  20 Radar Power Maintenance Panel

 FURNITURE (CONSTRUCTION WORK)

-  F-2 Pedestal-free Desk (W1,100 × D700)
-  F-4 Drawer Unit with Casters
-  F-5 Chair
-  F-8 Shelves(Double Hinged Doors)H1,800

7FL PLAN

Magnetic declination (-) 0° 18' west



Area Calculations

Floor	Floor Area (m2)	Construction Area (m2)
1FL	89.93	249.12
MPFL	-	57.01
2FL	124.09	263.21
3FL	171.93	252.92
4FL	16.59	252.92
5FL	-	116.64
6FL	-	116.64
7FL	107.22	116.64
8FL	17.35	116.64
9FL	30.17	116.64
Total	557.28 m2	1,658.36 m2
Building Coverage Area	171.93 m2	-



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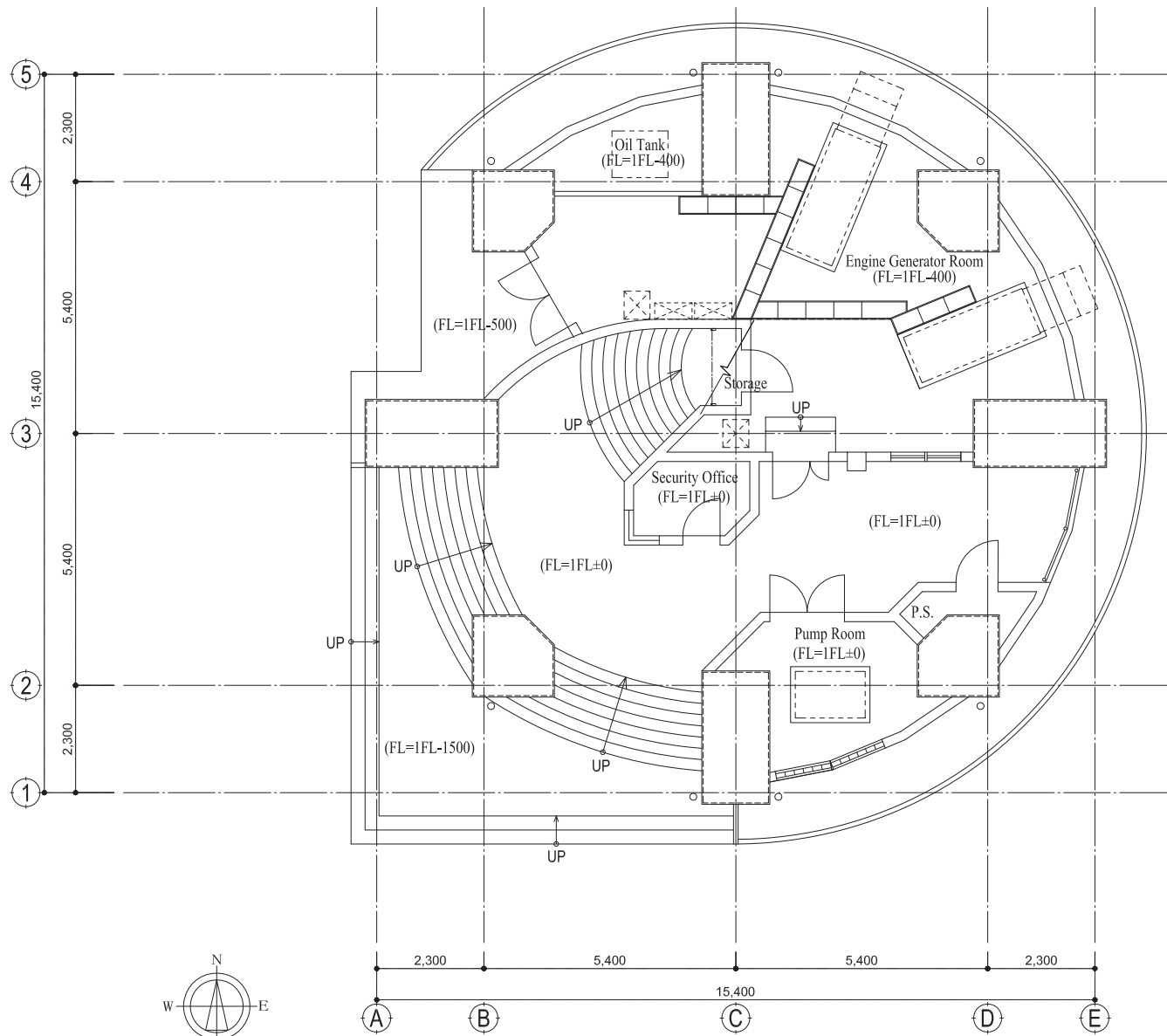


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
Site Plan

SCALE
1:600

DRAWING No.
A - 01 (R)



1FL PLAN



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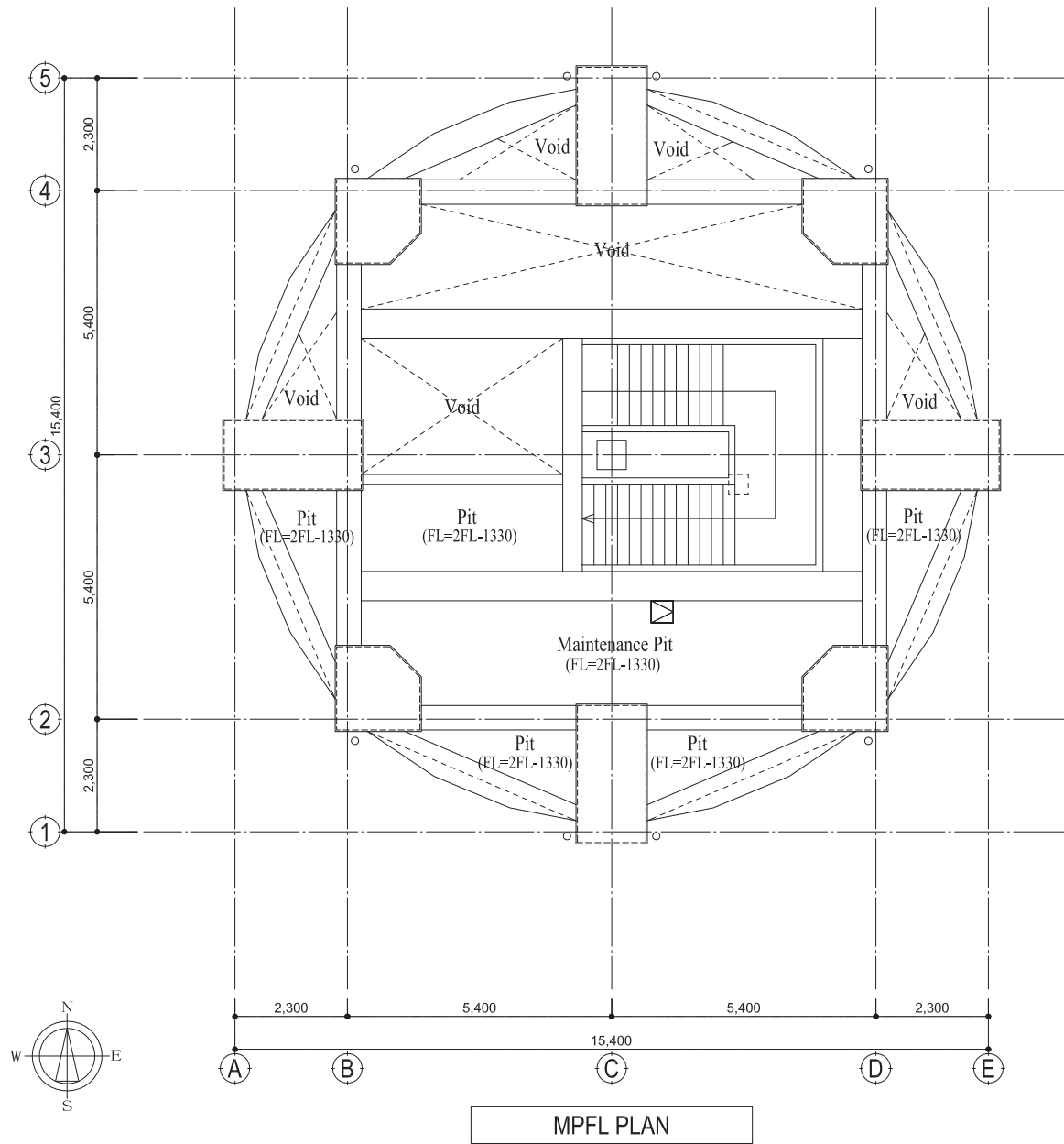


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 1

SCALE
1:100

DRAWING No.
A - 02 (R)



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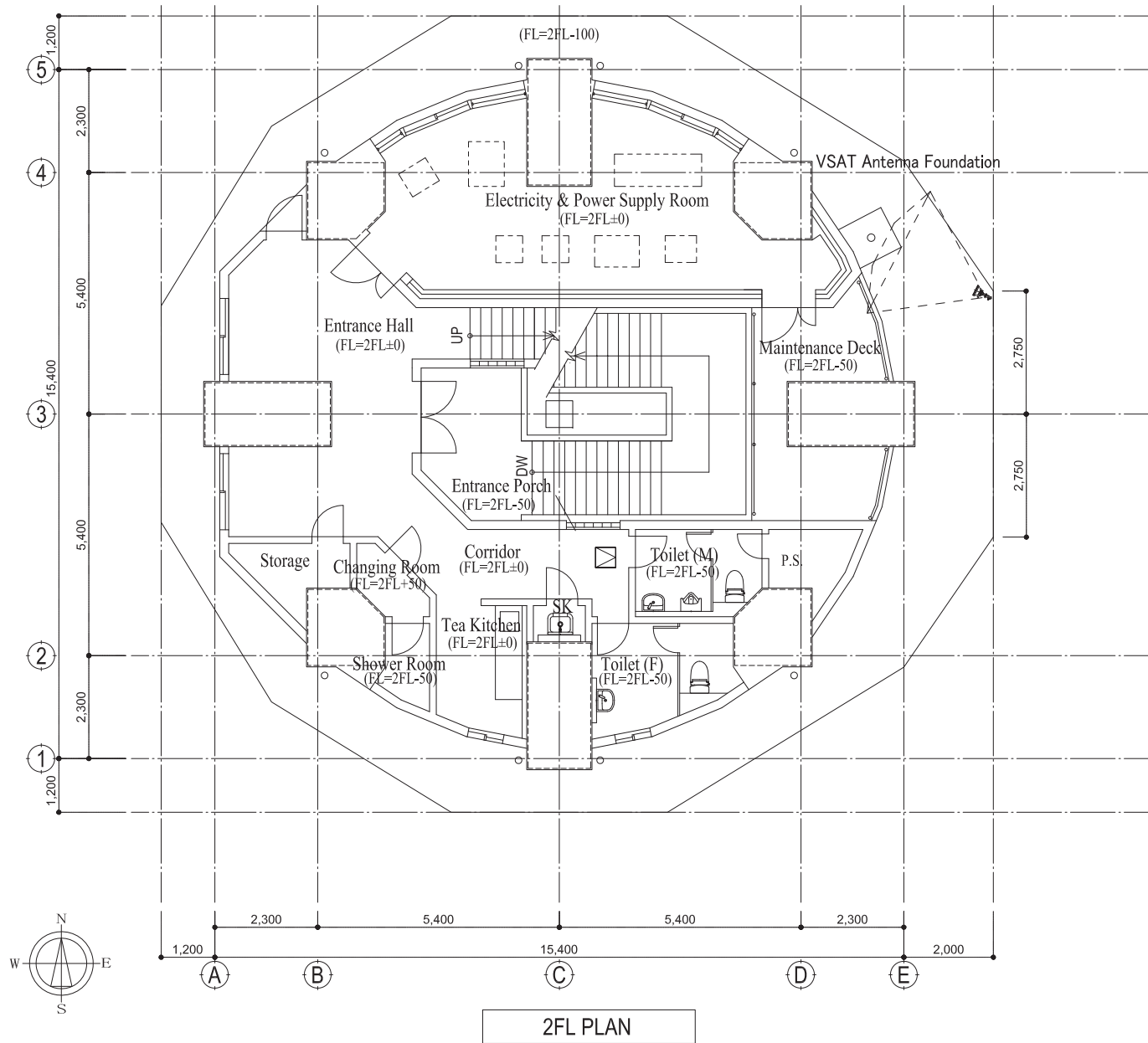


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 2

SCALE
1:100

DRAWING No.
A - 03 (R)



2FL PLAN



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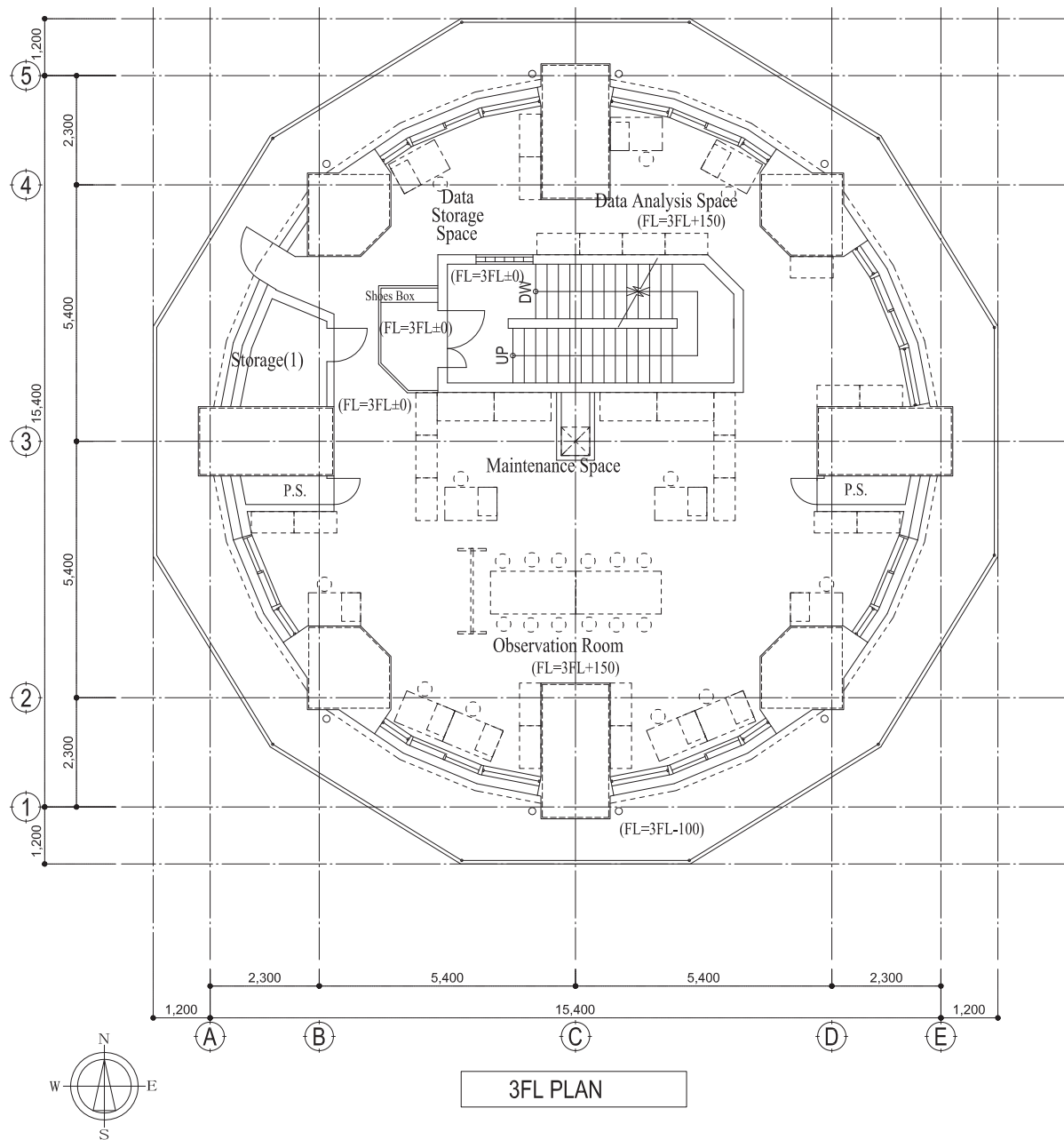


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 3

SCALE
1:100

DRAWING No.
A - 04 (R)



3FL PLAN



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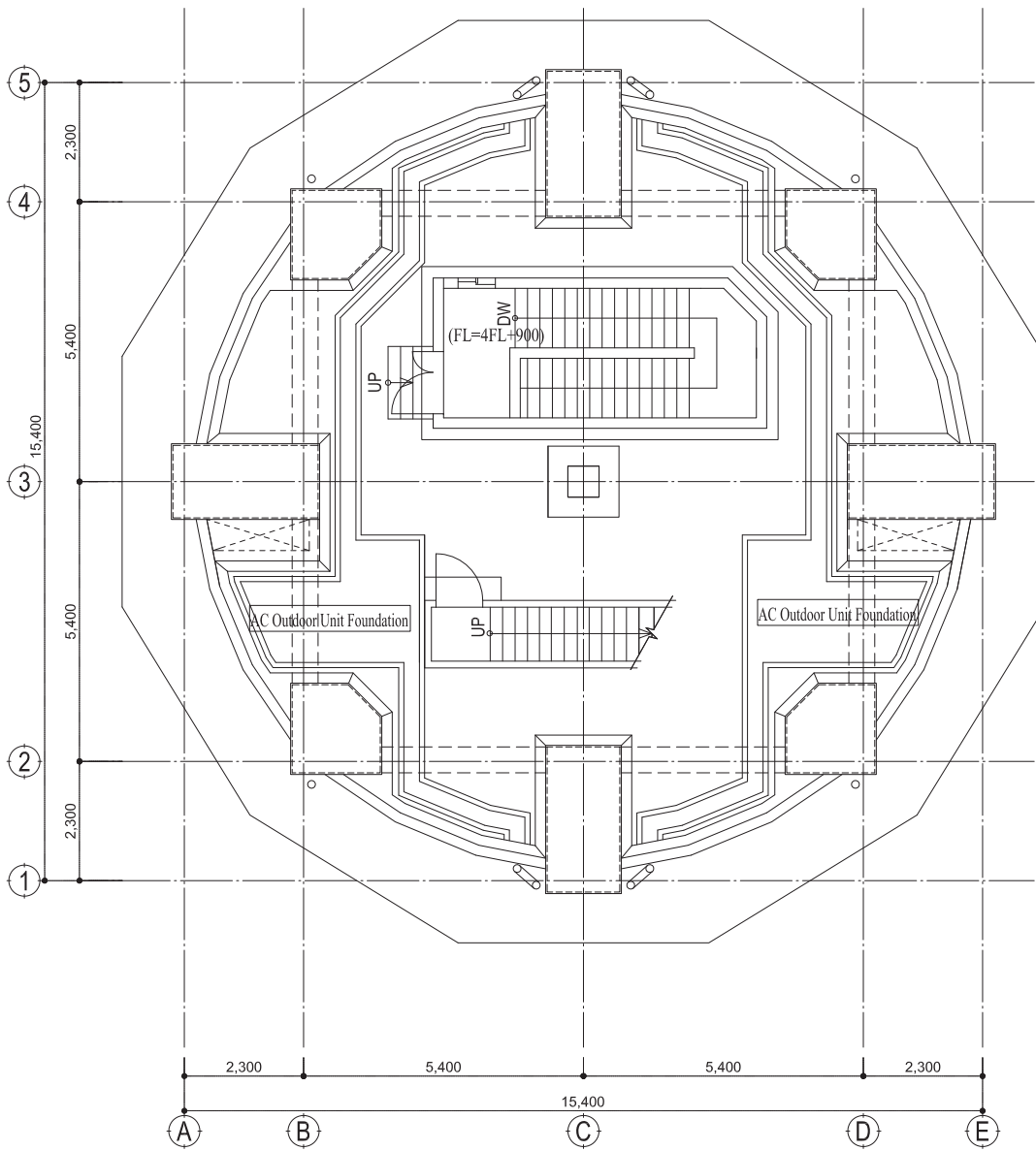


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

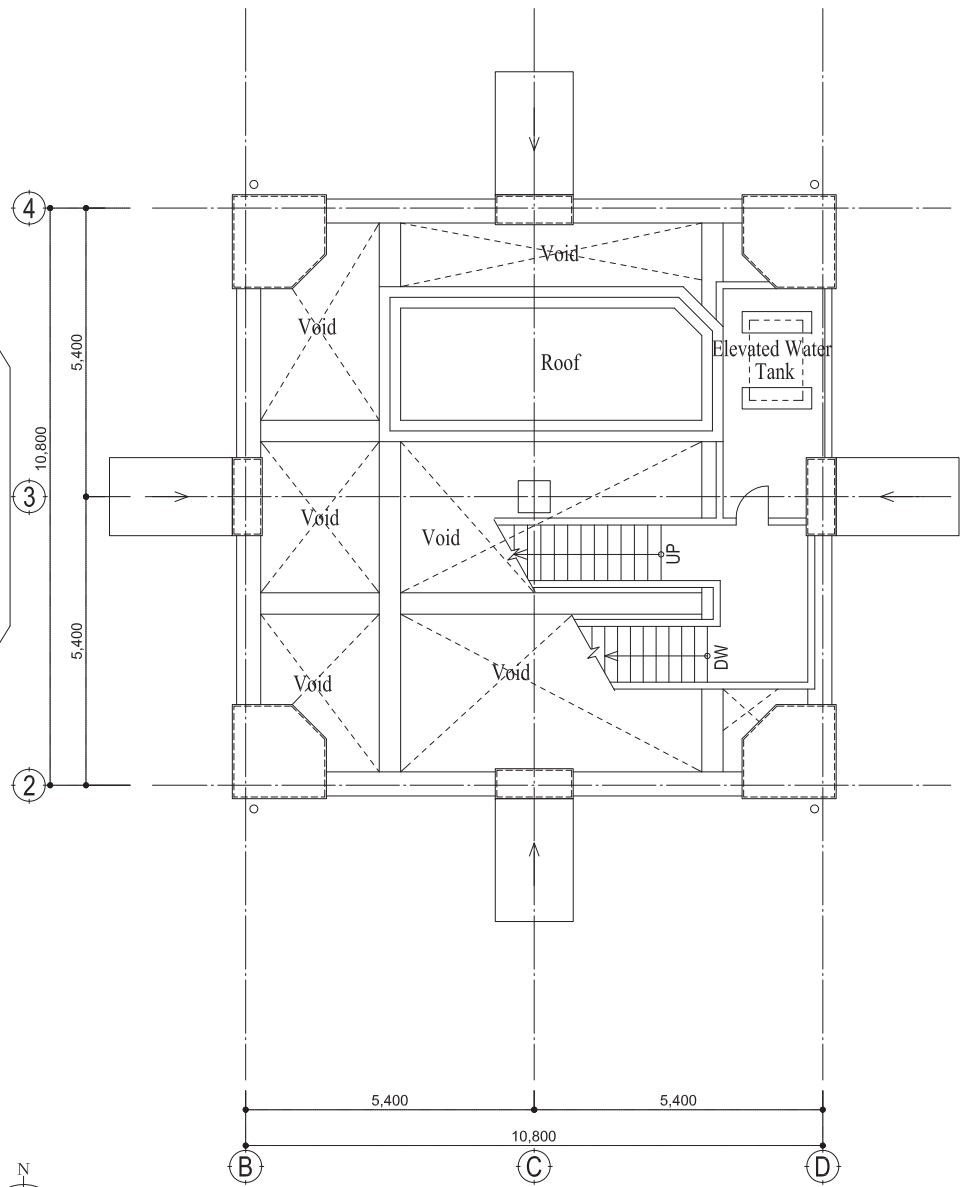
DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 4

SCALE
1:100

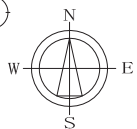
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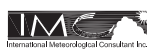
4FL PLAN



5FL PLAN



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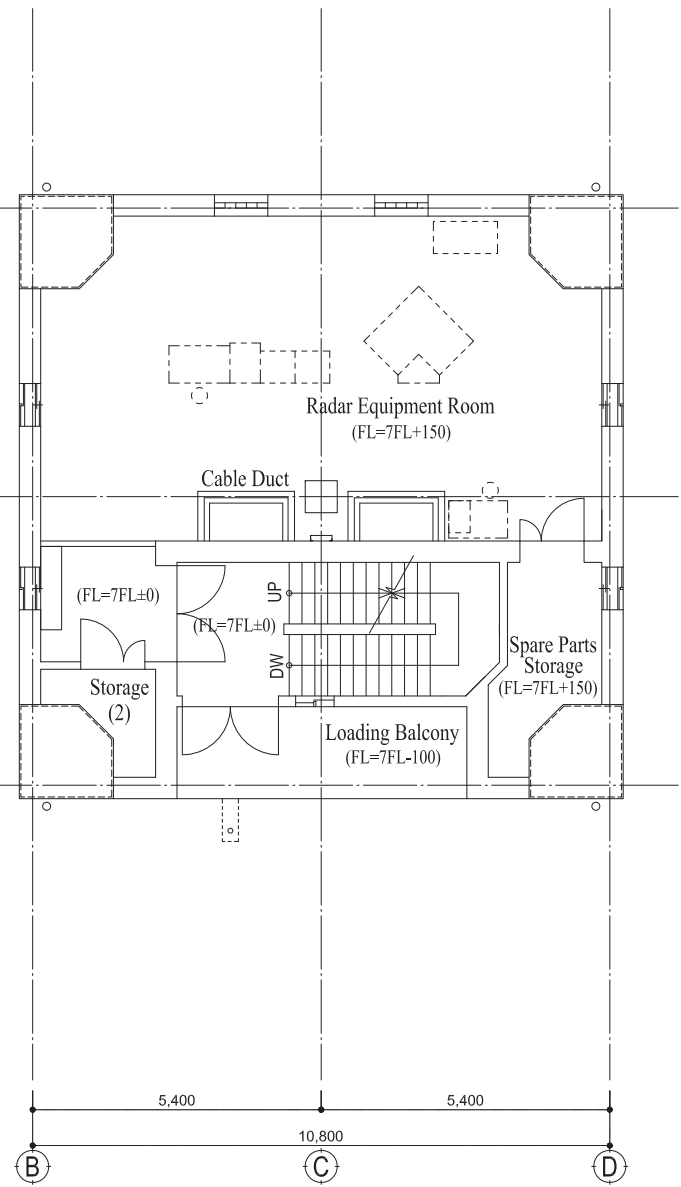
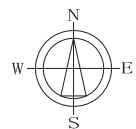
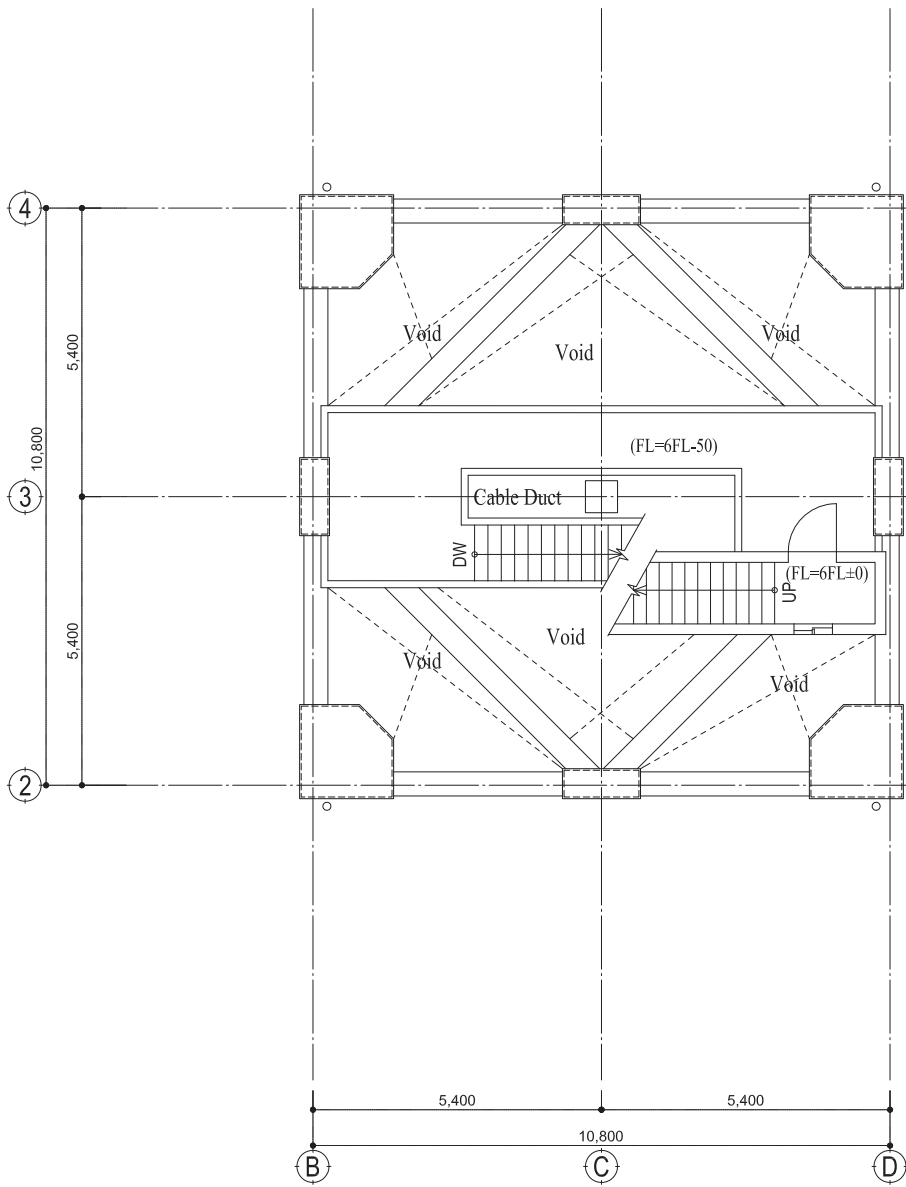


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 5

SCALE
1:100

DRAWING No.
A - 06 (R)



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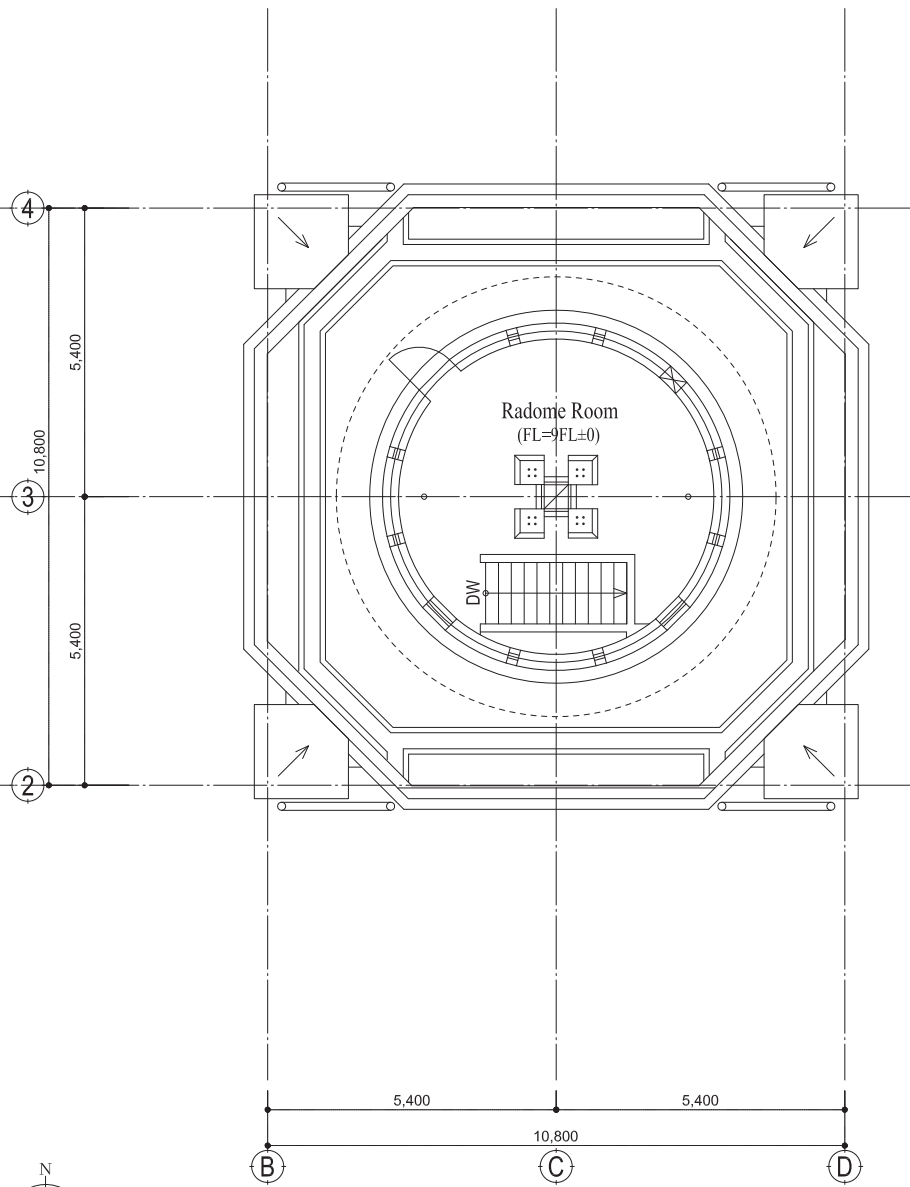
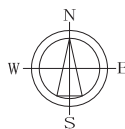
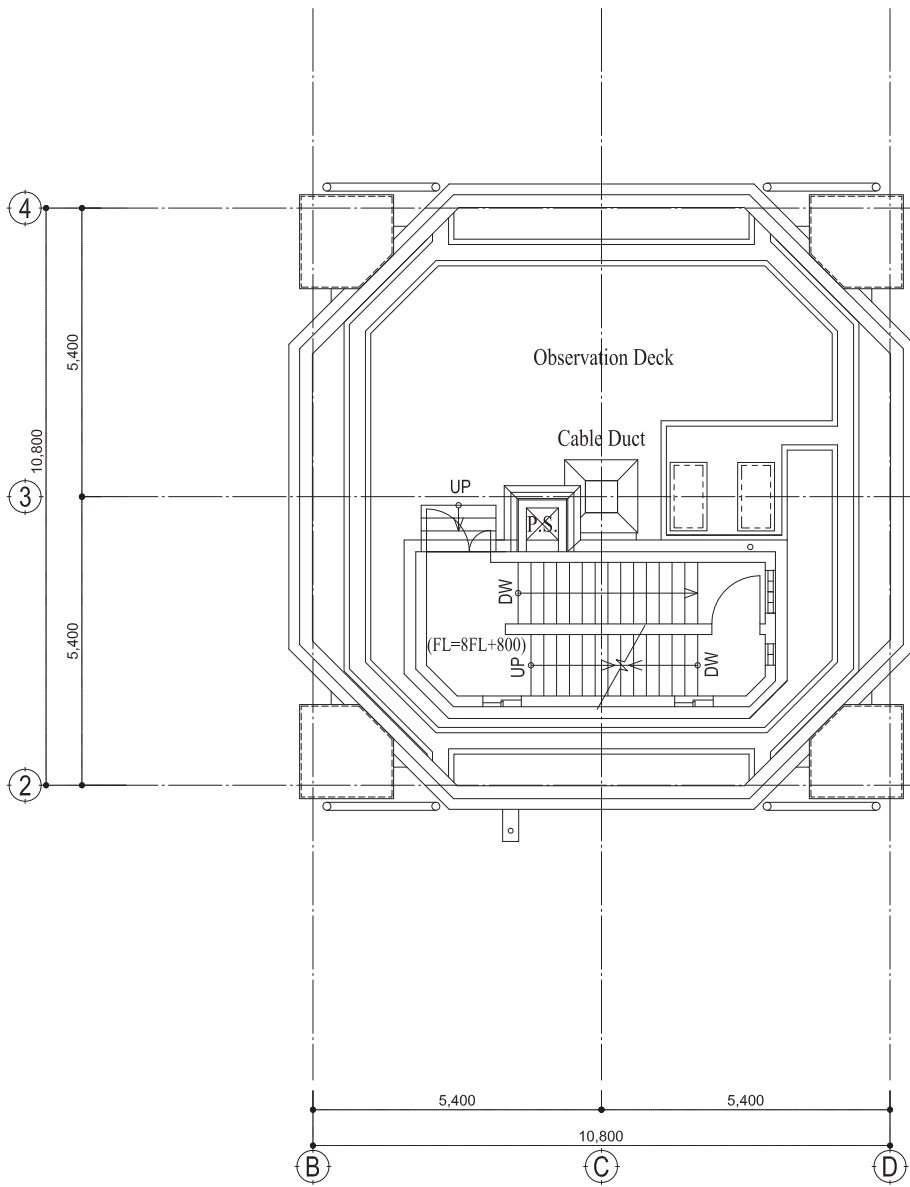


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

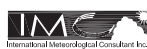
DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 6

SCALE
1:100

DRAWING No.
A - 07 (R)



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THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 7

SCALE
1:100

DRAWING No.
A - 08 (R)



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THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLES REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 1

SCALE
1:200

DRAWING No.
A - 09 (R)

LEGEND

①	C.S. Mortar t=25 Spray Tile
②	C.S. Mortar t=25
③	Fair-faced Concrete, Mortar Mending, Spray Tile
④	Waterproof Mortar t=30, ERP
⑤	Rain Leader Pipe: Galvanized Steel Pipe 150A, Spray Tile
⑥	Overflow Pipe: Galvanized Steel Pipe 100A, Spray Tile



NORTH ELEVATION

SOUTH ELEVATION



Japan Weather Association and
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THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 2

SCALE
1:200

DRAWING No.
A - 10 (R)

LEGEND

①	C.S. Mortar t=25 Spray Tile
②	C.S. Mortar t=25
③	Fair-faced Concrete, Mortar Mending, Spray Tile
④	Waterproof Mortar t=30, ERP
⑤	Rain Leader Pipe: Galvanized Steel Pipe 150A, Spray Tile
⑥	Overflow Pipe: Galvanized Steel Pipe 100A, Spray Tile





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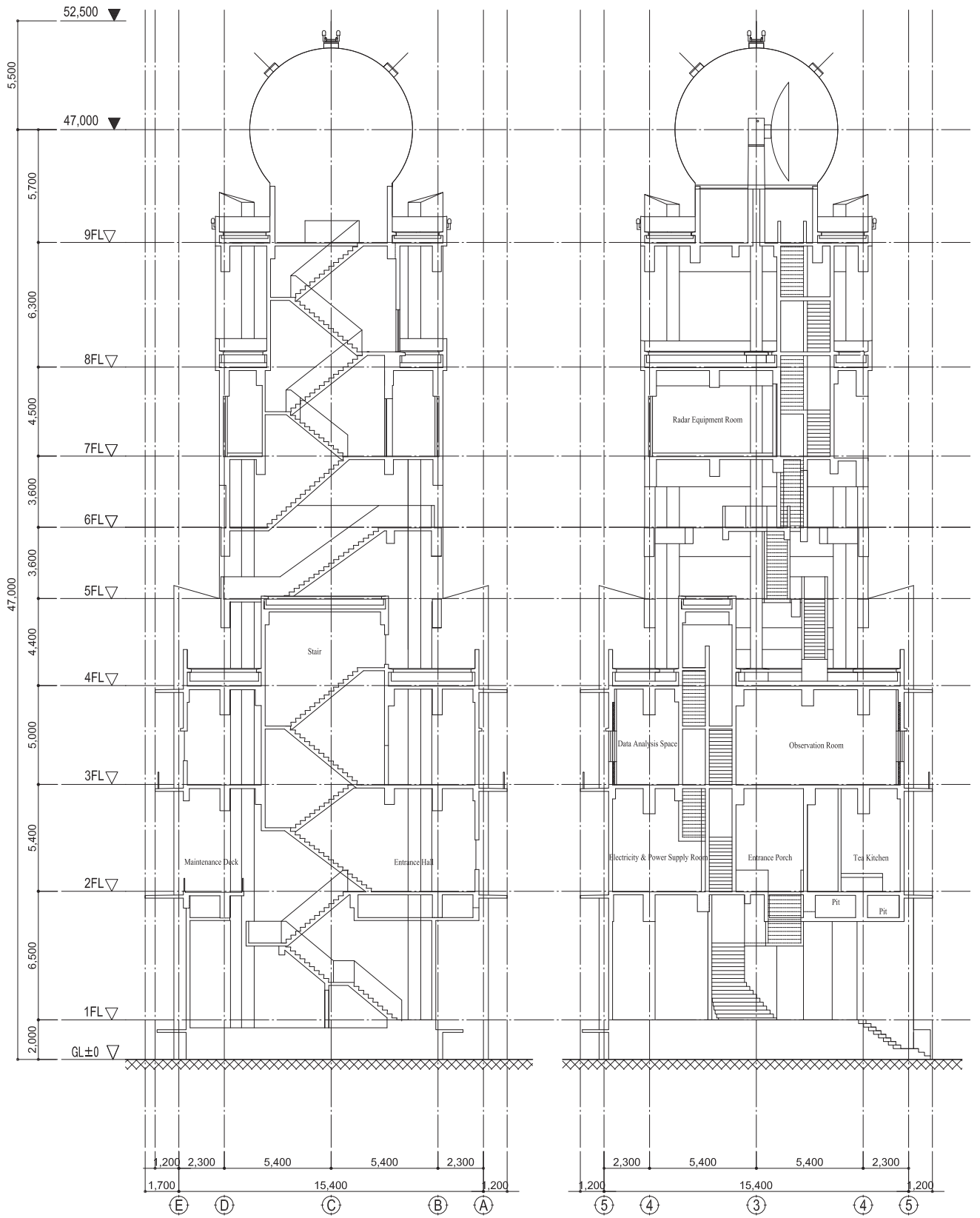


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLES REPUBLIC OF BANGLADESH

DRAWING TITLE
RANGPUR METEOROLOGICAL RADAR TOWER BUILDING
SECTION

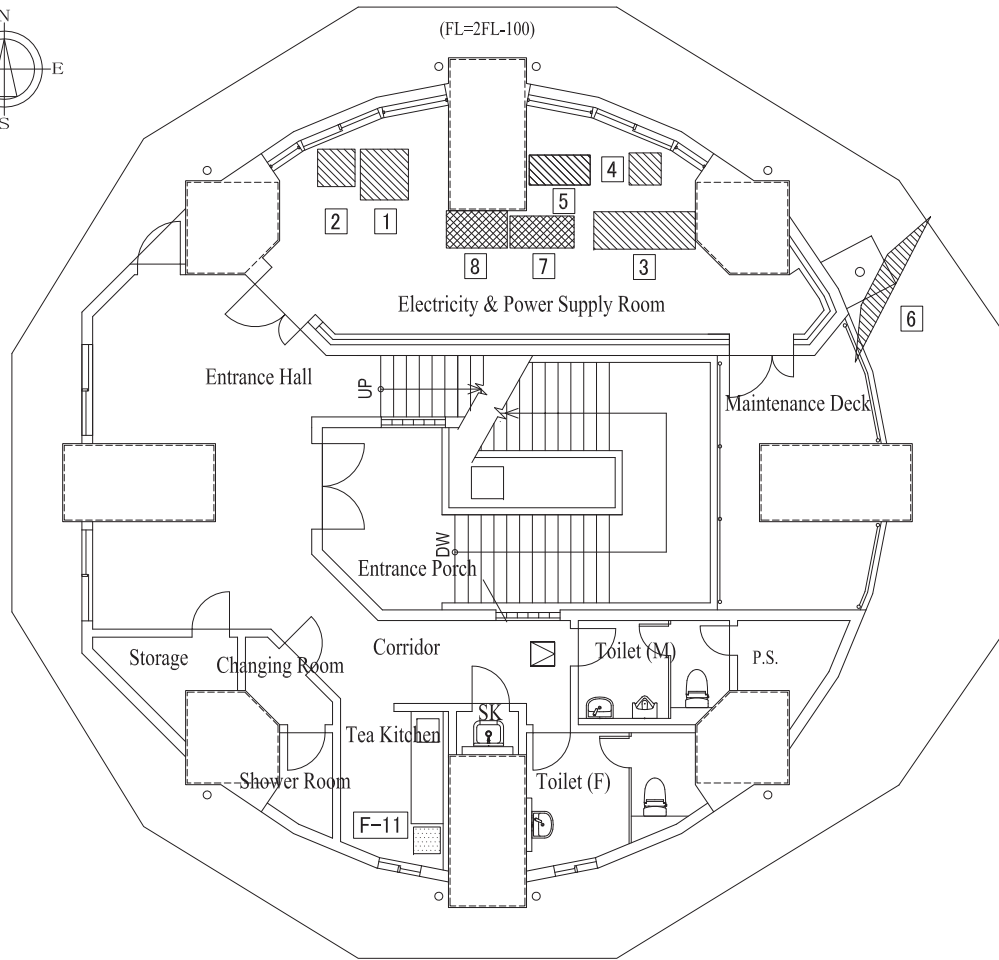
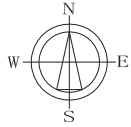
SCALE
1:200

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A - 11 (R)









SECTION 1


SECTION 2



2FL PLAN


 EQUIPMENT (EQUIPMENT WORK)

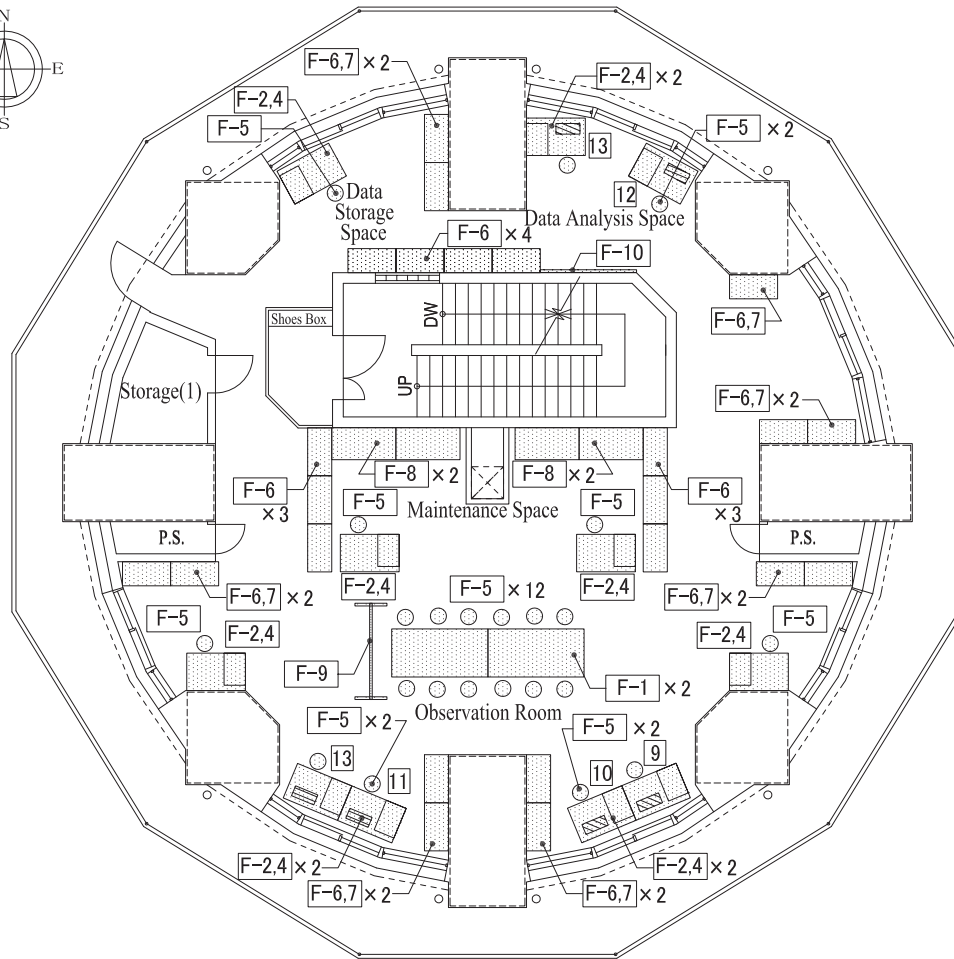
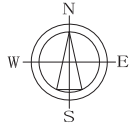
-  Radar AVR
-  Radar IT
-  Power Supply Capacitor
-  Emergency Power Backup Unit
-  Emergency Power Backup Battery
-  USAT Antenna

 EQUIPMENT (CONSTRUCTION WORK)

-  AVR
-  Isolation Transformer

 FURNITURE (CONSTRUCTION WORK)

-  Water Dispenser



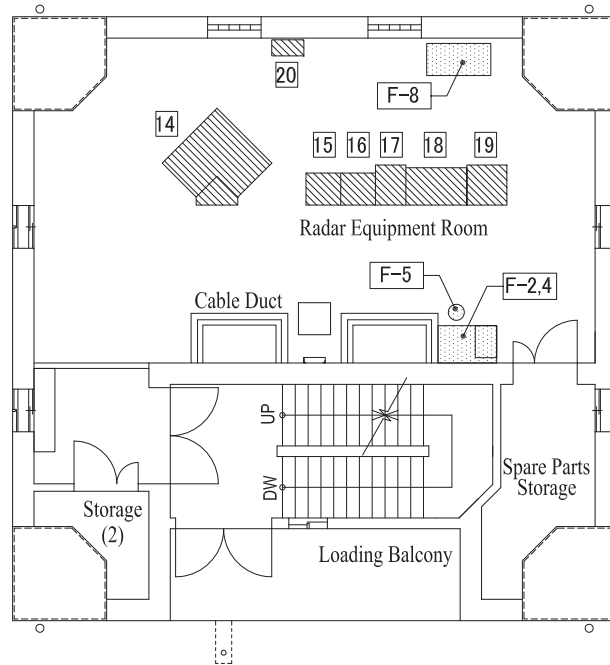
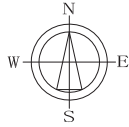
3FL PLAN

EQUIPMENT (EQUIPMENT WORK)

- Low Pressure Tracking Display Unit
- Severe Storm and Doppler Velocity Indicator
- Rader TASK Controller
- Data Analyzing Unit
- Colour Printer

FURNITURE (CONSTRUCTION WORK)

- Meeting Table (W900 × L1,800)
- Pedestal-free Desk (W1,100 × D700)
- Drawer Unit with Casters
- Chair
- Lateral Filling Cabinet H1,100
- Cabinet (Double Hinged Doors) H1,000
- Shelves (Double Hinged Doors) H1,800
- White Board : W1,800 × H900
- Pin Board



7FL PLAN

EQUIPMENT (EQUIPMENT WORK)

- 14 Transmitter
- 15 Antenna Controller & Dehydrator
- 16 DRSP
- 17 Data & Protocol Converter
- 18 Radar TASK Controller
- 19 VSAT In-Door Unit (IDU)
- 20 Radar Power Maintenance Panel

FURNITURE (CONSTRUCTION WORK)

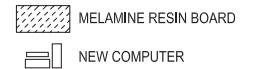
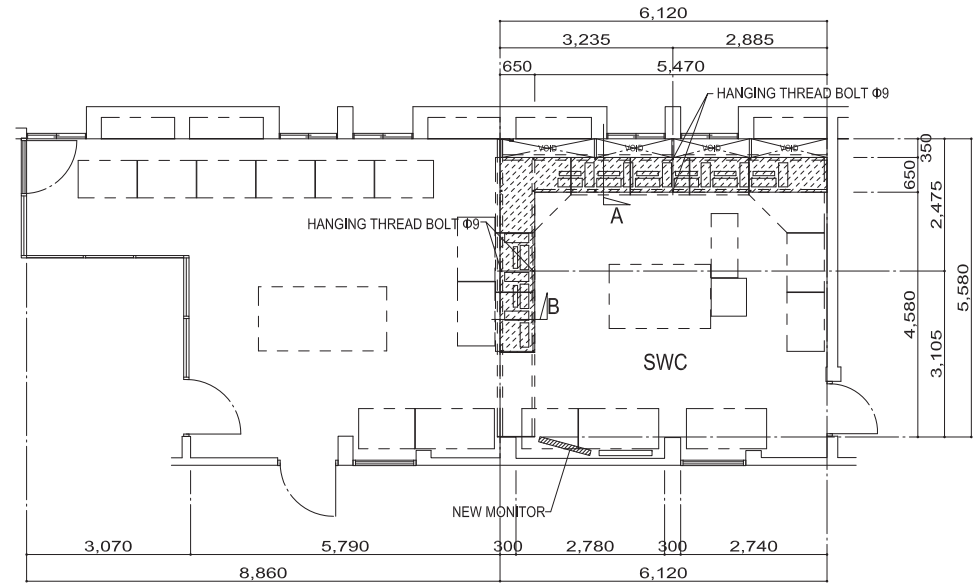
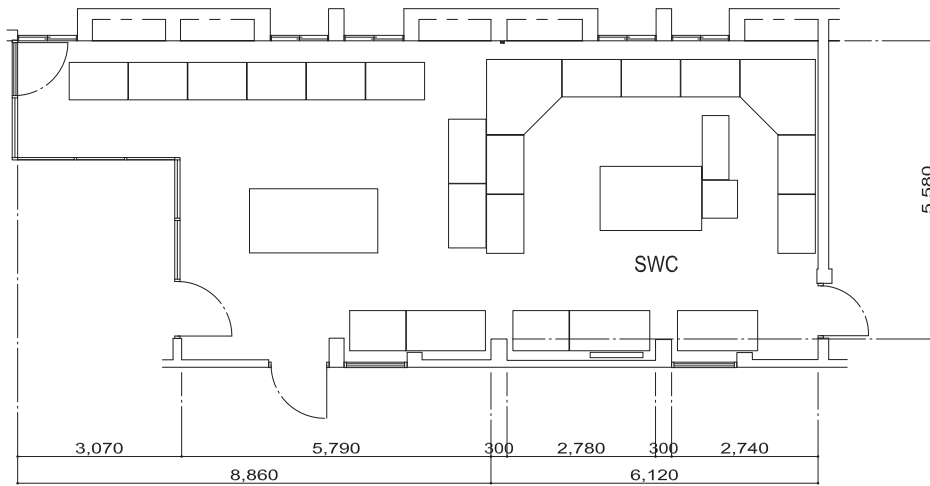
- F-2 Pedestal-free Desk (W1,100 × D700)
- F-4 Drawer Unit with Casters
- F-5 Chair
- F-8 Shelves(Double Hinged Doors)H1,800

STORM WARING CENTRE (BEFORE)

S=1:100

STORM WARING CENTRE (AFTER)

S=1:100

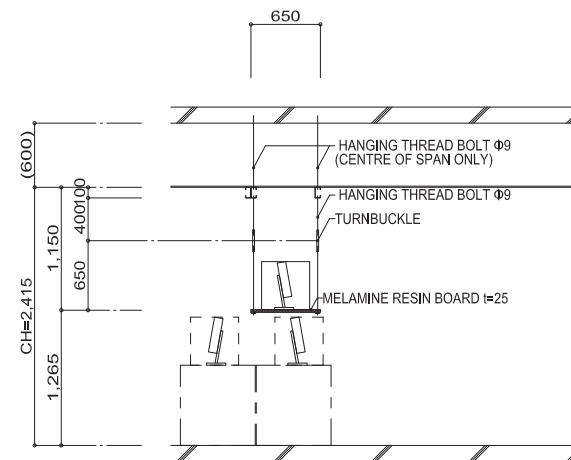
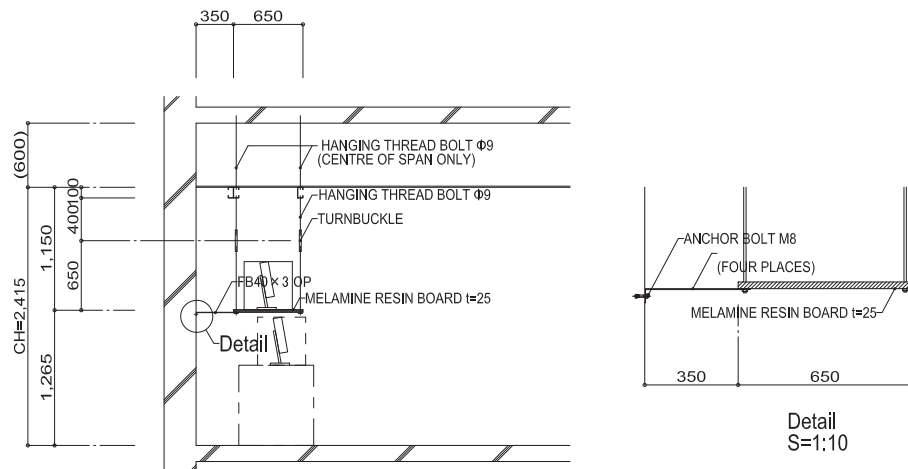


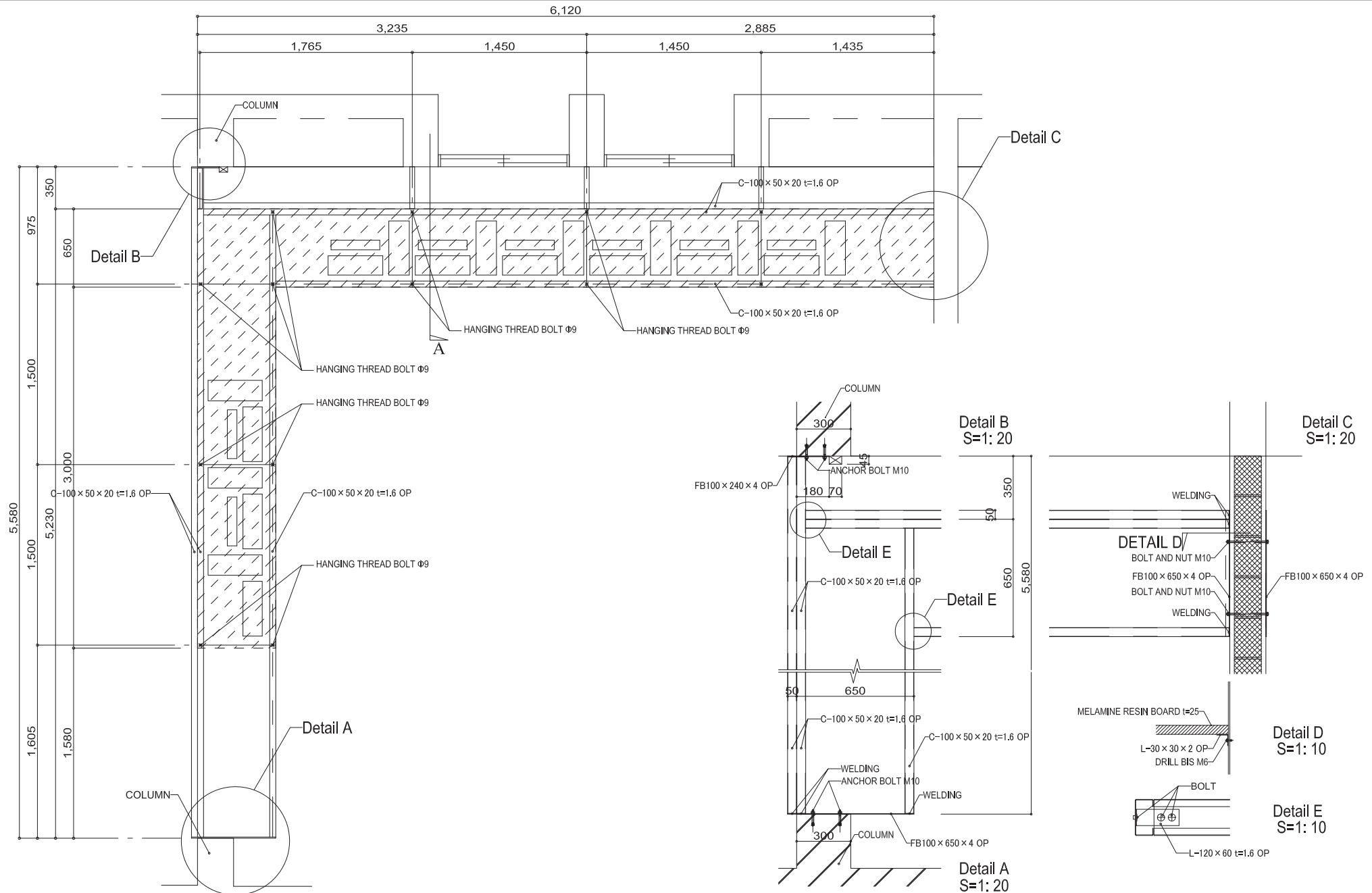
SECTION A

S=1:50

SECTION B

S=1:50





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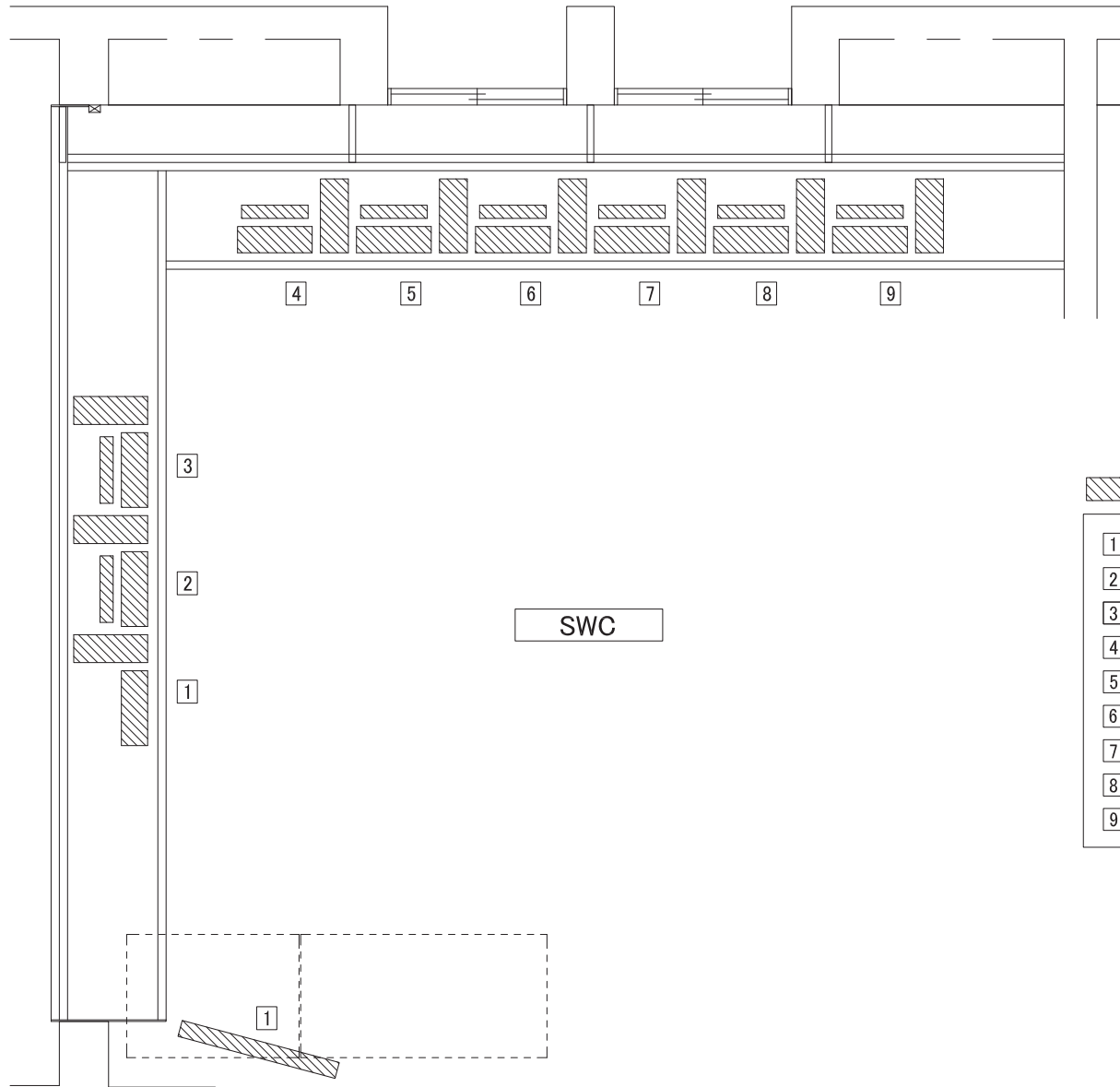


THE PROJECT FOR THE ESTABLISHMENT OF
METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

DRAWING TITLE
STROM WARNIG CENTRE(SWC) AT BMD HEAD OFFICE
FLOOR PLAN AND DETAILS

SCALE
1:30
1:20
1:10

DRAWING No.
EQ - 02 (SWC)



▨ EQUIPMENT (EQUIPMENT WORK)

- ① Composite Processor
- ② Meteorological Data Archiving Unit
- ③ Product Retrieval Unit
- ④ Doppler Velocity Indicator
- ⑤ Rainfall Intensity Indicator
- ⑥ Low Pressure Tracking Display Unit
- ⑦ Accumulated Rainfall Processor
- ⑧ Severe Storm and Doppler Velocity Indicator
- ⑨ Data Analyzing Unit



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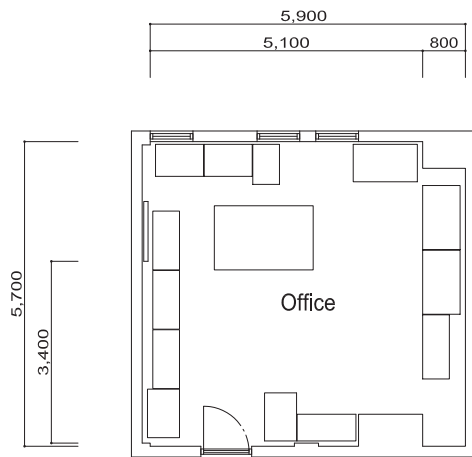


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METEOROLOGICAL RADAR SYSTEM AT DHAKA AND RANGPUR
IN THE PEOPLE'S REPUBLIC OF BANGLADESH

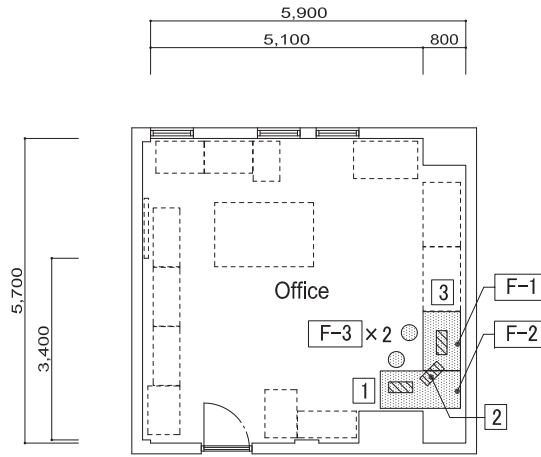
DRAWING TITLE
STORM WARNING CENTRE(SWC) AT BMD HEAD OFFICE
EQUIPMENT LAYOUT PLAN

SCALE
1:30

DRAWING No.
EQ - 03 (SWC)




Existing Layout Plan



Proposed Layout Plan

 EQUIPMENT (EQUIPMENT WORK)

- 1 Rainfall Intensity Display Unit
- 2 Doppler Velocity Display Unit
- 3 Composite Picture Display Unit

 FURNITURE (CONSTRUCTION WORK)

- F-1 Pedestal-free Desk(1100 × 700)
- F-2 Pedestal-free Desk(1500 × 700)
- F-3 Chair

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

According to the following table which shows that most of the natural disasters occurred during the pre-monsoon and monsoon seasons, there was no year wherein no damage was brought about by natural disasters in Bangladesh. From the attached table, it is clear that careful attention must be paid to the implementation schedule of any works to be done during the pre-monsoon and monsoon seasons.

Table 32: Disaster Occurrence Period

Season	Dry Season		Pre-monsoon Season			Monsoon Season			Post-monsoon Season			Dry Season
	1	2	3	4	5	6	7	8	9	10	11	12
Flood												
Flash Flood												
Storm												
Tornado												

1) Implementing agency for the Project

The responsible government agency of Bangladesh for the implementation of the Project is the BMD under the supervision of the Ministry of Defence. The BMD, as the Client, will be a signatory to the Consultancy Agreement and to the Contract.

2) Consultant

After the signing of the Exchange of Notes (E/N) between the Government of Bangladesh and the Government of Japan and the Grant Agreement (G/A) between the Government of Bangladesh and JICA for the Project, it is important to finalize the Agreement of Consulting Services as early as possible. The Agreement of Consulting Services will be signed by the BMD and a Japanese consulting firm, having its principal office in Japan and recommended by JICA.

The consulting firm will become the Consultant for the Project by signing the Agreement. The Consultant will then conduct a detailed design study in Bangladesh with the BMD and, in Japan, prepare the tender documents including technical specifications, drawings, diagrams, etc. In addition, the Consultant, instead of the BMD, will conduct a tender and supervise Project implementation for the successful completion of the Project as part of Japan's Grant Aid Assistance.

3) Contractor

A contractor with the required qualifications (an equipment supplier and a construction company) incorporated and registered in Japan, having its principal office in Japan, will be selected through an open public tender, in accordance with the tender documents prepared by the Consultant and in

accordance with JICA guidelines as approved by the BMD.

2-2-4-2 Implementation Conditions

<Conditions for the Installation of Equipment>

The meteorological radar system, computing equipment and other sophisticated equipment with electric and electronic circuits will be installed in the radar tower buildings. In accordance with the construction schedule, the dispatch of an electrical engineer is required during the time of the installation, adjustment and wiring of the electric power supply and power back-up equipment (AVR, radar power back-up unit, etc.). During the construction period, it is important that there should be smooth procurement of the required materials and hiring of skilled laborers to meet the construction schedule. In addition, specialized skilled engineers are needed for the installation, adjustment and commissioning of the radar system, computing equipment and the sophisticated meteorological equipment. They are essential to ensure the quality of the installation work necessary for accurate meteorological observations. Furthermore, as part of the technology transfer to the BMD staff, specialized highly skilled engineers are required as on-the-job trainees to ensure that the BMD can operate and maintain the equipment efficiently after the Project installation.

2-2-4-3 Scope of Works

The scope of works to be undertaken by Japan's Grant Aid Assistance and the Bangladesh side for the implementation of the Project are as follows.

Table 33: Major Undertakings to be done by Japan's Grant Aid and the Government of Bangladesh (BMD) under Implementation of the Project

No	Items	To be covered by Japan's Grant Aid	To be covered by Bangladesh (BMD)
General Items			
1	To undertake all necessary institutional and juridical procedures in Bangladesh.		●
2	To undertake the Environmental Impact Assessment procedures in Bangladesh, if required.		●
3	To handle duty (Tax) exemption procedures (payment of Custom Duty Value Added Tax : CDVAT), provide requisite legal and/or administrative documentations for customs clearance to customs broker/forwarder to be employed by the Contractor and make payment of all demurrage required at the port of disembarkation for the materials and equipment imported for the Project.		●
4	To provide necessary working spaces with Internet Connection at the BMD Head Office for the Consultant and the Contractor for the implementation of the Project.		●
5	Marine (Air) transportation of the materials and equipment imported from overseas (Japan).	●	
6	In-land transportation from the port of disembarkation in Bangladesh to each Project site.	●	

7	To accord Japanese and other foreign nationals including their dependent/s (if any), whose services may be required in connection with the supply of products and services under the signed contracts, such facilities as may be necessary for their entry into Bangladesh and stay therein for the smooth and uninterrupted performance of their work (i.e. to secure the Multiple Visa for more than 1 year including its extension/s required by the recipient country in connection thereof).		•
8	To exempt goods of Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed by the Government of Bangladesh with respect to their supply (products) and services under the signed contracts.		•
9	To pay bank commission for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.		•
10	To bear all the expenses, other than those to be borne by the Japan's Grant Aid, necessary for the implementation of the Project.		•
11	To ensure the security of the whole Project site/s and of the Japanese and other foreign nationals assigned to the Project prior to the commencement of and during Project implementation.		•
For the Construction of the Radar Tower Building			
12	To clear, level and reclaim the land prior to the commencement of construction work.		•
13	To secure sufficient spaces at the respective Project site/s for temporary facilities such as a contractor's office, workshop, building materials storage, etc. needed for the construction work.		•
14	To obtain necessary permissions from the relevant agencies for the construction of the Radar Tower Buildings in the Dhaka (Joydevpur) and Rangpur Radar Observation Stations.		•
15	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) along with electric poles/wires, etc. from the main supply line to the proposed site for the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.		•
16	To install the required step-down transformer as well as service entrance connections for the commercial power supply at the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.		•
17	To provide incidental facilities, such as water supply, telephone lines and internet provision, for Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.		•
18	To provide temporary facilities for the availability or accessibility of electricity, water, etc. for the construction work.		•
19	To construct the Radar Tower Buildings, including a) Architectural and civil works b) Electrical works including a lightning protection system c) Air-conditioning and Ventilation works d) Plumbing works	•	
20	To procure and install standard furniture for the Radar Tower Buildings.	•	
21	To undertake incidental outdoor works such as a guard shed, gardening, fencing, gates, boundary walls of the perspective offices and exterior lightings and to renovate the existing building in the Joydevpur Observatory.		•
22	To renovate the existing gates, boundary walls, exterior lightings and Rangpur radar tower building and to shift the existing observation field in the Rangpur Observatory.		•
23	To provide On-the-job Trainings (Initial Trainings) by the contractor on the operation and maintenance of the Radar Tower Buildings as well as its inherent facilities for the BMD.	•	
24	To ensure transport for the BMD personnel and to shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, accommodation, etc.		•
25	To provide the contractor's written guarantee to the BMD for the Radar Tower Buildings constructed under the Project for a period of twelve (12) months from the completion date of the equipment installation work.	•	
For Installation Work of the Equipment			
26	To remove and relocate the existing facilities if available for the installation of the equipment, if necessary.		•
27	To provide and allocate secure temporary storage area/room for the materials, tools and equipment needed during the installation process.		•

28	To obtain the required frequency for the Dhaka (Joydevpur) meteorological radar system (the existing frequency of Rangpur meteorological radar system is utilized for a new radar system).		●
29	To obtain the required VSAT user license from the Bangladesh Telecommunication Regulatory Commission (BTRC) for the use of satellite communication for the meteorological data satellite communication system (VSAT) to be installed.		●
30	To obtain the required space segment for the use of satellite communication for the meteorological data satellite communication system (VSAT) at the BMD Dhaka (Joydevpur) Radar Observation Station.		●
31	To establish the Digital Data Network (DDN) between the SWC at the BMD Head Office and the Dhaka (Joydevpur) Radar Observation Station as a backup data communication link.		●
32	To upgrade the data transmission speed of 64kbps to 128kbps for the existing Digital Data Network (DDN) between the SWC at the BMD Head Office and the BMD Meteorological Briefing Room in the Hazrat Shah Jalal International Airport (Dhaka).		●
33	To set up new assigned IP addresses in the computing equipment supplied under the Project.		●
34	To secure ample and strategically located space/s at the existing facilities (the SWC at the BMD Head Office and the BMD Meteorological Briefing Room in the Hazrat Shah Jalal International Airport (Dhaka)) for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project.		●
35	To procure and install furniture for the Equipment to be procured under the Project.	●	
36	To procure, install and adjust the required Equipment for Project implementation	●	
37	To conduct the commissioning for the total system.	●	
38	To provide On-the-job Trainings (Initial Trainings) by the contractor on the operation and maintenance of the Equipment for the BMD.	●	
39	To ensure transport for the BMD personnel and to shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, accommodation, etc.		●
40	To provide the contractor's written guarantee to the BMD for the Equipment and Installation Work executed under the Project for a period of twelve (12) months from the completion date of the equipment installation work.	●	
After the completion of the Project			
41	To renovate the existing gates, boundary walls and exterior lighting in and around the sites as if and when required.		●
42	To assign the required staff for the smooth operation and maintenance of the Equipment.		●
43	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment.		●
44	To provide adequate maintenance of the Radar Tower Building constructed under the Project so that they may function long lasting and effectively.		●
45	To properly operate and maintain, and also effectively utilize the facilities constructed and the Equipment procured/installed under the Project.		●
46	To allocate the necessary budget for the smooth conduct of meteorological radar observation and forecasting works.		●
47	To take necessary steps for creating proposed new posts and recruiting the required man power immediately after the Project Completion.		●
48	To periodically update all the operation/antivirus/application software(s).		●

2-2-4-4 Consultant Supervision

1) Principal Guidelines

- a) To take responsibility for expediting project implementation as well as providing smooth supervision, in accordance with the guidelines of Japan's Grant Aid Assistance and the Outline Design.
- b) To communicate closely with the responsible organizations and personnel of both countries, and complete the Project in time and in accordance with the implementation schedule.
- c) To provide appropriate advice to the personnel of the BMD and the contractor.
- d) To ensure the safety of the project implementation as its top priority through the early/advance detection of severe weather phenomena.

2) Consultant Supervision

- a) The Consultant will dispatch at least one responsible and highly capable personnel to Bangladesh during each implementation stage in the Project.
- b) Consultant technical specialists will be dispatched to Bangladesh for installation guidance, inspection work, etc. for the installation and configuration work of the major hardware, data communication equipment, computing equipment and system software.
- c) The Consultant will attend factory performance tests, configuration verifications and inspections of the equipment on behalf of and instead of the BMD.
- d) Qualified engineer(s) will be dispatched for data transmission tests in Bangladesh.

3) Scope of Work for Supervision

- a) The Consultant, in coordination with the BMD, will prepare the contract in accordance with JICA standards; select a Japanese prime contractor through tendering; and recommend the nominated contractor to the Government of Bangladesh.
- b) The Consultant will inspect and approve shop-drawings, system drawings & diagrams and material samples submitted by the contractor, and verify the performance and function of all equipment.
- c) Based on a review of the implementation schedule, the Consultant will provide instructions to the contractor and submit progress reports on the implementation of the Project to the BMD, the Embassy of Japan in Bangladesh, the JICA Bangladesh local office, etc.
- d) The Consultant will cooperate in the certification of payment, such as through the examination of notices of approval and invoices in connection with implementation cost to be disbursed during the implementation period and upon completion of the Project.

2-2-4-5 Quality Control Plan

According to past local meteorological data at the BMD Head Office in Dhaka, the temperature could reach up to more than 30°C. In view of this, the ambient and concrete temperature will be measured during concrete pouring to ensure correct concrete quality. The quality control plan for the main work is described in the table below.

Table 34: Quality Control Plan

Work	Work Type	Control Item	Method	Remarks
Structural Work	Concrete work	Fresh concrete Concrete strength	Slump, air volume, temperature Comprehensive strength test Chloride Quantity Test Alkali Aggregate Reactivity Test	Concrete strength test will be conducted at each site.
	Reinforcing work	Reinforcing bar Arrangement	Tensile test, mill sheet check Bar arrangement check Factory inspection sheet check	
	Pile work	Material, bearing capacity	Bearing capacity check	
Finishing Work	Roof work	Workmanship, leakage	Visual inspection, water spray test	
	Tile work	Workmanship	Visual inspection	
	Plastering work	Workmanship	Visual inspection	
	Door & Window work	Products, Installation accuracy	Factory inspection sheet check Visual inspection, dimension check	
	Painting work	Workmanship	Visual inspection	
	Interior work	Products, workmanship	Visual inspection	
Electrical Work	Power Receiving & Transforming	Performance, operation installation check	Factory inspection sheet check; withstand voltage, megar, operation, visual inspection	
	Conduit work	Bending, support check	Visual inspection, dimension	
	Wiring and Cable work	Sheath damage, loose connection check	Performance sheet check, cleaning before laying, marking after bolt fixing	
	Lightning work	Resistance, conductor support pitch check	Resistance measuring, visual inspection, dimension	
	Lighting work	Performance, operation, installation check	Performance sheet check, illumination measurement, visual inspection	
Mechanical Work	Water Piping Work	Support pitch, leakage	Visual inspection, leakage, water pressure test	
	Pump Installation	Slope, Support pitch, leakage	Visual inspection, leakage, flow test	
	Air-Con. work	Performance, operation installation check	Performance sheet check, temperature measurement	
	Sanitary Fixture	Operation, installation, leakage check	Visual inspection, flow test	

2-2-4-6 Procurement Plan

(1) Equipment Procurement

Maintenance requirements and the availability of the necessary parts and consumables in Bangladesh are two of the most important factors in selecting the equipment. The equipment procurement process must provide for continuing maintenance after the completion of the Project. None of the meteorological equipment, such as the pulse compression solid state Doppler radar system, the meteorological radar data display system, and etc., to be supplied under the Project is produced in Bangladesh. The pulse compression solid state Doppler radar system which has already been put into practical use for

meteorological observation and has confirmed its reliability, durability, accuracy and performance is only available and made in Japan. The designed mean time between failure (MTBF) of the transmitter for this system is more than 100,000 hours and the designed mean time to repair (MTTR) of the transmitter is 0.5 hours. In addition, since almost all the Japanese meteorological radar systems established under Japan's Grant Aid in other developing countries have been working well over the years, Japanese systems have received a high degree of confidence in the world. Therefore, it is certainly recognized, even by the WMO, that a Japanese system is the most suitable system for developing countries normally faced with operational and maintenance difficulties.

The activities of the private sector in Bangladesh will be useful in support of the computer and other sophisticated systems. There are major computing equipment manufactures and local agents/suppliers in the country. The procurement plan for the equipment is designed with a view to achieve a maximum possible degree of standardization as well as facilitating the acquisition of spare parts and maintenance services for the chosen computing equipment.

(2) Procurement of Construction Material

1) Procurement Policy of Construction Material

As the main construction materials can be procured locally, they will, in principle, be procured in Bangladesh. However, the products produced in Bangladesh are limited to gravel, sand, fresh concrete, some secondary concrete products (blocks, floor materials, etc.) and timber for temporary works, etc. Other construction materials imported from the neighboring countries are marketed throughout Bangladesh. As these imported materials can be easily procured locally, they are considered as part of the procurement of local products. In order to ensure the easy maintenance of the radar tower building, locally available materials will be utilized for construction.

2) Procurement Plan of Construction Material

[1] Structural Work

The main materials for the structural work, such as fresh concrete, plywood for form works, etc., can be procured locally. Locally made concrete blocks are available and are a common material for building construction.

[2] Building Exterior and Interior Work

Timber, tiles, paint, glass, aluminum window frames, etc. used for the exterior and interior of a building are imported from ASEAN countries and, in principle, are readily available in the local market. For the proposed buildings, airtight aluminum and steel doors & windows are required.

[3] Air-Conditioning and Plumbing Work

Imported air-conditioning equipment, exhaust fans, sanitary-fixtures, etc. are popular in Bangladesh. In principle, those products can be procured in the local market with a view to ease of repair and maintenance. However, large air-conditioning units and exhaust fans, which are unavailable in the local market, will be procured from ASEAN countries.

[4] Electrical Work

Imported and local Lighting fixtures, switches, lamps, electrical wires and cables, conduits and other items are available in the local market. They will, in principle, be procured in Bangladesh for the convenience of repair and maintenance. However, custom-made building equipment such as control panels, power distribution boards and switch boards will be procured from ASEAN countries.

Table 35: Major Materials Procurement Plan (Architectural Work)

Materials	Local Market		Procurement Plan		
	Condition	Import	Bangladesh	Third Country	Japan
Portland cement	○		✓		
Sand, aggregate	○		✓		
Reinforcing bar	○		✓		
Form (plywood)	○		✓		
Concrete block	○		✓		
Asphalt waterproofing	△		✓		
Wood	○		✓		
Aluminum door & window	△		✓		
Steel door & window	△		✓		
Wooden door & window	○		✓		
Door handle, lock	○		✓		
Floor hinge	○		✓		
Plane glass	○		✓		
Glass block	○		✓		
Laminated safety glass	○		✓		
Access floor panel	○		✓		
Access floor panel (heavy duty type)	△		✓		
Paint	○		✓		
Gypsum board (T-bar)	○		✓		
Cement board	○		✓		
Rockwool acoustic board (T-bar)	○		✓		
Glass wool, glass cloth	○		✓		
Carpet tile	△		✓		
PVC tile	○		✓		
Porcelain tile	○		✓		
Ceramic tile	○		✓		
Floor maintenance hatch	○		✓		
Kitchen	○		✓		
Roof drain	○		✓		
Steel drainage pipe (galvanized)	○		✓		
Concrete pavement block	○		✓		
Spray tile	○		✓		
Caulking	○		✓		

○ : Easy to procure in Bangladesh

△ : Available in the local market in Bangladesh but model and quantity are limited

× : Difficult to procure in Bangladesh

Table 36: Major Materials Procurement Plan (Mechanical and Electrical Work)

Work type	Materials	Local Market		Procurement Plan		
		Condition	Import	Bangladesh	Third Country	Japan
Air-conditioning work	Air conditioner	△		✓		
	Heat exchanger	×	ASEAN		✓	
	Exhaust fan (salt-proof)	△		✓		
Plumbing work	Sanitary fixture	○		✓		
	Pipe	○		✓		
	Fire extinguisher	○		✓		
	Water lifting pump	○		✓		
	Electric water heater	○		✓		
Electrical work	Lighting fixture (including LED)	○		✓		
	Obstruction light (LED)	×	Japan			✓
	Panel	△	ASEAN		✓	
	Wire, cable	○		✓		
	Conduit (PVC)	○		✓		
	Conduit (Steel)	○		✓		
	Cable-rack	○		✓		
	Telephone system	△	ASEAN		✓	
	Isolation Transformer	×	Japan			✓
	AVR	×	Japan			✓
	Fire alarm system	○		✓		
	Diesel engine generator	○		✓		
	Lightening protection	○		✓		

○ : Easy to procure in Bangladesh

△ : Available in the local market in Bangladesh but model and quantity are limited

×

3) Transportation Plan

Transportation of the equipment from Japan would principally use container shipment. The main disembarkation point for maritime cargo to Bangladesh is the Chittagong Seaport. Transport from Japan to the Chittagong Seaport takes at least 1 month including all the necessary procedures to be undertaken in Japan for exporting the equipment to Bangladesh while custom clearance takes 0.5 month.

In order to obtain tax exemptions in Bangladesh, the BMD will submit each copy of the “Contract signed by BMD and a selected supplier for the Project” and each “Proforma Invoice” to the National Board of Revenue (NBR) and the BMD will obtain the required permission for the tax exemptions 2 to 3 weeks after submission.



Figure 17: Route Map of Transport

As a consequence of the study, the safe inland transport up to each project site has been decided to be as follows.

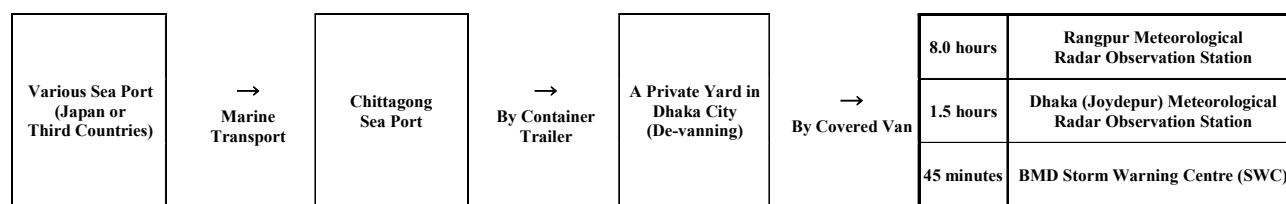


Figure 18: Inland Transport Route to Each Project Site

2-2-4-7 Operational Guidance Plan

The required operational guidance will be implemented through the practical operational simulation of each system during the course of the completion of equipment installation. During the equipment installation period, the operational guidance for cabling, piping (wave guide), unit replacement/adjustment, transmitter discharge, and etc. of the meteorological radar system will be imparted to the BMD. As such, the operational guidance of the said items will no longer be implemented after the completion of equipment installation. The operational guidance for each system will be implemented at the following places indicated in the table attached hereunder.

Table 37: Operation and Maintenance Training

Equipment	Dhaka Meteorological Radar Observation Station (Joydepur Observatory)	Rangpur Meteorological Radar Observation Station (Rangpur Observatory)	Storm Warning Centre (SWC) at the BMD Head Office	BMD Meteorological Briefing Room in Hazrat Shah Jalal International Airport (Dhaka)
Meteorological Radar System • Power Unit • Antenna • Radar Unit • Meteorological Radar Transmission Unit • Computer Network Unit • Power Back-up Unit • Application Software	○	○	-	-
Meteorological Radar Data Display System • Power Unit • Computer Network Unit • Application Software	○	○	○	○
Meteorological Data Satellite Communication System (VSAT) • Power Unit • VSAT Communication Unit • Computer Network Unit • Application Software	○	○	○	-

Apart from the Operation and Maintenance Training, technology transfer through the practical installation and adjustment works to be carried out by the BMD staff together with the Consultant and the contractor will be necessary and quite effective if done during the installation period. If technology transfer is conducted after completion of the installation work, it is difficult to simulate training on some parts/areas

located in deeper places within the system such as cabling and wiring routes, connecting points of each unit, and etc. which would require disassembling the radar system to be able to see them. In addition, repeated software installation by the BMD staff themselves is important to obtain further familiarization and technical knowledge. In case of a down in the system, disassembling the system and software reinstallation by the BMD staff may be required. Therefore, all the significant parts of technology transfer must be completed during the installation work period.

2-2-4-8 Soft Component Plan

<Soft Component>

None of the BMD’s technical staff have the practical experience in operating a digital meteorological radar system which is planned to be procured under the Project as the existing Dhaka and Rangpur meteorological radar systems are of the analog type. For the smooth operation and maintenance of the digital S-Band Doppler Pulse Compression Solid State Radar Systems, for the dissemination of high accuracy medium range weather forecasts to be prepared through weather guidance to the public, and for the assurance of the required sustainability of the project outcomes, the implementation of the technology transfers in the soft component mentioned below (soft component schedule is indicated in the Implementation Schedule attached hereunder) is required.

<Soft Component Target>

To enable the BMD to independently and appropriately operate the Meteorological Doppler Radar Systems.

<Soft Component Indicators>

Soft Component Indicators are as follows.

Table 38: Soft Component Indicators

No.	Item	Output	Objectively Verifiable Indicators	Means of Verification
1	Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery and Major Fault Countermeasures	Acquisition of technical know-how on appropriate inspection, adjustment, minor fault finding, remedy and recovery.	Inspection, adjustment, minor fault finding, remedy and recovery, and major fault countermeasures (a. routine maintenance using measuring instruments and tools, b. practice of replacing spare parts into the actual system and the subsequent confirmation of system operation, c. practice of remedy, recovery and major fault countermeasures: distributing information to the Consultant and the manufacturer and receiving technical advice) are carried out appropriately by the BMD.	<ul style="list-style-type: none"> Confirmation of proficiency through 1) routine maintenance using measuring instruments and tools; 2) practice of replacing spare parts into the actual system and the subsequent confirmation of system operation; 3) practice of minor fault finding, remedy and recovery; and 4) major fault countermeasures. Technical interviews
2	Prompt and Appropriate Meteorological Doppler	Technical knowledge	Meteorological Doppler radar operation and maintenance	<ul style="list-style-type: none"> Evaluation of the frequency of usage of the meteorological Doppler radar system

	Radar Operation and Maintenance utilizing the Meteorological Radar System Manual Summary and the Meteorological Radar System Maintenance & Management Record Book	acquisition of prompt and appropriate meteorological Doppler radar operation and maintenance	utilizing the meteorological radar system manual summary and the meteorological radar system maintenance & management record book are implemented promptly and appropriately.	manual summary. Confirmation of indication (daily, weekly, monthly) in the meteorological radar system maintenance & management record book and through technical interviews
3	Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode Sequence & Schedule	Appropriate meteorological radar operation.	Meteorological radar observation is implemented according to the radar observation sequence & schedule for Intensity Mode and Doppler Mode.	Confirmation of meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecast operation.

<Means of Verification for Outputs Achievement>

Means of verification for outputs achievement of the Soft Component are indicated in the Table 38 attached above.

<Scheduled Activities of Soft Component>

Scheduled Activities of Soft Component are as follows.

Table 39: Scheduled Activities of Soft Component

Output	Required Technique and Field	Current Technique and Required Technique Level	Target Group	Means of Implementation	Source of Implementation	Product
1. Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery, and Major Fault Countermeasures	An engineer capable of meteorological radar adjustment and fault finding.	Since engineers in the BMD have practical experience of adjusting and fault finding in an analog meteorological radar system, it is imperative that the BMD engineers should acquire the capability of adjusting and fault finding in a digital meteorological radar system.	Indicated in the table below	Routine maintenance using measuring instruments and tools.	<First> Expert Consultant on meteorological radar adjustment and fault finding: 1.20 man-months. (Period of Technology Transfer in Bangladesh: 36days) Direct Support <Second> Expert Consultant on meteorological radar adjustment and fault finding: 0.77 man-months. (Period of Technology Transfer in Bangladesh: 23days) Direct Support	Manual on routine maintenance using measuring instruments and tools.
				Practice of replacing spare parts into the actual system and the subsequent confirmation of system operation.		Manual on replacing spare parts into the actual system and the subsequent confirmation of system operation.
				Practice of countermeasure, minor fault finding, remedy and recovery.		Manual on fault finding, remedy and recovery.
				Practice of major fault countermeasures.		Manual on major fault countermeasures.
2. Preparation of Meteorological Doppler Radar System Manual Summary and Meteorological Radar System	An engineer capable of meteorological radar operation and maintenance.	Since engineers in the BMD have practical experience of operating and maintaining an analog meteorological radar system, it is imperative that the	Indicated in the table below	Discussion with the BMD engineers.	<First> Expert Consultant on meteorological radar operation and maintenance: 1.20 man-months (Period of Technology	Meteorological Doppler radar system manual summary
				Selection of the most important points from the meteorological Doppler radar system manual.		Meteorological radar system maintenance & management record book
				Production of the		

Maintenance & Management Record Book		BMD engineers should obtain the capability of operating and maintaining a digital meteorological radar system according to the meteorological Doppler radar system manual summary and the meteorological radar system maintenance & management record book.		<p>meteorological Doppler radar system manual summary.</p> <p>Production of the meteorological radar system maintenance & management record book.</p> <p>Utilization of the meteorological Doppler radar system manual and the meteorological radar system maintenance & management record book by the BMD engineers.</p>	<p>Transfer in Bangladesh: 36 days)</p> <p>Direct Support</p> <p><Second> Expert Consultant on meteorological radar operation and maintenance: 0.77 man-months. (Period of Technology Transfer in Bangladesh: 23days)</p> <p>Direct Support</p>	<p>→ Date and time of occurrence of system failure/trouble</p> <p>→ Cause/s of system failure/trouble (abnormal noise, part degradation, etc.)</p> <p>→ Repair procedures implemented</p> <p>→ Name and quantity of replaced parts</p> <p>→ Name of engineer/s who perform/s the repair /troubleshooting</p>
3. Preparation of the Sequence & Schedule for Intensity Mode and Doppler Mode	An engineer who can identify Clutter and Blind Area by using radar observation data and prepare a sequence & schedule for meteorological radar observation which is suited to the weather phenomena in Bangladesh	Since engineers in the BMD have no practical experience of CAPPI observation due to no CAPPI function in the existing analog meteorological radar system, it is imperative that the BMD engineers should obtain the capability of preparation of sequences & schedules for meteorological radar observation.	Indicated in the table below	<p>Discussion with the BMD engineers and lecture.</p> <p>Identification of Clutter of meteorological radar system and Blind Area at antenna elevation angle (0.5 interval degree, between 1-3 degrees).</p> <p>Preparation of Blind Area at antenna elevation angle (0.5 interval degree, between 1-3 degrees).</p> <p>Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode.</p> <p>Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.</p>	<p>Expert Consultant on meteorological radar observation: 1.03 man-month (Period of Technology Transfer in Bangladesh: 31 days)</p> <p>Direct Support</p>	Sequence & Schedule for Intensity Mode and Doppler Mode

Target personnel for each technology transfer in the Soft Component are indicated below.

Table 40: Target Personnel in the BMD for the Technology Transfer in the Soft Component (Technology Transfer of No. 1 & 2)

Engineers/Staff	BMD Head Office (including Storm Warning Centre: SWC)	Dhaka (Joydepur) Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station
Senior Electronic Engineer	1	0	0
Electronic Engineer	1	0	0
Assistant Electronic Engineer	2	2	1
Assistant Communication Engineer	4	0	0
Electronic Assistant	5	6	3
Foreman	3	0	1
Mechanic- II	3	2	0

**Table 41: Target Personnel in the BMD for the Technology Transfer in the Soft Component
(Technology Transfer of No. 3)**

Engineers/Staff	BMD Head Office (including Storm Warning Centre: SWC)	Dhaka (Joydepur) Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station
Senior Electronic Engineer	1	0	0
Electronic Engineer	1	0	0
Assistant Meteorologist	10	0	2

<Soft Component Product>

Soft Component Products are as follows.

Table 42: Soft Component Products in Technology Transfer

Product Name	Submission Time	No. of Pages	
Implementation report on 1) routine maintenance using measuring instruments and tools, 2) practice of replacing spare parts into the actual system and the subsequent confirmation of system operation, 3) practice of minor fault finding, remedy and recovery, and 4) major fault countermeasure.	After Technology Transfer	20	
Meteorological Doppler radar system manual summary		30	
Meteorological radar system maintenance and management record book		10	
Radar observation sequence & schedule for Intensity Mode and Doppler Mode		10	
Output Name	Content	Submission Time	No. of Pages
Soft Component Completion Report	<ul style="list-style-type: none"> • Scheduled Activities and Actual Achievement • Scheduled Outputs and Achievement • Factors which influence Achievement of Outputs • Recommendation • Outputs 	Completion of Soft Component	50

2-2-4-9 Implementation Schedule

Table 43: Implementation Schedule

Month	1	2	3	4	5	6	7	8	9
Detailed Design & Tendering Procedures	Total : 9.0 months								
Detailed Design	■	■	■						
Tendering Procedures				■	■	■	■	■	■

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34					
Rangpur Meteorological Radar Observation Station																																							
Construction Work	Total : 16.0 months																																						
Preparation Work	■																																						
Temporary/Piling/Earth Works		■	■	■	■																																		
Structure Work					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Finishing Work																																							
Building Equipment																																							
External Work																																							
Equipment Work	Total : 17.0 months																																						
Equipment Manufacturing																																							
Equipment Transportation																																							
Equipment Installation/Adjustment																																							
BMD Head Office Storm Warning Centre (SWC)																																							
Equipment Work	Total : 15.0 months																																						
Equipment Manufacturing																																							
Equipment Transportation																																							
Equipment Installation/Adjustment																																							
Hazrat Shahjalal International Airport (Dhaka)																																							
Equipment Work	Total : 15.0 months																																						
Equipment Manufacturing																																							
Equipment Transportation																																							
Equipment Installation/Adjustment																																							
Dhaka (Joydevpur) Meteorological Radar Observation Station																																							
Construction Work	Total : 16.0 months																																						
Preparation Work																																							
Temporary/Piling/Earth Works																																							
Structure Work																																							
Finishing Work																																							
Building Equipment																																							
External Work																																							
Equipment Work	Total : 17.0 months																																						
Equipment Manufacturing																																							
Equipment Transportation																																							
Equipment Installation/Adjustment																																							
Soft Component																																							
Soft Component (Activity No. 1)																																							
Soft Component (Activity No. 2)																																							
Soft Component (Activity No. 3)																																							

2-3 Obligations of Recipient Country

In the course of the implementation of the Project under Japan's Grant Aid Assistance, the BMD is responsible for the following tasks.

Table 44: Major Undertakings to be done by BMD under Implementation of the Project

No.	Items
General Items	
1	To undertake all necessary institutional and juridical procedures in Bangladesh.
2	To undertake the Environmental Impact Assessment procedures in Bangladesh, if required.
3	To handle duty (Tax) exemption procedures (payment of Custom Duty Value Added Tax : CDVAT), provide requisite legal and/or administrative documentations for customs clearance to customs broker/forwarder to be employed by the Contractor and make payment of all demurrage required at the port of disembarkation for the materials and equipment imported for the Project.
4	To provide necessary working spaces with Internet Connection at the BMD Head Office for the Consultant and the Contractor for the implementation of the Project.
5	To accord Japanese and other foreign nationals including their dependent/s (if any), whose services may be required in connection with the supply of products and services under the signed contracts, such facilities as may be necessary for their entry into Bangladesh and stay therein for the smooth and uninterrupted performance of their work (i.e. to secure the Multiple Visa for more than 1 year including its extension/s required by the recipient country in connection thereof).
6	To exempt goods of Japanese and other foreign nationals from internal taxes (VAT) and other fiscal levies which may be imposed by the Government of Bangladesh with respect to their supply (products) and services under the signed contracts.
7	To pay bank commission for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.
8	To bear all the expenses, other than those to be borne by the Japan's Grant Aid, necessary for the implementation of the Project.
9	To ensure the security of the whole Project site/s and of the Japanese and other foreign nationals assigned to the Project prior to the commencement of and during Project implementation.
For the Construction of the Radar Tower Buildings	
10	To clear, level and reclaim the land prior to the commencement of construction work.
11	To secure sufficient spaces at the respective Project site/s for temporary facilities such as a contractor's office, workshop, building materials storage, etc. needed for the construction work.
12	To obtain necessary permissions from the relevant agencies for the construction of the Radar Tower Buildings in the Dhaka (Joydevpur) and Rangpur Radar Observation Stations.
13	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) along with electric poles/wires, etc. from the main supply line to the proposed site for the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.
14	To install the required step-down transformer as well as service entrance connections for the commercial power supply at the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.
15	To provide incidental facilities, such as water supply, telephone lines and internet provision, for Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.
16	To provide temporary facilities for the availability or accessibility of electricity, water, etc. for the construction work.
17	To undertake incidental outdoor works such as a guard shed, gardening, fencing, gates, boundary walls of the perspective offices and exterior lightings and to renovate the existing building in the Joydevpur Observatory.
18	To renovate the existing gates, boundary walls, exterior lightings and Rangpur radar tower building and to shift the existing observation field in the Rangpur Observatory.
19	To ensure transport for the BMD personnel and to shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, accommodation, etc.
For Installation Work of the Equipment	
20	To remove and relocate the existing facilities if available for the installation of the equipment, if necessary.
21	To provide and allocate secure temporary storage area/room for the materials, tools and equipment needed during the installation process.

22	To obtain the required frequency for the Dhaka (Joydevpur) meteorological radar system (the existing frequency of Rangpur meteorological radar system is utilized for a new radar system).
23	To obtain the required VSAT user license from the Bangladesh Telecommunication Regulatory Commission (BTRC) for the use of satellite communication for the meteorological data satellite communication system (VSAT) to be installed.
24	To ensure the required space segment for the use of satellite communication for the meteorological data satellite communication system (VSAT) at the BMD Dhaka (Joydevpur) Radar Observation Station.
25	To establish the Internet Protocol Virtual Private Network (IP/VPN) between the SWC at the BMD Head Office and the Joydevpur Radar Observation Station as a backup data communication link.
26	To ensure the data transmission speed of 128kbps for the existing Digital Data Network (DDN) between the SWC at the BMD Head Office and the BMD Meteorological Briefing Room in the Hazrat Shah Jalal International Airport (Dhaka).
27	To set up new assigned IP addresses in the computing equipment supplied under the Project.
28	To secure ample and strategically located space/s at the existing facilities (the SWC at the BMD Head Office and the BMD Meteorological Briefing Room in the Hazrat Shah Jalal International Airport (Dhaka)) for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project.
29	To ensure transport for the BMD personnel and to shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, accommodation, etc.
After the completion of the Project	
30	To renovate the existing gates, boundary walls and exterior lighting in and around the sites as if and when required.
31	To assign the required staff for the smooth operation and maintenance of the equipment.
32	To procure the required spare parts and consumables for the smooth operation and maintenance of the equipment.
33	To provide adequate maintenance of the Radar Tower Building constructed under the Project so that they may function long lasting and effectively.
34	To properly operate and maintain, and also effectively utilize the facilities constructed and the equipment procured/installed under the Project.
35	To allocate the necessary budget for the smooth conduct of meteorological radar observation and forecasting works.
36	To take necessary steps for creating proposed new posts and recruiting the required man power immediately after the Project Completion.
37	To periodically update all the operation/antivirus/application software(s).

2-4 Project Operation Plan

(1) Operation and Maintenance Plan for the Equipment

1) Operational Plan of Meteorological Radar System

Upon completion of the Project, the hours of operation of each meteorological radar system have been planned in accordance with the annual transition of the climate in Bangladesh. The BMD has agreed to abide by the following operational plan.

Table 45: Estimated Annual Operation Hours of the proposed Dhaka (Joydevpur) Meteorological Radar System

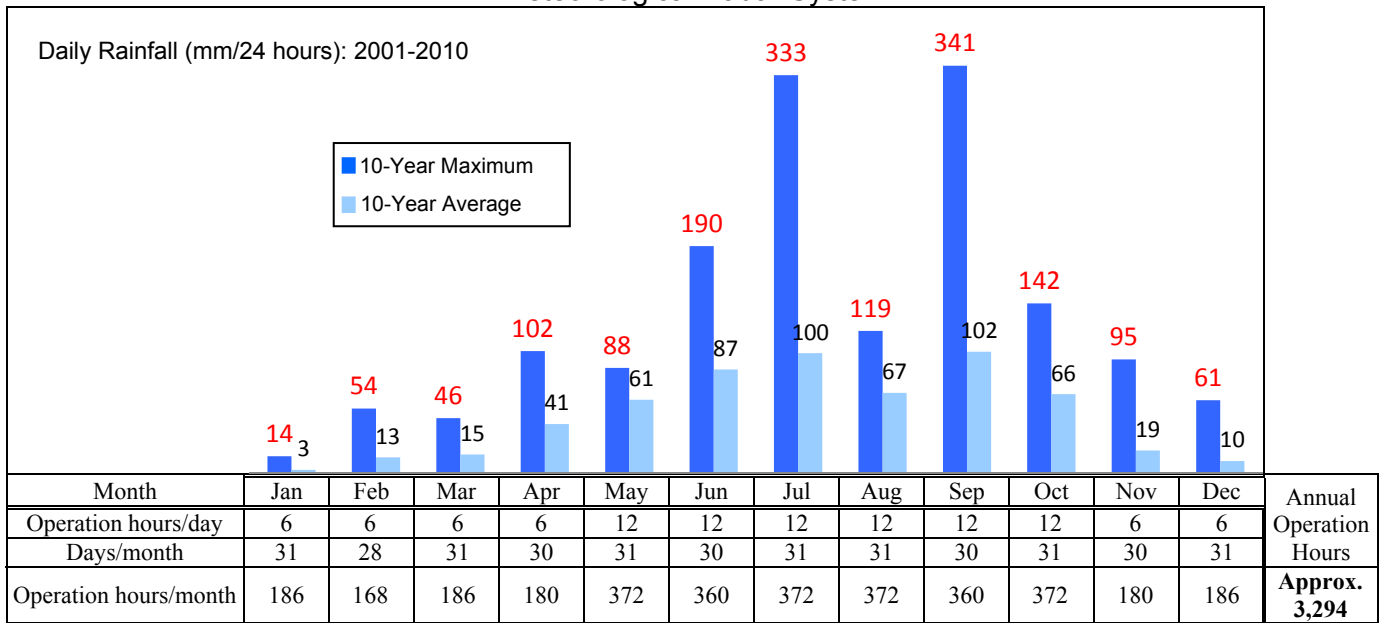
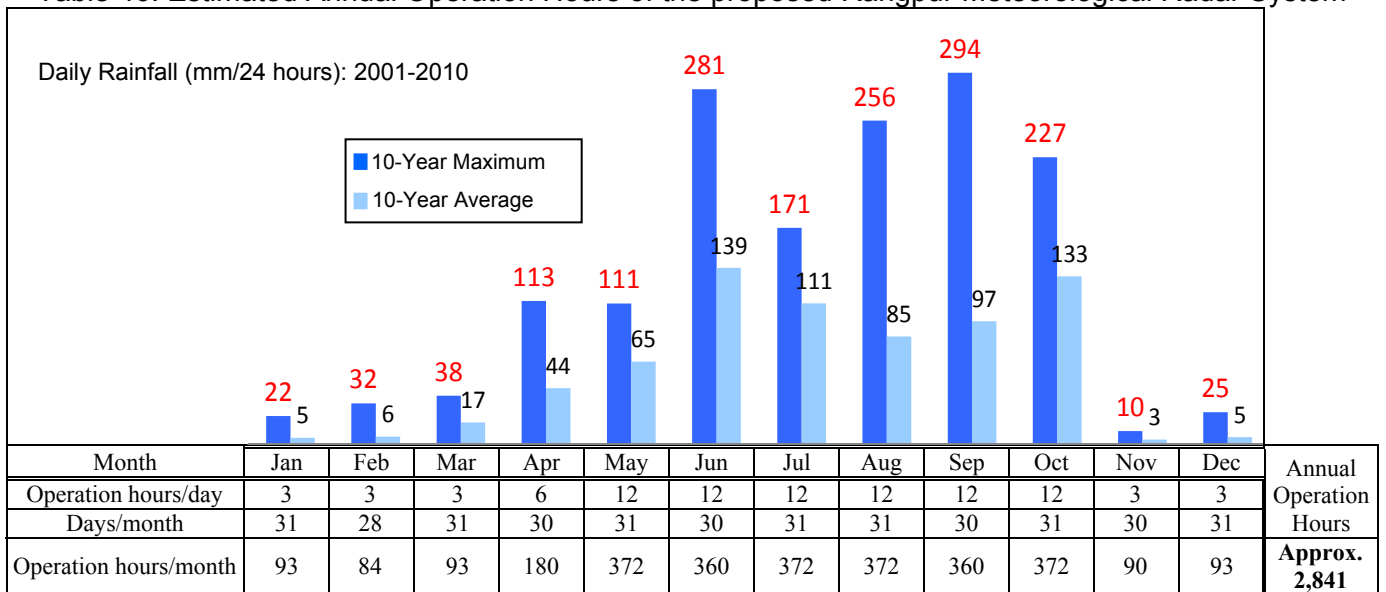


Table 46: Estimated Annual Operation Hours of the proposed Rangpur Meteorological Radar System



2) Operational Plan of Meteorological Radar System

For the appropriate operation of the meteorological radar system, the following number of staff is required.

Table 47: Current and Required Number of Staff after the Project Completion at Dhaka (Joydevpur) and Rangpur Meteorological Radar Stations

Engineers/Staff	Current	After the Project Completion	Current	After the Project Completion
	Existing Dhaka Meteorological Radar Observation Station	Dhaka (Joydevpur) Meteorological Radar Observation Station	Existing Rangpur Meteorological Radar Observation Station	Rangpur Meteorological Radar Observation Station
Senior Electronic Engineer	0	0	0	0
Electronic Engineer	0	0	0	0
Assistant Electronic Engineer	1	2	0	1
Assistant Communication Engineer	0	0	0	0
Assistant Meteorologist	0	0	0	2
Assistant (Meteorology)	0	0	0	1
Electronic Assistant	7	6	4	3
Mechanical Assistant	0	0	0	1
Mechanic- II	1	2	2	0
Senior Observer	0	0	0	4
MLSS (Peon)	1	1	1	0
Guard	0	4	2	3
Total	10	15	9	15

3) Staff Allocation and Radar Observation System Plan at Radar Observation Stations

In connection with equipment maintenance, consideration must be given to the following.

- Technical training for the BMD staff
- Establishment of appropriate measures against system failure
- A fully documented maintenance system, with proper document control
- Scheduled replacement of parts and overhauls
- Strengthening of the operation and maintenance structure of the BMD
- Establishment of technical and financial self-reliance of the BMD

4) Operation and Maintenance Plan for the Equipment

Operation and maintenance of the meteorological radar systems is carried out mainly by BMD electronic engineers and technical staff, however, the number of engineers and technical staff to do this is not sufficient, so it is essential that the existing vacant positions be filled. In order to become a senior electronic engineer or an electronic engineer, the technical staff must have practical experience as an assistant electronic engineer for a certain period of time. The BMD fully recognizes the need to fill the existing vacant positions and has made a firm commitment to recruit capable technical staff. For the staff recruitment, the Ministry of Defence as the supervising ministry of BMD, should give its effective cooperation and special attention on this matter.

In order for the BMD to become self-reliant in technical areas such as the operation and maintenance of radar systems, it is essential that it makes continuing efforts to fill vacancies and promote technology transfer for all staff levels, from entry level technicians to senior engineers.

Table 48: Number of the Existing and Vacant Positions of Each Electronic Engineer Post

Name of Post	Number of Positions	Existing Number	Number of Vacant Positions
Senior Electronic Engineer	1	-	1
Electronic Engineer	4	2	2
Assistant Electronic Engineer	Recruit: 3 Promotion: 3	Recruit: 2 Promotion: 3	Recruit: 1 Promotion: 0
Electronic Assistant	Recruit: 28 Promotion: 14	Recruit: 10 Promotion: 14	Recruit: 18 Promotion: 0

Recruitment for the post of Electronic Assistant and promotion to the post of Assistant Electronic Engineer from Electronic Assistant is pending for a decision to be made by the Ministry of Defense to take into account the seniority of the present diploma and non-diploma Electronic Assistants in the BMD.

5) Enhancement of the existing Electronic and Instrument Division

As of the present, the BMD has five (5) radar systems of which three (3) systems are Doppler and two (2) systems are conventional. With the two (2) new Doppler radar systems at the Dhaka (Joydevpur) and Rangpur Radar Observation Stations provided under the Project, all the radar systems of the BMD will now be Doppler, highly technical in nature and one of the latest and sophisticated models in its category. There will be complete composite pictures of all the radar systems available at the Dhaka Storm Warning Centre. In accordance with the current organogram of the BMD, the Dhaka, Rangpur and Moulvibazar Meteorological Radar Observation Stations are located under the Dhaka Storm Warning Centre and the Cox's Bazar and Khepupara Meteorological Radar Observation Stations are located under the Chittagong Regional Meteorological Office. The BMD has one (1) division, namely, the Electronic and Instrument in the BMD Head Office, responsible for monitoring all the radar systems and remote weather monitoring equipment, such as the automatic weather observation system & rain gauge, etc., in terms of the operation, maintenance and procurement of spare parts & consumables centrally. The meteorological Doppler radar systems consist of electronic and mechanical devices/units. The radar transmitter/receiver, signal processor, antenna controller and display unit are electronic and its antenna dish & pedestal, power back-up equipment, air conditioner, heat exchange, engine generator and substation are mechanical. Therefore, both an electronic engineer group and a mechanical engineer group conducting equipment operation & maintenance together collaboratively is the most effective and efficient way. In this regard, it is very difficult to operate and maintain these sophisticated and sensitive radar systems and equipment with the existing composition of the Electronic and Instrument Division. To avoid this situation and take effective and prompt measures for the system troubles, the existing Electronic and Instrument Division should be enhanced as follows.

Table 49: Current and Required Number of Staff for the Electronic and Instrument Division after the Project Completion

Engineers/Staff	Current Manpower	Proposed Manpower after the Project Completion
Deputy Director (Electronic and Instrument)	0	1
Senior Electronic Engineer	1	1
Senior Mechanical Engineer	0	1
Electronic Engineer	1	1
Mechanical Engineer	1	1

Assistant Electronic Engineer	1	1
Assistant Communication Engineer	0	1
Assistant Meteorologist	1	1
Electronic Assistant	1	3
Chemist	1	1
Mechanical Assistant	1	1
Senior Observer	1	1
Mechanic- Grad II	1	1
Laboratory Attendant	1	1
MLSS (Peon)	1	1
Total	12	17

(2) Operation and Maintenance Plan for the Radar Tower Building

There are three key issues for the maintenance of the radar tower building to be implemented by the BMD: (i) daily cleaning; (ii) maintenance to cover wear and tear, damage and aging; and (iii) security measures to ensure safety and to prevent crimes.

The daily cleaning of the building gives a good impression on the visitors/users and encourages people to respect the building and the equipment in it. Cleaning is also important to ensure the equipment continues to operate correctly. It helps in the rapid detection and repair of damaged equipment and prolongs the life of the building equipment. The main repair work will be refurbishing or replacing the exterior and interior materials protecting the building structure. The required inspections are outlined below.

Table 50: Outline of Regular Inspection for the Building

	Items of Maintenance Work	Frequency
Exterior	Repair and repainting of external walls	Repair: every 5 years, Repaint: every 15 years
	Inspection and repair of roofs	Inspection: every year Repair: as required
	Regular cleaning of drain pipes and drainage systems	Monthly
	Inspection and repair of sealing of external windows and doors	Every year
	Regular inspection and cleaning of ditches and manholes	Every year
Interior	Renewal of interior finishing	As required
	Repair and repainting of partition walls	As required
	Adjustment of window and door fitting	Every year

It is important that regular preventive maintenance of the building equipment is carried out before the equipment fails or requires repair or replacement of part(s). The life of the building equipment can be significantly extended by proper operation and regular inspection, lubrication, adjustment and cleaning. These regular inspections can prevent equipment failure and accidents. The regular inspection, replacement of consumables and cleaning/replacement of filters for ventilation and air-conditioning units should be carried out in accordance with the maintenance manual.

It is essential to establish a proper maintenance structure in the BMD, involving the rigorous implementation of regular inspection and maintenance procedures. This work may be assigned to the

private sector (local agents), if required. The general life expectancy of the major building equipment is shown below.

Table 51: Life Expectancy of Building Equipment

System	Building Equipment	Life Expectancy
Electrical System	• Distribution panels	20 – 30 years
	• LED lamps	20,000 – 60,000 hours
	• Fluorescent lamps	5,000 – 10,000 hours
	• Incandescent lamps	1,000 – 1,500 hours
Water Supply and Drainage Systems	• Pipes and valves	15 years
	• Sanitary fixture	25 – 30 years
Air-Conditioning System	• Pipes	15 years
	• Air-conditioning units and exhaust fans	15 years

2-5 Project Cost Estimate

2-5-1 Estimate of Project Cost and Capital Cost to be borne by the BMD

The required capital cost for the Project to be borne by the BMD has been estimated and is shown in the following tables.

Project Cost to be borne by the BMD

Total Project Cost: 455,280,000 Taka (approx. 600 Million JP Yen)

Table 52: Estimated Capital Cost to be borne by the BMD

No.	Items	Capital Cost (Taka)
1	To handle duty (Tax) exemption procedures (payment of Custom Duty Value Added Tax : CDVAT), provide requisite legal and/or administrative documentations for customs clearance to customs broker/forwarder to be employed by the Contractor and make payment of all demurrage required at the port of disembarkation for the materials and equipment imported for the Project.	247,100,000 245,600,000 (CDVAT: 30% of the equipment & transport cost) + 1,500,000 (Demurrage)
2	To exempt goods of Japanese and other foreign nationals from internal taxes (VAT) and other fiscal levies which may be imposed by the Government of Bangladesh with respect to their supply (products) and services under the signed contracts.	96,900,000 15% of the Local Portion of the Direct & Indirect Building Construction Cost
3	To pay bank commission for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.	60,400,000 3% of the Total Project Cost
4	To obtain necessary permissions from the relevant agencies for the construction of the Radar Tower Buildings in the Dhaka (Joydevpur) and Rangpur Radar Observation Stations.	300,000
5	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) along with electric poles/wires, etc. from the main supply line to the proposed site for the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.	2,000,000
6	To install the required step-down transformer as well as service entrance connections for the commercial power supply at the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.	10,000,000
7	To provide incidental facilities, such as telephone lines and internet provision, for the Dhaka (Joydevpur) and Rangpur Radar Tower Buildings.	1,500,000
8	To undertake incidental outdoor works such as a guard shed, gardening, fencing, gates, boundary walls of the perspective offices and exterior lightings and to renovate the existing building in the Joydevpur Observatory.	22,500,000
9	To renovate the existing gates, boundary walls, exterior lightings and Rangpur radar tower building and to shift the existing observation field in the Rangpur Observatory.	9,000,000

10	To obtain the required frequency for the Dhaka (Joydevpur) meteorological radar system (the existing frequency of Rangpur meteorological radar system is utilized for a new radar system).	500,000
11	To obtain the required VSAT user license from the BTRC for the use of satellite communication for the meteorological data satellite communication system (VSAT) to be installed.	380,000
12	To establish the Internet Protocol Virtual Private Network (IP-VPN) between the SWC at the BMD Head Office and the Joydevpur Radar Observation Station as a backup data communication link.	200,000
13	To ensure transport for the BMD personnel and to shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, accommodation, etc.	4,500,000
Total		455,280,000

Applied Exchange Rate: US\$ 1 = 103.76 JP Yen, 1 Taka = 1.32 JP Yen

2-5-2 Estimate of the Recurrent Cost for the Project to be borne by Bangladesh

(1) Recurrent Cost to be borne by the BMD

The annual recurrent costs considered as 5% of the annual inflation rate to be borne by the BMD for the first decade after the completion of the Project are attached hereunder. The recurrent costs have been calculated in accordance with the following fundamental conditions.

- Operation and maintenance to be carried out by the BMD
- Appropriate operation in accordance with the operations manuals
- Regular and proper maintenance according to the maintenance manuals

Table 53: Recurrent Cost of Dhaka (Joydevpur) Meteorological Radar Observation Station

Recurrent Cost of Dhaka (Joydevpur) Meteorological Radar Observation Station

Estimated Recurrent Cost														
Equipment	Item	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks	
1	Antenna	Grease (16kgs/can, For AZ/EL)	1	0	0	0	0	18,200	0	0	0	23,200	Every 5 years	
		Timing belt (For AZ/EL)	2	0	0	0	0	0	0	16,800	0	0	Every 8 years	
2	Antenna controller	AC fan	3	0	0	0	0	0	0	0	0	45,200	Every 10 years	
		AC fan	24	0	0	0	0	0	0	0	0	361,700	Every 10 years	
4	Receiver	AC fan	3	0	0	0	0	0	0	0	0	45,200	Every 10 years	
		CD for data storage (20sheets/1set)	2	2,900	3,100	3,200	3,400	3,500	3,700	3,900	4,100	4,300	4,500	
6	Printer	Printer ink cartridge	2	5,200	5,500	5,800	6,100	6,400	6,700	7,000	7,400	7,700	8,100	
		Paper (500sheets/1set)	4	1,200	1,300	1,300	1,400	1,500	1,500	1,600	1,700	1,800	1,900	
7	Power Supply Capacitor	AC fan	3	0	0	0	0	0	0	0	0	45,200	Every 10 years	
		Arrester	6	0	0	0	0	0	0	0	0	104,300	Every 10 years	
8	Diesel Engine Generator	Oil seal	2	0	3,000	3,100	3,300	3,500	3,600	3,800	4,000	4,200	4,400	Every 1 year
		Filter	2	0	0	11,500	0	12,700	0	14,000	0	15,500	0	Every 2 years
		Battery for Engine start	2	0	0	0	0	0	15,300	0	0	0	18,600	Every 5 years
Sub total (BDT)			9,300	12,900	24,900	14,200	45,800	30,800	30,300	34,000	33,500	662,300		

Others													
Cost Item	Details	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
1	Electricity Charge	1	652,762	685,400	719,670	755,654	793,436	833,108	874,764	918,502	964,427	1,012,648	*1
2	Fuel cost	1	124,938	131,185	137,744	144,631	151,863	159,456	167,429	175,800	184,590	193,820	*2
3	Water supply charge	1	0	0	0	0	0	0	0	0	0	0	*3
4	Special maintenance	1	0	0	576,800	0	0	667,700	0	0	773,000	0	For 5 days at site
5	Radome	1	16,400	17,300	18,100	19,000	20,000	21,000	22,000	23,100	24,300	25,500	
6	Pest-control	1	14,800	15,500	16,300	17,100	18,000	18,900	19,800	20,800	21,900	23,000	
Sub total (BDT)			808,900	849,385	1,468,614	936,385	983,299	1,700,164	1,083,993	1,138,202	1,968,217	1,254,968	
Total (BDT)			818,200	862,285	1,493,514	950,585	1,029,099	1,730,964	1,114,293	1,172,202	2,001,717	1,917,268	
Total (JPY)			¥1,095,315	¥1,154,331	¥1,999,349	¥1,272,537	¥1,377,643	¥2,317,221	¥1,491,691	¥1,569,213	¥2,679,675	¥2,566,624	

Estimate of annual electricity charge

Annual power consumption

Annual power consumption by commercial power (90%)

Annual power consumption by DEG (10%)

Annual fuel consumption

(kWh) 75,709

(kWh) 68,138

(kWh) 7,571

(Liter) 1,893

Fuel consumption of DEG = 0.25 Liter/kWh

*1 Annual electricity charge of commercial power

*2 Annual fuel cost of DEG

*3 Annual water supply charge

*4 Inflation: 5%/year considered

(BDT) 652,762

(BDT) 124,938

(BDT) 0

Electrical charge = 9.58 BDT/kWh

Fuel cost = 66.00 BDT/Liter

Exchange rate = 0.747 BDT/JPY

Table 54: Recurrent Cost of Rangpur Meteorological Radar Observation Station

Recurrent Cost of Rangpur Meteorological Radar Observation Station

Estimated Recurrent Cost

Equipment	Item	Qty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks	
1	Antenna	Grease (16kgs/can, For AZ/EL)	1	0	0	0	0	18,200	0	0	0	23,200	Every 5 years	
		Timing belt (For AZ/EL)	2	0	0	0	0	0	0	16,800	0	0	Every 8 years	
2	Antenna controller	AC fan	3	0	0	0	0	0	0	0	0	45,200	Every 10 years	
3	Transmitter	AC fan	24	0	0	0	0	0	0	0	0	361,700	Every 10 years	
4	Receiver	AC fan	3	0	0	0	0	0	0	0	0	45,200	Every 10 years	
5	Product Monitor	CD for data storage (20sheets/1set)	2	2,900	3,100	3,200	3,400	3,500	3,700	3,900	4,100	4,300	4,500	
6	Printer	Printer ink cartridge	2	5,200	5,500	5,800	6,100	6,400	6,700	7,000	7,400	7,700	8,100	
		Paper(500sheets/1set)	4	1,200	1,300	1,300	1,400	1,500	1,500	1,600	1,700	1,800	1,900	
7	Power Supply Capacitor	AC fan	3	0	0	0	0	0	0	0	0	0	45,200	Every 10 years
		Arrester	6	0	0	0	0	0	0	0	0	0	104,300	Every 10 years
8	Diesel Engine Generator	Oil seal	2	0	3,000	3,100	3,300	3,500	3,600	3,800	4,000	4,200	4,400	Every 1 year
		Filter	2	0	0	11,500	0	12,700	0	14,000	0	15,500	0	Every 2 years
		Battery for Engine start	2	0	0	0	0	0	15,300	0	0	0	18,600	Every 5 years

Sub total (BDT)	9,300	12,900	24,900	14,200	45,800	30,800	30,300	34,000	33,500	662,300
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Others

Cost Item	Details	Qty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
1	Electricity Charge		589,017	618,468	649,391	681,861	715,954	751,752	789,339	828,806	870,246	913,759	*1
2	Fuel cost	Fuel consumption of DEG	112,728	118,364	124,283	130,497	137,022	143,873	151,066	158,620	166,551	174,878	*2
3	Water supply charge		0	0	0	0	0	0	0	0	0	0	*3
4	Special maintenance	System brush-up by manufacture's engineer	1	0	0	576,800	0	667,700	0	0	773,000	0	For 5 days at site
5	Radome	Caulking repair	1	16,400	17,300	18,100	19,000	20,000	21,000	22,000	23,100	24,300	25,500
6	Pest-control	Exterminating vermination	1	14,800	15,500	16,300	17,100	18,000	18,900	19,800	20,800	21,900	23,000

Sub total (BDT)	732,945	769,632	1,384,874	848,458	890,976	1,603,225	982,205	1,031,326	1,855,997	1,137,137
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Total (BDT)	742,245	782,532	1,409,774	862,658	936,776	1,634,025	1,012,505	1,065,326	1,889,497	1,799,437
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Total (JPY)	¥993,635	¥1,047,566	¥1,887,248	¥1,154,830	¥1,254,051	¥2,187,450	¥1,355,428	¥1,426,139	¥2,529,447	¥2,408,885
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Estimate of annual electricity charge

Annual power consumption	(kWh)	68,316
Annual power consumption by commercial power (90%)	(kWh)	61,484
Annual power consumption by DEG (10%)	(kWh)	6,832
Annual fuel consumption	(Litter)	1,708

Fuel consumption of DEG = 0.25 Litter/kWh

*1 Annual electricity charge of commercial power

(BDT) 589,017

Electrical charge = 9.58 BDT/kWh

*2 Annual fuel cost of DEG

(BDT) 112,728

Fuel cost = 66.00 BDT/Litter

*3 Annual water supply charge

(BDT) 0

Exchange rate = 0.747 BDT/JPY

*4 Inflation: 5%/year considered

Table 55: Recurrent Cost of the BMD Head Office

Recurrent Cost of BMD Head Office

Estimated Recurrent Cost

Equipment	Item	Qty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks	
Storm Warning Centre (SWC)														
1	Product Monitor	CD for data storage (20sheets/1set)	2	2,900	3,100	3,200	3,400	3,500	3,700	3,900	4,100	4,300	4,500	
2	Printer	Printer ink cartridge	4	10,500	11,000	11,500	12,100	12,700	13,400	14,000	15,500	16,200		
		Paper(500sheets/1set)	10	3,400	3,500	3,700	3,900	4,100	4,300	4,500	4,700	5,000	5,200	
3	Compact UPS	Battery	9	0	0	66,900	0	0	76,400	0	0	88,400	0	Every 3 years
4	3KVA UPS	Battery	1	0	0	123,600	0	0	143,100	0	0	165,600	0	Every 3 years
Meteorological Briefing Room in Hazrat Shahjalal International Airport														
1	Compact UPS	Battery	3	0	0	22,000	0	0	25,500	0	0	29,500	0	Every 3 years

Sub total (BDT)	16,800	17,600	230,000	19,400	20,300	266,400	22,400	23,500	308,300	25,900
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Others

Cost Item	Details	Qty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
1	Electricity Charge		164,738	172,975	181,624	190,705	200,240	210,252	220,765	231,803	243,393	255,563	*1
2	Fuel cost	Fuel consumption of Existing DEG	14,916	15,662	16,445	17,267	18,130	19,037	19,989	20,988	22,038	23,140	*2
3	Communication charge	IP-VPN, Jopy despur - Dhaka (SWC)	1	56,400	59,300	62,200	65,300	68,600	72,000	75,600	79,400	83,400	87,500
4	Frequency License Fee	for Joydepur Satellite Communication	1	200,000	210,000	220,500	231,500	243,100	255,300	268,000	281,400	295,500	310,300

Sub total (BDT)	436,054	457,937	480,769	504,772	530,070	556,589	584,354	613,591	644,331	676,503
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Total (BDT)	452,854	475,537	710,769	524,172	550,370	822,989	606,754	637,091	952,631	702,403
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Total (JPY)	¥606,230	¥636,596	¥951,498	¥701,703	¥736,774	¥1,101,726	¥812,254	¥852,866	¥1,275,276	¥940,299
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Estimate of annual electricity charge

Annual power consumption of Storm Warning Centre (SWC)	(kWh)	13,608
Annual power consumption of Meteorological Briefing Room in Hazrat Shahjalal International Airport	(kWh)	4,493
Total annual power consumption	(kWh)	18,101
Annual power consumption by commercial power (95%)	(kWh)	17,196
Annual power consumption by DEG (5%)	(kWh)	905
Annual fuel consumption	(Litter)	226

Fuel consumption of DEG = 0.25 Litter/kWh

*1 Annual electricity charge of commercial power

(BDT) 164,738

Electrical charge = 9.58 BDT/kWh

*2 Annual fuel cost of DEG

(BDT) 14,916

Fuel cost = 66.00 BDT/Litter

*3 Inflation: 5%/year considered

Exchange rate = 0.747 BDT/JPY

(2) Annual Budget Trends

The recurrent costs of the Dhaka (Joydevpur) Radar Observation Station and the Rangpur Radar Observation Station are estimated to be almost equivalent to the existing operation & maintenance budgets of these stations. On the other hand, the recurrent cost of the BMD Head Office is estimated to be increased by approximately 8% of the existing operation & maintenance budget. The estimated total recurrent cost of the Project is only approximately 1% of the total amount of the BMD budget. In addition, since the BMD has so far secured all the required budgets for the operation and maintenance of all the equipment procured under the implemented projects of Japan's grant aid, it has been assessed that there will be no problems in this regard. Furthermore, the BMD has committed to the Preparatory Survey Team to allocate the required budget for the Project.

Table 56: Fiscal Annual Budget of BMD 2007-2014

Year	Budget (1,000 Taka)	Ratio to Preceding year (%)
2007-2008	215,000	-
2008-2009	234,500	109.07
2009-2010	261,000	111.30
2010-2011	298,000	114.18
2011-2012	377,100	126.54
2012-2013	395,500	104.88
2013-2014	416,320	105.26

Chapter 3

Project Evaluation

Chapter 3 Project Evaluation

3-1 Preconditions

The procedures required for the implementation of this Project are as follows.

Table 57: Required Procedures for Custom Clearance

Office Concerned	Submission Time	Required Period	Required Documents to be submitted by the BMD	Applicant
Chittagong Customs House (CCI&E : Chief Controller, Office of Import & Export)	Immediately after a shipment's arrival at a port	15 - 20 days	<ul style="list-style-type: none"> · Application Form: 1 original · Exchange of Notes: 1 copy · Contract: 1 copy · Shipping Invoice: 1 original · Bill of Lading: 1 original · Packing List: 1 original · Certificate of Origin: 1 original · No Objection Certificate issued by BTRC: 1 original 	BMD

<Approval of the Executive Committee for the National Economic Council (ECNEC)>

Any project to be implemented in Bangladesh requires the approval of the ECNEC. In case that a project is not approved by the ECNEC, the allocation of the required budget, conclusion of a consultant agreement and contract, tax exemptions (refunding), import permissions, etc. cannot be made. Therefore, for a smooth implementation of the Project, the Development Project Proposal (DPP) for the Project prepared by the BMD and submitted through the Ministry of Defence and the Planning Commission must be approved by the ECNEC prior to the commencement of the Project.

<Custom Duty Value Added Tax: CDVAT and Demurrage>

The DPP for the Project in which the Custom Duty Value Added Tax and the Demurrage to be paid by the BMD is indicated must be approved by the ECNEC. Immediately after the signing of the Contract, a master list of the equipment to be imported to Bangladesh and a shipment schedule must be submitted to the BMD. In case that the CDVAT payment by the BMD is delayed, the demurrage is collaterally increased.

<Value Added Tax : VAT>

Since the BMD has scheduled to refund the VAT to the Contractor, the DPP for the Project in which the BMD's refunding is indicated must be approved by the ECNEC.

<Government Registration>

According to government regulation, the organization implementing the project has to register all of the equipment and facilities of the project as government property in order to obtain the necessary budget for continuing its operation and maintenance via the following procedure.

After the completion of the Project, the BMD applies to the Ministry of Finance for a budget (to cover operations, maintenance and salary expenses) to be included in the Government budget in the following manner.

BMD → Ministry of Defense → Ministry of Establishment → Ministry of Finance

Upon receipt of this request, it normally takes 6 months to obtain approval from the Ministry of Finance.

<Procurement of Spare Parts>

The rules of the Government of Bangladesh for the procurement of spare parts by a government agency are as follows.

- i) The government agency, which needs the spare parts, must obtain the necessary budget.
- ii) The agency prepares the specifications for the required spare parts.
- iii) The specifications are submitted by the agency to the Department of Procurement and Inspection (DPI) under the Ministry of Commerce.
- iv) Tendering procedures, tender execution and selection of a supplier are conducted by the DPI.

In practice, these procedures create delays in spare parts procurement and are a barrier to the smooth procurement of spare parts for government facilities. Under these circumstances, in order to remove this barrier and improve the efficiency of Government procurement, the Central Procurement Technical Unit (CPTU) was established in the Ministry of Planning in April 2003 and a document entitled “*the Public Procurement Regulations, 2003*” was issued and became effective on October 1, 2008 which governs all procurements made by government agencies in Bangladesh. Since the regulations apply to all public procurement, all government organizations can procure required spare parts, technical services, etc. from a supplier/manufacturer by following the regulation guidelines. In cases wherein the supplier/manufacturer who supplied the original equipment is the only organization that can supply the required spare parts and technical services, the government agency can make a direct procurement from that supplier/manufacturer. The meteorological radar system meets this condition. As such, a contract for spare parts procurement between the BMD and the contractor who supplies the radar system is required. This contract must be in accordance with the procedures laid down in the PPAP. It has been confirmed, through discussions with the CPTU, that the said regulation enables the BMD to make a direct procurement of the necessary spare parts from the supplier / manufacturer of the radar systems to be supplied under the Project. The BMD now has the authority to procure all spare parts directly.

<Satellite Communication >

A VSAT user license issued by the Bangladesh Telecommunication Regulatory Commission (BTRC) will be required for the use of the meteorological data satellite communication systems between the Dhaka (Joydevpur) Meteorological Radar Observation Station and the SWC. An application form can be obtained on the website of the BTRC. If an application is complete, the license will be issued in about two months after the submission of the application documents. The BTRC will charge the BMD for an annual license

fee of 200,000 Taka/system in order to use the meteorological data satellite communication systems to be supplied under the Project with the costs specified below.

- ◆ License Fee: annually 200,000 Taka/system
- ◆ Data Speed Fee
 - Less than 128Kbps: Annually 30,000 Taka/system
 - 128 – 512 Kbps: Annually 50,000 Taka/system
 - More than 512Kbps: Annually 100,000 Taka/system

<Building Construction Permit>

In order to construct a radar tower building in Gazipur (Joydevpur) and Rangpur, the acquisition of a building permit from the Municipality Corporation (Pourashava) of Gazipur and Rangpur is required. In order to apply for a building permit, the following documents and drawings must be submitted to the Municipality Corporation. After around 20 days from the date of submission, the permit is issued should no problem arise.

Table 58: Required Documents for the Building Construction Permit of the Municipality Corporation (Pourashava) of Gazipur (Joydevpur) and Rangpur

	Documents	Required Number
1	Prescribed Form	1 Original
2	Site Plan	3 Copies
3	Building Design Drawings	2 Copies
4	Structural Design Drawing	2 Copies
5	Soil Test Report	2 Copies
6	Land Ownership Documents	2 Copies
7	BMD Forward Letter	1 Original

3-2 Necessary Inputs from the Recipient Country

In order to further enhance the benefits of this Project, the following recommendations are strongly encouraged and should be implemented accordingly.

- 1) Manpower Development
 - a) Continuous recruitment of human resources for the next generation; and,
 - b) Development of more qualified technical personnel through training and other related manpower development programs.
- 2) Natural Disaster Prevention and Management
 - a) Setting up of redundancies in the announcement of warnings and other information dissemination methods through multi-channels to ensure reaching out to the general populace; and,

fee of 200,000 Taka/system in order to use the meteorological data satellite communication systems to be supplied under the Project with the costs specified below.

- ◆ License Fee: annually 200,000 Taka/system
- ◆ Data Speed Fee
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- 2) Natural Disaster Prevention and Management
 - a) Setting up of redundancies in the announcement of warnings and other information dissemination methods through multi-channels to ensure reaching out to the general populace; and,

- b) Continuing educational activities for the general public in coordination with various related disaster management agencies and the mass media for a more effective natural disaster prevention and management strategy.
- 3) Longer Life Span of the Equipment procured and the Radar Tower Buildings constructed under the Project
- a) Regularly secure the necessary budget for the efficient operation and maintenance of the systems and building equipment, and the procurement of requisite spare parts and consumables for all the equipment to be supplied under the Project;
 - b) Ensure the protection of the buildings, equipment and facilities against theft and vandalism; and,
 - c) Regularly paint and caulk the caulking grooves of the Radar Tower Buildings.

3-3 Important Assumptions

- 1) Utilization of the meteorological information/data and forecasts/warnings by the mass media (TV, radio, newspaper), the Prime Minister's Office, the National/State/Provincial Disaster Management Authority, the Federal Flood Commission, Ministry of Water & Power, Provincial Information and Public Works Department, other government ministries, police departments, other government-affiliated organizations, Bangladesh Red Crescent Society, etc.
- 2) No change in global warming countermeasures, natural disaster countermeasures, and meteorological service policies as determined by the government of Bangladesh.
- 3) Maintenance of a cooperative structure among the mass media (TV, radio, newspaper), the Prime Minister's Office, the National/State/Provincial Disaster Management Authority, the Federal Flood Commission, Ministry of Water & Power, Provincial Information and Public Works Department, other government-affiliated organizations, Bangladesh Red Crescent Society, etc.
- 4) Continuance of service by a BMD staff who has received the soft component training or on-site training related to the Project.

3-4 Project Evaluation

3-4-1 Relevance

1) Population to directly benefit from the Implementation of the Project

The overall objective of the Project is to reduce the devastation arising from meteorological disasters. This could be achieved by improving the BMD's capabilities in meteorological observation and forecast/warning in preparation for heavy rain. Floods caused by heavy rain are extreme manifestations of nature that may lead to immeasurable loss and distress for quite a number of people and have also become determining factors for the significant set-back of the national economy. Therefore, the population to be benefited both directly and indirectly by the Project will be the whole nation of Bangladesh (approx. 126 million based on below figures). As a result of the population control promoted by Bangladesh Government, the population growth rate decreased to 1.37% in 2011, close to the world average. However, there is still real concern that the number of victims will proportionally increase due to the fact the population of Bangladesh has been steadily increasing. The following table indicates the population of the 6 respective administrative districts in Bangladesh.

Table 59: Administrative Districts and Population in Bangladesh

No.	Administrative District	Capital	Area (km ²)	Population (2011)
1	Khulna	Khulna	22,272	15,563,000
2	Syhet	Syhet	12,596	9,807,000
3	Dhaka	Dhaka	31,120	46,729,000
4	Chittagong	Chittagong	33,771	28,079,000
5	Barisai	Barisai	13,297	8,147,000
6	Rajshahi	Rajshahi	18,197	18,329,000
Total			131,253	126,654,000



2) Objectives of the Project

In Bangladesh, one of the most disaster-prone countries in the world, the surveillance of meteorological phenomena by the five meteorological radar systems established under Japan's grant aid is of great importance for the reduction of damages caused by natural disasters. However, the existing Dhaka meteorological radar system has been dysfunctional and the existing Rangpur meteorological radar system has completely stopped due to aging. Therefore, the key objective of the Project is the effective mitigation of the devastation caused by natural disasters through the re-strengthening of the radar observation network composed of the five meteorological radar systems through the replacement of the existing Dhaka and Rangpur meteorological radar systems with state-of-the-art S-band Doppler pulse compression solid state radar system.

3) Development Plan of Bangladesh

The Ministry of Planning, in charge of formulating the national development plan, incorporated this Project as an urgent undertaking under the poverty reduction strategy of the “Sixth Five-Year Plan, Financial Year 2011-2015” since it plays an important role in the establishment of an early warning system against natural disasters and the reduction of economic losses. Moreover, the BMD Strategic Plan includes the implementation of this Project, which was approved by the Ministry of Defence and submitted to the Ministry of Planning. The implementation of this Project which is in accordance with Japan’s aid policy, “Overcoming social vulnerability,” is expected to greatly contribute to achieving the goal of the development plan in Bangladesh.

4) Aid Policy of Japan

Japan and Bangladesh have developed congenial bilateral relations based on Bangladesh’s strong affinity towards Japan since its independence. Bangladesh has sustained an annual economic growth rate of 5-6% and has attracted attention as a potential production base, following China and Vietnam. However, the country is a LDC wherein a third of the population is still living below the poverty line.

Japan’s major aid policy in Bangladesh is the “Acceleration of sustainable economic growth with equity and bringing people out of poverty towards becoming a middle-income country.” For the realization of this aid policy, the Government of Japan focuses on the following two priority areas.

1. Accelerating inclusive economic growth; and,
2. Overcoming social vulnerability.

Under the latter priority area, the provision of aid for “Disaster Prevention/Climate Change Countermeasure” is stated as one of Japan’s important roles. Specifically, the development of infrastructure resistant to natural disasters such as massive floods or tropical cyclones which are predicted to increase due to climate change and the establishment of a disaster information management system are included. It is truly significant to strengthen the meteorological monitoring system and improve disaster prevention capabilities in the whole of Bangladesh through the Grant Aid from Japan as it is in congruence with Japanese priorities in terms of international cooperation.

3-4-2

Effectiveness

Table 60: Achievement Indicator

Indicator	Present (Base Line: 2014)	Target
Enhancement of Severe Weather Monitoring Capability	Wind velocity: only manual observation	Wind velocity within the radar detection range: maximum 75m/s within a 200km radius
	Precipitation intensity 1mm/h or more within the radar detection range: within a 350km radius from the existing meteorological radar system	Radar precipitation intensity 1mm/h or more within the radar detection range: within a 450km radius from the meteorological radar system
	No hourly radar accumulated rainfall data within a 350km radius from the existing meteorological radar system	Hourly radar accumulated rainfall data within a 450km radius from the meteorological radar system
	Observation intervals of rainfall intensity within the radar detection range: PPI mode	Observation intervals of wind direction, wind velocity, and rainfall intensity within the radar detection range: PPI mode and CAPPI mode
	Radar Composite Picture consisted of 3 Doppler and 2 Ordinary Meteorological Radar Systems at the SWC at the BMD Head Office.	Composite Picture consisted of 5 Doppler Meteorological Radar Systems at the SWC at the BMD Head Office.
Enhancement of the capability for downburst and wind shear monitoring around the Hazrat Shah Jalal International Airport (Dhaka)	Subjective observation of the area surrounding the Hazrat Shah Jalal International Airport (Dhaka)	Objective observation of downburst and wind shear through radar observation within a 200km radius from the Dhaka Meteorological Radar Observation Station
	No provision of radar images to the Hazrat Shah Jalal International Airport (Dhaka)	Provision of radar images to the Hazrat Shah Jalal International Airport (Dhaka)

As adequately pointed out in the careful and comprehensive evaluation of the effects of the Project, considerable and enhanced benefits can be achieved vis-à-vis the improvement of the BMD's capabilities in reducing human loss and the recurrent economic set-back brought about by meteorological disasters such as floods, tropical cyclones and tornados. The Project would substantially contribute to the mitigation of the adverse effects of the meteorological disasters and effectively safeguard the basic human needs of the Bangladesh people.

Moreover, in order to reduce the BMD's operational and maintenance costs, the equipment was designed to minimize spare parts and consumables. Since the biggest expected recurrent cost of the Project is electricity, the equipment and facilities were designed in such a way so as to minimize power consumption. As a result, the BMD's budget is expected to be able to cover the Bangladeshi portion of the capital and recurrent costs of the Project.

In conclusion, the implementation of the Project is considered to be an appropriately suitable and worthwhile endeavor.