Pakistan Meteorological Department
The Islamic Republic of Pakistan

# PREPARATORY SURVEY REPORT
# ON
# THE PROJECT FOR
# ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM
# IN
# THE ISLAMIC REPUBLIC OF PAKISTAN

January 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

---

INTERNATIONAL METEOROLOGICAL CONSULTANT INC.
JAPAN WEATHER ASSOCIATION
CTI ENGINEERING INTERNATIONAL CO., LTD.

| GE |
| --- |
| JR |
| 14-002 |

# PREFACE

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

The survey team held a series of discussions with the officials concerned of the Government of the Islamic Republic of Pakistan, 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 the Islamic Republic of Pakistan for their close cooperation extended to the survey team.

January, 2014

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

# Summary

## Summary

Pakistan is a country located in South Asia with about 1,500km of length from north to south and with a big difference in elevation. Due to this topographic feature, Pakistan is often affected and damaged by various natural disasters such as earthquakes, floods, landslides, cyclones, drought, etc. Most of the meteorological disasters in Pakistan occur during the monsoon period because the cumulonimbi of the Inter Tropical Convergence Zone or tropical depressions bring about torrential rain, hail, strong wind, etc. These meteorological phenomena, occurring almost annually, cause tremendous damages to Pakistan such as flooding of farms, collapse of houses, damage of electricity facilities, landslide and loss of many lives, thereby, heavily impacting the national economy.

The recent most devastating catastrophe that occurred in the country was the Indus River Flood in 2010 (Affected people: over 20 million, Killed or Missing: over 2,000). More than half of the people killed lost their lives due to mudflows in the upper or middle river basin, landslides in the mountainous area and collapsed houses due to torrential rain. It also left wide areas of devastated farmland, washed away houses and destroyed roads and bridges. As a consequence, this massive flood inflicted incalculable negative impact on the Pakistani economy and became the worst flood in Pakistani history. In order to predict possible disaster risks and take appropriate countermeasures, the wide and prompt dissemination of information is highly necessary by improving weather forecast accuracy and minimizing its preparation time.

As indicated above, these natural disasters have led to the loss of human lives and properties and the stagnation of socio-economic activities in Pakistan. In particular, poor people, who are extremely vulnerable to natural disasters, can be most easily and adversely affected. As such, these natural disasters have become a major obstacle for Poverty Reduction, one of the development strategies of the Government of Pakistan. Moreover, there is a growing concern that global climate change will increase the frequency and scale of these natural disasters in the medium-to-long-term run and create more adverse impact on Pakistan, one of the natural disaster-prone areas. Thus, in Pakistan, there is a strong demand for the improvement of its disaster management system including its early warning system.

Under these circumstances, the Government of Pakistan has decided to establish the Specialized Medium Range Weather Forecasting Center (hereinafter referred to as the “SMRFC”) in the PMD in order to improve the accuracy of short-range weather forecast (within 24 hours) as well as that of medium-range weather forecast (over 48 hours). At the same time, the SMRFC has a plan to strengthen its weather information dissemination capabilities. However, they do not have the necessary equipment for weather forecasting analysis and weather information dissemination in the SMRFC. In addition, the meteorological radar system, which is located in the capital city, Islamabad, has been dysfunctional because of aging and could possibly stop completely in a few years. The replacement of the Islamabad meteorological radar system, which plays an important role in meteorological observation around the capital region, is an urgent task.

In response to the fact that enormous damages caused by abnormal weather due to climate change have been increasing, the National Climate Change Policy has been developed under the Ministry of Climate Change in August 2012. In this policy, vulnerability to climate change and its adoption plan are described according to each sector (water resource, agriculture, forestry, ecosystem, disaster preparedness, etc.). Under disaster preparedness, the Government of Pakistan is supposed to implement the following measures in cooperation with the related organizations:

1. Securement of financial resources for the implementation of the National Disaster Risk Management Framework formulated by NDMA.
2. Clarification of the roles and responsibilities of the ministries concerned in case natural disaster occurs.
3. Strengthening of early warning systems for cyclones and formulation of evacuation plans for coastal areas.
4. Dissemination of early warnings and community participation for disaster risk mitigation activities.
5. Strengthening of observation, forecast and early warning systems for floods, flash floods, drought, etc.
6. Infrastructure construction of electricity, communication and transportation in which quick restoration is required in case abnormal weather occurs.

Furthermore, the concrete Action Plan for the above National Climate Change Policy has been formulated and categorized into four timelines: top priority, short-term, medium-term and long-term. For the implementation of the National Climate Change Policy, National and Provincial Climate Change Policy Implementation Committees have been established and it holds a conference every six months to report policy implementation progress and modify & update the National Climate Change Policy every five years.

As indicated above, more than twenty (20) years have already passed since the Islamabad meteorological radar system was established under the grant aid of Japan. Despite the follow-up maintenance which was performed in 2011, it is now in critical condition wherein its function deteriorates day by day and may not be able to recover once a serious failure occurs. Thus it is strongly required, as a permanent measure, to replace the existing Islamabad meteorological radar system which plays an important role in weather observation around Islamabad. In addition, the installation of meteorological observation equipment and weather forecast & data transmission system, weather information dissemination system, etc. in the SMRFC is necessary. Due to a lack of financial and technical capabilities, the Government of Pakistan has requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities, etc. under Japan's Grant Aid Assistance scheme. The requested components had been decided in "Priority 1" of the "Multi-Hazard Early Warning Project" conducted under Japan's Aid.

In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Establishment of a Specialized Medium Range Weather Forecasting Center (SMRFC) and Strengthening

of the Early Warning and Dissemination Network in the Islamic Republic of Pakistan (hereinafter referred to as the "Preparatory Survey"). The Japan International Cooperation Agency (hereinafter referred to as "JICA") sent the Preparatory Survey Team (1) to Pakistan in order to conduct the Preparatory Survey (1) from September 17 to October 1, 2012. The team confirmed the appropriateness and purpose of each requested component, had a series of discussions with the officials concerned from the Government of Pakistan and collected the necessary and pertinent information and data for preliminary deliberation in the Analysis in Japan (1). As a consequence, the requested components were classified as the target and non-target items for Analysis in Japan (1) as shown in the following table.

JICA then sent the Preparatory Survey (2) Team to Pakistan in order to conduct the Preparatory Survey (2) from November 14 to December 26, 2012. In accordance with the results of various considerations in the Analysis made in Japan (1) on the items indicated in the above tables which were classified in the Preparatory Survey (1), the team conducted several discussions with the officials concerned from the Government of Pakistan including the PMD and further studies on the required equipment, scale and quantities for the project implementation paying particular attention to the present situation in Pakistan from various perspectives such as the operation & maintenance capabilities of the PMD, appropriate equipment arrangement plan, etc. As a result, it was finally confirmed that the following items indicated in the table attached hereunder are required for the Project and are objects of the Analysis in Japan (2). In particular, in order to assess the viability of the reutilization of the existing Meteorological Radar Tower for the Project, a comprehensive structural evaluation of the existing Islamabad Meteorological Radar Tower Building, such as the confirmation of the current situation of the main structures, structural calculation, schmidt hammer test for concrete compressive strength (concrete deterioration diagnosis) and analysis of horizontal distortion angle due to wind pressure, was conducted. As a result, it was confirmed that the reutilization of the existing Meteorological Radar Tower Building for the Project is a dangerous and not viable option.

JICA sent the Preparatory Survey (3) Team again to Pakistan from June 29 to July 6, 2013 in order to explain and discuss the outline design & draft survey report. In the course of 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 object items of the Preparatory Survey for the Project.

Table1: Object Items of the Preparatory Survey

| Component | Islamabad | | Lahore | | Karachi | Multan | Gilgit |
|---|---|---|---|---|---|---|---|
| | PMD Islamabad Head Office | Meteorological Office in New Benazir Bhutto International Airport (NBBIA) | PMD Lahore Regional Meteorological Center | PMD Lahore Flood Forecasting Division | PMD Karachi Tropical Cyclone Warning Center | PMD Multan Meteorological Office | PMD Gilgit Meteorological Office |
| Procurement and Installation of Equipment | | | | | | | |
| SMRFC (Specialized Medium Range Weather Forecasting Center) Weather Forecasting & Development System (including Lightning System, Power Back-up | 1 | - | - | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| System, Isolation Transformer, Auto Voltage Regulator, Power Supply Capacitor and Test Instruments, Spare Parts and Ancillary Facility) | | | | | | | |
| Meteorological Data Trunk Communication System | 1 | - | 1 | 1 | 1 | 1 | 1 |
| GTS Message Switch System | 1 | - | - | - | - | - | - |
| S-Band Doppler Pulse Compression Solid State Radar System (including Power Back-up System, Isolation Transformer, Auto Voltage regulator, Power Supply Capacitor and Test Instruments and Spare Parts) | 1 | - | - | - | - | - | - |
| Meteorological Radar Data Display System | 2 | 1 | - | - | - | - | - |
| Wind Profiler System (including Ancillary Facility) | 1 | - | - | - | - | 1 | - |
| Construction of Radar Tower Building | | | | | | | |
| Construction of a new Radar Tower Building (including Lightning System, Power Back-up System, Isolation Transformer, Auto Voltage regulator, maintenance equipment) | 1 | - | - | - | - | - | - |

In line with real concerns that global climate change will increase the frequency and scale of natural disasters in the medium-to-long-term run and create more adverse impacts on Pakistan, one of the natural disaster-prone areas, the improvement of the disaster management system including early warning systems is also an urgent task in Pakistan. Therefore, a key objective of this Project is to contribute to the effective mitigation of the devastation caused by these natural disasters. To achieve this objective, the existing meteorological radar system will be replaced, the upper-air observation system, forecast & development system, meteorological data trunk communication system and GTS message switch system will be installed, and the SMRFC will be established in the PMD Islamabad Head Office. This assistance from the Government of Japan will enable the PMD to: 1) enhance its monitoring capability of hazardous meteorological phenomena; 2) improve the accuracy of its short-range weather forecast (within 24-48 hours); 3) have the capability to handle medium-range weather forecast (over 48 hours); and, 4) strengthen its prompt dissemination capability of forecasts/warnings.

The overall objective of the Project is to reduce the devastation arising from meteorological disasters. This could be achieved by improving the PMD's capabilities of meteorological observation and forecasts/warnings 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 Pakistan (approx. 172 million). There is also real concern that the number of victims will proportionally increase due to the fact that the population of Pakistan has been steadily increasing by 2% and will be the 4th largest country in the world after India, China and the United States in 2050.

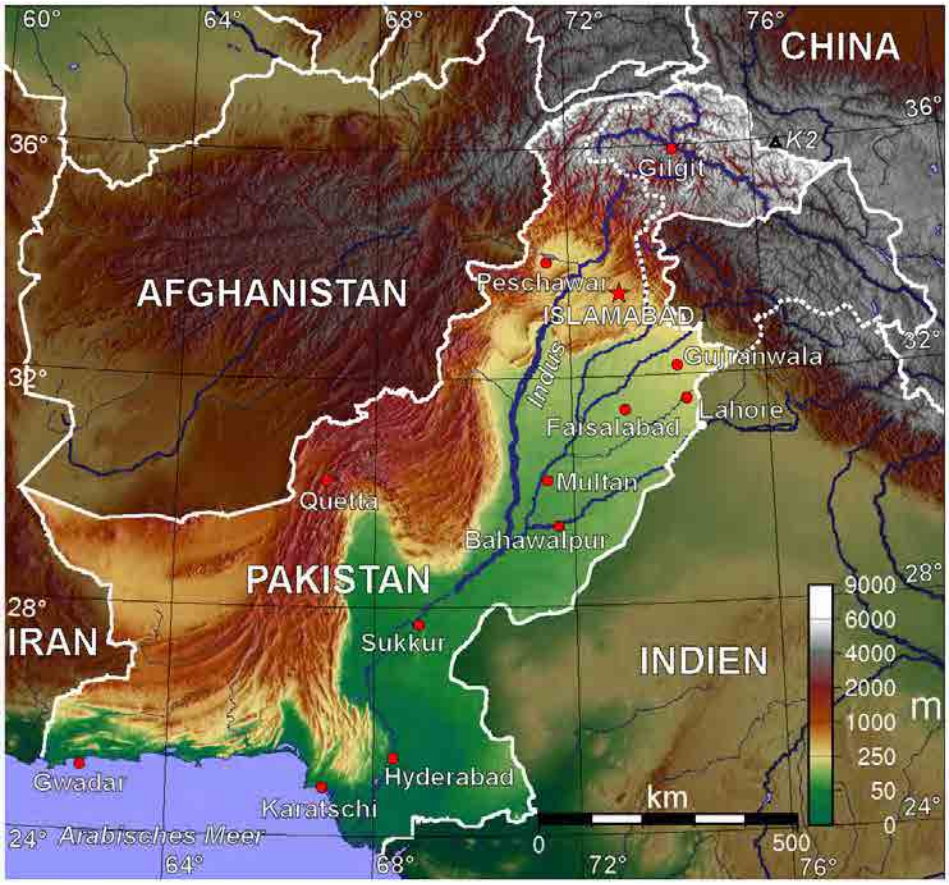
As adequately pointed out in the careful and comprehensive evaluation of the effects of the Project, considerable and enhanced benefits can be achieved vis-à-vis the improvement of the PMD's capabilities in reducing human loss and the recurrent economic set-back brought about by meteorological disasters. The Project would substantially contribute to the mitigation of the adverse effects of meteorological disasters and effectively safeguard the basic human needs of the Pakistani people as well as those of its neighboring countries.

Moreover, in order to reduce the PMD'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 PMD's budget is expected to be able to cover the Pakistani 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.

# Contents

## ■ Islamic Republic of Pakistan

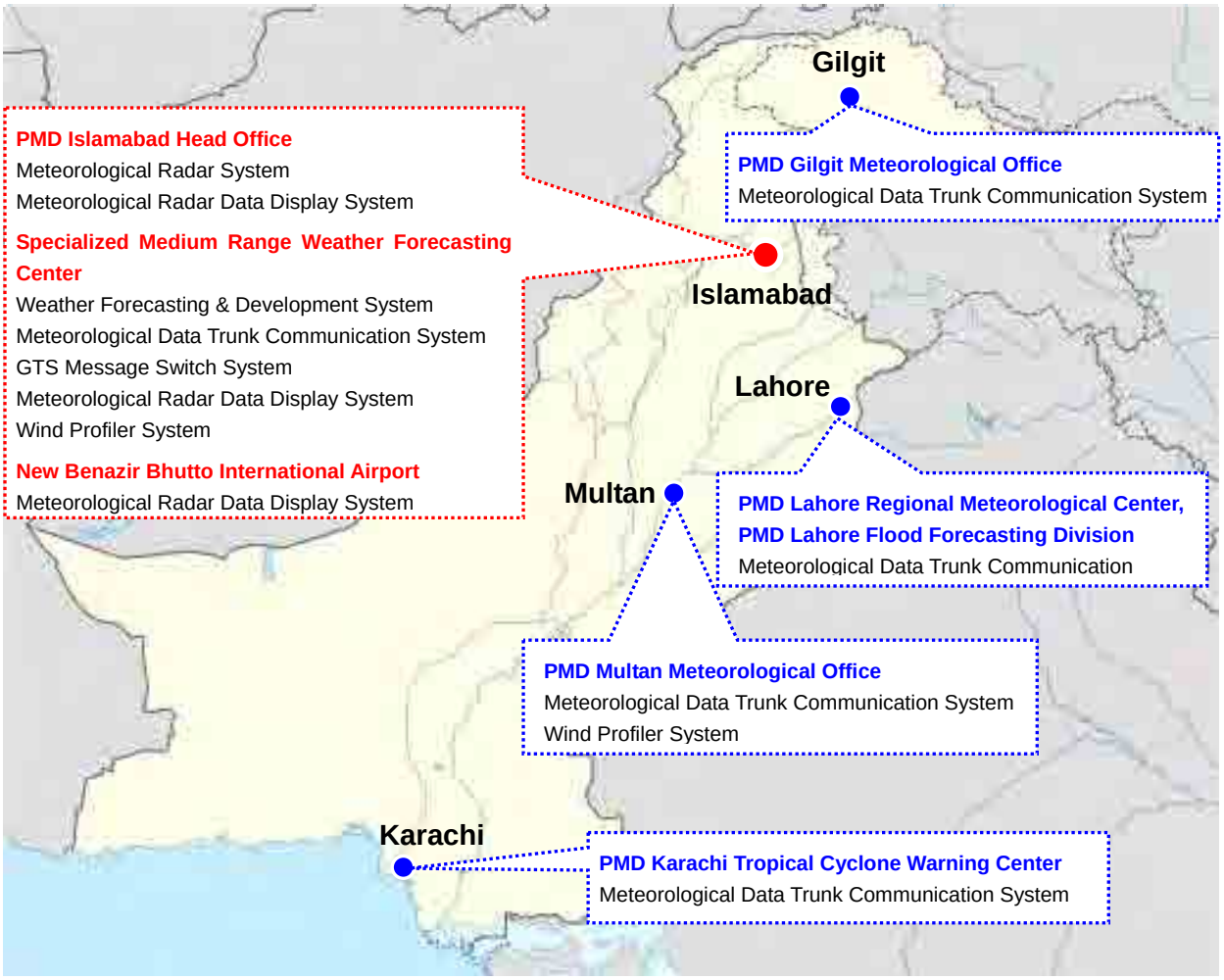



Figure: Project Sites Allocation Map

**Islamabad Meteorological Radar Tower Building**

# List of Figures

## Chapter 1 Background of the Project



## Chapter 2 Contents of the Project



## Chapter 3 Project Evaluation

# List of Tables

**Summary**



**Chapter 1 Background of the Project**

## Chapter 2 Contents of the Project

## Chapter 3 Project Evaluation

# ABBREVIATIONS

ASEAN : Association of Southeast Asian Nations
CAPPI : Constant Altitude Plan Position Indicator
CDA : Cabinet Directory/Capital Development Authority
CRED : Centre for Research on the Epidemiology of Disasters
DCPC : Data Collection and Processing Centre
DHA : Defense and Home Affairs
EIA : Environmental Impact Assessment
EPA : Environmental Protect Authority
FAB : Frequency Allocation Board
FBR : Federal Board of Revenue
GPV : Grid Point Value
GISC : Global Information System Centre
GTS : Global Telecommunication System
IESCO : Islamabad Electric Supply Company
JICA : Japan International Cooperation Agency
MTBF : Mean Time Between Failure
MTTR : Mean Time To Repair
MOCC : Ministry of Climate Change
NBBIA : New Benazir Bhutto International Airport
NC : National Centre
NDMA : National Disaster Management Authority
NDMC : National Disaster Management Commission
NDMO : National Disaster Management Ordinance
NDRMF : National Disaster Risk Management Framework
NWFC : National Weather Forecasting Center
NWP : Numerical Weather Prediction
PMD : Pakistan Meteorological Department
PTA : Pakistan Telecommunication Authority
SMRFC : Specialized Medium Range Weather Forecasting Center
VPN : Virtual Private Network
WIS : WMO Information System
WMO : World Meteorological Organization

# Chapter 1
# Background of the Project

# Chapter 1 Background of the Project

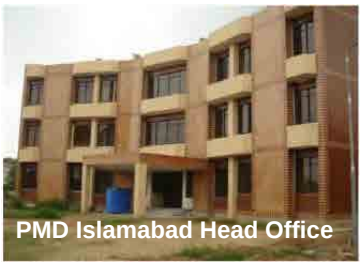
## 1-1 Background of the Project

Pakistan is a country located in South Asia with about 1,500km of length from north to south and with a big difference in elevation. Due to this topographic feature, Pakistan is often affected and damaged by various natural disasters such as earthquakes, floods, landslides, cyclones, drought, etc. Most of the meteorological disasters in Pakistan occur during the monsoon period because the cumulonimbi of the Inter Tropical Convergence Zone or tropical depressions bring about torrential rain, hail, strong wind, etc. These meteorological phenomena, occurring almost annually, cause tremendous damages to Pakistan such as flooding of farms, collapse of houses, loss of electricity, landslide and loss of many lives, thereby, heavily impacting the national economy.

The recent most devastating catastrophe that occurred in the country was the Indus River Flood in 2010 (Affected people: over 20 million, Killed or Missing: over 2,000). More than half of the people killed lost their lives due to mudflows in the upper or middle river basin, landslides in the mountainous area and collapsed houses due to torrential rain. It also left wide areas of devastated farmland, washed away houses and destroyed roads and bridges. As a consequence, this massive flood inflicted incalculable negative impact on the Pakistani economy and became the worst flood in Pakistani history. In order to predict possible disaster risks and take appropriate countermeasures, the wide and prompt dissemination of information is highly necessary by improving weather forecast accuracy and minimizing its preparation time.

As indicated above, these natural disasters have led to the loss of human lives and properties and the stagnation of socio-economic activities in Pakistan. In particular, poor people, who are extremely vulnerable to natural disasters, can be most easily and adversely affected. As such, these natural disasters have become a major obstacle for Poverty Reduction, one of the development strategies of the Government of Pakistan. Moreover, there is a growing concern that global climate change will increase the frequency and scale of these natural disasters in the medium-to-long-term run and create more adverse impact on Pakistan, one of the natural disaster-prone areas. Thus, in Pakistan, there is a strong demand for the improvement of their disaster management system including its early warning system.

In response to this urgent need, the Government of Pakistan has decided to establish the Specialized Medium Range Weather Forecasting Center (hereinafter referred to as the “SMRFC”) in the Pakistan Meteorological Department (hereinafter referred to as the “PMD”) in order to improve the accuracy of short-range weather forecast (within 24 hours) as well as that


PMD Islamabad Head Office

of medium-range weather forecast (over 48 hours). At the same time, the SMRFC has a plan to strengthen its weather information dissemination capabilities. However, they do not have the necessary equipment for weather forecasting analysis and weather information dissemination in the SMRFC. In addition, the meteorological radar system, which is located in the capital city, Islamabad, has been dysfunctional because of aging and could possibly stop completely in a few years. The replacement of the Islamabad meteorological radar system, which plays an important role in meteorological observation around the capital region, is an urgent task.

## 1-2 Natural Disasters in Pakistan

- Natural Disasters and Precipitation

Floods are the most frequently and widely happening disasters in Pakistan. On the other hand, flash floods and landslides occur frequently in the northern upper river basin.

The figure on the right shows the distribution map of mean annual precipitation in Pakistan. The precipitation in the northern area, where Islamabad is located, is obviously much greater than any other area. This means that heavy rains in the northern area cause flash floods or landslides in the upper river basin with rainwater gradually flowing into the river which, in turn, causes flooding in the middle and lower river basin. Therefore, the strengthening of meteorological observation capability in the northern area will contribute to the effective mitigation of meteorological disasters.

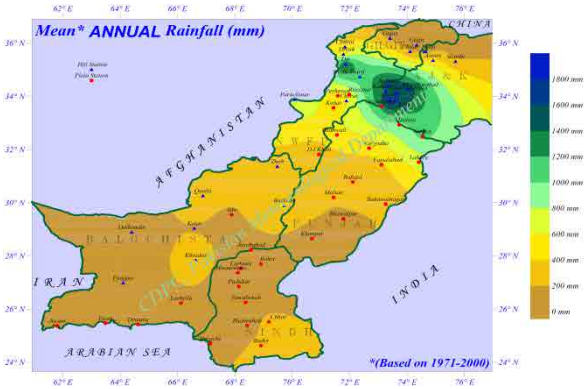


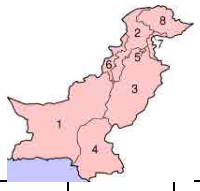

Figure1: Distribution Map of Mean Annual Precipitation in Pakistan

Categorized by disaster type, the following tables show the number of killed/missing and affected people of natural disasters which occurred in Pakistan from 2001 to 2010. As can be seen from these tables, flash floods and landslides occur mainly in the northern area as represented by the Khyber Pakhtunkhwa. On the other hand, floods happen everywhere and the prone areas are the Khyber Pakhtunkhwa state in the northern area, the Punjab state in the central area and the Sindh and Balochistan states. Furthermore, disasters caused by tropical cyclones are concentrated on the coastal areas of Sindh and Balochistan states while having little impact on inland areas.


## Table2: Natural Disasters occurred in Pakistan (2001-2010) <Flood/Flash Flood/Landslide>

| Year | Disaster Type | Killed/ Missing | Affected People | Name of State | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **8** | **2** | **7** | **5** | **6** | **3** | **1** | **4** |
| | | | | Gilgit Baltistan | Khyber Pakhtunkhwa | Azad Jammu and Kashmir | Islamabad Capital Territory | Federally Administered Tribal Areas | Punjab | Balochistan | Sindh |
| 2001 | Flash Flood | 210 | 400,179 | | | | ■ | | | | |
| 2002 | Flood | 23 | 4,010 | | | | | | ■ | | |
| | Flash Flood | 14 | | | | ■ | | | | | |
| 2003 | Flood | 230 | 1,266,223 | | | | | | ■ | ■ | ■ |
| | Flash Flood | 36 | 20 | | ■ | | | | | | ■ |
| 2004 | Flood | 5 | | | | | | | ■ | | |
| 2005 | Flood | 616 | 7,523,543 | | ■ | | | | ■ | ■ | |
| 2006 | Flood | 380 | 8,125 | | ■ | ■ | | | ■ | ■ | ■ |
| | Flash Flood | 20 | | | | | | | ■ | | |
| | Landslide | 29 | 5 | | ■ | | | | | | |
| 2007 | Flood | 460 | 2,186 | | | | | | | | ■ |
| | Flash Flood | 66 | 520 | | ■ | | | | | | ■ |
| | Landslide | 100 | 2 | | ■ | ■ | | | | | |
| 2008 | Flood | 83 | 290,764 | | ■ | | | | ■ | | |
| 2009 | Flood | 52 | 70 | | | | | | | | ■ |
| | Flash Flood | 50 | 75,010 | | ■ | | | | | | |
| 2010 | Flood | 2,031 | 20,359,518 | ■ | ■ | ■ | | | ■ | ■ | ■ |
| | Flash Flood | 60 | 4,000 | | ■ | | | | | | ■ |
| | Landslide | 19 | 26,700 | | ■ | | | | | | |

Data Source: WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT) & Consultant Team




## Table3: Natural Disasters occurred in Pakistan (2001-2010) <Storm/Cyclone>

| Year | Disaster Type | Killed/ Missing | Affected People | Name of State | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **8** | **2** | **7** | **5** | **6** | **3** | **1** | **4** |
| | | | | Gilgit Baltistan | Khyber Pakhtunkhwa | Azad Jammu and Kashmir | Islamabad Capital Territory | Federally Administered Tribal Areas | Punjab | Balochistan | Sindh |
| 2001 | Storm | 4 | 500 | | | | | | ■ | | |
| 2002 | Storm | 14 | 12 | | | | | | ■ | | |
| 2003 | Storm | 51 | 2,557 | | | | | | | ■ | ■ |
| 2005 | Storm | 58 | | | | | | ■ | | | |
| 2007 | Cyclone | 242 | 1,650,000 | | | | | | | ■ | ■ |
| 2010 | Cyclone | 23 | 4,000 | | | | | | | | ■ |

Data Source: WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT) & Consultant Team


## Table4: Natural Disasters occurred in Pakistan (2001-2010) <Heat Wave/Cold Wave/Avalanche>

| Year | Disaster Type | Killed/ Missing | Affected People | Name of State | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **8** | **2** | **7** | **5** | **6** | **3** | **1** | **4** |
| | | | | Gilgit Baltistan | Khyber Pakhtunkhwa | Azad Jammu and Kashmir | Islamabad Capital Territory | Federally Administered Tribal Areas | Punjab | Balochistan | Sindh |
| 2002 | Heat Wave /Cold Wave | 113 | 24 | | | | | | ■ | ■ | ■ |
| 2003 | Heat Wave /Cold Wave | 200 | | | | | | | ■ | | |
| 2005 | Avalanches | 24 | | | ■ | | | | | | |
| | Heat Wave /Cold Wave | 106 | 200 | | | | | | ■ | ■ | ■ |
| 2007 | Avalanches | 43 | 3 | | ■ | | | | | | |
| 2010 | Avalanches | 31 | 3,705 | | ■ | | | | | | |

Data Source: WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT) & Consultant Team

## Reason for Heavy Rain in the Northern Area - Upper Trough & Monsoon Low

Heavy rain in the northern area is mainly caused by the combination of an upper trough and a monsoon low. As shown in the figure on the right, an upper trough frequently passes above the northern area of Pakistan. This upper trough is closely related to the upper westerlies. The upper westerlies is the westerly wind which blows at an altitude of 5,500m to 5,800m and meanders north and south due to topography, temperature difference between the north and south, low pressure and high pressure system, etc. Since the upper westerlies above Pakistan is blocked by mountain peaks more than 8,000 meters high and with the Tibetan Plateau stretching in the east side, it tends to meander toward the south and create troughs around the northern area of Pakistan.

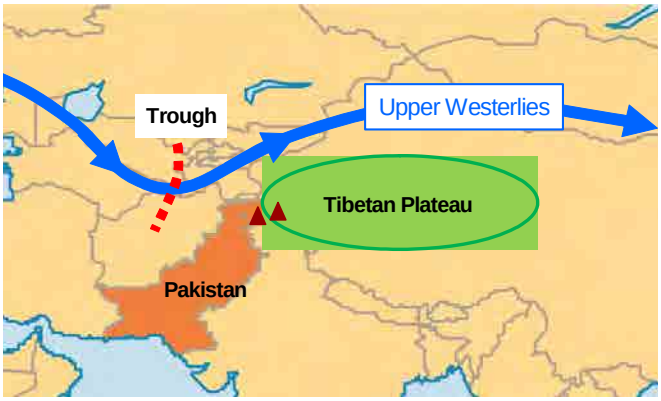



Figure2: Upper Westerlies and Trough near Pakistan

The Figure below shows the mechanism of meteorological phenomenon caused by the combination of an upper trough and a surface monsoon low.

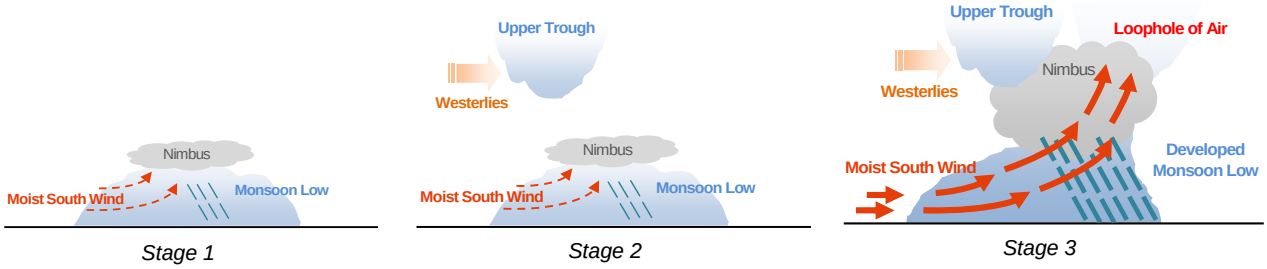



Figure3: Meteorological Phenomenon caused by Upper Trough and Monsoon Low Pressure

Stage 1: Moist south wind blows toward the surface monsoon low and nimbus clouds are formed.
Stage 2: Upper trough approaches surface monsoon low with the flow of the westerlies.
Stage 3: Monsoon low develops rapidly and grows taller creating a vertical loophole of air. Due to this loophole of air, more and more moist south wind can blow toward monsoon low causing continuous rain that leads to heavy rain.

In order to detect such a meteorological phenomenon in the northern area and improve the accuracy of forecast by the PMD, the monitoring of rain clouds by the meteorological radar system is required. In addition, it is necessary to know the wind speed & direction in the upper air through an upper air observation. Hence, further to and/or in addition to the upper air observation by Pilot balloon and radiosonde stations which may be conducted a few times in a day, the vertical wind profiler system which can make 24 hours continuous and unmanned observation of temporal vertical distribution of wind speed

& direction and of weather phenomena such as air turbulence, etc. through radio waves transmitted from the ground to the upper air 4km-12km high (during rain) is crucial in the generation of more accurate forecasts using numerical models. Moreover, the wind profiler system is able to provide information more frequently than the more expensive radiosonde facilities without increasing its expenses for power consumption. Furthermore, there is a lower possibility of technical problem as it has no breakable driving mechanism. For these reasons, the wind profiler system is the most appropriate apparatus for meteorological organization in a developing country.

As such, weather observation through a meteorological radar system coupled with wind profiler systems and data processing & analysis by computer systems, such as the weather forecasting & development system, etc., is extremely effective in improving the forecast accuracy of the PMD and can contribute to the reduction of the adverse effects from meteorological disasters in Pakistan. The implementation of the Project is, therefore, strongly desired and would certainly prove to be a worthwhile endeavor.

## 1-3 Brief Summary on the Requests for the Project by Pakistan

As indicated above, more than twenty (20) years have already passed since the Islamabad meteorological radar system was established under the grant aid of Japan. Despite the follow-up maintenance which was performed in 2011, it is now in critical condition wherein its function deteriorates day by day and may not be able to recover once a serious failure occurs. Thus it is strongly required, as a permanent measure, to replace the existing Islamabad meteorological radar system which plays an important role in weather observation around Islamabad. In addition, the installation of meteorological observation equipment and weather forecast & data transmission system, weather information dissemination system, etc. in the SMRFC is necessary. Due to a lack of financial and technical capabilities, the Government of Pakistan has requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities, etc. under Japan's Grant Aid Assistance scheme. The requested components had been decided in "Priority 1" of the "Multi-Hazard Early Warning Project" conducted under Japan's Aid.

In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Establishment of a Specialized Medium Range Weather Forecasting Center (SMRFC) and Strengthening of the Early Warning and Dissemination Network in the Islamic Republic of Pakistan (hereinafter referred to as the "Preparatory Survey"). The Japan International Cooperation Agency (hereinafter referred to as "JICA") sent the Preparatory Survey Team (1) to Pakistan in order to conduct the Preparatory Survey (1) from September 17 to October 1, 2012. The team confirmed the appropriateness and purpose of each requested component, had a series of discussions with the officials concerned from the Government of Pakistan and collected the necessary and pertinent information and data for preliminary deliberation in the Analysis in Japan (1). As a consequence, the requested components were classified as the target and non-target items for Analysis in Japan (1) as shown in the following table.

Table5: Target Items of Preliminary Deliberation of the Analysis in Japan (1)

| No. | Component | Qty | Description of the Request and Purpose of the Component |
|---|---|---|---|
| **1** | **SMRFC (Specialized Medium Range Weather Forecasting Center)** | | |
| 1-1 | Meteorological Data Processing, Analyzing & Forecasting System with High Speed Computer including Agro meteorological Data Processing & Analysis Unit | 1 | Enhancement of the existing PC clustering system from 2T flops/sec to 20T flops/sec for operating a Regional NWP Model with a resolution of 5km grid size. Model operation round the clock producing the output on 3 hourly bases.<br>High accuracy weather forecasts up to 3 days will be produced by the enhanced computing system. Extended period to cover middle range up to 10 days weather forecasts to charter the needs of additional outlooks (weather guidance). |
| | | 1 | Decision support system using output of the NWP Model: advisory on crop water requirement, timing of pest control, sowing/harvesting and field operation for agriculture sector.<br>Issuance of agro meteorological information to the farmers (5-7 days in advance) on periodical bases for all the agro-climatic zones of Pakistan using existing Mass media and SMS. |
| 1-2 | Meteorological Information Dissemination System and Weather Information Broadcasting Program Production System | 1 | Simplified radio broadcast transmission system (30 transmitters on local weather observatories) for regional area and radio programme production system (radio booth, recorder and data transfer equipment). |
| 1-3 | NOAA HRPT System | 1 | Monitoring of dense fog, sea surface temperature, soil moisture, outgoing long radiation (OLR), snow cover, NDVI, land use products and global precipitation estimates from a Polar Orbit Meteorological |

| | | | |
|---|---|---|---|
| | | | Satellite. |
| 1-4 | GTS Message Switch System | 1 | The New GTS Message Switching System to be installed in PMD Islamabad for switching over the existing GTS Message Switching System in Karachi. |
| 1-5 | Meteorological Data Trunk Communication System including Network Management System (VPN) | 8 | Communication Network for data exchange among PMD offices, and publication and dissemination of weather forecasts and warnings to the government and organizations related to disaster management. |
| 1-6 | Lightning Protection and Power Supply System for SMRFC<br>- Power Backup System (UPS)<br>- Isolation Transformer for the Equipment<br>- Isolation Transformer for the Building Facility<br>- Automatic Voltage Regulator<br>- Engine Generator | 1 | For the protection of equipment and systems of the SMRFC from lightning and surges and the provision of stable power. |
| 1-7 | Necessary Spare Parts and Test Equipment for SMRFC | 1 | For maintenance of the equipment and systems supplied under the Project by the SMRFC. |
| **2** | **Meteorological Radar** | | |
| 2-1 | Meteorological Radar<br>• Meteorological Radar System<br>• Meteorological Radar Data Display System<br>• Necessary Spare Parts and Test Equipment for Meteorological Radar<br>• Construction of Radar Tower Building including Power Supply System mentioned below;<br>- Power Backup System (UPS)<br>- Isolation Transformer for the Equipment<br>- Isolation Transformer for the Building Facility<br>- Automatic Voltage Regulator<br>- Engine Generator | 1 | For continued radar observation.<br>For stable and highly accurate radar observation. |
| 2-2 | Meteorological Radar Data Composite Picture System (including Existing Meteorological Radar 8 bit Modification System) | 1 | The equipment to describe and display the Radar Composite Pictures from the newly established Islamabad radar data and other existing radar data. (including data modification system to convert the existing radar data into 8 bit data) |
| **3** | **Upper-air Observation System** | | |
| 3-1 | Upper-air Observation System (Wind Profiler) with Meteorological Data Satellite Communication System (VSAT) | 5 | Currently, the PMD cannot carry out periodical upper air observation using radio sonde due to the lack of financial resources. With the help of 5 radio sonde stations, the upper air data will be produced and will be consumed by the local forecasting system. In addition, the upper air data will be shared with the global community. |
| **4** | **Mobile-type Micro Weather Radar System** | | |
| 4-1 | Mobile-type Micro Weather Radar System with Power Supply Apparatus | 1 | The required mobile radar system (X band) enables the PMD to monitor severe weather events (small and local scale phenomena) in the disaster prone areas in Pakistan. |

Table6: Non-target Items of Preliminary Deliberation of the Analysis in Japan (1)

| No. | Component | Qty | Description of the Request and Purpose of the Component |
|---|---|---|---|
| 1-1 | Forecast Support System with Plotting Apparatus | 1 | The equipment which can printout (or plot) some kinds of weather charts, drawn by the free software, on one sheet of larger paper such as 1.3 m ×1m. |
| 1-2 | Meteorological Product Display System | 3 | Three (3) large sized (52 inches) LCD Displays. Each display is installed at (1) Forecast room for forecasting work, (2) the entrance lobby of the PMD for the reference & viewing of visitors and (3) airport lobby to display the weather information to general airport users. |
| 1-3 | Vehicle | 1 | Government of Pakistan has already one purchased for the Project. |
| 1-4 | Environmental Monitoring System, Spread Spectrum Data Transmission System with Power Supply Apparatus | 2 | The system, which has similar functions with the existing one in Multan, provided by the Government of Italy to monitor environmental conditions. |

JICA then sent the Preparatory Survey (2) Team to Pakistan in order to conduct the Preparatory Survey (2) from November 14 to December 26, 2012. In accordance with the results of various considerations in the Analysis made in Japan (1) on the items indicated in the above tables which were classified in the Preparatory Survey (1), the team conducted several discussions with the officials concerned from the Government of Pakistan including the PMD and further studies on the required equipment, scale and quantities for the project implementation paying particular attention to the present situation in Pakistan from various perspectives such as the operation & maintenance capabilities of the PMD, appropriate equipment arrangement plan, etc. As a result, it was finally confirmed that the following items indicated in the table attached hereunder are required for the Project and are objects of the Analysis in Japan (2). In particular, in order to assess the viability of the reutilization of the existing Meteorological Radar Tower for the Project, a comprehensive structural evaluation of the existing Islamabad Meteorological Radar Tower Building, such as the confirmation of the current situation of the main structures, Structural Calculation, schmidt hammer test for concrete compressive strength (concrete deterioration diagnosis) and analysis of horizontal distortion angle due to wind pressure, was conducted. As a result, it was confirmed that the reutilization of the existing Meteorological Radar Tower Building for the Project is a dangerous and not viable option.

JICA sent the Preparatory Survey (3) Team again to Pakistan from June 29 to July 6, 2013 in order to explain and discuss the outline design & draft survey report. In the course of 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 object items of the Preparatory Survey for the Project.

Table7: Object Items of the Preparatory Survey

| Component | Islamabad | | Lahore | | Karachi | Multan | Gilgit |
|---|---|---|---|---|---|---|---|
| | PMD Islamabad Head Office | Meteorological Office in New Benazir Bhutto International Airport (NBBIA) | PMD Lahore Regional Meteorological Center | PMD Lahore Flood Forecasting Division | PMD Karachi Tropical Cyclone Warning Center | PMD Multan Meteorological Office | PMD Gilgit Meteorological Office |
| Procurement and Installation of Equipment | | | | | | | |
| SMRFC (Specialized Medium Range Weather Forecasting Center) Weather Forecasting & Development System (including Lightning System, Power Back-up System, Isolation Transformer, Auto Voltage Regulator, Power Supply Capacitor and Test Instruments, Spare Parts and Ancillary Facility) | 1 | - | - | - | - | - | - |
| Meteorological Data Trunk Communication System | 1 | - | 1 | 1 | 1 | 1 | 1 |
| GTS Message Switch System | 1 | - | - | - | - | - | - |
| S-Band Doppler Pulse Compression Solid State Radar System (including Power Back-up System, Isolation Transformer, Auto Voltage regulator, Power Supply Capacitor | 1 | - | - | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| and Test Instruments and Spare Parts) | | | | | | | |
| Meteorological Rader Data Display System | 2 | 1 | – | – | – | – | – |
| Wind Profiler System (including Ancillary Facility) | 1 | – | – | – | – | 1 | – |
| Construction of Radar Tower Building | | | | | | | |
| Construction of a new Radar Tower Building (Lightning System, Power Back-up System, Isolation Transformer, Auto Voltage regulator, maintenance equipment) | 1 | – | – | – | – | – | – |

## 1-4 Negative Impact on the Development of the Pakistani Economy

The figure below shows the GDP growth rate of Pakistan. It shows that the GDP growth rate drops in the year after Pakistan suffers from serious catastrophic damage caused by a natural disaster. In 2008, the GDP growth rate fell drastically to 1.6% from the previous year since Cyclone "Yemyin" hit Pakistan and the total estimated damages was worth about 1,620 million US dollars. In addition, the GDP growth rate also dropped to 2.9% in 2011 which was the year after the historical meteorological disasters (flood and landslide) happened and brought about unprecedented human losses of about 2,000 people either dead or missing and about 10 billion US dollars of total estimated damage. These rates clearly show that the damages caused by meteorological disasters have serious negative impacts on the economic development of the whole country.

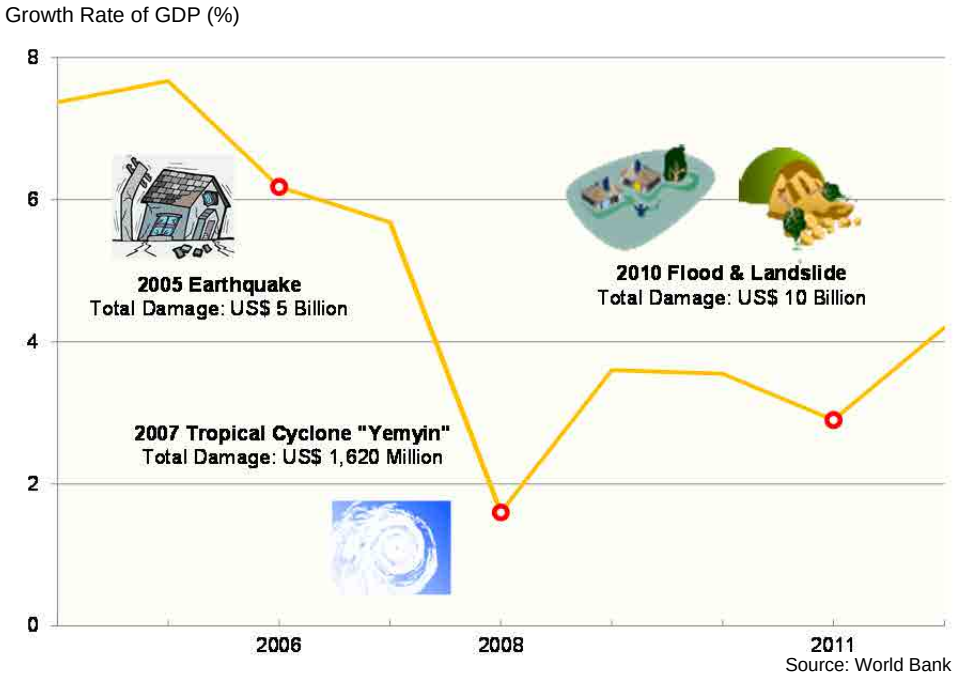



Figure4: Growth Rate of GDP and Natural Disasters

## 1-5 Project Site Location Information

Table8: Project Site Location Information

| Name of Site | PMD Islamabad Head Office | | PMD Multan Meteorological Office |
|---|---|---|---|
| | Meteorological Radar, Wind Profiler | Specialized Medium Range Weather Forecasting Center | |
| Latitude | N 33º 40'57.2" | N 33º 41'01.6" | N 30º 11'52.8" |
| Longitude | E 73º 03'50.8" | E 73º 03'50.7" | E 71º 25'22.1" |
| Altitude | 523m | 525m | 122m |

| Name of Site | PMD Karachi Tropical Cyclone Warning Center | PMD Lahore Flood Forecasting Center |
|---|---|---|
| Latitude | N 24º 55'58.1" | N 31º 32'33.1" |
| Longitude | E 67º 08'33.2" | E 74º 19'29.5" |
| Altitude | 121m | 163m |

| Name of Site | PMD Lahore Regional Meteorological Center | PMD Gilgit Meteorological Office |
|---|---|---|
| Latitude | N 31º 32'32.4" | N 35º 55'10.1" |
| Longitude | E 74º 19'32.9" | E 74º 19'56.4" |
| Altitude | 169m | 1,463m |

## 1-6 Stability of Commercial Power

Stability measuring tests of commercial power by a power quality analyzer were conducted at each project site with the results indicated in the following table. As a consequence of the tests, it was confirmed that power back-up systems such as engine generators, automatic voltage regulators, etc. are indispensable for the Project.

Table9: Stability of Commercial Power (Measured by Power Quality Analyzer)

| Name of Site | | PMD Islamabad Head Office | PMD Multan Meteorological Office |
|---|---|---|---|
| Commercial Power (Voltage: Nominal) | | 400V, 50Hz, 3-phase 4-wire | 400V, 50Hz, 3-phase 4-wire |
| Voltage (Nominal: 230V)* | Max. | 250.4 | 243.8 |
| | Min. | 215.0 | 228.0 |
| Frequency (Hz) | Max. | 50.43 | 50.16 |
| | Min. | 48.60 | 48.95 |
| Frequency of Electric Outage | Winter | 3 times/day (approx. 1 hour/time) | 4 times/day (approx. 1 hour/time) |
| | Summer | 7 times/day (approx. 1 hour/time) | 4 times/day (approx. 1 hour/time) |

| Name of Site | | PMD Karachi Tropical Cyclone Warning Center | PMD Lahore Flood Forecasting Center and Regional Meteorological Center |
|---|---|---|---|
| Commercial Power (Voltage: Nominal) | | 400V, 50Hz, 3-phase 4-wire | 400V, 50Hz, 3-phase 4-wire |
| Voltage (Nominal: 230V)* | Max. | 254.2 | 254.4 |
| | Min. | 202.6 | 232.4 |
| Frequency (Hz) | Max. | 50.42 | 50.14 |
| | Min. | 48.98 | 48.78 |
| Frequency of Electric Outage | Winter | 4 times/day (approx. 1 hour/time) | 4 times/day (approx. 1 hour/time) |
| | Summer | 7 times/day (approx. 1 hour/time) | 6 times/day (approx. 1 hour/time) |

| Name of Site | | PMD Gilgit Meteorological Office |
|---|---|---|
| Commercial Power (Voltage: Nominal) | | 400V, 50Hz, 3-phase 4-wire |
| Voltage (Nominal: 230V)* | Max. | 240 |
| | Min. | 180 |
| Frequency (Hz) | Max. | 50.3 |
| | Min. | 48 |
| Frequency of Electric Outage | Winter | 4 times/day (approx. 1 hour/time) |
| | Summer | 1 time/ day( approx. 1 hour/day) |

*Result of measuring that nominal 400V 3-phase power divided into 3 lines × 220V Single-phase

Since the airport is under construction, the test was not conducted at Meteorological Office in New Benazir Bhutto International Airport (NBBIA)

## 1-7 Existing Internet Connection

Table10: Existing Internet Connection

| Name of Site | | PMD Islamabad Head Office | | | | PMD Multan Meteorological Office | PMD Karachi Tropical Cyclone Warning Center |
|---|---|---|---|---|---|---|---|
| Internet Service Provider | | NAYATEL | World Call | | | PTCL | PTCL |
| Connection Type | | Optical Fiber Link Shared Line | Optical Fiber Link Dedicated Line | | | DSL Link Shared Line | Radio Link Dedicated Line |
| Static IP Address | | ○ | ○ | | | × | ○ |
| Contracted Line Capacity (bps) | | 1 M | 3 M (R&D) | 3 M (Forecasting & Seismic) | 3M (Others) | Max. 2 M | 2 M |
| Speed Test* Result (bps) | Download | 0.98 M | 2.97 M | 3.67 M | 0.28 M | 1.90 M | 2.09 M |
| | Upload | 5.46 M | 17.71 M | 5.31 M | 0.18 M | 0.39 M | 1.77 M |

| Name of Site | | PMD Lahore Flood Forecasting Center | | PMD Lahore Regional Meteorological Center | | PMD Gilgit Meteorological Office |
|---|---|---|---|---|---|---|
| Internet Service Provider | | PTCL | NTC | PTCL | NTC | SCO |
| Connection Type | | DSL Link Shared Line | DSL Link Dedicated Line | DSL Link Shared Line | DSL Link Shared Line | DSL Link Shared Line |
| Static IP Address | | × | ○ | × | ○ | × |
| Contracted Line Capacity (bps) | | Max. 2 M | 1 M | Max. 4 M | 1 M | 4M |
| Speed Test* Result (bps)* | Download | 0.90 M | 0.94 M | 0.80 M | 1.97 M | 4M (Shared) |
| | Upload | 0.39 M | 0.43 M | 0.40 M | 0.60 M | 4M (Shared) |

*Speed Test at Internet speed test site www.speedtest.com.pk

Since the airport is under construction, the test was not conducted at Meteorological Office in New Benazir Bhutto International Airport (NBBIA)

## 1-8 Natural Conditions of Pakistan

The ratio of each disaster in Pakistan is as follows.

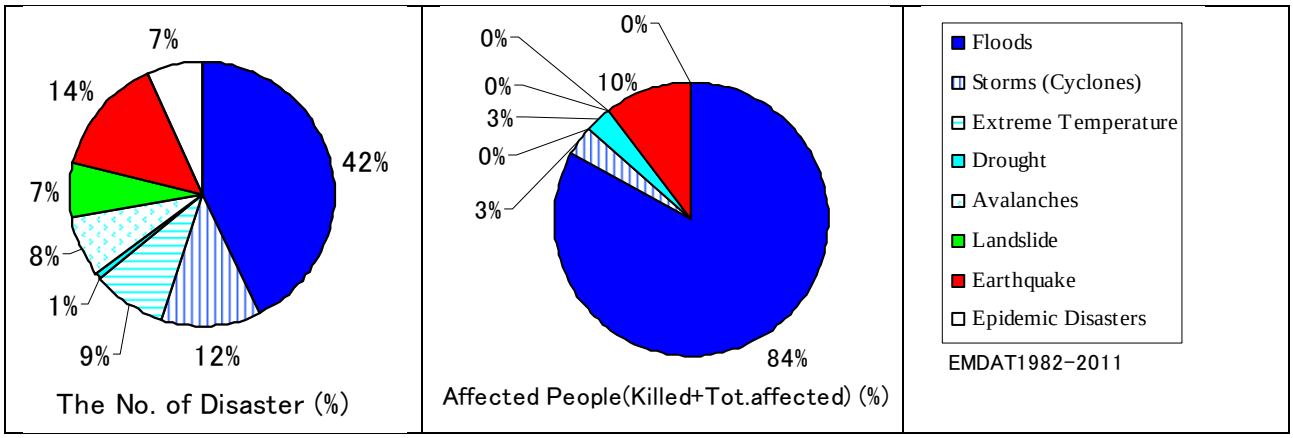



Figure5: Ratio of each Disaster in Pakistan

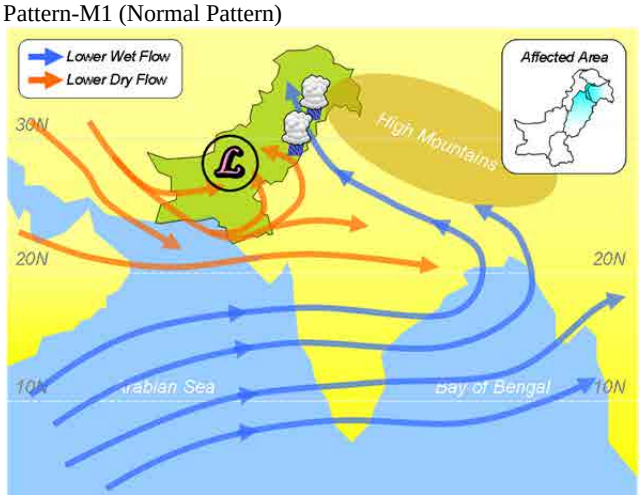
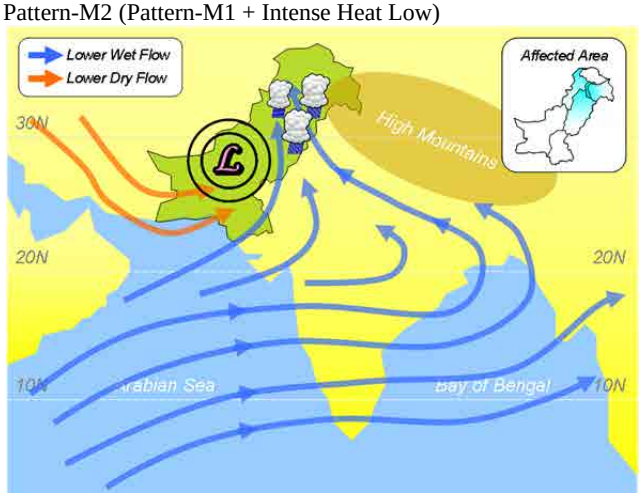
The tables below show the period of typical precipitation events and their details including mechanism and influence on Pakistan.

Table11: Calendar of Typical Precipitation Events in Pakistan

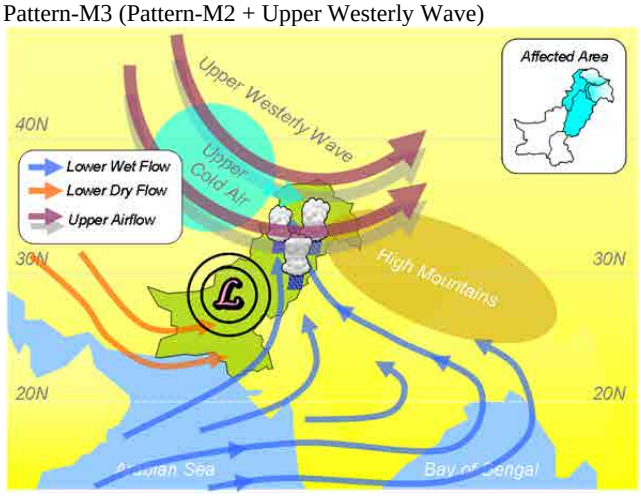
Season of each Event
Peak Season of Each Event

Summer Monsoon

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ← | ← | ← | → | | | |

| | |
|---|---|
| Pattern-M1 (Normal Pattern)<br>  | Mechanism:<br>During the summer monsoon season, major sources of moisture transported to Pakistan are from the Bay of Bengal and the Arabian Sea with the former contributing much more than the latter. After traveling along the foot of the Himalayas, wet airflow penetrates into northeastern Pakistan and brings precipitation.<br><br>Expected Rainfall (in Islamabad):<br>15 mm/24h or 40 mm/event<br>(More rainfall is expected in the mountainous area due to the orographic effect.) |
| Pattern-M2 (Pattern-M1 + Intense Heat Low)<br>  | Mechanism:<br>In addition to Pattern-M1, when a Seasonal Low (Heat Low) located northeast of the Balochistan province intensifies, moist airflow from the Arabian Sea is accelerated and transported into northern Pakistan. Combined with the moisture coming from the Bay of Bengal, this causes more intense and widespread precipitation.<br><br>Expected Rainfall (in Islamabad):<br>30-40 mm/24h or 70 mm/event<br>(More rainfall is expected in the mountainous area due to the orographic effect.)<br><br>Recent Record: 96 mm/24h (27-Jul-2006, Muzaffarabad, Kashmir) |

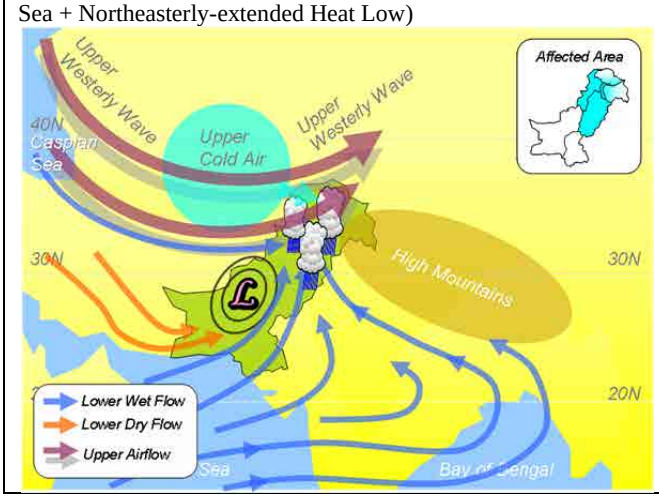
Pattern-M3 (Pattern-M2 + Upper Westerly Wave)




Mechanism:
In addition to Pattern-M2, when the Upper Westerly Wave at 500hPa level is accompanied by the upper cold air and moves lower down the lower latitude than usual, more precipitating clouds can be developed.

Expected Rainfall (in Islamabad):
50 mm/24h or 100 mm/event
(More rainfall is expected in the mountainous area due to the orographic effect.)

Pattern-M4 (Pattern-M3 + Upper Westerly Wave from Caspian Sea + Northeasterly-extended Heat Low)




Mechanism:
In addition to Pattern-M3, in case the Upper Westerly Wave at 500hPa level travels from the Caspian Sea, and is accompanied by low level moisture and isobars of Heat Low are extended northeastward, most severe rainfall is expected in the summer monsoon season.

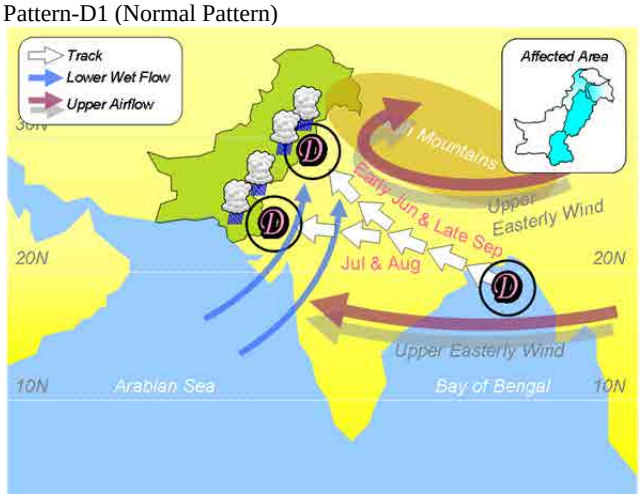
Expected Rainfall (in Islamabad):
Over 50 mm/24h, or over 100 mm/event
(In this weather pattern, very much localized rainfall is expected.)

Recent Record: 592 mm/24h (23-Jul-2001, Islamabad)

## Monsoon Depression

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ← | — | — | → | | | |

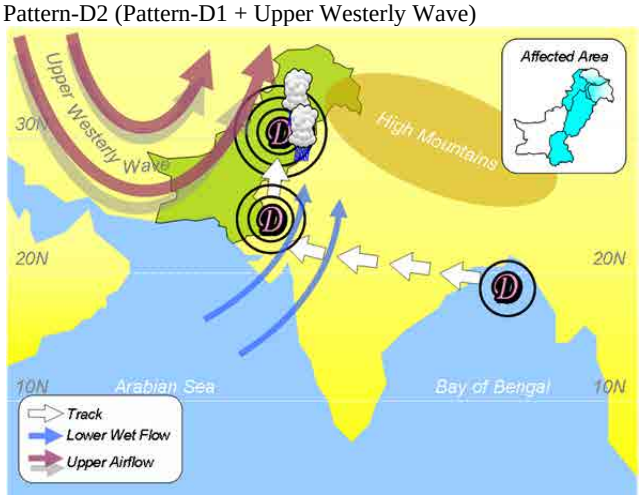
Pattern-D1 (Normal Pattern)




Mechanism:
During the summer monsoon season, Monsoon Depressions (or Tropical Depressions) are normally formed over the Bay of Bengal, north of 18N latitude, and migrate west-northwestward across the central or northern parts of India by the seasonal upper easterly wind blowing from the Tibetan High. These depressions generally weaken after crossing India due to a cut-off of moisture supply. However, when moisture is supplied from the Arabian Sea, they can keep their intensity and adopt a westerly course to reach Pakistan.

Expected Rainfall (in Islamabad):
70-80 mm/24h or 120 mm/event
(More rainfall is expected in the mountainous area due to the orographic effect.)

Pattern-D2 (Pattern-D1 + Upper Westerly Wave)



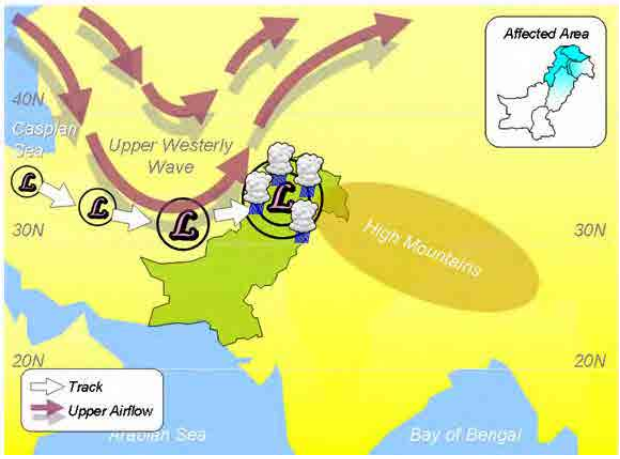

Mechanism:
In addition to Pattern-D1, when the Upper Westerly Wave at 500hPa level meanders lower than usual to the lower latitude, the Monsoon Depressions approaching Pakistan tend to become re-developed and suddenly adopt a northward track. This weather pattern causes the most severe floods in the rivers of Satluj, Ravi, Chenab and Jhelum as recorded in 1992 and 1997.

Expected Rainfall (in Islamabad):
100-120 mm/24h or 150 mm/event
(More rainfall is expected in the mountainous area due to the orographic effect.)

## Western Disturbance

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ◄ | ► | | | ► | ◄ | - | - | - | - | ◄ | |

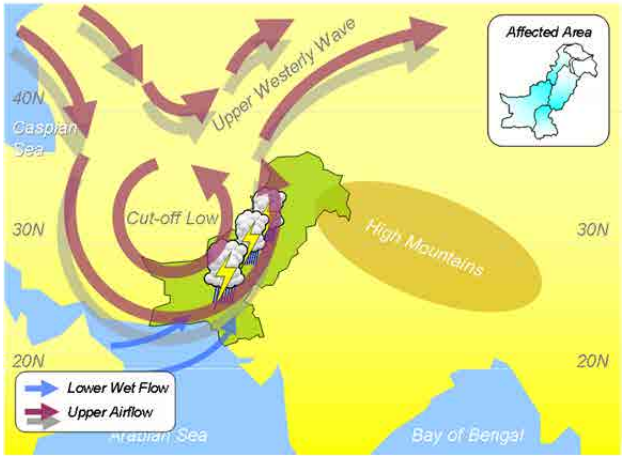
Pattern-W1 (Normal Pattern)




Mechanism:
During the winter season, most of the precipitation are induced by mid-latitude low pressure systems referred to as "Western Disturbances" which come to Pakistan by the Upper Westerly Wave after travelling far from the Mediterranean Sea. On the other hand, in case the Upper Westerly Wave approaches Pakistan during the hot dry season (March - May), more severe events such as rain/dust-storms or even tornados tend to occur especially in the northern and central Punjab province.

Expected Rainfall (in Islamabad):
30 mm/24h or 50 mm/event
(More rainfall is expected in the mountainous area due to the orographic effect especially during the winter season due to strong winds induced by a large pressure gradient.)

Pattern-W2 (Pattern-W1 + Cut-off Low + Moist Flux from the Arabian Sea)




Mechanism:
In addition to Pattern-W1, in case the Cut-off Low is completely separated from the normal Upper Westerly Wave and sufficient moist flux is supplied into the lower level from the Arabian Sea, more intense, widespread and persistent precipitation is induced. The location of the affected area differs according to the position of the Cut-off Low. Once this situation occurs, it normally lasts for 2 to 3 days because the Cut-off Low does not move steadily eastward.

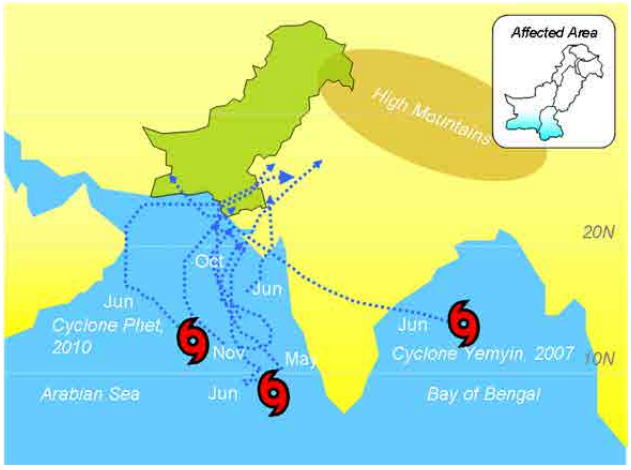
Expected Rainfall (in Islamabad):
40 mm/24h or 60 mm/event
(More rainfall is expected in the mountainous area due to the orographic effect.)

Recent Record: 401 mm/2days (29to30-Jul-2010, Risalpur, KP)

Tropical Cyclone

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ← | → | | | | ← | → | |

Pattern-C




Mechanism:
The Tropical Cyclone season is around the same time as the Pre-monsoon and Post-monsoon seasons in the oceanic regions of South Asia. In Pakistan, historically damaging cyclones were mainly recorded in June. Cyclones formed over the Bay of Bengal sometimes re-intensify over the Arabian Sea after crossing India and making landfall in Pakistan, such as Cyclone Yemyin in 2007.

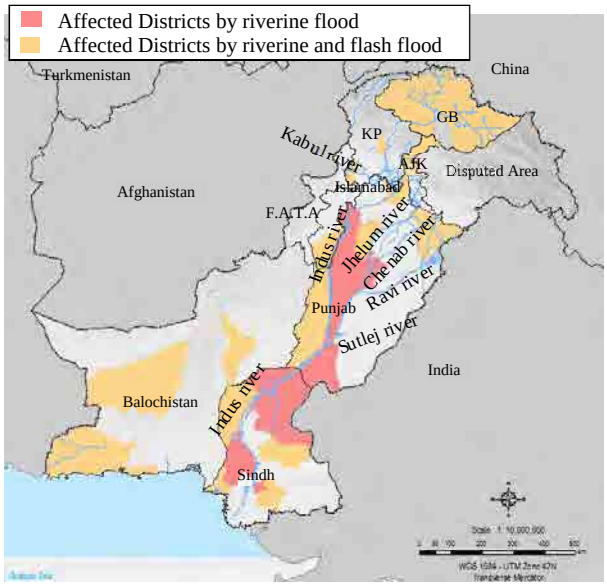
Recent Damaging Cyclones:
Cyclone Phet (June, 2010)
Cyclone Yemyin (June, 2007)
Cyclone Gonu (June, 2007)

Table below shows the period of disasters due to precipitation events and their details including mechanism, most affected areas, etc. in the northern part of Pakistan.

Table12: Calendar of Disaster due to Precipitation Events in the Northern Part of Pakistan

Riverine Flood

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ← | → | | → | | | |




Mechanism:
Due to heavy rainfall by monsoon trough and monsoon depression.

Expected Phenomenon:
Riverine floods have steadily deteriorated human livelihood through long inundation periods.

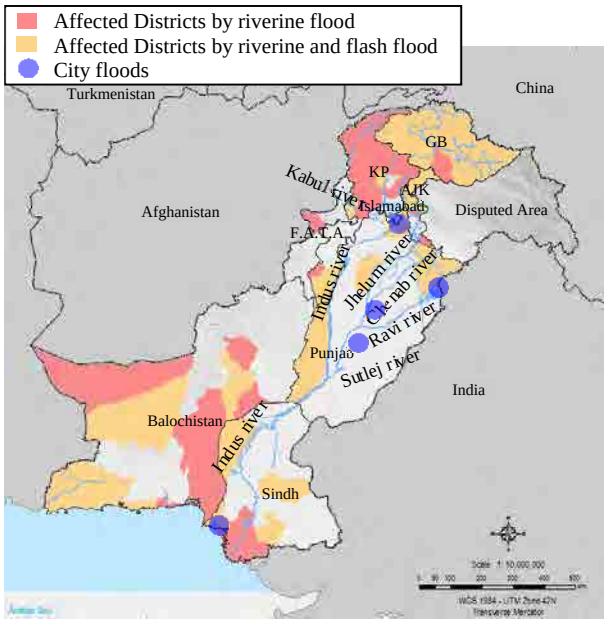
Most Affected Area:
In major rivers: Indus, Kabul, Jhelum, Chenab, Ravi, and Sutlej, and their major tributaries.

Frequency:
(All regions)
0.77 event/year 222 dead/event
1,712,590 affected/event
(GB, KP, AJK, Punjab, FATA)
0.63 event/year 215 dead/event
1,680,997 affected/event

Historical:
2010/07, 1992/09

## Flash Flood

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ← | — | — | — | — | — | — | → | | | ↔ |




Mechanism:
Due to heavy rainfalls in short time ranges by monsoon trough, monsoon depression, low/depressions and/or cold front.

Expected Phenomenon:
Flash floods claim lives through its rapid and high water flows in just a short time.
City floods due to water overflowing from the river or drainage channels are also included as a kind of "Flash Flood".

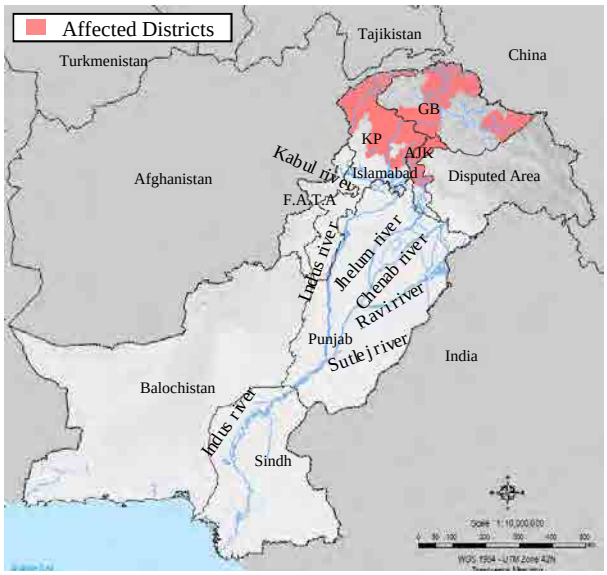
Most Affected Area:
In hill torrents from the hill ranges with small to medium scale catchment tributaries

Frequency:
(All regions)
1.27 event/year 171 dead/event
992,284 affected/event
(GB, KP, AJK, Punjab, FATA)
0.87 event/year 110 dead/event
916,764 affected/event

Historical:
2010/07, 2006/08

## Landslide

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ← | | ← | — | → | | ↔ | | | | | |




Mechanism:
Occurs after/during heavy rains which weaken the ground in place of steep hilly/mountainous topography, weakness in geology, slope instability and prolonged heavy rains.

Expected Phenomenon:
This is a phenomenon in which a part of or all of the soil on a slope moves downward slowly under the influence of groundwater and gravity. Since a large amount of soil mass usually moves, serious damage can occur. If a slide has started, it is extremely difficult to stop it.

Most Affected Area:
In particular, the northern regions of Pakistan such as GB, AJK and KP provinces are vulnerable.

Frequency:
(All regions)
0.30 event/year 23 dead/event
3,302 affected/event
(GB, KP, AJK, Punjab, FATA)
0.27 event/year
24 dead/event
3,713 affected/event

Historical:
2007/03, 2006/07

## 1-9 Topographic and Geotechnical Surveys

At the PMD Islamabad Head Office, which is the proposed site for the construction of a new radar tower building, the topographic and geotechnical surveys indicated in the following tables were implemented by a local contractor consigned by the Preparatory Survey Team.

Table13: Topographic Survey

| | |
|---|---|
| Required Works | • Position of the existing building, observation facility, observation field<br>• Bearing survey of the magnetic north<br>• Calculation of the area planned |
| | • Plane surveying（0.5m contour line)<br>- 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<br>- Indication of ground level at intervals of 10m<br>- Public roads, ponds, river and each water level<br>- Setting bench marks |
| Required Products | • Plane surveying map<br>• Longitudinal profile and cross section<br>• AutoCAD data file in CD-ROM |

Table14: Geotechnical Survey

| | |
|---|---|
| Boring (All core boring) | Required number of borings: 3<br>Maximum depth of borings: 40m (Borings shall be extended to a more suitable bearing layer for a building construction even if borings have reached more than a depth of 40m. After reaching the bearing layer, borings shall be continued to a depth of at least 3m. ) |
| Collecting soil samples | • Undisturbed soil sampling: 3 samples (at different levels) x 3 holes<br>• Disturbed soil sampling: 3 samples (at different levels) x 3 holes<br>• 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 |

Table15: Geotechnical Survey Result of Islamabad Meteorological Radar Observation Station

| Boring No. | | BH-1 | | BH-2 | | BH-3 | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Soil Type | N-value | Water Content (%) | N-value | Water Content (%) | N-value | Water Content (%) |
| 0.0-1.0 | Silty Clay | 9 | - | 11 | - | 16 | - |
| 1.0-2.0 | | 11 | - | 13 | - | 10 | - |
| 2.0-3.0 | | 9 | - | 25 | - | 13 | - |
| 3.0-4.0 | | 9 | - | 15 | - | 17 | - |
| 4.0-5.0 | | 10 | - | 16 | - | 14 | - |
| 5.0-6.0 | | 33 | - | 33 | 11.6 | 28 | - |
| 6.0-7.0 | | 27 | - | 33 | - | 27 | - |
| 7.0-8.0 | | 29 | - | 37 | - | 31 | - |
| 8.0-9.0 | | >50 | - | 27 | - | 45 | - |
| 9.0-10.0 | | >50 | - | 36 | - | 41 | 11.2 |
| 10.0-11.0 | | 43 | - | 41 | - | 43 | - |
| 11.0-12.0 | | 39 | - | 39 | - | 35 | - |
| 12.0-13.0 | | 38 | - | 37 | - | 32 | - |
| 13.0-14.0 | | 39 | - | 28 | - | 25 | 9.6 |
| 14.0-15.0 | | 26 | - | 31 | 10.5 | 27 | - |
| 15.0-16.0 | | 27 | - | 28 | - | 31 | - |
| 16.0-17.0 | | 26 | 12.2 | 25 | - | 29 | - |
| 17.0-18.0 | | 33 | - | 27 | - | 28 | 10.3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18.0-19.0 | | 40 | - | 38 | 12.0 | 35 | - |
| 19.0-20.0 | | 27 | - | 37 | - | 36 | 12.0 |
| 20.0-21.0 | | 27 | - | 27 | - | 36 | 12.5 |
| 21.0-22.0 | | 30 | - | 29 | - | 34 | - |
| 22.0-23.0 | | 28 | - | 28 | - | 45 | - |
| 23.0-24.0 | | 30 | - | 38 | - | 37 | - |
| 24.0-25.0 | | 25 | - | 42 | 13.2 | >50 | - |
| 25.0-26.0 | | 29 | 14.5 | 38 | - | >50 | - |
| 26.0-27.0 | | 36 | - | 43 | 14.6 | 48 | - |
| 27.0-28.0 | | 42 | - | >50 | - | >50 | - |
| 28.0-29.0 | | >50 | - | >50 | - | >50 | - |
| 29.0-30.0 | | >50 | - | >50 | - | >50 | 14.5 |
| 30.0-31.0 | | >50 | - | >50 | - | >50 | - |
| 31.0-32.0 | | >50 | - | 48 | - | >50 | - |
| 32.0-33.0 | | >50 | - | >50 | - | >50 | 12.7 |
| 33.0-34.0 | | >50 | - | >50 | - | >50 | - |
| 34.0-35.0 | | >50 | - | >50 | 16.3 | >50 | - |
| 35.0-36.0 | | >50 | 16.5 | >50 | - | >50 | - |
| 36.0-37.0 | | >50 | - | >50 | - | >50 | 13.5 |
| 37.0-38.0 | | >50 | - | >50 | - | >50 | - |
| 38.0-39.0 | | >50 | - | >50 | - | >50 | - |
| 39.0-40.0 | | >50 | - | >50 | - | >50 | 13.8 |

## 1-10 Existing Facility and Equipment

<Existing Islamabad Radar Tower Building>

Since the periodical external wall painting of the existing Islamabad Radar Tower Building has been well maintained by the PMD, the existing damage cannot be easily identified. However, the gradual and overall deterioration of the existing building has been progressing due to the passage of 22 years. Pictures of the existing Islamabad Radar Tower Building are attached hereunder.

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

| | |
|---|---|
|  |  |
| Overview of the Existing Islamabad Meteorological Radar Tower Building | Observation Room<br>Water leakage due to a damaged drainage pipe |
|  |  |
| Anti-Room<br>Concrete tiny cracks | Radom Room<br>Water leakage from the basering on the Radome foundation |
|  |  |
| Radar Equipment Room | Observation Room |

| | |
|---|---|
|  |  |
| Roof Top<br>Rain water gutter | Roof Top<br>Damaged hatch due to rust |

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

Table16: Result of Schmidt Hammer Test for Concrete Compressive Strength of Islamabad Existing Meteorological Radar Tower Building

| Location | Schmidt Hammer Test No. | No. | No. | Rejection/ Acceptance Region | | Average of Acceptance Value (R) | Concrete Compressive Strength (F) of Islamabad Existing Meteorological Radar Tower Building | |
|---|---|---|---|---|---|---|---|---|
| Slab | 1 | 52 | 43. 9 | Rejection Region: ≥+20% of Average =43.9×1.2=52.7<br><br>Acceptance Region<br><br>Rejection Region: ≤ -20% of Average =43.9×0.8=35.1 | 52 | 43. 6 | coefficient angle of inclination +90°→43.6-3.4=40.2<br><br>F=α×(13R-184)/9.8<br><br>α=coefficient of concrete age<br>concrete age ≤ 1,000 days: α=0.6 | 20.7 N/mm$^2$ |
| | 2 | 43 | | | 43 | | | |
| | 3 | 44 | | | 44 | | | |
| | 4 | 47 | | | 47 | | | |
| | 5 | 46 | | | 46 | | | |
| | 6 | 36 | | | 36 | | | |
| | 7 | 44 | | | 44 | | | |
| | 8 | 38 | | | 38 | | | |
| | 9 | 56 | | | 56 | | | |
| | 10 | 37 | | | 37 | | | |
| | 11 | 42 | | | 42 | | | |
| | 12 | 46 | | | 46 | | | |
| | 13 | 48 | | | 48 | | | |
| | 14 | 35 | | | 35 | | | |

Concrete Compressive Strength for Structural Design: 21N/mm$^2$

Concrete Compressive Strength for Quality Management according to Standard of Architectural Institute of Japan (AIJ): 24N/mm$^2$

Table17: Comprehensive Structural Evaluation for the existing Islamabad 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: 500mmx500mm | Out of range for allowable stress (during seismic) | Fail (Danger) |
| Girder: 400mmx800mm | Out of range for allowable stress (during seismic) | Fail (Danger) |
| Grade Beam: 400mmx1840mm | Within the allowable stress | Pass |
| Slab: 130mm | 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 | | |
| Slab | Current concrete compression strength: 20N/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 these new systems, a new radar tower building is required. | |

<Existing Computer Cluster in the PMD Islamabad>

The PMD is currently using the German Regional NWP Model (Meso-scale model) by the Existing Computer Cluster mainly for research and development purposes.

Table18: Main Units composed the Existing Computer Cluster

| No. | Main Unit | Manufacturer | Model Name | Q'ty | Photo |
|---|---|---|---|---|---|
| 1 | Rack Enclosure | DELL | PowerEdge 4220 | 2 |  |
| 2 | Blade Enclosure | DELL | PowerEdge M1000e | 3 |  |
| 3 | Blade Server | DELL | PowerEdge M600<br>Quad-core Intel Xeon X5470 (3.33GHz)×2<br>(2Flops×4core×3.33GHz×2CPU/node=53.75Flops/node)<br>Memory: 8BG, HDD: 128GB×2 (Raid) | 32 |  |
| 4 | Monitor & Keyboard | DELL | UH945 Rack mount Keyboard, US Touchpad | 2 |  |
| 5 | Network Storage | DELL | EMC2 CX4-120 (12TB SATA+5TB Fiber Chanel) | 1 |  |
| 6 | Fiber Channel Blade Switch | DELL | Brocade M5424 | 4 |  |
| 7 | Fiber Channel Blade Switch | DELL | GbE pass-through module for Dell M-Series blades | 4 |  |
| 8 | Server Switch | Cisco | SFS 7000D | 4 |  |
| 9 | Fiber Channel Switch | DELL | Brocade 300 | 2 |  |
| 10 | Port Switch | Cisco | Catalyst 2950 | 2 |  |
| 11 | Modular Access Router | Cisco | 2621 | 2 |  |

Pictures of the Existing Computer Cluster

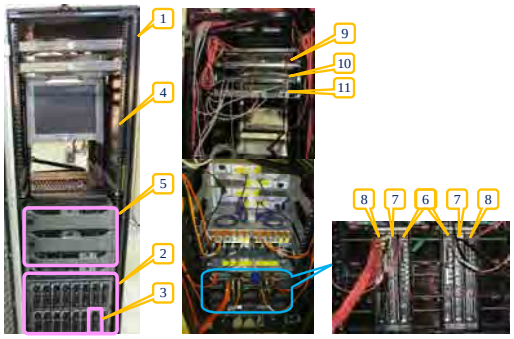



Table19: Software & Models installed in the Existing Computer Cluster

| Software & Models | Details |
|---|---|
| Operating System | Red Hat Enterprise Linux 5.3 |
| Message Passing Interface | Open MPI 1.4.2 |
| Task Scheduler | IBM Platform LSF HPC 7 update 5 |
| File Manager | Midnight Commander (MC) |
| Compiler (Fortran, C & C++) | Intel Compilers 13.0 |
| | GCC 4.1.2 |
| | gfortran 4.1.2 |
| | NetCDF 4.1.3 |
| | NetCDF Operator (NCO) 4.2.3 |
| Programming Language | PERL 5.8.8 |
| | NCL (NCAR Command Language) v6 |
| Parser Generator | Another Tool for Language Recognition (Antlr) 1.2.2 |
| Reference Library | Libpng |
| Visualization Software | Grid Analysis and Display System (GrADS) 2.0.48 |
| | ImageMagick |
| | JasPer |
| Data Manipulation Software | HDF |
| | Climate Data Operators (CDO) |
| Data Compression Library | SZIP |
| | ZLIB |
| Generating Scanners Tool | Flex 2.5.37 |
| GRIB(Gridded Binary) manipulation software | wgrib v1.8.0.9ml |
| | wgrib2 |
| Numerical Computations Library | Gsl(GNU Scientific Library)-config 1.15 |
| Statistical Software | R |
| FTP Client | gFTP 2.0.9 |
| System Management Tool | Chassis Management Controller 3.21 |
| NWP Model | High Resolution Regional Model (HRM) developed by the German Weather Service (Deutscher Wetherdienst : DWD) – Hydrostatic Model<br>Horizontal Grid Distance: 11km<br>Vertical Coordinate: Pressure Coordinate<br>Vertical Layer: 40 layers from ground level-0.1hPa (altitude 65km) |
| Regional Climate Model | Providing Regional Climates for Impacts Studies, pronounced pray-sea (PRECIS) developed by the UK Met. Office |
| | Regional Climate Models (RegCM) developed by the International Centre for Theoretical Physics (ICTP) |
| | Rossby Centre regional atmospheric model (RCA4) developed by the Swedish Meteorological and Hydrological Institute (SMHI) |

## 1-11 Consideration for Environmental Conservation

In order to implement the Project, it was confirmed by the PMD with the Environmental Protection Authority (EPA) in the Ministry of Climate Change (MOCC) 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

After the huge earthquake which happened in the Northern area of Pakistan back in October 2005, Pakistan began strengthening its overall administrative functions for disaster prevention. Since then, the National Disaster Management Ordinance (NDMO) was enacted and the National Disaster Management Commission (NDMC) and the National Disaster Management Authority (NDMA) were established. In addition, the National Disaster Risk Management Framework (NDRMF) was formulated. The NDMA has just started to undertake disaster prevention activities in line with the NDRMF, such as the establishment of local disaster management authorities, the formulation of disaster prevention plans at the local level, etc. The core organization of this disaster management system is the PMD which has the huge responsibility of issuing forecasts/warnings on natural disasters such as floods or cyclones.

Pakistan is a disaster-prone country which is often damaged by floods, landslides, cyclones, droughts, etc. These natural disasters lead to the loss of human lives and properties, thereby, contributing to the significant set-back of socio-economic activities. Particularly, the damages these disasters bring to poor people, who are extremely vulnerable to natural disasters, are tremendous, thus, proving to be a major obstacle for Poverty Reduction, one of the development strategies of the Government of Pakistan. The most devastating catastrophe in Pakistani history was the Indus River Flood in 2010 (Affected people: over 20 million, Killed or Missing: over 2,000). More than half of the people killed lost their lives due to mudflows in the upper or middle river basin, landslides in the mountainous area or collapsed houses due to torrential rain. In order to mitigate such natural disasters which bring about extensive damages, it is imperative to predict these disaster risks in advance and take the appropriate and effective countermeasures. Therefore, it is highly necessary that the PMD improve its capability of meteorological observation and forecast/warning accuracy as well as to disseminate more promptly and timely the weather information (forecast/warning) to the proper channels.

In addition, global climate change has a potential to increase the frequency and scale of these natural disasters in the medium-to-long-term run and creates risks of adverse impacts on Pakistan, one of the natural disaster-prone countries. Thus, the establishment of a disaster management system including an early warning system is an urgent task in Pakistan.

Given the situation indicated above, the key objective of the Project is the strengthening of the disaster prevention system and prior countermeasures against natural disasters by improving the

PMD’s meteorological observation system and forecast/warning dissemination system. To achieve this objective, the replacement and establishment of a new meteorological observation & data process analysis system in addition to the installation of a weather information dissemination system are absolutely essential. These will largely enhance the PMD’s capabilities in meteorological observation, weather forecasting and dissemination of forecasts/warnings, and consequently, will contribute to the mitigation of damages caused by natural disasters.

## 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 to contribute to disaster prevention in Pakistan.
b) To enable the PMD 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 Pakistan.
c) To enable the PMD to monitor weather conditions around-the-clock on a real time basis.
d) To enable the PMD to promptly issue a weather information and/or a warning to the public.
e) To ensure the improvement of the PMD's overall function and capacity in reducing human loss and economic setback brought about by natural disasters through the upgrading of the PMD's monitoring capabilities of meteorological phenomena.
f) To determine and set up the size and components of the Project to match with the technical, operational and maintenance capabilities of the PMD.

[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 PMD.
c) To design the Islamabad Meteorological Radar System 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 PMD.
d) To design the Islamabad Meteorological Radar System 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 Islamabad Meteorological Radar System are delivered to the PMD Head Office and National Weather Forecasting Center (NWFC) every 15 minutes.
f) To design the system so that it is within the PMD's capability to operate, maintain and repair.
g) To select equipment for which spare parts and consumables can be easily procured and replaced.
h) To select reliable and durable equipment suitable for the local environment.
i) To minimize the recurrent costs of the PMD for the operation, maintenance and repair of the equipment.
j) To ensure the accuracy of radar data through meticulous adjustment and proper calibration.
k) To design the equipment so as to minimize lightning damage.
l) 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.
m) To design the equipment to operate using 230V Single Phase/400V 3-Phase 4-Wire ±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 Building satisfies the following requirements:

a) To ensure, as much as possible, that the height of the radar tower building 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 Islamabad Meteorological Radar Tower Building is not more than 0.075 degree.
c) To adopt the design wind pressure: 6.4kN/$m^2$ and the seismic zone factor: Z=0.20 of the Building Code of Pakistan-Seismic Provisions-2007.
d) To ensure that the working environment for the PMD's 24-hour/day work schedule of observations is conducive to ensuring effective and efficient performance.

e) 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.
f) To make use of local building materials for the easy maintenance of the radar tower building by the PMD.
g) 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 to be procured under the Project (radar transmitter, operation terminals, display monitors, spare parts, test instruments and power back-up system) are to be installed in for the smooth operation of the equipment under the appropriate environment at a controlled temperature/humidity.

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 PMD personnel to easily reach each room for the regular maintenance of the radar equipment without getting wet during rainy season.

3) Lightning

Frequent lightning occurs especially during the rainy season. A lightning protector is, therefore, indispensable to prevent damage to the building and to the equipment.

4) Wind

For calculating the design wind pressure: 6.4kN/$m^2$ of the Building Code of Pakistan-Seismic Provisions-2007.

5) Earthquake

For calculation of the seismic zone factor: Z=0.20 and the importance factor (I) = 1.25 of the Building Code of Pakistan-Seismic Provisions-2007 will be applied.

6) 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 building is as follows:

Table20: Foundation Type of the Proposed Islamabad Meteorological Radar Tower Building

| | Islamabad Meteorological Radar Tower Building |
|---|---|
| Foundation type | 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

Most of the construction materials can be procured from the local market. For the Project, durable maintenance materials not containing asbestos will be selected from locally available materials.

3) Use of Local Construction Methods and Local Workers

Laborers are classified according to their skills (e.g. as carpenters, plasterers, steel fitters, etc.) and skill level is variable in Pakistan. In order to be able to utilize local laborers as often as possible, reinforced concrete structures, 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 Pakistan, 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 building.

2) Equipment Installation Work

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

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

1) User-friendly equipment

The equipment to be supplied under the Project will be used to support the PMD’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 PMD 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 PMD 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 building only.
- The utilization of natural light to reduce energy requirements by minimizing the hours of artificial lighting required.
- Usage of LED for artificial lightning.
- 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 building must be sufficiently robust enough to withstand very heavy rains, local severe storms and lightning strikes to enable the provision of meteorological services 24 hours per day.

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

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 building, 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, 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.

Table21: Object Items of the Preparatory Survey

| Component | Islamabad | | Lahore | | Karachi | Multan | Gilgit |
|---|---|---|---|---|---|---|---|
| | PMD Islamabad Head Office | Meteorological Office in New Benazir Bhutto International Airport (NBBIA) | PMD Lahore Regional Meteorological Center | PMD Lahore Flood Forecasting Division | PMD Karachi Tropical Cyclone Warning Center | PMD Multan Meteorological Office | PMD Gilgit Meteorological Office |
| Procurement and Installation of Equipment | | | | | | | |
| SMRFC (Specialized Medium Range Weather Forecasting Center) Weather Forecasting & Development System (including Lightning System, Power Back-up System, Isolation Transformer, Auto Voltage Regulator, Power Supply Capacitor and Test Instruments, Spare Parts and Ancillary Facility) | 1 | - | - | - | - | - | - |
| Meteorological Data Trunk Communication System | 1 | - | 1 | 1 | 1 | 1 | 1 |
| GTS Message Switch System | 1 | - | - | - | - | - | - |
| S-Band Doppler Pulse Compression Solid State Radar System (including Power Back-up System, Isolation Transformer, Auto Voltage regulator, Power Supply Capacitor and Test Instruments and Spare Parts) | 1 | - | - | - | - | - | - |
| Meteorological Rader Data Display System | 2 | 1 | - | - | - | - | - |
| Wind Profiler System (including Ancillary Facility) | 1 | - | - | - | - | 1 | - |
| Construction of Radar Tower Building | | | | | | | |
| Construction of a new Radar Tower Building (including Lightning System, Power Back-up System, Isolation Transformer, Auto Voltage regulator, maintenance equipment) | 1 | - | - | - | - | - | - |

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

(1) Equipment Plan

1) SMRFC Weather Forecasting & Development System

The PMD has made a plan to establish the Specialized Medium Range Weather Forecasting Center (SMRFC) at the PMD Islamabad Head Office and to introduce the Numerical Weather Prediction (NWP) System (including the NWP model) in order to improve the accuracy of medium-range

weather forecast. Under these circumstances, the required computer system (weather forecasting & development system) including the peripheral equipment will be established under the Project for high accuracy medium range weather forecasts of up to 10 days. These are to be prepared through weather guidance (rainfall, temperature, humidity and wind speed) by using global NWP products created by meteorological agencies from developed countries.

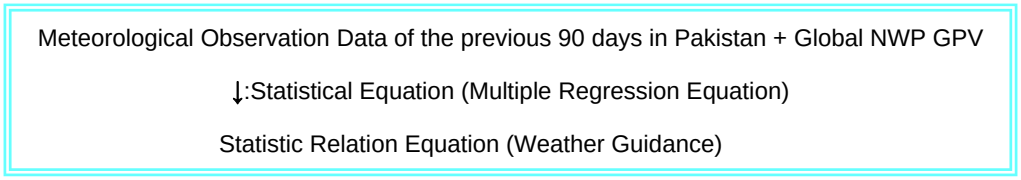
Since the PMD has a plan to introduce a non-hydrostatic NWP model (Weather Research and Forecasting (WRF) Model, etc.), the weather forecasting & development system (computer cluster) for the SMRFC to be procured under the Project must have the required calculation capability and data storage capacity for the development & operation of weather guidance and a non-hydrostatic NWP model.

Forecast production procedures in the SMRFC have been planned as shown in the following table.

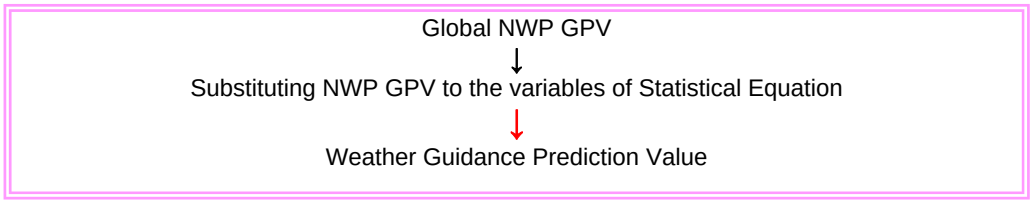
Table22: Forecast Production Procedures in the SMRFC

| Short Range and Medium Range Forecasts | Forecast Production Procedures by the SMRFC |
|---|---|
| Short Range Forecast: 1-3days (24 - 72hours) | Short range forecasts to be prepared by comparing the calculation results of the Regional NWP Model, real observation data and prediction value of weather guidance. |
| Medium Range Forecast: over 3 days (72 hours) - 10days | Medium range forecasts to be prepared through the:<br>1. Detection of the error tendency between the short range weather guidance prediction value and the regional NWP model grid point value (GPV).<br>2. Calculation of the weather guidance prediction value for medium range forecast by the global NWP grid point value (GPV) of foreign countries.<br>3. Correction of the weather guidance prediction value for medium range forecast by the error tendency between the short range weather guidance prediction value and the regional NWP model grid point value (GPV). |

For weather guidance, the production of a statistical equation is needed for the first step as shown in the following figure.




By substituting the GPV of the Global NWP to the variables of the Statistical Equation, the weather guidance prediction value is obtained as shown in the following figure.




The global NWP model grid point value (GPV) for the calculation of weather guidance prediction values for short range weather forecasts are shown in the following table.

Table23: Global NWP Model GPV for the Calculation of Weather Guidance Prediction Value

| | Time | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Calculation Time of Weather Guidance (UTC) | 00Z | - | 06Z | - | 12Z | - | 18Z | - | 24Z | |
| | Today | | | | | | | Tomorrow | | |
| Local Time in Pakistan | 05:00 | 08:00 | 11:00 | 14:00 | 17:00 | 20:00 | 23:00 | 02:00 | 05:00 | |
| Prediction Time of Regional NWP Model (UTC) | 24Z | 27Z | 30Z | 33Z | 36Z | 39Z | 42Z | 45Z | 48Z | 72Z |
| | Tomorrow | | | | | | | Day after next | | Three days later |
| Local Time in Pakistan | 05:00 | 08:00 | 11:00 | 14:00 | 17:00 | 20:00 | 23:00 | 02:00 | 05:00 | 05:00 |
| Time of Global NWP Model GPV for the Calculation of Weather Guidance Prediction Value by Meteorological Elements | | | | | | | | | | |
| Maximum Temperature (UTC) | 33Z | - | 27Z | - | 21Z | - | 15Z | - | 57Z | 81Z |
| Minimum Temperature (UTC) | 24Z | - | 18Z | - | 12Z | - | 06Z | - | 48Z | 72Z |
| Daily Rainfall (UTC) | 24Z | - | 24Z | - | 24Z | - | 24Z | - | 48Z | 72Z |

UTC: Coordinated Universal Time

Through the utilization of the global NWP Model GPV shown in the following table, the 4-10 days weather guidance prediction value is calculated.

Table24: Calculation Time of Weather Guidance for Medium Range Forecast (Maximum Temperature)

| Weather Guidance Prediction Value | Initial Condition Time (UTC) | Usable Global NWP Model GPV for Calculation of Weather Guidance Prediction Value | Coordinated Universal Time (UTC) | Pakistan Local Time |
|---|---|---|---|---|
| 4 days ahead (96 hours prediction) | 12Z (Current Day) | 93 hours (Average of 90 hours and 96 hours) | 09Z | 14:00 |
| 5 days ahead (120 hours prediction) | | 120 hours | 12Z | 17:00 |
| 6 days ahead (144 hours prediction) | | 144 hours | 12Z | 17:00 |
| 7 days ahead (168 hours prediction) | | 168 hours | 12Z | 17:00 |
| 8 days ahead (192 hours prediction) | | 192hours | 12Z | 17:00 |
| 9 days ahead (216 hours prediction) | | 216 hours | 12Z | 17:00 |
| 10 days ahead (240 hours prediction) | | 216 hours | 12Z | 17:00 |

Since the Grid Point Value (GPV) of the JMA Global NWP Model (GSM) is available as a free service (for up to 9-day predictions), it is useful for the 10-day medium range forecast to be prepared by the PMD.

Table25: Grid Point Value (GPV) of JMA Global NWP Model (GSM) for the WMO RA-II

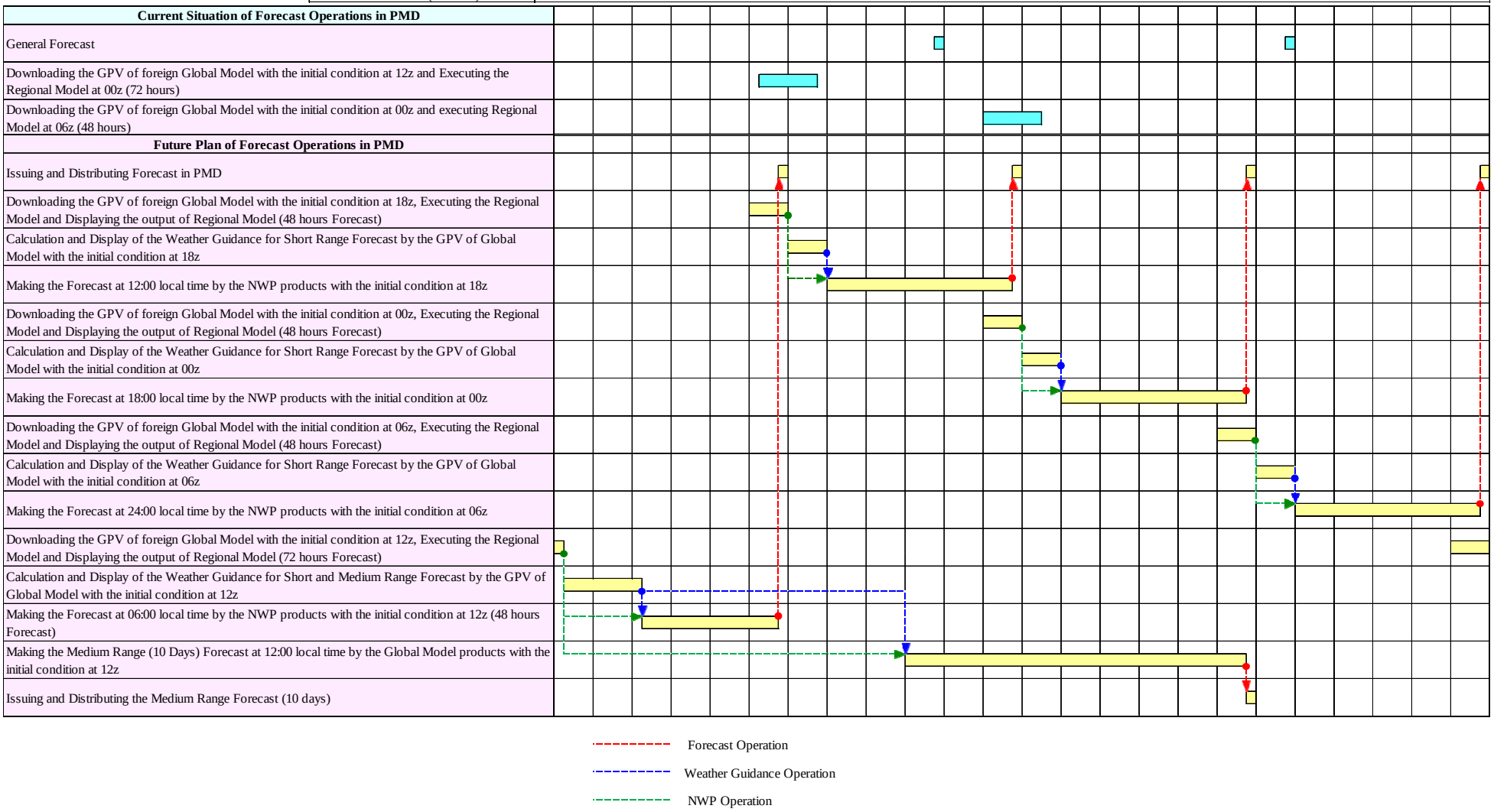
| | |
|---|---|
| Data Area | S5° - N90°, E30° - E195° |
| Surface Grid Size | 0.25deg. × 0.25deg. |
| Upper Air Grid Size | 0.5deg. × 0.5deg. |
| Surface 11 Elements | Zonal Wind, Meridional Wind, Temperature, Relative Humidity, Local Pressure, Sea Surface Pressure, Accumulated Precipitation, Total Cloud Amount, Upper Layer Cloud Amount, Middle Layer Cloud Amount, Lower Layer Cloud Amount |
| Pressure Layers | 1000, 975, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10hPa |
| 1000-600hPa GPV | Geo-potential Height, Zonal Wind, Meridional Wind, Temperature, Relative Humidity, Updraft (6 elements) |
| 500hPa GPV | Geo-potential Height, Zonal Wind, Meridional Wind, Temperature, Relative Humidity, Updraft, Vorticity (7 elements) |
| 300-0hPa GPV | Geo-potential Height, Zonal Wind, Meridional Wind, Temperature, Updraft (5 elements) |
| 0-84 hours (3.5days) | 3 hourly Predictions, Initial Time = 00UTC, 06UTC, 12UTC, 18UTC (every 6hour) |
| 84-96 hours (4 days) | 6 hourly Predictions, Initial Time = 12UTC (every 24hour) |
| 96-192hours (8 days) | 12 hourly Predictions, Initial Time = 12UTC (every 24hour) |
| 192-216hours (9 days) | 24 hourly Predictions, Initial Time = 12UTC (every 24hour) |

The table on the Current Situation and Future Plan of Forecast Operations in the PMD is attached hereunder.

## Table26：Current Situation and Future Plan of Forecast Operations in the PMD

| Coordinated Universal Time（UTC） | 19 | 20 | 21 | 22 | 23 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Time (Pakistan) | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |

| |
|---|
| **Current Situation of Forecast Operations in PMD** |
| General Forecast |
| Downloading the GPV of foreign Global Model with the initial condition at 12z and Executing the Regional Model at 00z (72 hours) |
| Downloading the GPV of foreign Global Model with the initial condition at 00z and executing Regional Model at 06z (48 hours) |
| **Future Plan of Forecast Operations in PMD** |
| Issuing and Distributing Forecast in PMD |
| Downloading the GPV of foreign Global Model with the initial condition at 18z, Executing the Regional Model and Displaying the output of Regional Model (48 hours Forecast) |
| Calculation and Display of the Weather Guidance for Short Range Forecast by the GPV of Global Model with the initial condition at 18z |
| Making the Forecast at 12:00 local time by the NWP products with the initial condition at 18z |
| Downloading the GPV of foreign Global Model with the initial condition at 00z, Executing the Regional Model and Displaying the output of Regional Model (48 hours Forecast) |
| Calculation and Display of the Weather Guidance for Short Range Forecast by the GPV of Global Model with the initial condition at 00z |
| Making the Forecast at 18:00 local time by the NWP products with the initial condition at 00z |
| Downloading the GPV of foreign Global Model with the initial condition at 06z, Executing the Regional Model and Displaying the output of Regional Model (48 hours Forecast) |
| Calculation and Display of the Weather Guidance for Short Range Forecast by the GPV of Global Model with the initial condition at 06z |
| Making the Forecast at 24:00 local time by the NWP products with the initial condition at 06z |
| Downloading the GPV of foreign Global Model with the initial condition at 12z, Executing the Regional Model and Displaying the output of Regional Model (72 hours Forecast) |
| Calculation and Display of the Weather Guidance for Short and Medium Range Forecast by the GPV of Global Model with the initial condition at 12z |
| Making the Forecast at 06:00 local time by the NWP products with the initial condition at 12z (48 hours Forecast) |
| Making the Medium Range (10 Days) Forecast at 12:00 local time by the Global Model products with the initial condition at 12z |
| Issuing and Distributing the Medium Range Forecast (10 days) |



The results of the evaluation for the required calculation resource for the proposed SMRFC Weather Forecasting & Development System (in accordance with the Table26 on the Current Situation and Future Plan of Forecast Operations in the PMD) are as follows.

<Amount of Computation required for the Processes of Weather Guidance>

The monthly processes of weather guidance are:

- Confirmation and arrangement of the original daily records on surface meteorological observation for the last 90 days, input of Rainfall, Daily Minimum & Maximum Temperature, Daily Maximum Wind Speed and Daily Minimum Humidity Values into Excel sheets and download of Global Model GPVs from other countries;
- Selection of files for layers and prediction hours appropriate to the Forecast Target (predictions), extraction of the GPV per element corresponding to the latitude and the longitude of each observatory and calculation of virtual predictors by the GPV per element from the selected files;
- Selection of predictors and the creation of prediction equations through the decreasing and increasing predictors method using observation data and virtual predictors for 90 days; and,
- Graphic display of the prediction by weather guidance, observation value and error for verification in the time series.

In addition, the daily processes of weather guidance are:

- Download of Global Model GPVs from other countries (0-216 hours);
- Selection of the files for layers and forecast hours appropriate to predictions, extraction of the GPV for element corresponding to the latitude and the longitude of each observatory and calculation of predictions with the GPV per Element from the selected files;
- Calculation of the predictors and GPV by extracting the element corresponding to the latitude and longitude from the files for layers and forecast hours;
- Derivation of predictions per element for each observatory using the prediction equation obtained;
- Improvement of each prediction equation by Kalman Filter; and,
- Horizontal drawing GPV, guidance value, observation data and error of prediction by weather guidance, and graphic display of prediction by weather guidance, observation data and error in time series.

In consideration of the estimated performance ability of the theoretical value (4%) and the number of meteorological observatories expected to be put up within the next 10 years, the required calculation resource of the Weather Forecasting & Development System is approximately 1TFLOPS for the implementation of the monthly and daily processes of the weather guidance indicated above.

<Amount of Computation required for the Non-Hydrostatic NWP Model>

Since the PMD has a plan to introduce a non-hydrostatic NWP model into the Weather Forecasting & Development System, the required amount of computation for the Non-Hydrostatic NWP Model operation is evaluated in accordance with the following conditions.

- Horizontal Grid Distance: 5km-10km
- Operation of the Forecast: 4 times/day (Forecast for 48 hours: 3 times/day, Forecast for 72 hours: 1 time/day)
- Calculation Time for Forecast for 48 hours: 30 minutes
- Calculation Time for Forecast for 72 hours: 45 minutes
- Calculation Area: 4,000 km×3,600 km
- Calculation Time Step: 24 seconds - 40 seconds (time interval)

For the smooth operation of a non-hydrostatic NWP model, the required calculation resource of the Weather Forecasting & Development System is approximately 15TFLOPS.

As a consequence of the evaluations indicated above, the total calculation resource required for the Weather Forecasting & Development System is 16 TFLOPS.

In addition, since it is expected that the data volume required for a non-hydrostatic NWP model increases daily, a hard disk with sufficient capacity is indispensable for the operation of the Weather Forecasting & Development System. As indicated in the table below, a 40-TByte hard disk is required.

Table27：Required Capacity of the Hard Disks for the Weather Forecast & Development System

| Items examined for calculation of required Data Volume | Data Volume required for Prediction and Verification |
|---|---|
| GSM GPV Data for RA-II Area in JMA (for 2 years) | Downloaded Data Capacities of 3-hourly GPV of GSM (until 84 hours) with initial condition at 00z, 06z and 18z: 368MB<br>Downloaded Data Capacities of 3-hourly GPV of GSM (24-hourly from 84 hours to 216 hours) with initial condition at 12z: 368MB+368 MB ×(216hrs-84hrs)/87hrs/8=437.8MB<br>Downloaded Data Capacities per day with initial condition at 00z, 06z, 12z and 18z: 368MB×3+437.8MB=1,541.8MB=1.5418GB<br>Downloaded Data Capacities for 730 days (2 years): 1.5418GB×730days=1.1255TB≈1.13TB |
| Output Data of Regional Model (for 2 years) | Data Capacities of Regional Model for 24 hours Forecast: 3.7GB<br>Data Capacities of Regional Model for 48 hours Forecast: 3.7GB×2=7.4GB<br>Data Capacities per day: 7.4GB×3+7.4GB×1.5=22.2GB+11.1GB=33.3GB<br>Data Capacities per 2 years: 33.3GB×730days=24.3TB≈25TB |
| Free Space of Hard Disks required for Calculation | 10TB |
| Total | 1.13TB+25TB+10TB=36.13TB≈40TB |

2) Meteorological Radar System

The requested meteorological radar system is of the S band radar system which is the most suitable type for the observation of precipitation over a very wide area. It 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. For these reasons, it has been selected as the most suitable system to monitor large-scale and distant phenomena such as tropical cyclones. The S band radar system must be a Doppler system with a changeable function accurately having quantitative rainfall observation and air-turbulence observation capability for monitoring rapidly changing weather conditions (air-turbulence, storm wind of tropical cyclone, storm, tornado) in real time.

The frequency allocated and allowed by the Frequency Allocation Board (FAB) to the PMD for the proposed Doppler radar system will be used. Technical features of the S band meteorological Doppler radar system are as follows.

Table28: Major Features of Meteorological Radar System

| Major Features | Existing Radar System | Proposed Radar System |
|---|---|---|
| Frequency | 5.3GHz (C band) | 2.7-2.9GHz (S band) |
| Wavelength | Approx. 5.7cm | Approx. 10cm |
| Detectable Maximum Range of Precipitation Intensity 1mm/h or more | 350km radius | 450km radius |
| Detectable Maximum Range of Wind Velocity | - | 200km radius |
| Data Grid | 5.0km | 0.625km |
| Observable Maximum Wind | - | More than 70m/s |
| Transmission Power | 250kW | 10kW (Peak Value) |
| Doppler Function | None | Available |
| Accumulated Rainfall | None | Available |
| Rainfall Data | 6 gradation level rainfall qualitative data | 0-250mm/h rainfall intensity quantitative data |

As indicated in the table attached hereunder, the existing meteorological radar system can detect a precipitation rate of 1mm/h or more within a 350km radius only. However, with the proposed meteorological Doppler radar system, it is designed to be able to detect a precipitation rate of 1mm/h or more within a 450km radius.

Table29: Comparison of Precipitation Detection Range between the Existing Radar System and the Proposed Radar System by Reception Power (dbm) Precipitation Intensity

| Detection Range of the Existing C Band Radar System (Antenna Diameter: 4m, Reception Power: -107dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Distance (km) | Precipitation Intensity (mm/h) | | | | | | |
| | **0.50** | **1.00** | **5.00** | **10.00** | **20.00** | **40.00** | **100.00** |
| **10** | -73.8 | -69.0 | -57.8 | -53.0 | -48.2 | -43.4 | -37.0 |
| **50** | -88.6 | -83.8 | -72.6 | -67.8 | -63.0 | -58.2 | -51.8 |
| **100** | -95.6 | -90.8 | -79.6 | -74.8 | -70.0 | -65.2 | -58.8 |
| **150** | -100.1 | -95.3 | -84.1 | -79.3 | -74.5 | -69.7 | -63.3 |
| **200** | -103.6 | -98.8 | -87.6 | -82.8 | -78.0 | -73.2 | -66.8 |
| **250** | -106.6 | -101.8 | -90.6 | -85.8 | -80.9 | -76.1 | -69.8 |
| **300** | -109.2 | -104.3 | -93.2 | -88.3 | -83.5 | -78.7 | -72.3 |
| **350** | -111.5 | -106.7 | -95.5 | -90.7 | -85.9 | -81.1 | -74.7 |
| **400** | -113.7 | -108.8 | -97.7 | -92.8 | -88.0 | -83.2 | -76.8 |
| **450** | -115.7 | -110.9 | -99.7 | -94.9 | -90.1 | -85.2 | -78.9 |

| Detection Range of the proposed S Band Radar System (Antenna Diameter: 5m, Reception Power: -110dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Distance (km) | Precipitation Intensity (mm/h) | | | | | | |
| | **0.50** | **1.00** | **5.00** | **10.00** | **20.00** | **40.00** | **100.00** |
| **10** | -77.3 | -70.5 | -59.4 | -54.5 | -97.4 | -44.9 | -38.5 |
| **50** | -89.7 | -84.9 | -73.7 | -68.9 | -64.1 | -59.3 | -52.9 |
| **100** | -96.3 | -91.4 | -80.3 | -75.4 | -70.6 | -65.8 | -59.4 |
| **150** | -100.3 | -95.5 | -84.3 | -79.5 | -74.6 | -69.8 | -63.5 |
| **200** | -103.3 | -98.5 | -87.3 | -82.5 | -77.6 | -72.8 | -66.5 |
| **250** | -105.7 | -100.9 | -89.7 | -84.9 | -80.1 | -75.3 | -68.9 |
| **300** | -107.8 | -103.0 | -91.8 | -87.0 | -82.2 | -77.4 | -71.0 |
| **350** | -109.6 | -104.8 | -93.6 | -88.8 | -84.0 | -79.2 | -72.8 |
| **400** | -111.3 | -106.5 | -95.3 | -90.5 | -85.7 | -80.9 | -74.5 |
| **450** | -112.8 | -108.0 | -96.8 | -92.0 | -87.2 | -82.4 | -76.0 |

Out of Range  New Area of Detection  Reliable Detection Range

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

[1] Doppler Mode

The meteorological radar system is designed to work in Doppler mode which detects the wind motion and wind patterns of severe weather phenomena such as tropical cyclones, local severe storms and tornadoes within a 200km radius. This will help the PMD to monitor the movement and development of severe weather systems for the preparation of 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

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

[3] Required Radar Display and Output Information Functions

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

Table30: Required Radar Display and Output Information Functions

| | Radar Display and Output Information Functions | Purpose of Observation/Utilization |
|---|---|---|
| 1 | PPI Display (Intensity, Doppler Velocity, Velocity Width) | Rainfall |
| 2 | RHI Display (Intensity) | |
| 3 | Location Manual Data Input and Low Pressure Track Display | |
| 4 | Identified Heavy Rainfall Level Display | |
| 5 | Accumulated Rainfall (1H, 2H, 3H, 6H, 12H, 24H) | |
| 6 | Z-R Parameter Registration | |
| 7 | Dissemination of Accumulated Rainfall Data | |
| 8 | Specific District Rainfall Amount Display | |
| 9 | Surface Rain Display | |
| 10 | Range Time Indicator | |
| 11 | Composite Picture Display | |
| 12 | Wind Velocity and Direction | Wind Velocity and Direction |
| 13 | Wind Profile of Upper Layer | |
| 14 | Wind Shear Information Display | |
| 15 | Overlay Display of Plural Products | |
| 16 | Specific District Strong Wind Display | |
| 17 | CAPPI Display | 3-dimensional |
| 18 | Echo Height Display | |
| 19 | Vertically Integrated Liquid | |
| 20 | Maximum Rainfall Display | |
| 21 | 3-dimensional Data Display | |
| 22 | Cross Section | |
| 23 | Radar Control and Monitoring | Radar Control and Monitoring |
| 24 | Observation Scheduling | |
| 25 | Stored Data Listing on Each External Storages | Storing and Retrieving |
| 26 | Storing To External Storages | |
| 27 | Retrieved Data Listing From External Storages | |
| 28 | Various Weather Products Retrieving from External Storages | |
| 29 | Data Receiving | Display, Data Input and Output |
| 30 | JPG Image Output | |
| 31 | Multi-Window Display | |
| 32 | Map Overlay Feature | |
| 33 | Information of Pointed Locations (Location, Numerical Radar Echo Value, Distance of Specified Span) | |
| 34 | Zooming Display (2 Times or 4 Times Selectable) | |
| 35 | Animation | |
| 36 | Map Edit | |
| 37 | Product Output to Web (GIF Animation Format) | Web |
| 38 | Radar Images to Internet Server at Http Style | |
| 39 | Login From Internet Browser and Download | |

The figure of the “Maximum Detection Area and Observed Data Processing Area of the Proposed Islamabad Meteorological Radar System” after the completion of the Project is attached hereunder.

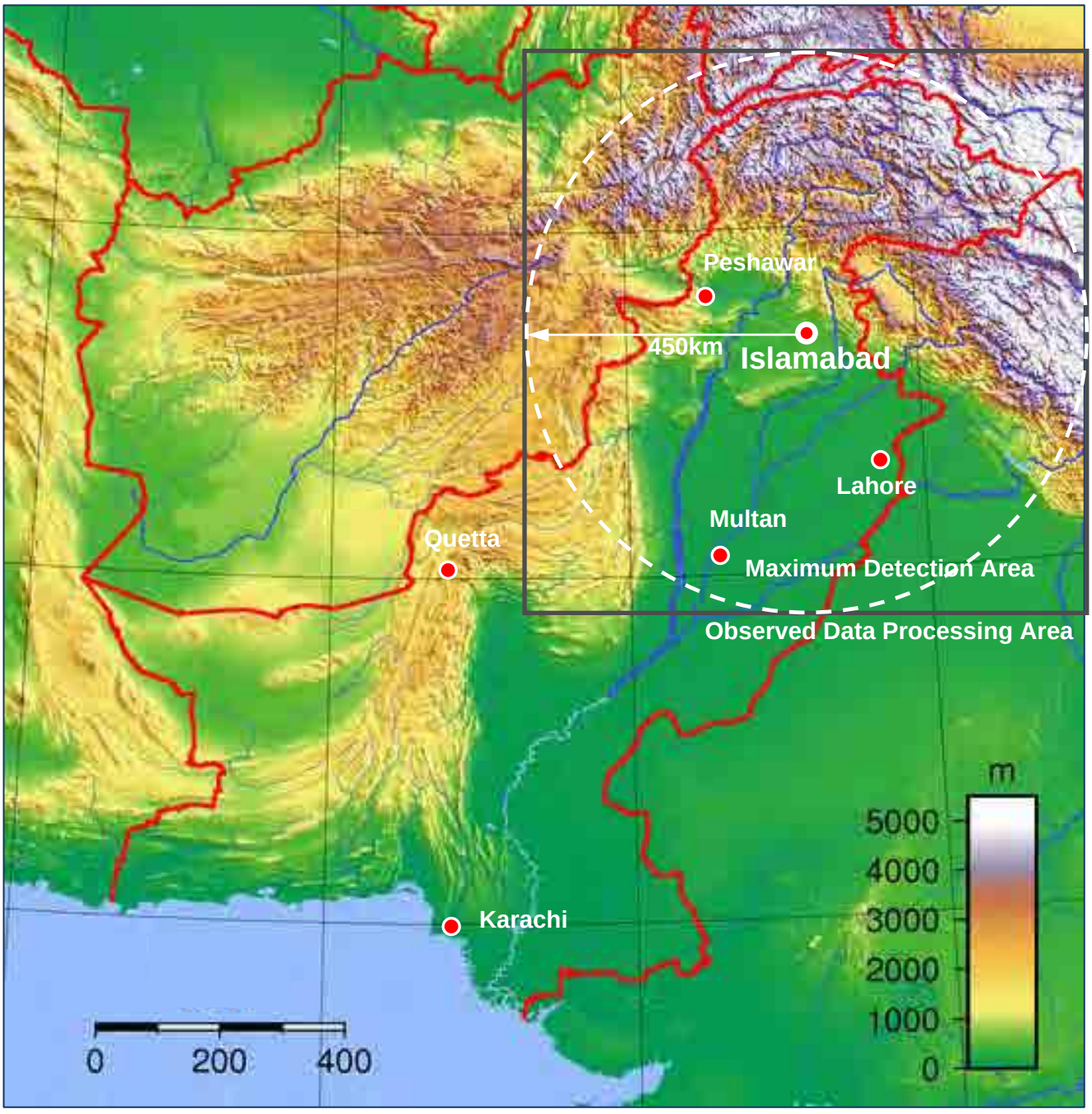



Figure6: Maximum Detection Area and Observed Data Processing Area of the Proposed Islamabad Meteorological Radar System

3) 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 as the PMD’s forecasters will utilize them for routine weather forecasting & warning. In addition, the PMD’s forecasters are required to do a substantial amount of work in a short time so the

meteorological radar data display systems are to be installed in the proposed Islamabad Meteorological Radar Tower Building, the National Weather Forecasting Center in the PMD Head Office and the new Benazir Bhutto International Airport Meteorological Office so that they do not need to leave the area. Displays of the system must have minimized heat production for effective room cooling, must be of the power-saving type and must have less screen reflections for a smooth 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. The Islamabad Meteorological Radar Tower Building and the National Weather Forecasting Center will be connected by an optical fiber line to make high-speed data transmission possible and prevent the intrusion of lightning surges.

4) Meteorological Data Trunk Communication System

This system is a network management system using a Virtual Private Network (VPN) for data exchange among each PMD office and for the release/dissemination of the PMD's meteorological data, information and forecast/warning. As indicated in the following figure, network terminating units (N.T.U.) installed in several networks are safely connected to the Internet as a global shared network by an "Encrypted Virtual Tunnel". It is possible to be safely communicating with a PC in a remotely-situated network connected by a VPN similar to communicating/data-exchanging with a PC connected via a dedicated link. In addition, the utilization of a VPN can decrease the threat of cyber-attacks. It is possible to have stable data-exchange and release/dissemination of information and forecast/warning even if the PMD Website is experiencing heavy traffic and/or during heavy rains and flooding. The recurrent cost of a VPN link is cheaper than that of a dedicated link and the VPN security level has been enhanced by cryptographic technology improvement.

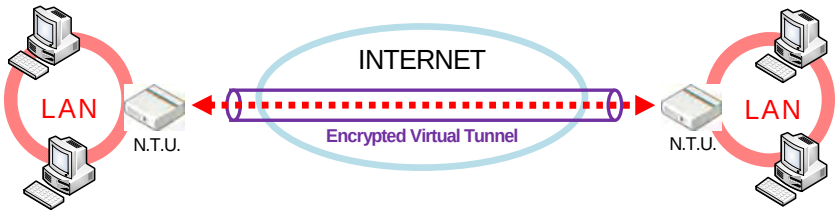


Figure7: Internet VPN Diagram to connect between LANs

5) GTS Message Switch System

The continuous provision of the observed data through the Global Telecommunication System (GTS) is an extremely important role for Pakistan to play in order to fulfill its responsibility as a member of the WMO. A GTS Message Switch System will be installed in the PMD Islamabad Head Office as a substitute for the existing GTS Message Switch in Karachi. Through the establishment of the GTS network in the PMD Islamabad Head Office, the PMD can receive important information from a channel other than the Internet and timely transmit the observed data from Pakistan to the rest of the world. Since recent weather forecasts in the world are prepared through the global data processing and analysis done by the global model of numerical weather prediction (NWP), the transmission of observed data from

developing countries, most of which have undeveloped meteorological communication networks, is a very significant key point for the further improvement of weather forecasts in the world.

Currently, the WMO strongly promotes the WMO Information System (WIS) as a communication infrastructure for effective international data exchange. The WIS has been designed as a response to the new requests or needs coming from the increase of data products from and the rapid diffusion of the Internet. It consists of the Global Information System Centre (GISC), the Data Collection and Processing Centre (DCPC) and the National Centre (NC). The GTS Message Switch System to be installed under the Project will satisfy the following points:

- To connect by Virtual Private Network (VPN) the internet connection to be established
- To connect with the Global Information System Center (GISC)
- To compose dual systems against any operation stoppage

6) Wind Profiler System

The Wind Profiler System is an apparatus which can make a continuous, unmanned observation of the temporal vertical distribution of wind speed & direction and of weather phenomena such as air turbulence, etc. through radio waves transmitted from the ground to the upper air 4km-12km high (during rain). It has also been known that there is a lower frequency of technical problem because it has no driving mechanism which is easily breakable. The Wind Profiler System enables the PMD to continuously observe wind in the atmosphere, watch weather phenomena and accumulate observed data for the prediction and countermeasure preparation for climate change. Moreover, it enables the PMD to not only obtain observed data significant for the accurate and prompt preparation of weather forecasts but also to monitor the weather phenomena in the Northern Hemisphere, such as vertical wind direction change and updraft from a change in wind direction. The locations of the Wind Profiler Systems have been designated to be in the premises of the PMD Head office and PMD Multan meteorological office. The main characteristics of the Wind Profiler System are indicated in the following table.

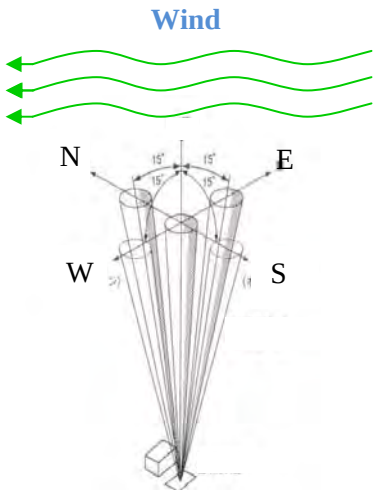



Figure8: Wind Profiler System Conceptual Diagram

Table31: Main Characteristics of the Wind Profiler

| Item | Descriptions |
|---|---|
| Frequency | 1.3 GHz Band |
| Observation Elements | East-west, north-south and vertical component of the wind (including the fall velocity of precipitation particles) |
| Resolution of Observed Data | Wind Speed (Vertical, Horizontal): 0.1 m/s, Wind Direction: 1° |
| Accuracy | Wind Speed: 1m/s (Horizontal), 0.2 m/s (Vertical) |
| | Wind Direction: 15°(≦5m/s), 10°(>5m/s) |
| Observation Range | Wind Speed: 0-90m/s (Horizontal), 0-30m/s (Vertical) |
| Transmitting Power | 6kW (peak)or less |
| Receiving Sensitivity | Signal to Noise Ratio: +3dB or more (@Altitude 5.5km)<br>Conditions：<br>• Radar equation (reference) : $\frac{S}{N} = \frac{Pt\ G^2\ \theta^2\ \lambda^2\ \Delta R\ \eta\ I}{256\ \pi^2\ R^2\ k\ T\ B}$<br>$I = Np\ Nc\ Npsn\ NctFFT$<br>$\eta = 0.38\ \lambda^{-1/3}\ Cn^2$<br>$Cn^2 = 10^{-0.000276\,R\,-\,13.862}$<br>• Refractivity Turbulence Structure Constant ($Cn^2$): $10^{-0.000276\times R(m)-13.862}$<br>• Range Resolution (ΔR): 300m<br>• Ambient temperature: 290K<br>• Surface Noise Temperature: 36K |

To be able to distribute globally the observed data from the Wind Profiler Systems through the GTS Message Switch System, the management of the quality of observed data is quite important. Therefore, it is decided that this function (indicated in the following table) be included in the Wind Profiler Systems.

Table32: Quality Management of Wind Profiler Observation Data

| Process of Quality Management | Description |
|---|---|
| Removal of bird echo | Removal of echo from migratory birds |
| Removal of ground clutter | Removal of terrain from mountains and buildings |
| Spectrum width check | Prevention of observation errors due to a variety of noises |
| Homogeneity check in the wind field | Prevention of incorrect calculation due to heterogeneity of the wind field in the five direction beams |
| Consensus average | Acquisition of approximated observation data to real value |
| Quadric surface approximation check | Removal of data containing values showing extreme deviation from the data recorded before or after the observation periods or the data for the upper and lower layers |
| Vertical shear check | Removal of incorrect observation data of vertical wind having a shear that exceeds a certain value |
| Manual Quality Management | Prevent malfunctions of the automated quality management system |

The “Schematic Diagram of PMD Specialized Medium Range Weather Forecasting Center (SMRFC) and Meteorological Observation & Data Communication Network System” is attached hereunder.

# Schematic Diagram of PMD Specialized Medium Range Weather Forecasting Center (SMRFC) and Meteorological Observation & Data Communication Network System

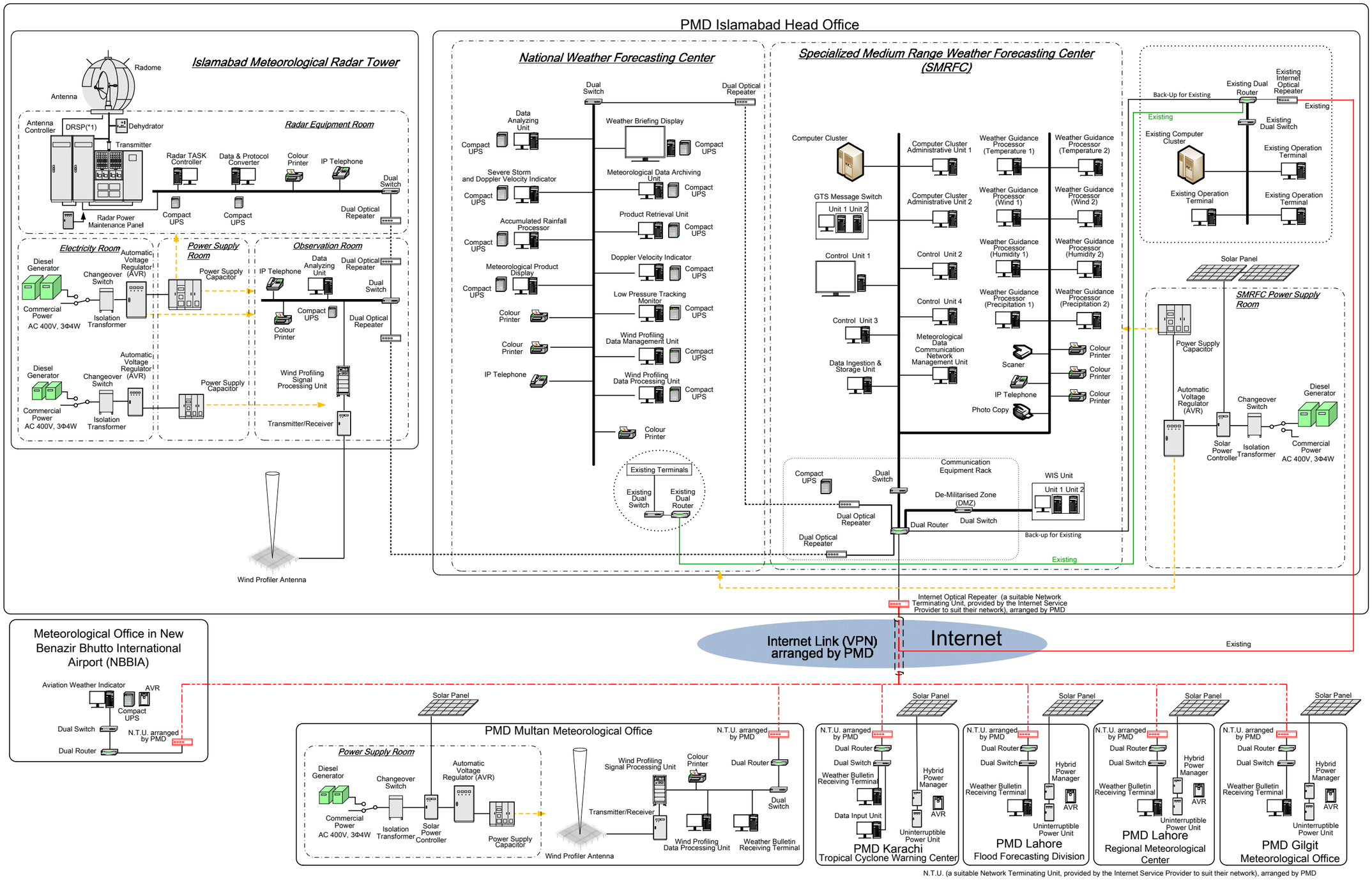



Figure9: Schematic Diagram of the PMD Specialized Medium Range Weather Forecasting Center (SMRFC) and Meteorological Observation & Data Communication Network System

(2) Major Equipment List

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

Table33: Main Equipment Components

| Component | Islamabad | | Lahore | | Karachi | Multan | Gilgit |
|---|---|---|---|---|---|---|---|
| | PMD Islamabad Head Office | Meteorological Office in New Benazir Bhutto International Airport (NBBIA) | PMD Lahore Regional Meteorological Center | PMD Lahore Flood Forecasting Division | PMD Karachi Tropical Cyclone Warning Center | PMD Multan Meteorological Office | PMD Gilgit Meteorological Office |
| SMRFC (Specialized Medium Range Weather Forecasting Center) Weather Forecasting & Development System (including Lightning System, Power Back-up System, Isolation Transformer, Auto Voltage Regulator, Power Supply Capacitor and Test Instruments, Spare Parts and Ancillary Facility) | 1 | - | - | - | - | - | - |
| Meteorological Data Trunk Communication System | 1 | - | 1 | 1 | 1 | 1 | 1 |
| GTS Message Switch System | 1 | - | - | - | - | - | - |
| S-Band Doppler Pulse Compression Solid State Radar System (including Power Back-up System, Isolation Transformer, Auto Voltage regulator, Power Supply Capacitor and Test Instruments and Spare Parts) | 1 | - | - | - | - | - | - |
| Meteorological Rader Data Display System | 2 | 1 | - | - | - | - | - |
| Wind Profiler System (including Ancillary Facility) | 1 | - | - | - | - | 1 | - |

# Major Equipment List

SMRFC (Specialized Medium Range Weather Forecasting Center)
Weather Forecasting & Development System

| Name of Site: PMD Islamabad Head Office (Specialized Medium Range Weather Forecasting Center) | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Computer Cluster | 1 set | For creating weather guidance. |
| Computer Cluster Administrative Unit | 2 sets | For controlling and administrating the Computer Cluster. |
| Control Unit with Large Monitor | 1 set | For collecting and displaying weather guidance data. |
| Control Unit | 3 sets | For collecting weather guidance data. |
| Weather Guidance Processor (Temperature) | 2 sets | For processing weather guidance (Temperature) |
| Weather Guidance Processor (Wind) | 2 sets | For processing weather guidance (Wind) |
| Weather Guidance Processor (Humidity) | 2 sets | For processing weather guidance (Humidity) |
| Weather Guidance Processor (Precipitation) | 2 sets | For processing weather guidance (Precipitation) |
| Meteorological Product Display | 1 set | For displaying meteorological product |
| Compact UPS | 2 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. |
| Colour Printer | 3 sets | For printing weather guidance image. |
| IP Telephone | 1 set | For voice communication through IP network. |
| Scanner | 1 set | For creating a soft copy of printed weather data. |
| Photo Copy | 1 set | For printing weather guidance image. |
| Dual Switch-1 | 1 set | For connecting all the computer equipment to LAN. |
| Dual Switch-2 | 1 set | For connecting all the computer equipment to LAN. |

| | | |
|---|---|---|
| Dual Optical Repeater | 2 sets | For converting electrical and optical signal on LAN for protection against surges. |
| Communication Equipment Rack | 1 set | For installing communication equipment. |
| Diesel Generator | 2 sets | For generating stable electric power through a diesel engine in case of power failure. |
| Isolation Transformer | 1 set | For protecting each equipment from surges in voltage in the main power. |
| Solar Power Controller | 1 set | For controlling the electric power generated by solar panel. |
| Solar Panel | 1 set | For generating electric power and supplying it to the system. |
| 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 the Electric Dual Layer Capacitor energy to the radar system when power failure occurs. |
| Spare Parts LAN Arrester | 16 sets | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## Meteorological Data Trunk Communication System

| Name of Site: PMD Islamabad Head Office (Specialized Medium Range Weather Forecasting Center) | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Meteorological Data Communication Network Management Unit | 1 set | For managing the network for meteorological data communication |
| Data Ingestion & Storage Unit | 1 set | For ingesting and storing meteorological data. |
| Dual Router | 1 set | For forwarding data packets between computer networks. |
| Spare Parts LAN Arrester | 2 sets | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## Meteorological Data Trunk Communication System

| Name of Site: PMD Multan Meteorological Office | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Weather Bulletin Receiving Terminal | 1 set | For receiving meteorological bulletins from the Islamabad Head Office. |
| Dual Switch | 1 set | For connecting all the computer equipment to LAN. |
| Dual Router | 1 set | For forwarding data packets between computer networks. |
| Spare Parts LAN Arrester | 1 set | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## Meteorological Data Trunk Communication System

| Name of Site: PMD Karachi Tropical Cyclone Warning Center | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Data Input Unit | 1 set | For inputting meteorological data to be stored at the Islamabad Head Office. |
| Weather Bulletin Receiving Terminal | 1 set | For receiving weather bulletins from the Islamabad Head Office. |
| Dual Switch | 1 set | For connecting all the computer equipment to LAN. |
| Dual Router | 1 set | For forwarding data packets between computer networks. |
| Automatic Voltage Regulator (AVR) | 2 sets | For supplying constant or regulated voltage to the system. |
| Hybrid Power Manager | 2 sets | For converting solar generated DC power to AC power that can be utilized for the system and managing solar generated power in order to support commercial power. |
| Uninterruptible Power Unit | 2 sets | For supplying back-up AC power to the system in case of power failure. |
| Solar Panel | 2 sets | For generating electric power and supplying it to the system. |
| Spare Parts LAN Arrester | 3 sets | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## Meteorological Data Trunk Communication System

| Name of Site: PMD Lahore Flood Forecasting Division, PMD Lahore Regional Meteorological Center and PMD Gilgit Meteorological Office | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Weather Bulletin Receiving Terminal | 1 set | For receiving weather bulletins from the Islamabad Head Office. |
| Dual Switch | 1 set | For connecting all the computer equipment to LAN. |

| | | |
|---|---|---|
| Dual Router | 1 set | For forwarding data packets between computer networks. |
| Automatic Voltage Regulator (AVR) | 1 set | For supplying constant or regulated voltage to the radar system. |
| Hybrid Power Manager | 1 set | For converting solar generated DC power to AC power that can be utilized for the system and managing solar generated power in order to support commercial power. |
| Uninterruptible Power Unit | 1 set | For supplying back-up AC power to the system in case of power failure. |
| Solar Panel | 1 set | For generating electric power and supplying it to the system. |
| Spare Parts LAN Arrester | 2 sets | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## GTS Message Switch System

| Name of Site: PMD Islamabad Head Office (Specialized Medium Range Weather Forecasting Center) | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| GTS Message Switch | 1 set | For transmitting and receiving observed data globally through the GTS network. |
| WMO Information System (WIS) Unit | 1 set | For providing and collecting meteorological data to and from the WMO Information System (WIS). |
| Spare Parts LAN Arrester | 4 sets | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## S-Band Doppler Pulse Compression Solid State Radar System

| Name of Site: PMD Islamabad Head Office (Islamabad Meteorological Radar Tower) | | |
|---|---|---|
| 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.<br>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 | 1 set | 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. |
| Compact UPS | 2 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. |
| Dual Switch | 1 set | For connecting all the computer equipment to LAN. |
| Colour 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. |
| IP Telephone | 1 set | For voice communication through IP network. |
| 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: PMD Islamabad Head Office (Islamabad Meteorological Radar Tower) | | | |
|---|---|---|---|
| Equipment | | Quantity | Purpose |
| Data Analyzing Unit | | 1 set | For analyzing weather phenomena by using observed radar data. |
| Compact UPS | | 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. |
| Colour Printer | | 1 set | For printing radar image. |
| IP Telephone | | 1 set | For voice communication through IP network. |
| Dual Switch | | 1 set | For connecting all the computer equipment to LAN. |
| Dual Optical Repeater | | 2 sets | For converting electrical signal and optical signal on LAN for protection against surges. |
| Spare Parts | LAN Arrester | 1 set | For maintenance of the system. |
| Service Manuals | | 2 sets | For maintenance of the system. |

## Meteorological Radar Data Display System

| Name of Site: PMD Islamabad Head Office (National Weather Forecasting Center) | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Data Analyzing Unit | 1 set | For analyzing weather phenomena by using observed radar data. |
| Severe Storm and Doppler Velocity Indicator | 1 set | For monitoring and alerting severe storm condition by various Doppler radar products. |
| Accumulated Rainfall Processor | 1 set | For generating and sending accumulated rainfall data. |
| Weather Briefing Display | 1 set | For displaying observed radar data for weather briefing. |
| Meteorological Data Archiving Unit | 1 set | For storing of radar and weather information to a selected media. |
| Product Retrieval Unit | 1 set | For retrieving and displaying radar data. |
| Doppler Velocity Indicator | 1 set | For monitoring and alerting severe storm condition by various Doppler radar products. |
| Low Pressure Tracking Monitor | 1 set | For tracking low pressure course and predicting low pressure course and time. |
| Compact UPS | 8 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. |
| Colour Printer | 2 sets | For printing radar image. |
| IP Telephone | 1 set | For voice communication through IP network. |
| 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 protection against surges. |
| Spare Parts LAN Arrester | 8 sets | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## Meteorological Radar Data Display System

| Name of Site: Meteorological Office in New Benazir Bhutto International Airport (NBBIA) | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Aviation Weather Indicator | 1 set | For monitoring aviation weather by using various Doppler radar products. |
| Compact UPS | 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. |
| Automatic Voltage Regulator (AVR) | 1 set | For supplying constant or regulated voltage to the radar system. |
| Dual Switch | 1 set | For connecting all the computer equipment to LAN. |
| Dual Router | 1 set | For forwarding data packets between computer networks. |
| Spare Parts LAN Arrester | 1 set | For maintenance of the system. |
| Service Manuals | 2 sets | For maintenance of the system. |

## Wind Profiler System

| Name of Site: PMD Islamabad Head Office | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Wind Profiler Antenna | 1 set | For electrical high speed beam scanning in the North, East, South, and West directions and more, and transmitting pencil beams towards the sky and receiving scattered echo from the atmosphere. |
| Transmitter/Receiver | 1 set | For amplifying the signal of solid-state amplifiers and transmitting the signal to the Antenna Unit and of the echo transmitted by low noise amplifiers and also transmitting the signal to the Signal Processing Unit. |
| Wind Profiling Signal Processing Unit | 1 set | For digitizing the analog signal transmitted from the Transmitter/ Receiver Unit, and carrying out the decode of pulse compression, integration, FFT, and averaging to the digitized data, and producing the spectrum data. For storing the spectrum data in an HDD and transmitting it to the Data Processing Unit. |
| Wind Profiling Data Processing Unit | 1 set | For operating the system such as observation start, observation stop, and setting of observation parameters by using GUI. For carrying out removal of ground echo, fitting, and quality control to the spectrum data transmitted from the Signal Processing Unit. For producing and storing moment and average data which is the basic data of wind velocity calculation. |

| | | | |
|---|---|---|---|
| Wind Profiling Data Management Unit | | 1 set | For storing and managing observed wind profiling data. |
| Compact UPS | | 2 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. |
| Colour Printer | | 1 set | For printing radar image. |
| Fence | | 1 set | For shielding the lateral leaky wave and suppressing ground echo (clutter). |
| Diesel Generator | | 2 sets | For generating stable electric power through diesel engine in case of power failure. |
| 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 the Electric Dual Layer Capacitor energy to the radar system when power failure occurs. |
| Spectrum Analyzer | | 1 set | For maintenance of the system. |
| Oscilloscope | | 1 set | |
| Tool Kit | | 1 set | |
| Extension Cord | | 1 set | |
| Water Level | | 1 set | |
| Maintenance Ladder | | 2 sets | |
| Spare Parts | [For Transmitter/Receiver] | | For maintenance of the system. |
| | Transmitter Power Amp. | 2 sets | |
| | Remote Control Unit | 1 set | |
| | Power Supply Units (for Transmitter/Receiver) | 1 set | |
| | [For Wind Profiler Signal Processing Unit] | | |
| | HUB | 1 set | |
| | Blower Chassis-1 | 1 set | |
| | CPU Card | 1 set | |
| | Timing Card | 1 set | |
| | Diverter Card | 1 set | |
| | Interface Card | 1 set | |
| | Modulator Card | 1 set | |
| | Transmit Frequency Generate Chassis | 1 set | |
| | LAN Interface Output Card | 1 set | |
| | Pulse Compression Integrate Card | 1 set | |
| | A/D Converter Card | 1 set | |
| | Blower Chassis-2 | 1 set | |
| | Frequency Converter Chassis | 1 set | |
| | Blower Chassis-3 | 1 set | |
| | GPS Card | 1 set | |
| | Power Supply Units (for Wind Profiler Signal Processing Unit) | 1 set | |
| | LAN Arrester | 2 sets | |
| Service Manuals | | 2 sets | For maintenance of the system. |

## Wind Profiler System

| Name of Site: PMD Multan Meteorological Office | | |
|---|---|---|
| Equipment | Quantity | Purpose |
| Wind Profiler Antenna | 1 set | For electrical high speed beam scanning in the North, East, South, and West directions and more, and transmitting pencil beam towards the sky and receiving scattered echo from the atmosphere. |
| Transmitter/Receiver | 1 set | For amplifying the signal of solid-state amplifiers and transmitting the signal to the Antenna Unit and of the echo transmitted by low noise amplifiers and also transmitting the signal to the Signal Processing Unit. |
| Wind Profiling Signal Processing Unit | 1 set | For digitizing the analog signal transmitted from the Transmitter/ Receiver Unit, and carrying out the decode of pulse compression, integration, FFT, and averaging to the digitized data, and producing the spectrum data. For storing the spectrum data in an HDD and transmitting it to the Data Processing Unit. |

| | | | |
|---|---|---|---|
| Wind Profiling Data Processing Unit | | 1 set | For operating the system, such as observation start, observation stop, and setting of observation parameters by using GUI. For carrying out removal of ground echo, fitting, and quality control to the spectrum data transmitted from the Signal Processing Unit. For producing and storing moment and average data which is the basic data of wind velocity calculation. |
| Colour Printer | | 1 set | For printing radar image. |
| Fence | | 1 set | For shielding the lateral leaky wave and suppressing ground echo (clutter). |
| Diesel Generator | | 2 sets | For generating stable electric power through the diesel engine in case of power failure. |
| Isolation Transformer | | 1 set | For protecting each equipment from surges in voltage in main power. |
| Solar Power Controller | | 1 set | For controlling the electric power generated by solar panel |
| Solar Panel | | 1 set | For generating electric power and supplying it to the system. |
| 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 the Electric Dual Layer Capacitor energy to the radar system when power failure occurs. |
| Spectrum Analyzer | | 1 set | For maintenance of the system. |
| Oscilloscope | | 1 set | |
| Tool Kit | | 1 set | |
| Extension Cord | | 1 set | |
| Water Level | | 1 set | |
| Maintenance Ladder | | 2 sets | |
| Spare Parts | [For Transmitter/Receiver] | | For maintenance of the system. |
| | Transmitter Power Amp. | 2 sets | |
| | Remote Control Unit | 1 set | |
| | Power Supply Units (for Transmitter/Receiver) | 1 set | |
| | [For Wind Profiler Signal Processing Unit] | | |
| | HUB | 1 set | |
| | Blower Chassis-1 | 1 set | |
| | CPU Card | 1 set | |
| | Timing Card | 1 set | |
| | Diverter Card | 1 set | |
| | Interface Card | 1 set | |
| | Modulator Card | 1 set | |
| | Transmit Frequency Generate Chassis | 1 set | |
| | LAN Interface Output Card | 1 set | |
| | Pulse Compression Integrate Card | 1 set | |
| | A/D Converter Card | 1 set | |
| | Blower Chassis-2 | 1 set | |
| | Frequency Converter Chassis | 1 set | |
| | Blower Chassis-3 | 1 set | |
| | GPS Card | 1 set | |
| | Power Supply Units (for Wind Profiler Signal Processing Unit) | 1 set | |
| | LAN Arrester | 2 sets | |
| Service Manuals | | 2 sets | For maintenance of the system. |

(3) Basic Plan of the Facility

1) Proposed Building Construction Site

The outline and current situation of the infrastructures of the proposed Islamabad Meteorological Radar Tower Building are as follows.

Table34: Construction Site for Proposed Meteorological Radar Tower Building

| Study Items | | Proposed Site for the Islamabad Meteorological Radar Tower Building |
|---|---|---|
| Picture of Proposed Site | |   |
| Land Expropriation | | PMD Islamabad Head Office |
| Location | | |
| | Latitude<br>Longitude | N 33º 40’ 57.2”<br>E 73º 03’ 50.8” |
| Altitude | | 523m |
| Area of PMD Islamabad Head Office | | 22,124m$^2$ |
| Enough Space for Radar Tower Construction | | Enough space available |
| Access Road | | Available |
| Description Outline of the Premises | | The premises are located in Islamabad city, surrounded by public facilities. |
| Infrastructure | | |
| | Commercial Power Supply | Available |
| | Public Water Supply System | Available |
| | Public Sewerage System | Not available |
| | Telephone Line | Available |
| | Internet Access | Available |
| | Mobile Phone Service | Available |
| Staff House | | Available |
| Staff Commuting | | No Problem |

2) Architectural Design

[1] Floor Plan

The floor plan is virtually symmetrical, making possible a structural design that is safe and avoidance of 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 is also to serve as an evacuation route). Construction methods and materials follow local practice and the building is of standard grade in Pakistan.

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.

Table35: Calculation Base of Each Room in the Proposed Meteorological Radar Tower Building

| Name of Room | Islamabad Meteorological Radar Tower Building Floor Area ($m^2$) | Room Function | Calculation Base |
|---|---|---|---|
| Radome Room | 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 Storage for Spare Parts) | 89.75 | 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, approx. $90m^2$ is required. |
| Observation Room | 154.05 | For the following equipment and furniture.<br>• weather observation terminals,<br>• data analysis terminal,<br>• VoIP exchange,<br>• optical repeater,<br>• dual switch,<br>• printer,<br>• IP telephone,<br>• UPS for PCs,<br>• desk for the terminal,<br>• filing cabinets,<br>• white board,<br>• data storage cabinets,<br>• data storage cabinets for keeping observation records and observed data of the radar system for analysis,<br>• cabinets for maintenance instruments and operation & maintenance manuals<br>Space for keeping spare parts & consumables. | Radar observation space and installation space for all the equipment described in the left column.<br>A space for data analysis terminal, desk, data storage cabinets and also working space.<br>Necessary space for keeping all data secured.<br>Maintenance space for various type of the equipment and keeping space for maintenance instruments, measuring equipment. |
| Electricity & Power Supply Room | 44.20 | For isolation transformers, power distribution boards, cable rack, test terminals, AVR, etc.<br><br>For radar power back-up system (capacitor) and control rack. | Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column.<br>Installation, operation and maintenance space for all the apparatuses described in the left column. |
| Toilet | 22.12 | European Style Commode: M1+F1, Urinal:1, Wash basin: M1+F1, , Slop Sink: 1 | — |
| Tea Kitchen | 9.26 | Kitchen: 1 | — |
| Changing Room | 1.72 | Changing space for taking shower | — |
| Shower Room | 2.42 | Space for taking shower. | — |
| Storage | 2.38 | Storage space for spare materials and miscellaneous goods. | Storage space for spare materials and miscellaneous goods. |
| Engine Generator Room | 78.96 | For 75kVA engine generator: 2, 15kVA engine generator: 2, oil pumps: 2, service tank: 2, accessories, etc. | Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column. |
| Pump Room | 15.12 | Water reservoir tank: 1<br>Pump for water reservoir tank: 2 | For maintenance space and installation space for Water reservoir tank: approx. 15 $m^2$ required. |

[2] Sectional Plan

I. Height of the Radar Tower Building

The required radar antenna center height for the proposed radar system in the Islamabad Meteorological Radar Observation Station is at least 68m as shown in the figure below. Though not visible in the picture, there are woods behind the Pakistan Monument which are a few meters higher than the top of the Pakistan Monument. To make the radar beam exceed the height of the woods, observation must be conducted at an angle of more than +0.5 degrees.

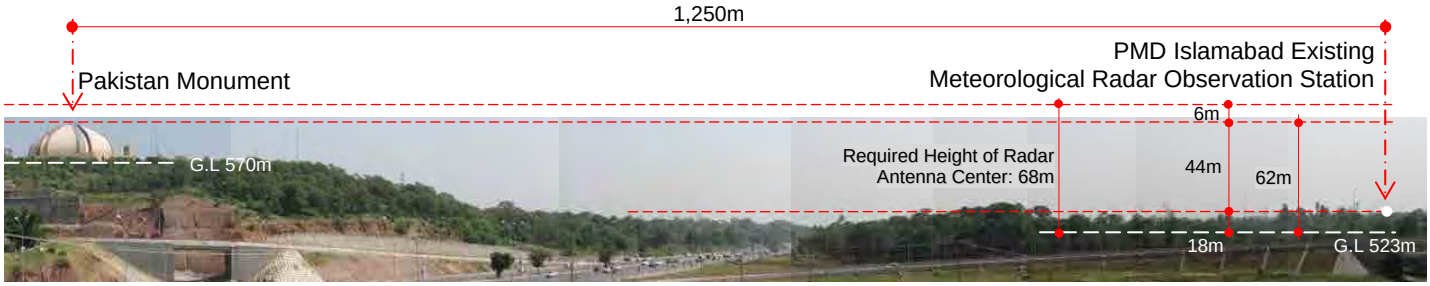



Figure10: Required Height of Radar Antenna Center for the proposed PMD Islamabad Radar System

II. Ground Level

At the proposed site, there is a benchmark which is the reference ground level made or determined in the course of the topographic survey work. Such reference will be used for the construction of the radar tower building.

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, a 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 building, thereby, 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 15cm for easy wiring of power and signal cables, trouble-free maintenance and simple future expansion. An antistatic, heavy-duty access floor has been selected for the radar equipment room in which a high power radar transmitter weighing about 1 ton is to be installed.

b) External Walls

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

c) Ceiling

The radar equipment cable rack, which is located in the radar equipment room and the observation room (the major rooms of the proposed radar tower building), must be protected against dust. In addition, so as to improve the air tightness of these rooms and to reduce equipment noise, the ceilings will be finished with acoustic boards. Since both of these rooms are to be air-conditioned, the use of ceiling boards will also improve the efficiency of air-conditioning.

d) Window

Since the sustained wind pressure to be used for the windows of the radar equipment room located at a height of 50m is expected to reach approximately 2,500 $N/m^2$ a laminated glass with reinforced film will be used. In order to ensure double protection for preventing wind and rain water from entering into the room, two aluminum windows will be individually installed inside and outside.

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 PMD and are stated as follows.

Table36: Finishing Materials of the Proposed Meteorological Radar Tower Building

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

Table37: Bases for Adoption of Materials
of the Proposed Meteorological Radar Tower Building

| | | 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. | To be procured locally |
| | **Walls** | Reinforced concrete blocks will be applied. Concrete blocks are generally used locally and are considered highly reliable in terms of both ease and accuracy of construction. | |
| **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. | |
| | **Walls** | Cement sand mortal (trowel-coated) will be applied primarily for its durability, and vinyl paint will be applied to avoid dirt. Glazed ceramic tiles will be laid in the toilets and the slop sink booth. | |
| | **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 mortal. | |
| **Windows 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 building, the Building Code of Pakistan 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 a reference, 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, pile and foundation of the proposed radar tower building are indicated in the following table.

Table38: Bearing Layer, Pile and Foundation of the Proposed Meteorological Radar Tower Building

| | Islamabad Meteorological Radar Observation Station |
|---|---|
| Depth of Bearing Layer | 31.0m |
| N value of Bearing Layer | Over 50 |
| Piling | Required |
| Designed Pile Length | 28.8m |
| Required Number of the Designed Pile | 24 |
| Diameter of the Designed Pile | 1.2m |
| Foundation type | Pile foundation (cast in site concrete) |

III. Structure Type

Reinforced concrete has been selected as the construction material for the proposed radar tower building. Floor slabs are to be reinforced concrete while exterior walls and partition walls are to be locally made out of concrete blocks.

IV. Design Load

a) Dead load

The weight of all the structural and finishing materials has been included in the calculation of the dead weight of the radar tower building. The following combined weight as a special dead load will be considered.

Table39: 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 | 2.0 tons |
| Electricity & Power Supply 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 proposed radar tower building are equipment installation spaces, the live load of the proposed radar tower building is deemed to be identical to that of telecommunication equipment rooms in Japan.

c) Wind load

To calculate the wind load of the proposed Radar Tower Building, the following calculation formula for the design wind pressure as shown in BCP-SP-2007 (Building Code of Pakistan-Seismic Provisions-2007) is utilized.

Design wind pressure: $P=Ce\times Cq\times Iw\times Qs$ ($kN/m^2$)
Ce: Combined height, exposure and gust factor coefficient
Cq: Pressure coefficient for the structure
Iw: Importance Factor
Qs: Wind stagnation pressure ($kN/m^2$)

- $P=1.97\times3.6\times1.15\times0.78=6.36(kN/m^2)$

  Ce=1.97 Cq=3.60 Iw=1.15 Qs=0.78

d) Seismic load

For the calculation of the seismic load, the seismic zone factor in Islamabad (Zone 2B, Z = 0.20) as indicated in the BCP-SP-2007 (Building Code of Pakistan-Seismic Provisions-2007) is applied. The importance factor: I = 1.25 is used, since the importance of the building is considered.

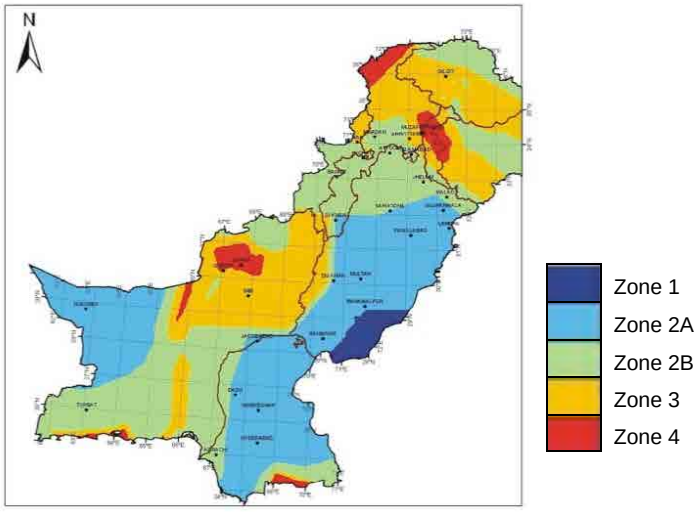



Figure11: Seismic Zoning Map of Pakistan

V. Structural Building Material

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

- Concrete (conventional concrete)
  : specified concrete strength Fc= $24N/mm^2$ (Foundation to 8F slab)
  Fc= $21N/mm^2$ (over 8F slab)
- 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

Table40: Power Intake Facility

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

II. Power generating facility

Table41: Power Generating Facility

| | Islamabad Meteorological Radar Tower Building | |
|---|---|---|
| Number of Engine Generator | 2 | 2 |
| Capacity | 75kVA | 15kVA |
| Output | 400V, 3-phase 4-wire, 50Hz | |
| Fuel Tank Capacity | 1,000 liters×2 | |

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.

Table42: Trunk Line and Power Facility

| | Islamabad Meteorological Radar Tower Building |
|---|---|
| Trunk line for lighting and power | 230V/400V, 3-phase 4-wire |
| Branch power circuits | 400V, 3-phase 4-wire |
| Branch lighting circuits | 230V, single-phase 2-wire |
| Branch equipment circuits | 400V, 3-phase 4-wire |

IV. Lighting and power outlet

The voltage required for lighting and the 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 LED, primarily for their low power consumption, though incandescent fixtures will also be used to some extent, depending on the particular situation. Lighting levels in the various rooms will be approximately as shown in the following table.

Table43: Approximate Lighting Levels in the Various Rooms

| | Islamabad Meteorological Radar Tower Building |
|---|---|
| Radome Room | 200 Lx |
| Radar Equipment Room | 300 Lx |
| Observation Room | 300 Lx |
| Engine Generator Room | 200 Lx |
| Electricity & Power Supply Room | 200 Lx |
| Pump Room | 200 Lx |
| Entrance Hall | 200 Lx |
| Other Rooms | 200 Lx |

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

V. Telephone system

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

VI. Intercom system

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

VII. Alarm system

An alarm panel will be installed in the observation room. The following building equipment warnings will also 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 1st floor will be connected to the terminal box for earthing. All the equipment to be installed in the electricity 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 building. A connection box will be placed at the radome room for the lightning rod. Inside the building structure, copper tapes will be laid on 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 observation deck, will be included in the building portion of the Project. For all of the obstruction lights, two power distribution boards will be installed on the first floor and in the radar equipment room

and an automatic blinking switch will be installed on the first floor. All the aviation obstruction lights will be furnished with surge arresters. Connecting work between the obstruction lights on 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 room and the engine generator room. 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 available in the PMD Islamabad Head Office so a water supply gate valve will be installed for the water inflow to the proposed radar tower building. To supply public water to the proposed radar tower building, a pump room with a water reservoir tank and feed pumps are required.

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 through 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 PMD personnel in the operations area and for some visitors.

III. Sanitary fixtures

- Closet bowl: tank type western-style
- Urinal: stall type
- Washbasin: wall-mounted type
- Slop sink: wall-mounted type

IV. Fire extinguisher

Fire extinguishers will be supplied in the following rooms.

Table44: Fire Extinguisher

| | Islamabad Meteorological Radar Tower Building |
|---|---|
| Radome Room | $CO_2$ type |
| Radar Equipment Room | $CO_2$ type |
| Observation Room | $CO_2$ type |
| Engine Generator Room | ABC type |
| Electricity & Power Supply Room | $CO_2$ type |
| Pump Room | $CO_2$ type |
| Tea Kitchen | 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 and the observation 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.

Table45: Air-conditioning and Ventilation System

| | Islamabad Meteorological Radar Tower Building |
|---|---|
| Radome Room | Fan forced ventilation |
| Radar Equipment Room | Air-conditioning system Heat exchange system |
| Observation Room | Air-conditioning system Fan forced ventilation |
| Engine Generator Room | Fan forced ventilation |
| Electricity & Power Supply Room | Air-conditioning system Fan forced ventilation |
| Pump Room | Fan forced ventilation |
| Shower Room | Fan forced ventilation |
| Toilet (M & F) | Fan forced ventilation |
| Tea Kitchen | 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 & power supply room, pump room, etc., forced ventilation systems will also be adopted. Furthermore, appropriate ventilation systems will be installed in the other rooms to meet the following conditions.

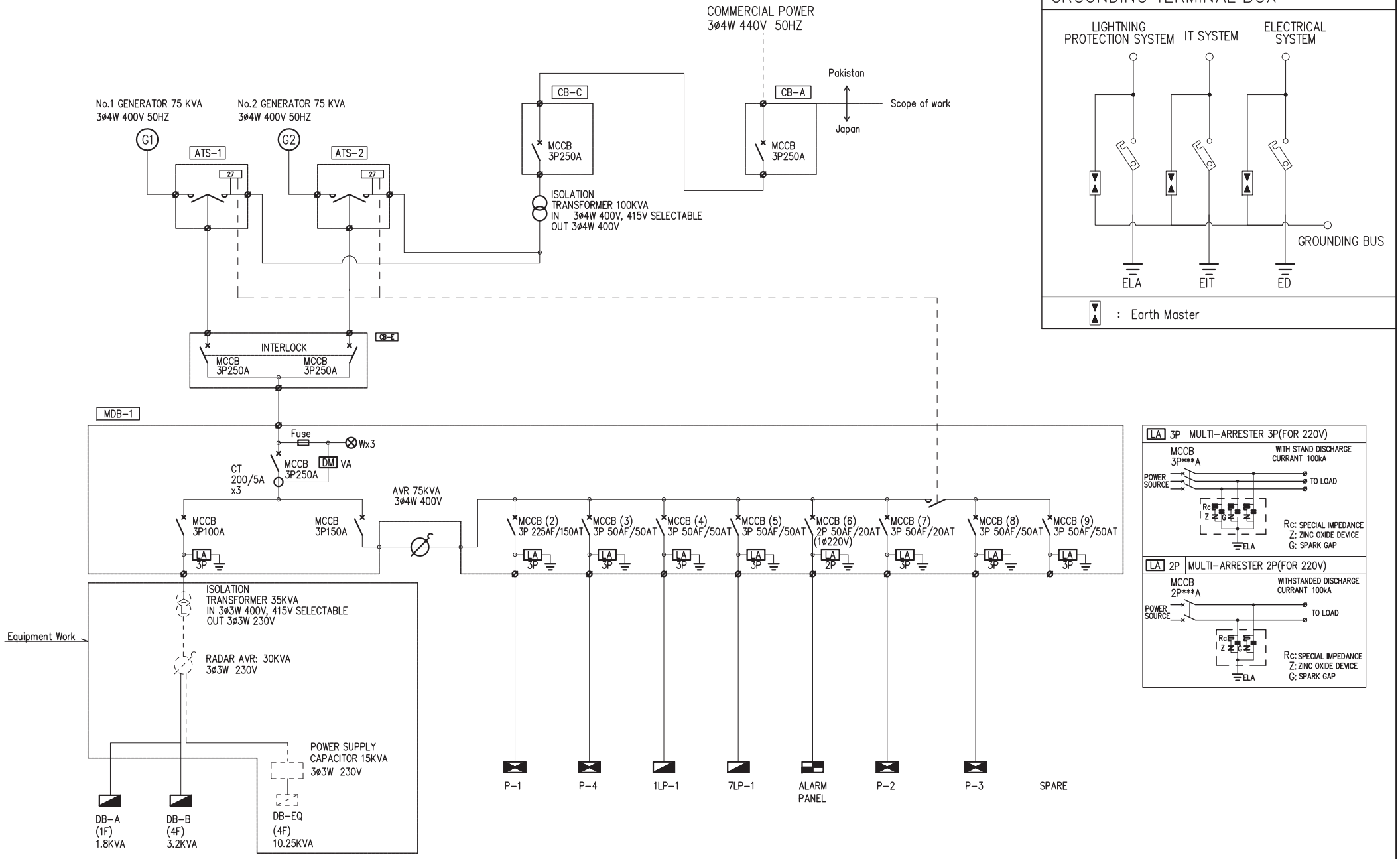
<Environmental conditions>

- Outside condition: 32°C (maximum temperature: 31.6°C)
- Indoor condition: temperature 26°C humidity 40-60%
  In the radar equipment room and the electricity & power supply room: temperature 25°C humidity 40-60%

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

<Islamabad Meteorological Radar Tower Building>

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




## GROUNDING TERMINAL BOX

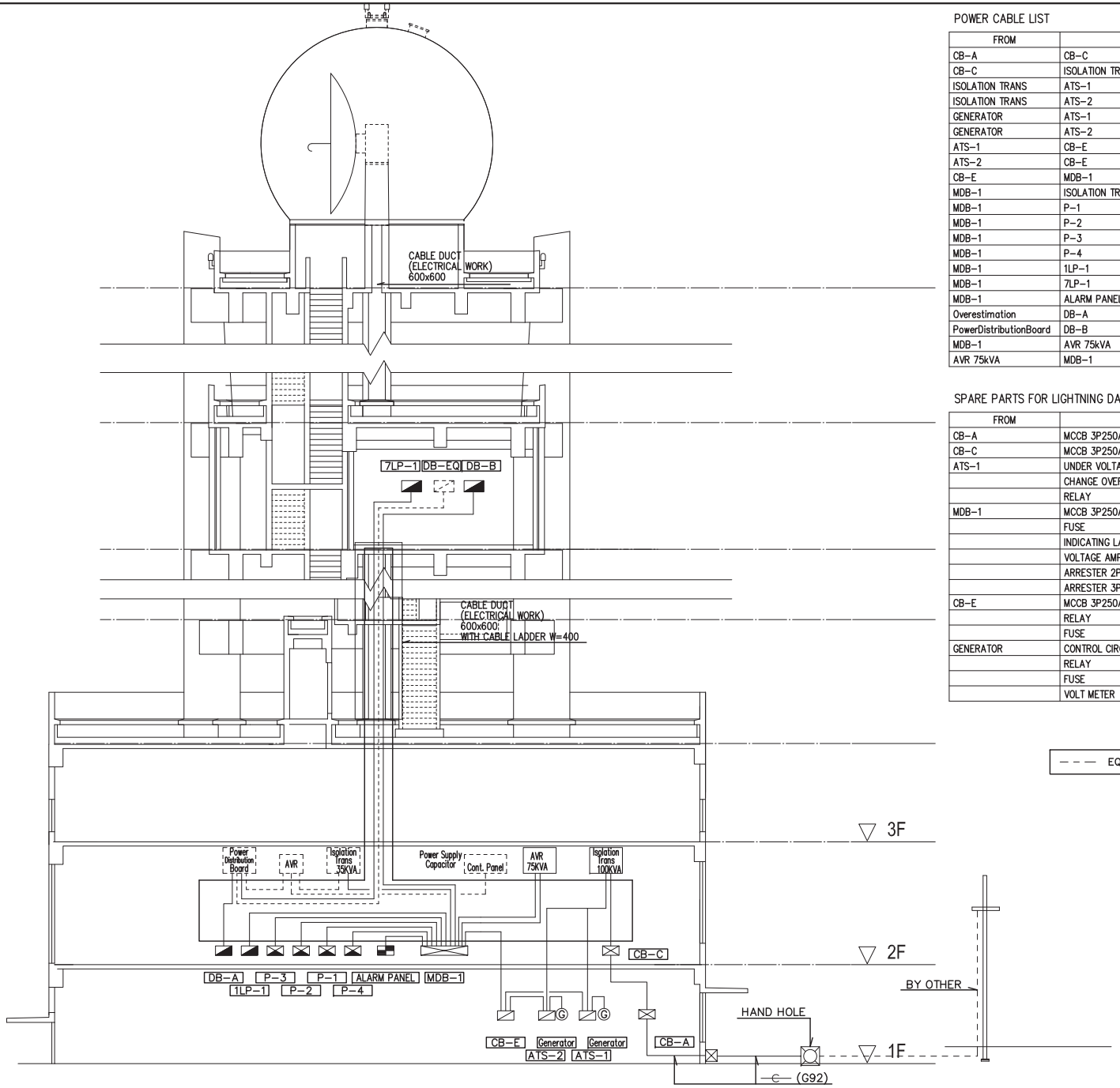








| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>POWER FEEDER DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 01 |




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 +E70sq | (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 | 1LP-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 |
| Overestimation | 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 3P250A | 1 |
| CB-C | MCCB 3P250A | 1 |
| ATS-1 | UNDER VOLTAGE RELAY | 1 |
| | CHANGE OVER SWITCH | 1 |
| | RELAY | 4 |
| MDB-1 | MCCB 3P250A | 1 |
| | FUSE | 6 |
| | INDICATING LAMP | 3 |
| | VOLTAGE AMPERE INDICATOR | 1 |
| | ARRESTER 2P | 2 |
| | ARRESTER 3P | 7 |
| CB-E | MCCB 3P250A | 1 |
| | RELAY | 4 |
| | FUSE | 4 |
| GENERATOR | CONTROL CIRCUIT BOARD | 1 |
| | RELAY | 4 |
| | FUSE | 4 |
| | VOLT METER | 1 |

- - - EQUIPMENT WORK



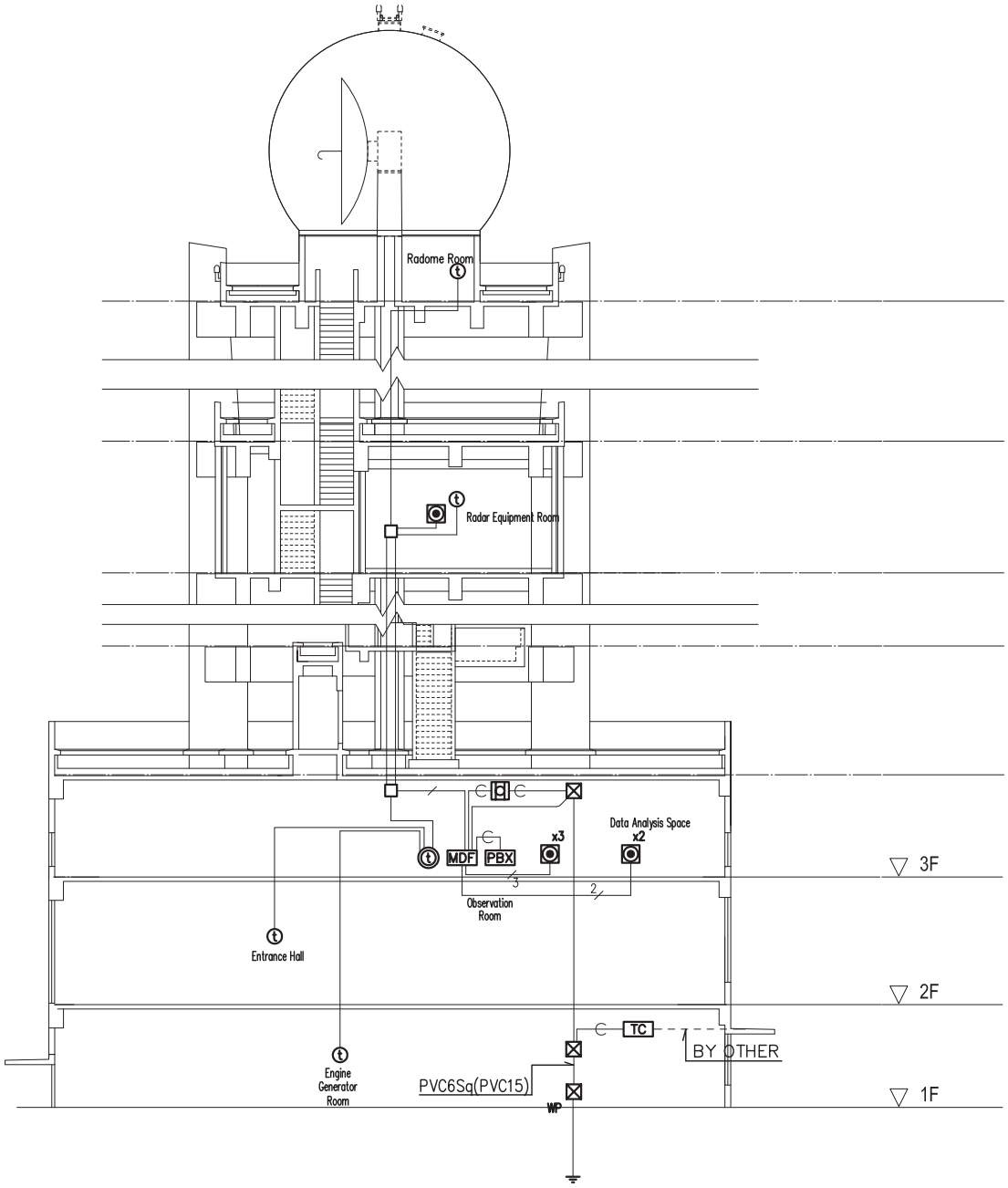
CONSORTIUM OF
INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),
JAPAN WEATHER ASSOCIATION (JWA) AND
CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII)

THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING
POWER RISER DIAGRAM

SCALE
NONE

DRAWING No.
SD - 02

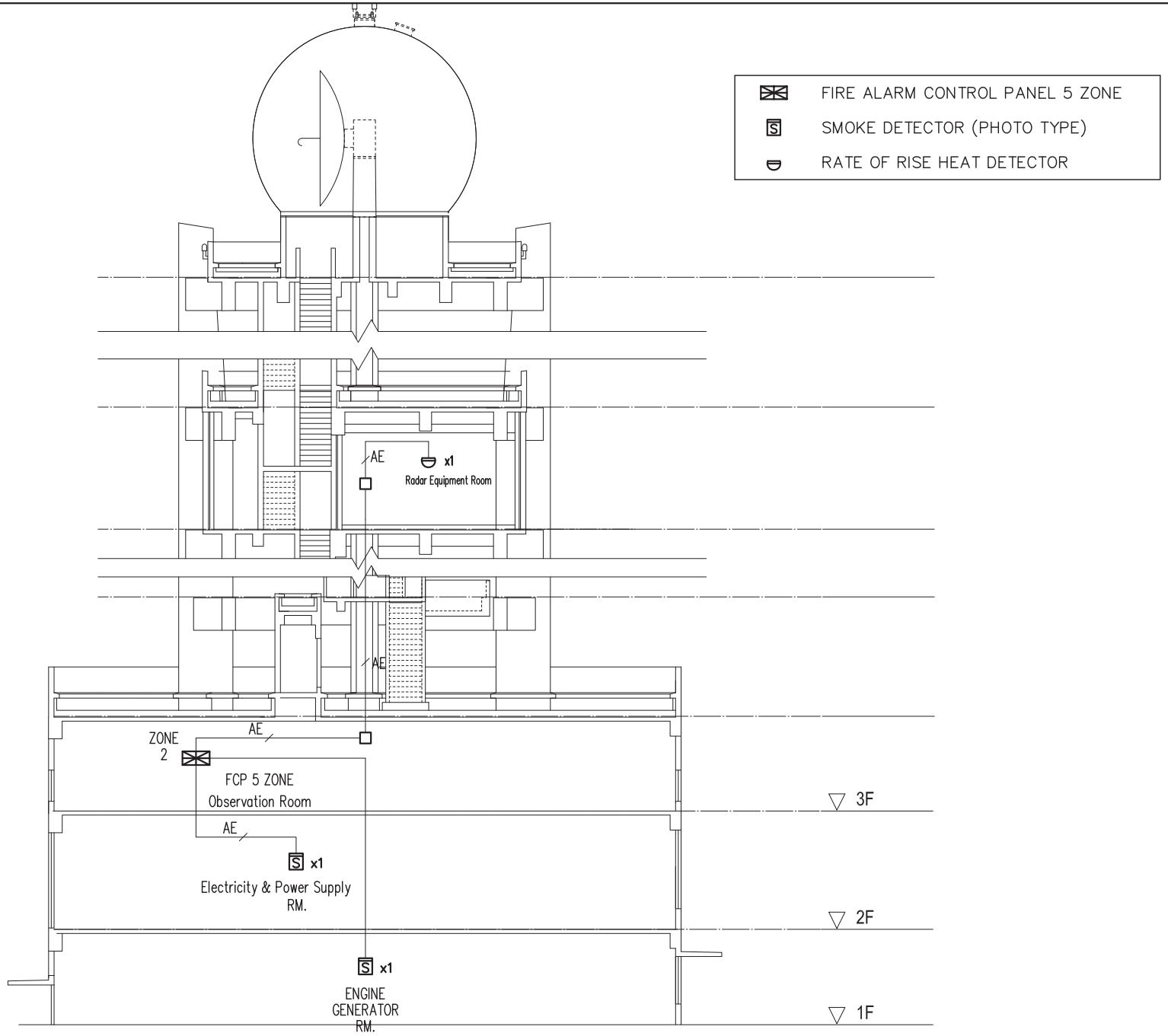



REMARK

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

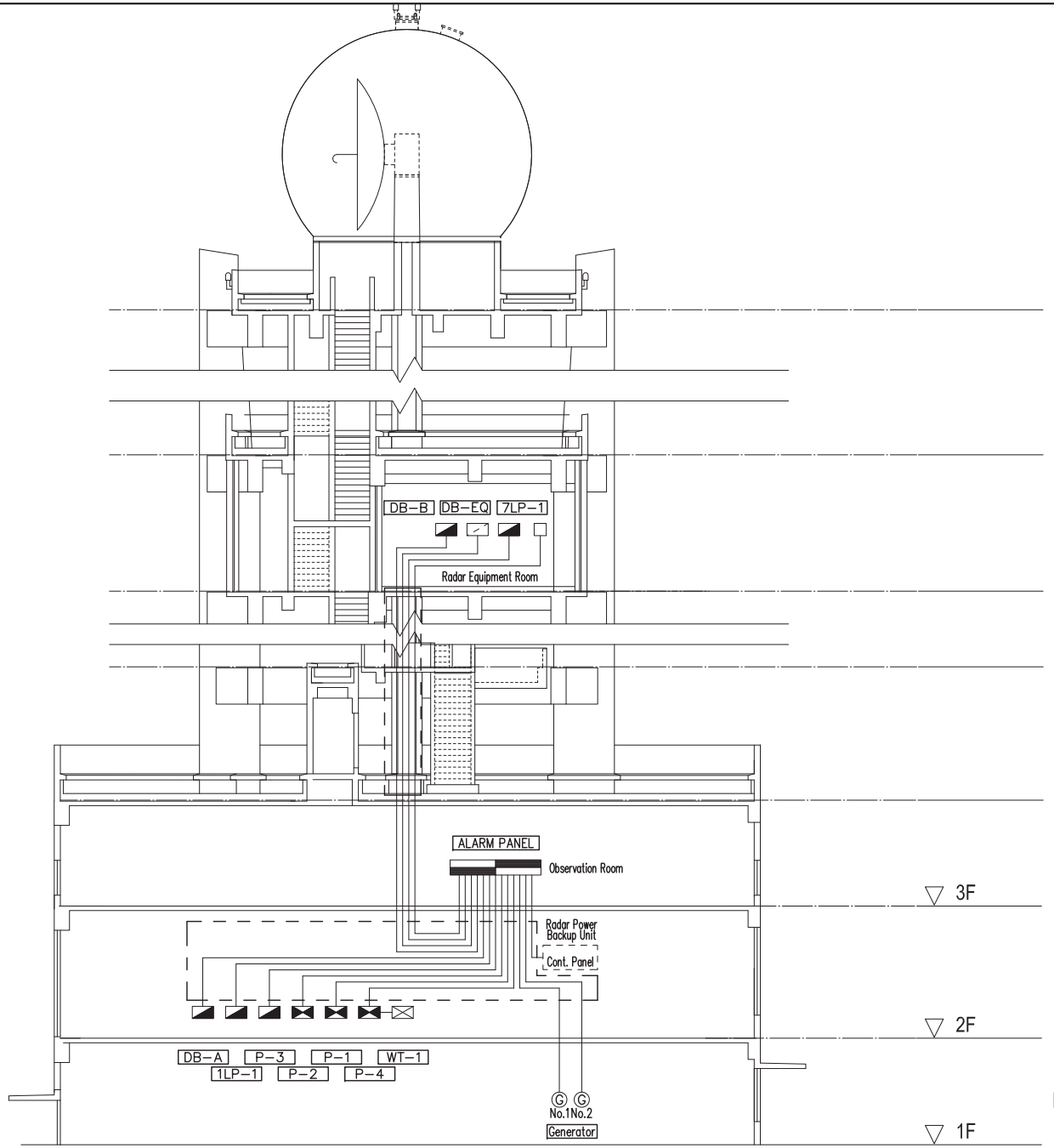


| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>INTERPHONE & TELEPHONE DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 03 |

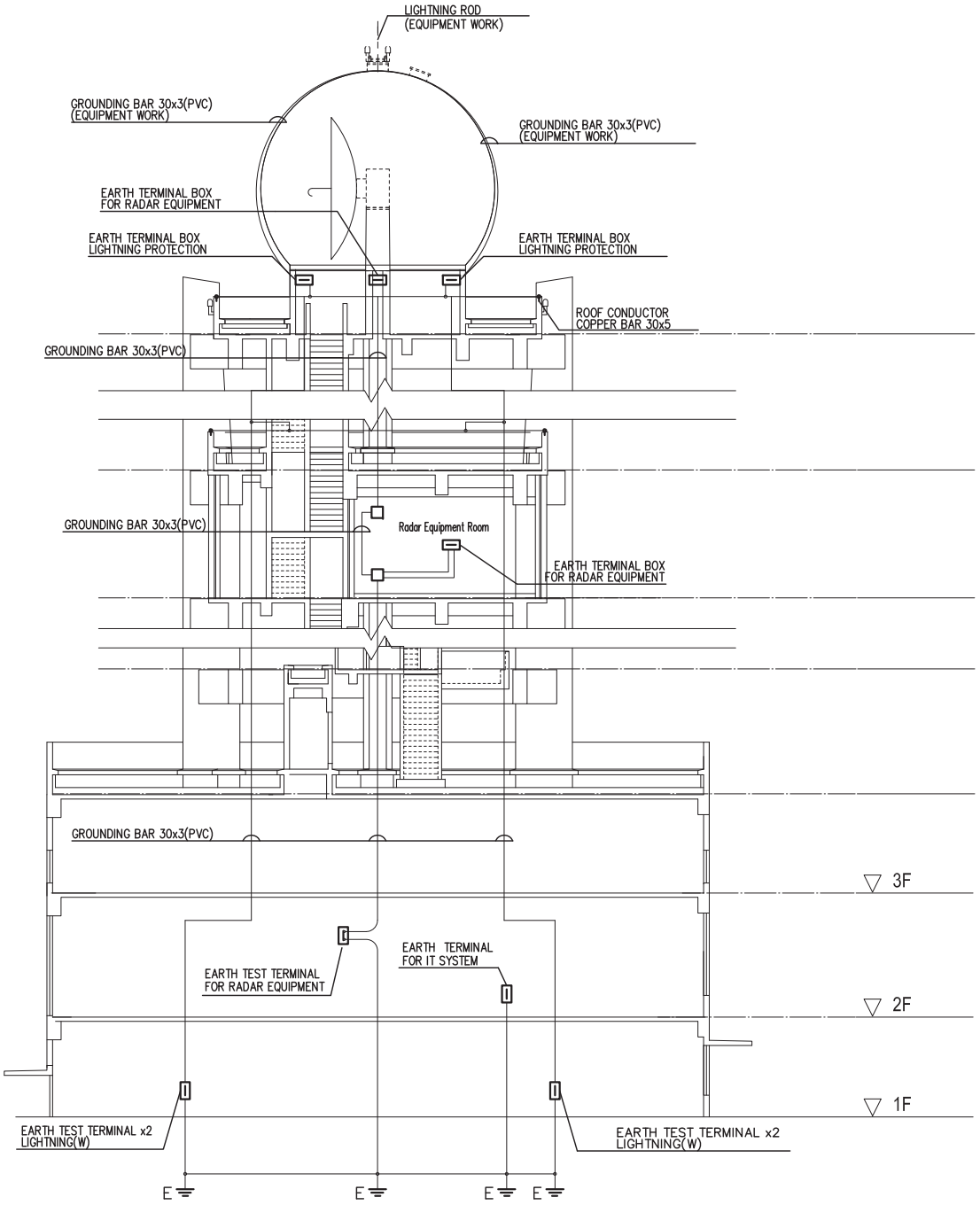





| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>RISER FIRE ALARM DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 04 |

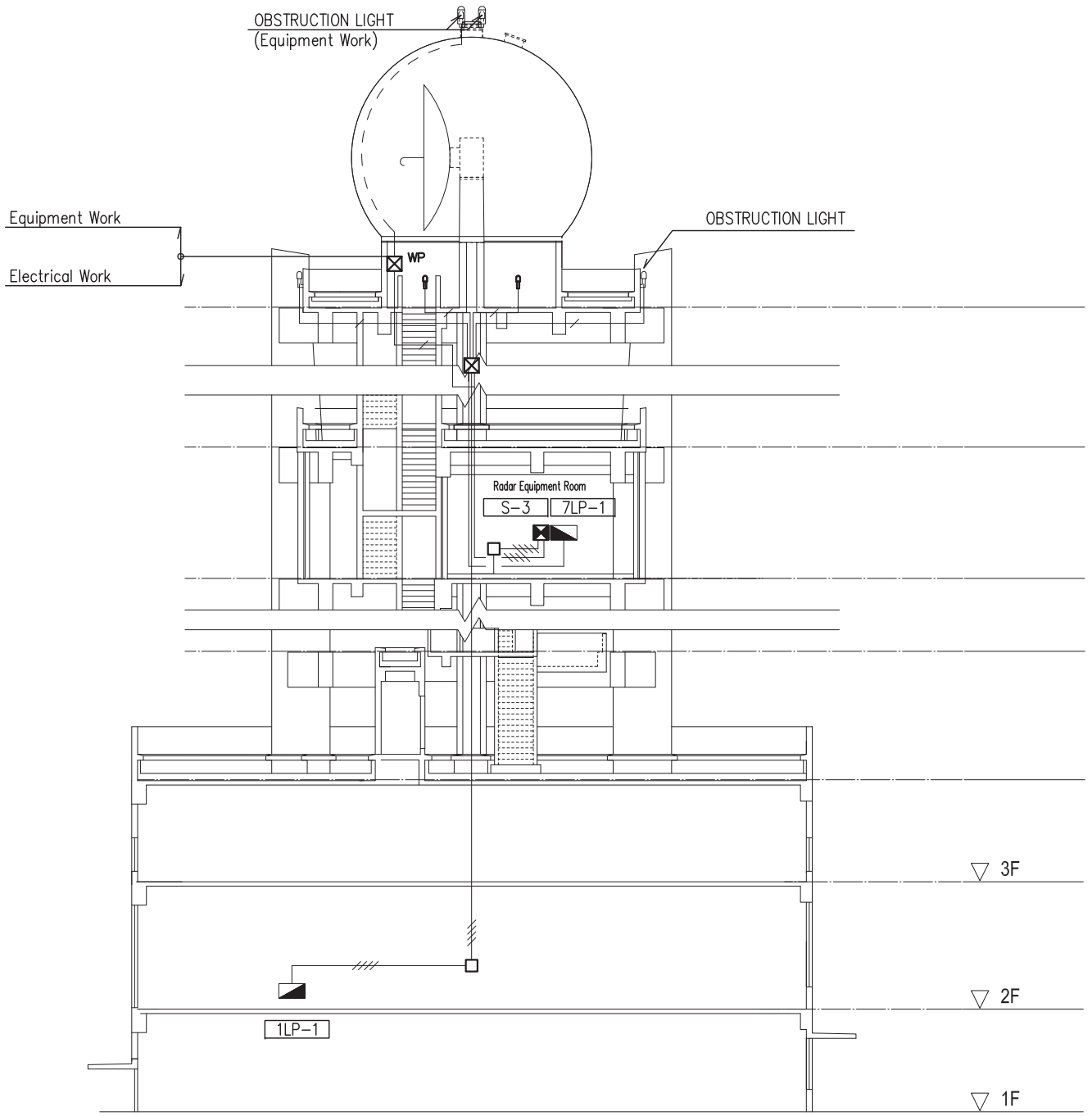



| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>ALARM DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 05 |



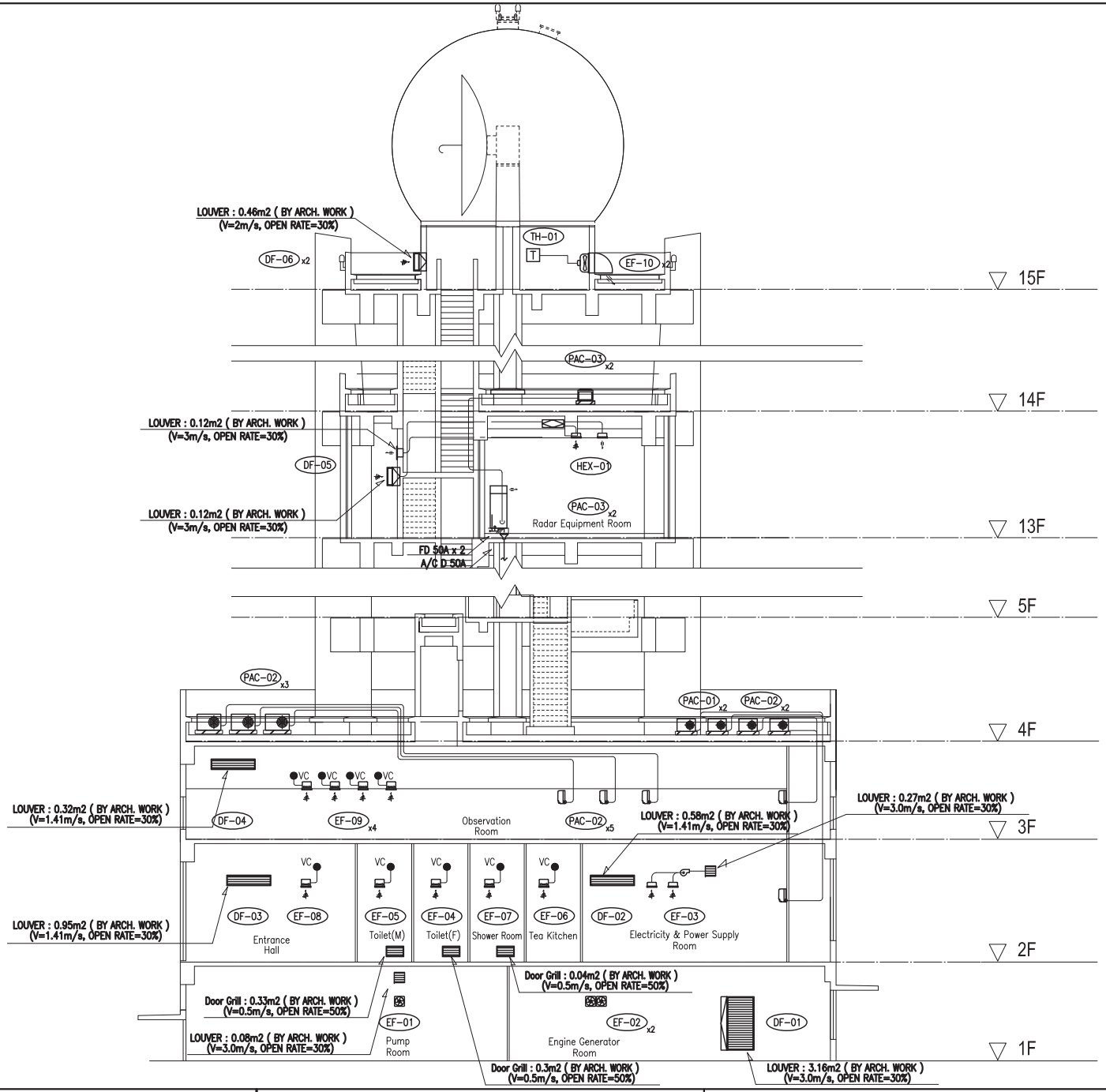



| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>RISER LIGHTNING PROTECTION<br>& GROUNDING DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 06 |



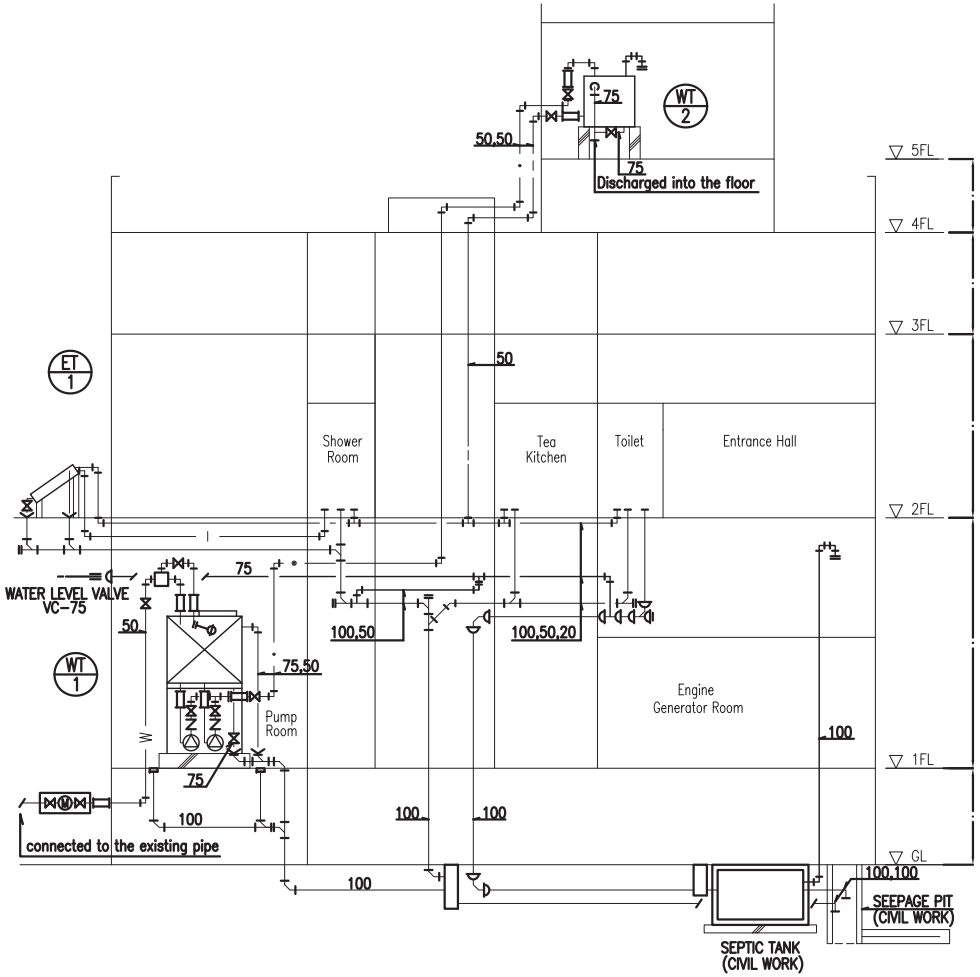



| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>RISER OBSTRUCTION LIGHTING DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 07 |






| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>AIR-CONDITIONING & VENTILATION DIAGRAM | SCALE<br>NONE | DRAWING No.<br>SD - 08 |




| ITEM | 1F | 2F | | | | | TOTAL | REMARK |
|---|---|---|---|---|---|---|---|---|
| | PUMP ROOM | TOILET(M) | TOILET(F) | SHOWER ROOM | TEA KITCHEN | SERVICE | | |
| WATER CLOSET | | 1 | 1 | | | | 2 | |
| LAVATORY | | 1 | 1 | | | | 2 | |
| PAPER HOLDER | | 1 | 1 | | | | 2 | |
| FAUCET | 1 | 1 | 1 | | 1 | 1 | 5 | |
| MIRROR | | 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) | EMERGENCY POWER SUPPLY | | |
| WT-1 | POTABLE WATER | FPR Tank | 1 | | | | | O | Pump Room | RC FOUNDATION |
| | TANK / PUMP | Rated capacity 2.5 $m^3$ | | | | | | | | (CIVIL WORK) |
| | | Dimension 1,000 x 1,500 x 2,000H | | | | | | | | 1.8x1.8x0.3mH |
| | | Accessories Manhole 600ø Breather | | | | | | | | |
| | | Ball tap 25A , overflow and drain pipe 40A | | | | | | | | |
| | | Electrode 4P | | | | | | | | |
| | | Constant pressure type pump | 2 | 3 | 440 | 50 | 1.5 | | | |
| | | 40 ø x 100 l/min x 270 kpa x 2 pcs (1 spare) | | | | | | | | |
| | | Accessories Flexible connector for suction 40A | | | | | | | | |
| | | | | | | | | | | |
| WT-2 | POTABLE WATER | FRP tank | 1 | | | | | | 5FL Roof | RC FOUNDATION |
| | GRAVITY TANK | Rated capacity 1.5 $m^3$ | | | | | | | | (CIVIL WORK) |
| | | Dimension 1,000 x 1,500 x 1,500H | | | | | | | | 0.4x1.4x0.5mH |
| | | Earth quake proof 2.0G(Wind –Proof type) | | | | | | | | |
| | | Accessories Flat frame 150H,manhole 600 ø | | | | | | | | |
| | | Electrode 4P | | | | | | | | |
| | | | | | | | | | | |
| ET-1 | Solar heat water | Model : Natural circulation method type | 1 | | | | | | 2F Out door | |
| | heater | Dimension: Collector 1002x2002x60 (Two pieces) | | | | | | | | |
| | | Water storage tank 465x2008x505 | | | | | | | | |
| | | Heat to collect Area : 4.02$m^2$ | | | | | | | | |
| | | Water storage volume : 200 LIT | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| ABC | FIRE EXTINGUISHER | ABC Dry chemical, wall hang | 2 | | | | | | Each room | |
| | | 10 Lbs Discharge time 14 sec | | | | | | | | |
| | | | | | | | | | | |
| CO2 | FIRE EXTINGUISHER | Carbon dioxicide, wall hang | 9 | | | | | | Each room | |
| | | 10 Lbs Discharge time 14 sec | | | | | | | | |
| | | | | | | | | | | |
| | SEPTIC TANK | Septic tank & Seepage pit (RC type, Civil work) | 1 | | | | | | Out door | |
| | (CIVIL WORK) | Blower pump (Civil work) | | | | | | | | |



CONSORTIUM OF
INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),
JAPAN WEATHER ASSOCIATION (JWA) AND
CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII)

THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING
WATER SUPPLY & DRAINAGE DIAGRAM

SCALE
NONE

DRAWING No.
SD - 09

(4) Basic Plan of the Ancillary Facility

1) Site and Ancillary Facility

Table46: Construction Sites for Ancillary Facilities

| Study Items | | Islamabad Power Back-up Shed | Islamabad Wind Profiler Antenna Foundation and Concrete Shelter | Multan Power Back-up Shed | Multan Wind Profiler Antenna Foundation and Concrete Shelter |
|---|---|---|---|---|---|
| Picture of Proposed Site | |  |  |  |  |
| Land Expropriation | | PMD Islamabad Head Office | PMD Islamabad Head Office | Multan Meteorological Office | Multan Meteorological Office |
| Location | Latitude<br>Longitude | N 33º 41'01.6"<br>E 73º 03'50.7" | N 33º 40'57.2"<br>E 73º 03'50.8" | N 30º 11'52.8"<br>E 71º 25'22.1" | N 30º 11'52.8"<br>E 71º 25'22.1" |
| | Altitude | 525m | 523m | 122m | 122m |
| Enough Space for Radar Tower Construction | | Enough space available | Enough space available | Enough space available | Enough space available |
| Access Road | | Available | Available | Available | Available |
| Commercial Power Supply | | Available | Available | Available | Available |
| Internet Access | | Available | Available | Available | Available |
| Mobile Phone Service | | Available | Available | Available | Available |

2) Site and Ancillary Facility Layout Plan

[1] Floor Plan

Construction methods and materials follow local practice and the buildings are of standard grade in Pakistan. The floor area of each room, the room's function and the method of calculation of the size of each room are shown in the following tables.

Table 47: Calculation Base of Each Ancillary Facility

| Name of Room | Floor Area ($m^2$) | Room Function | Calculation Base |
|---|---|---|---|
| Islamabad Power Back-up Shed | 33.6 | For installation of 2 engine generators, 1,000 litter service tank | Operation and maintenance space for engine generators (2) |
| Multan Power Back-up Shed | 27.5 | For installation of 2 engine generators, 1,000 litter service tank | Operation and maintenance space for engine generators (2) |
| Islamabad Wind Profiler Antenna Foundation and Concrete Shelter | 46.0 | For installation of transmitter/receiver, power supply capacitor | - |
| Multan Wind Profiler Antenna Foundation and Concrete Shelter | 46.0 | For installation of transmitter/receiver, power supply capacitor | - |

[2] Internal and External Finishing 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 PMD as follows.

Table48: Finishing Materials of Each Ancillary Facility

| Finishing Materials of Power Back-up Shed & Antenna Foundation and Concrete Shelter | | |
|---|---|---|
| Exterior Finishing | Roof Floor | Fare-faced Concrete |
| | Wall | Concrete blocks<br>Fare-faced Concrete<br>Cement sand mortar base spray tile finish |
| Interior Finishing | Floors | Cement sand mortal base, Epoxy resin paint finish |
| | Skirting | Cement sand mortar base, Epoxy resin paint finish |
| | Wall | Cement Sand mortal base, Vinyl paint finish |
| | Ceiling | Fare-faced Concrete<br>Cement sand mortar base, Emulsion paint finish |
| Window and Door | Exterior | Glass block, Aluminum window, Aluminum grille, Stainless steel door |

[3] Structural Plan

I. Structural Design Standard

In order to formulate and develop the structural design of the proposed radar tower building, the Building Code of Pakistan 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 a reference, if so required.

II. Structure Type

Reinforced concrete has been selected as the construction material for the proposed ancillary facilities. The floor slabs are to be reinforced concrete while exterior walls and partition walls are to be locally made out of concrete blocks.

[4] Electrical Facility Design

I. Power intake facility

Power Back-up Shed: 230V, 3-phase, 4-wire

II. Lighting and power outlet

Lighting fixtures will be mainly LED for their low power consumption. The lighting levels will be approximately as shown below.

Power Back-up Shed: 200 Lx

III. Grounding system

All the equipment to be installed in the Power Back-up Shed will be connected to a terminal box grounded by erecting a grounding electrode and running a wire from there to the terminal box.

IV. Fire extinguisher

Fire extinguishers will be supplied in the following room.

Power Back-up Shed: ABC Type × 2

### 2-2-3 Outline Design Drawing

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

<PMD Islamabad Head Office, Islamabad Meteorological Radar Tower Building>

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

- Equipment Layout 1 : EQ-01
- Equipment Layout 2 : EQ-02
- Equipment Layout 3 : EQ-03

< PMD Islamabad Head Office, Specialized Medium Range Weather Forecasting Center>

- Equipment Layout 4 : EQ-04

< PMD Islamabad Head Office, National Weather Forecasting Center>

- Equipment Layout 5 : EQ-05

<Ancillary Facility in PMD Islamabad Head Office>

- Power Back-up Shed : EQ-06
- Wind Profiler Antenna Foundation and Concrete Shelter : EQ-07

< PMD Lahore Regional Meteorological Center>

- Equipment Layout 6 : EQ-08

< PMD Lahore Flood Forecasting Division>

- Equipment Layout 7 : EQ-09

< PMD Karachi Tropical Cyclone Warning Center>

- Equipment Layout 8 : EQ-10

<PMD Multan Meteorological Office>

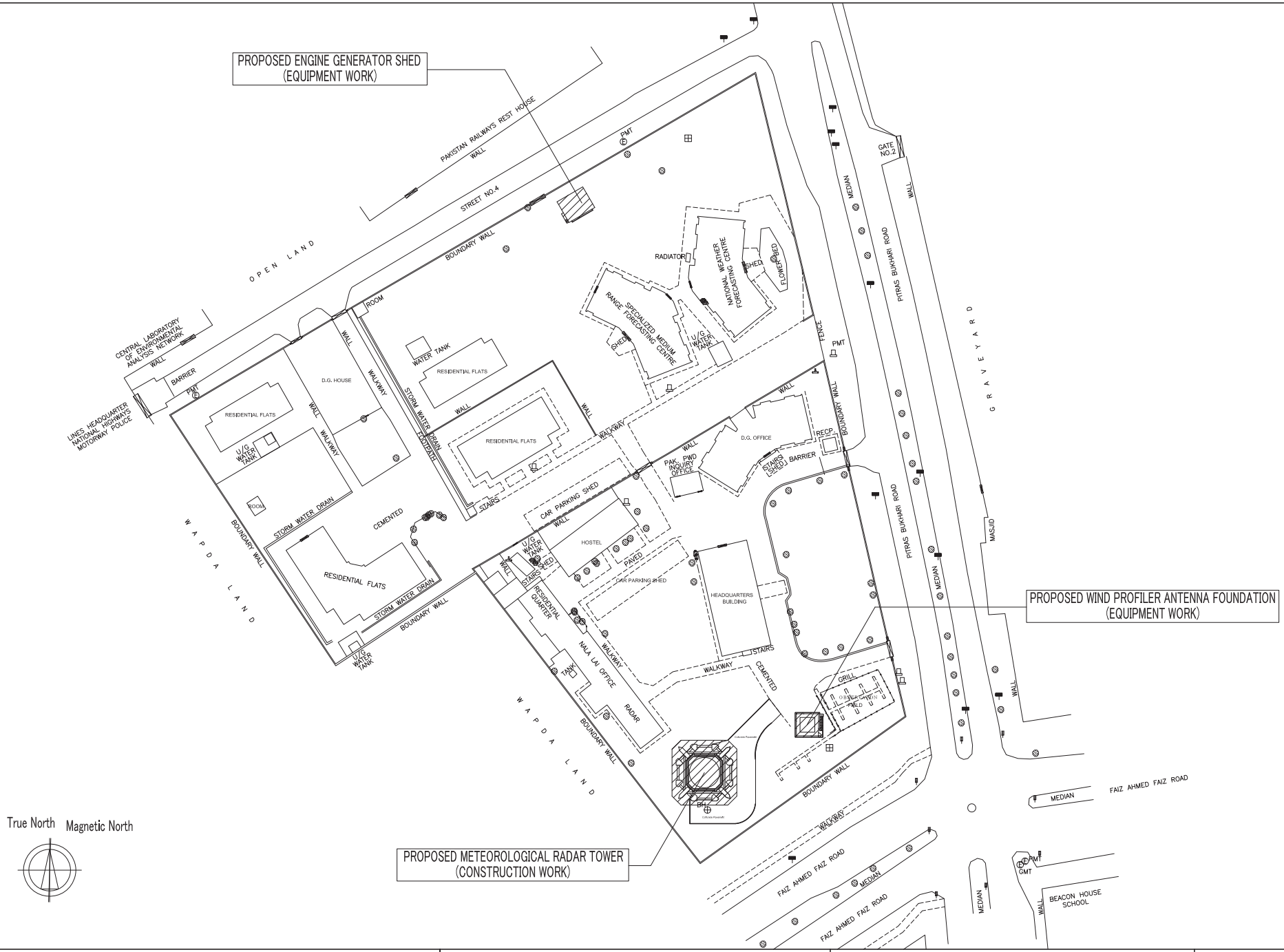
- Site Plan : EQ-11
- Equipment Layout 9 : EQ-12

<Ancillary Facility in PMD Multan Meteorological Office>

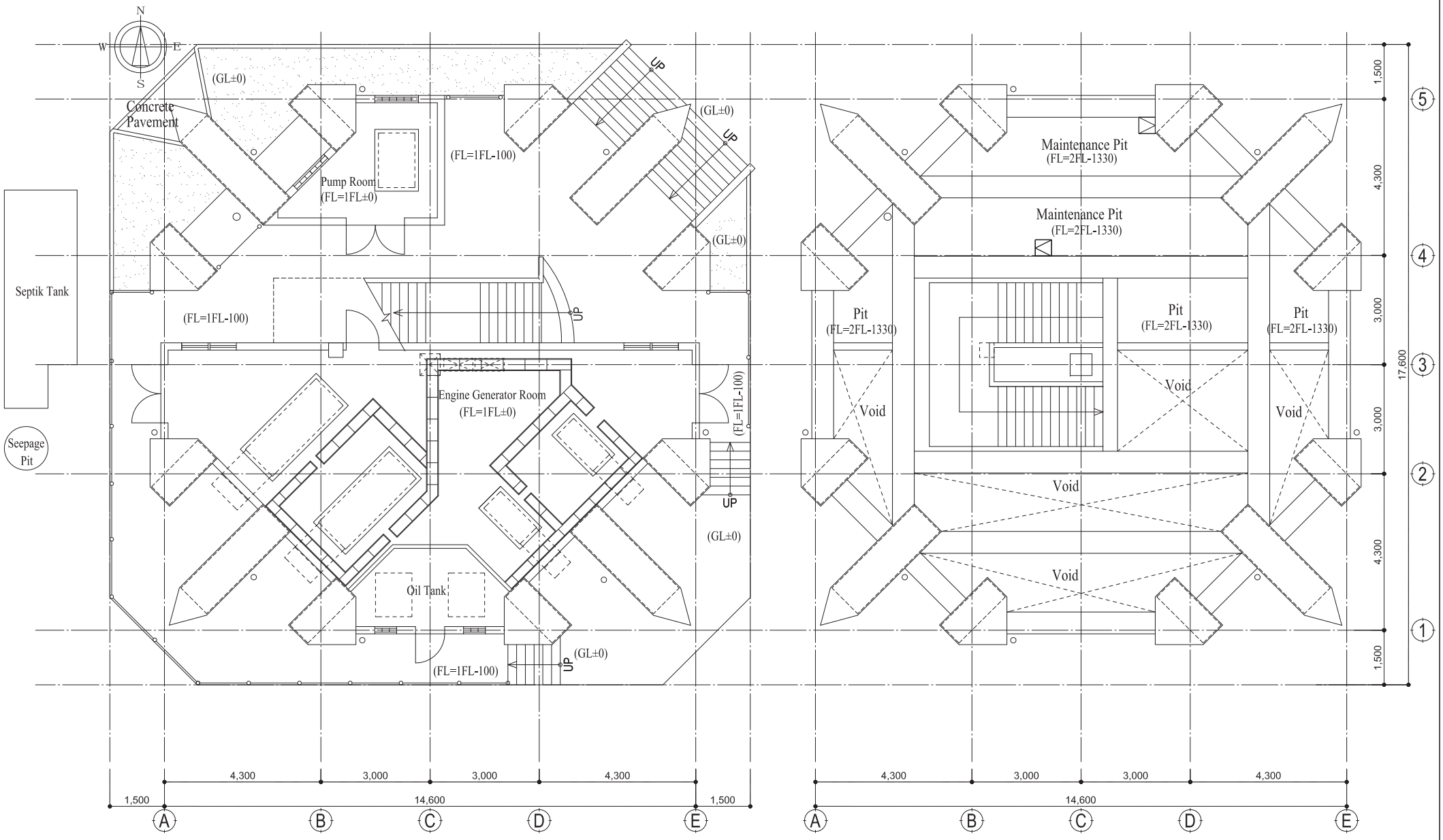
- Power Back-up Shed : EQ-13
- Wind Profiler Antenna Foundation and Concrete Shelter : EQ-14

<PMD Gilgit Meteorological Office>

- Equipment Layout 10 : EQ-15



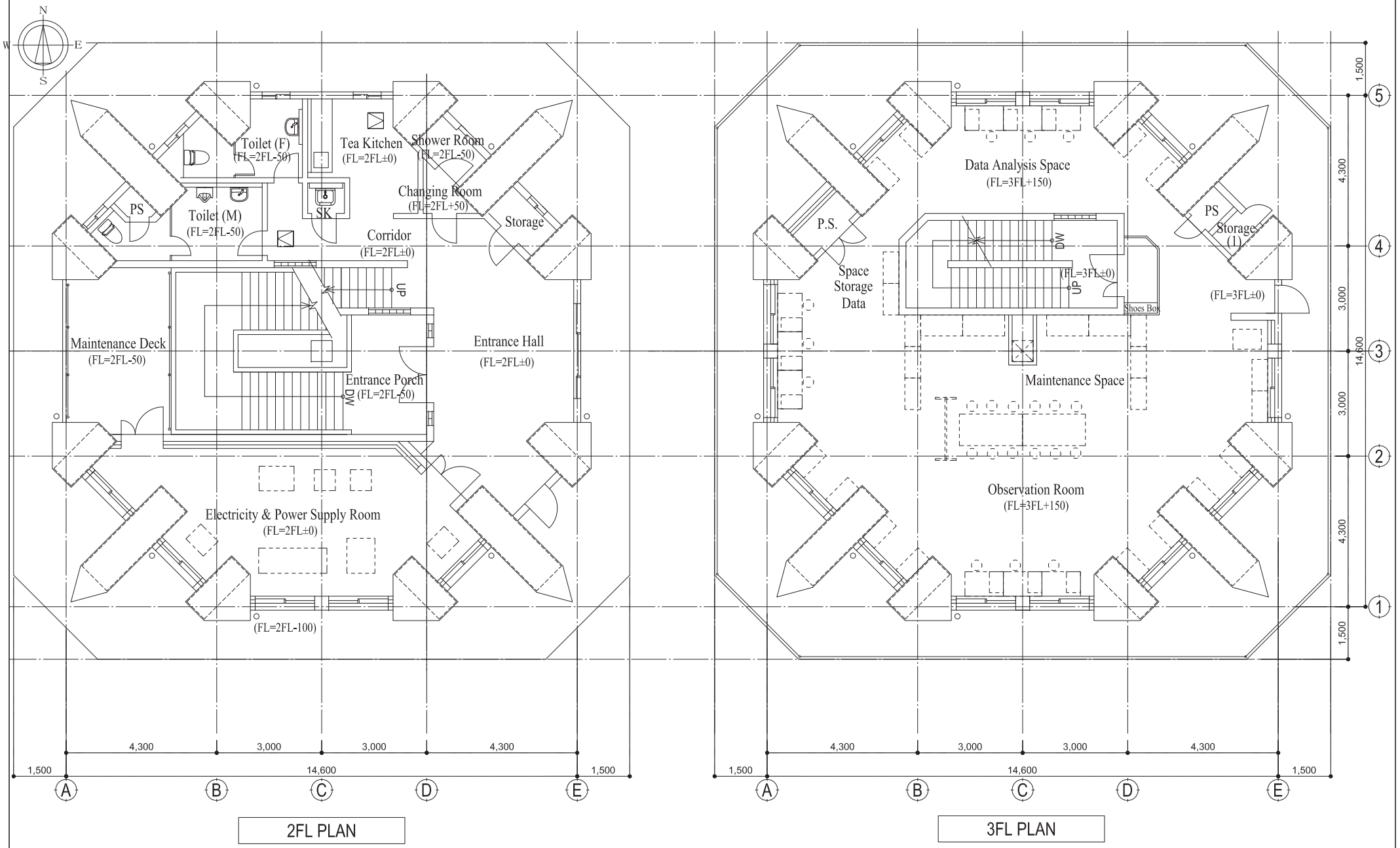

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>SITE PLAN | SCALE<br>1:1000 | DRAWING No.<br>A - 01 |



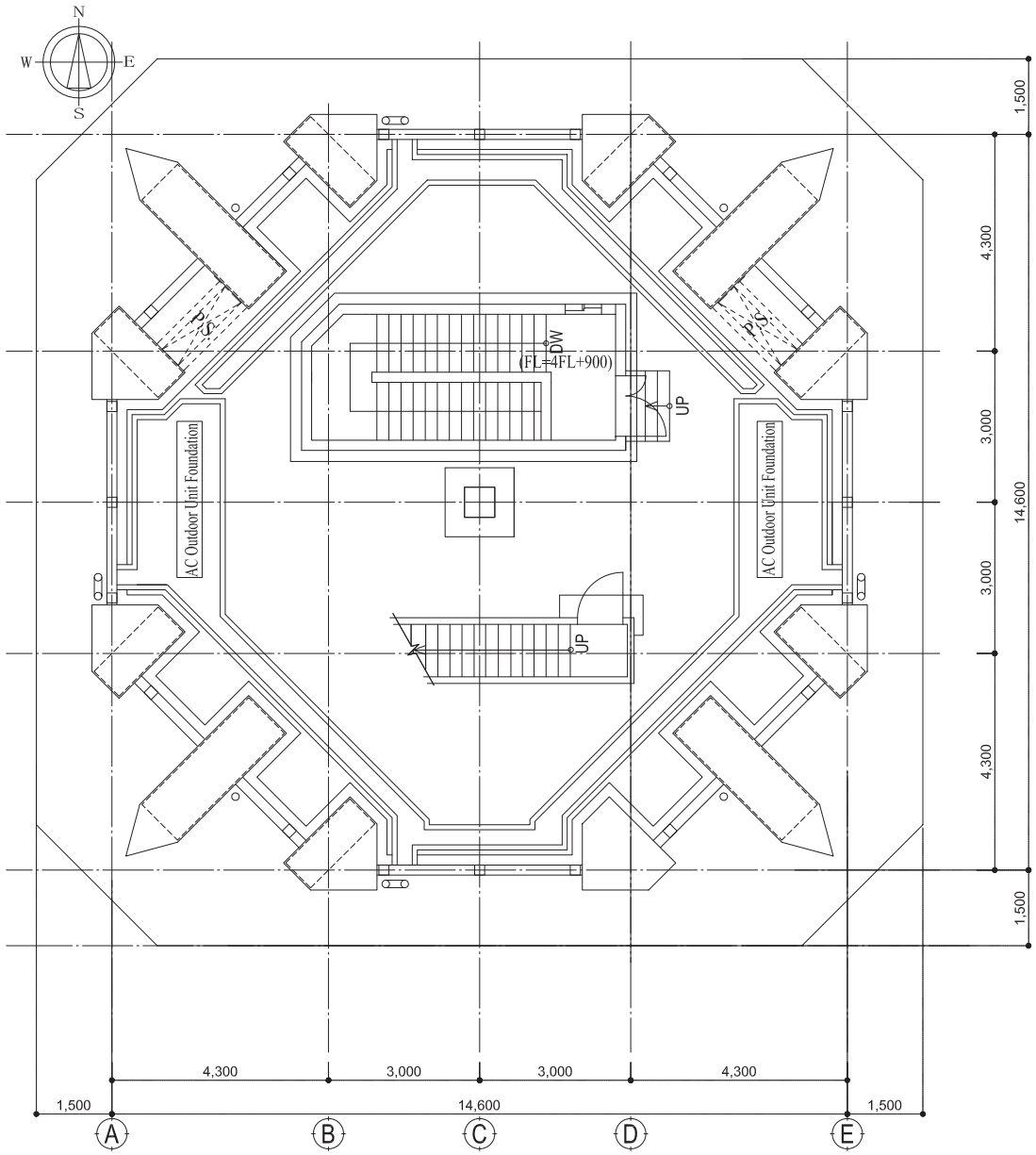

1FL PLAN

MPFL PLAN

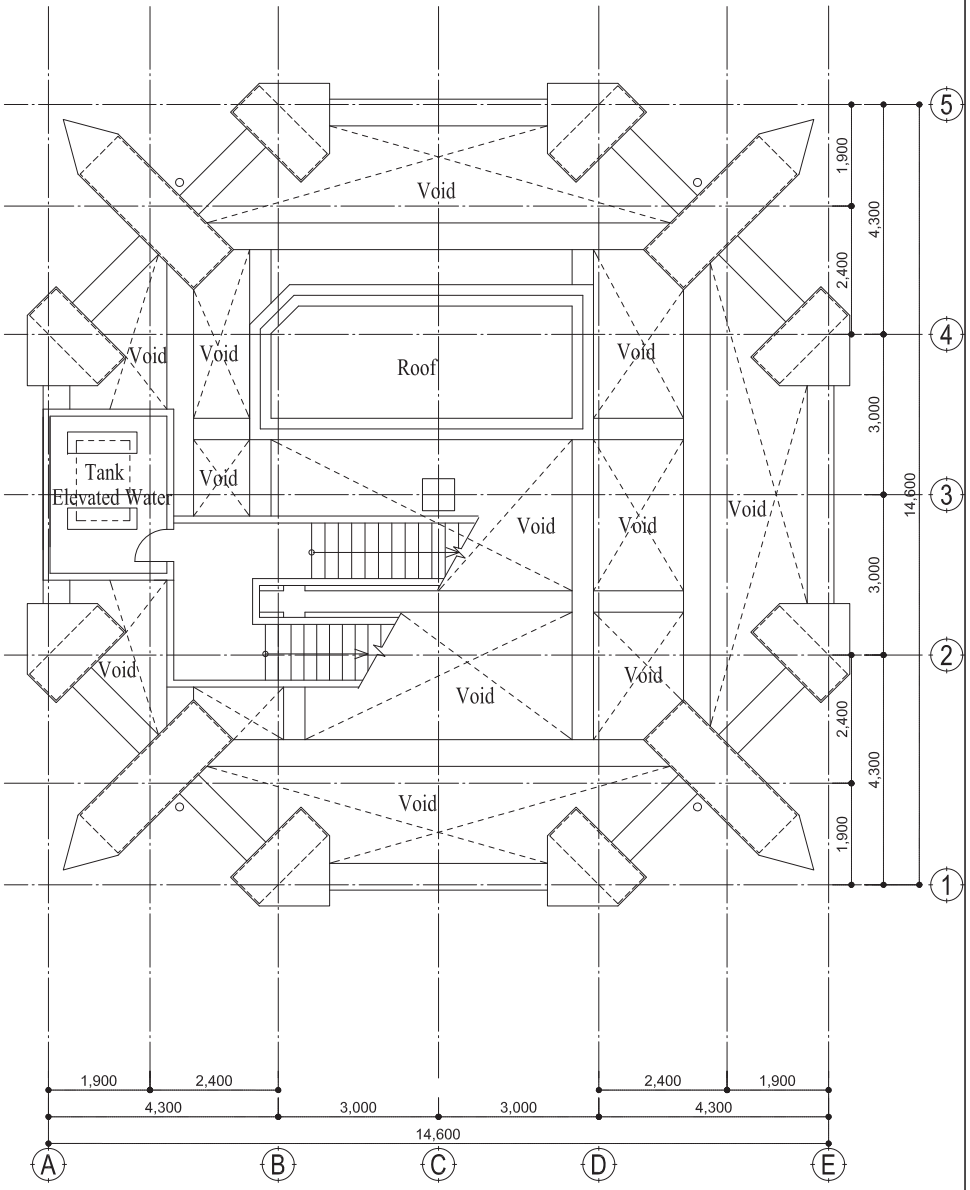
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 1 | SCALE<br>1:100 | DRAWING No.<br>A - 02 |




| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 2 | SCALE<br>1:100 | DRAWING No.<br>A - 03 |

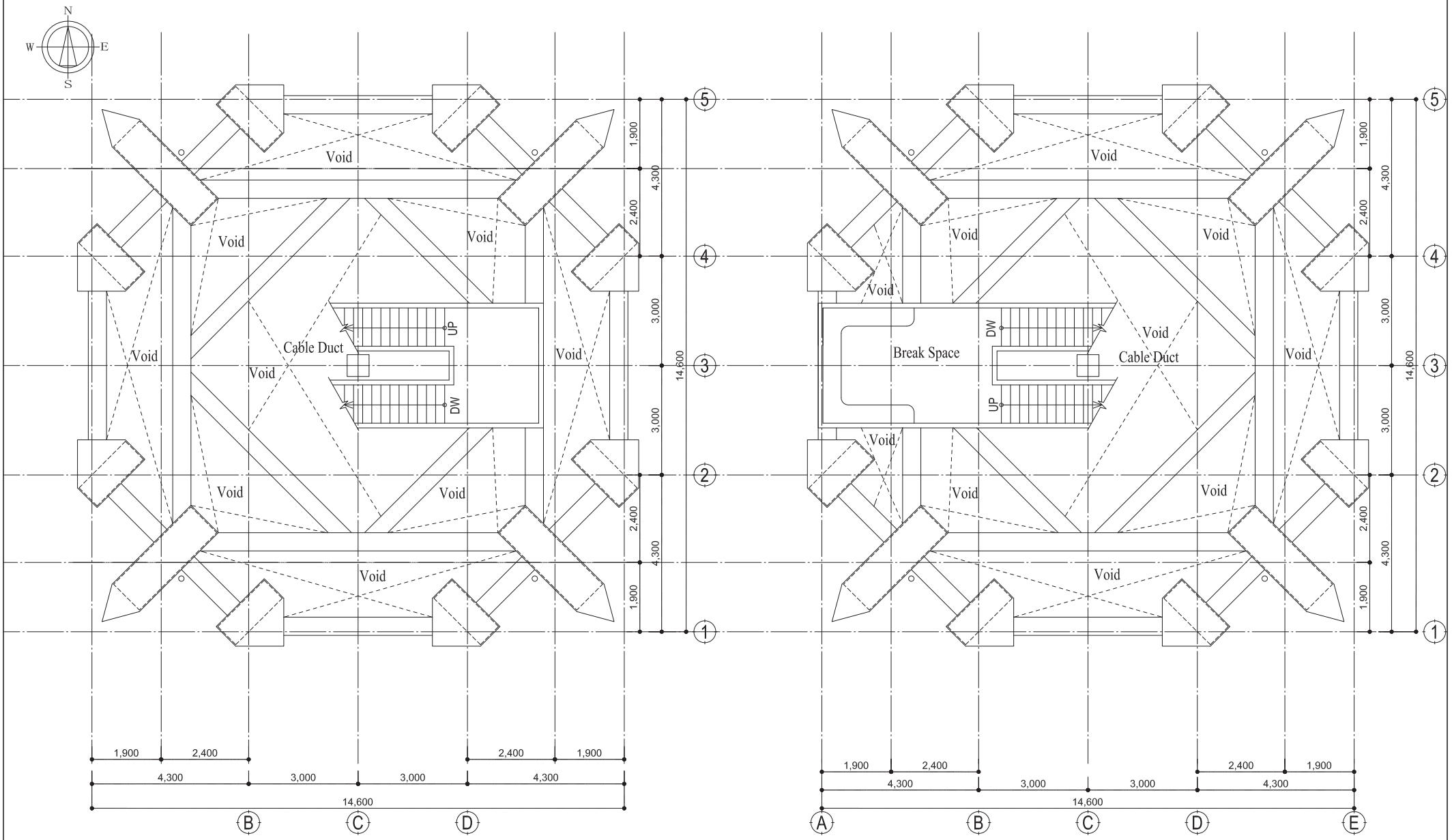



4FL PLAN




5FL PLAN

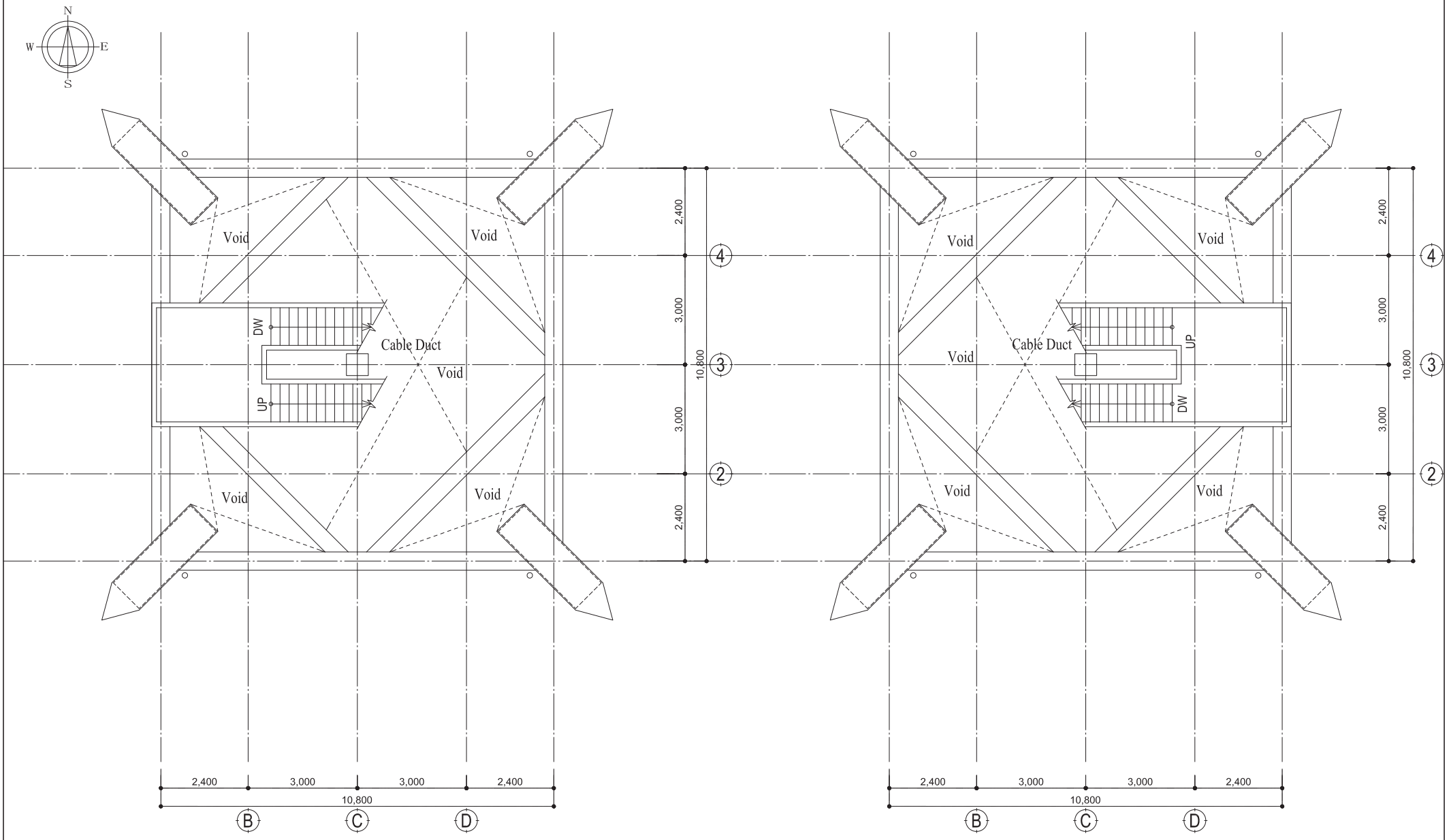
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 3 | SCALE<br>1:100 | DRAWING No.<br>A - 04 |




6, 8FL PLAN

7FL PLAN

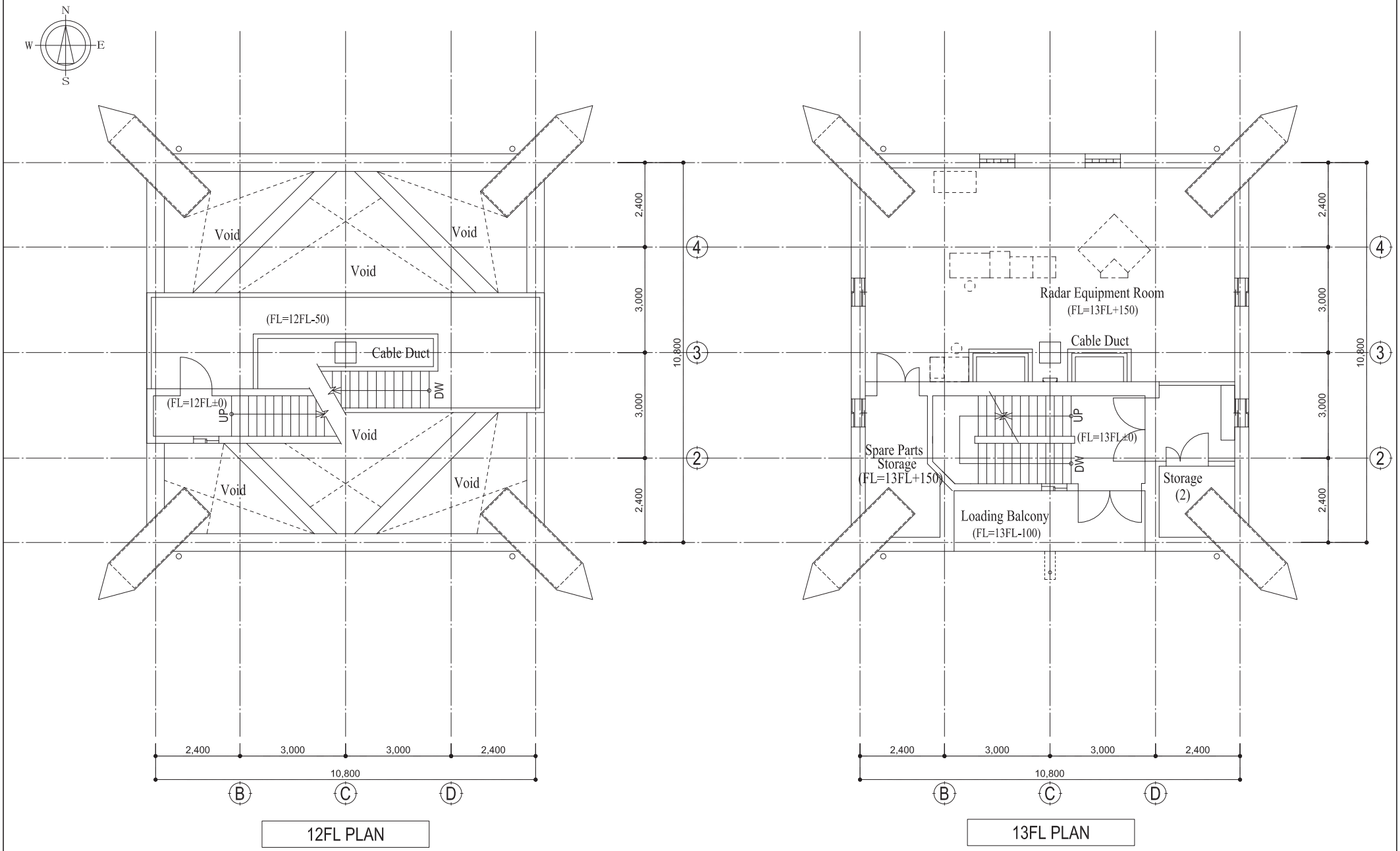
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 4 | SCALE<br>1:100 | DRAWING No.<br>A - 05 |



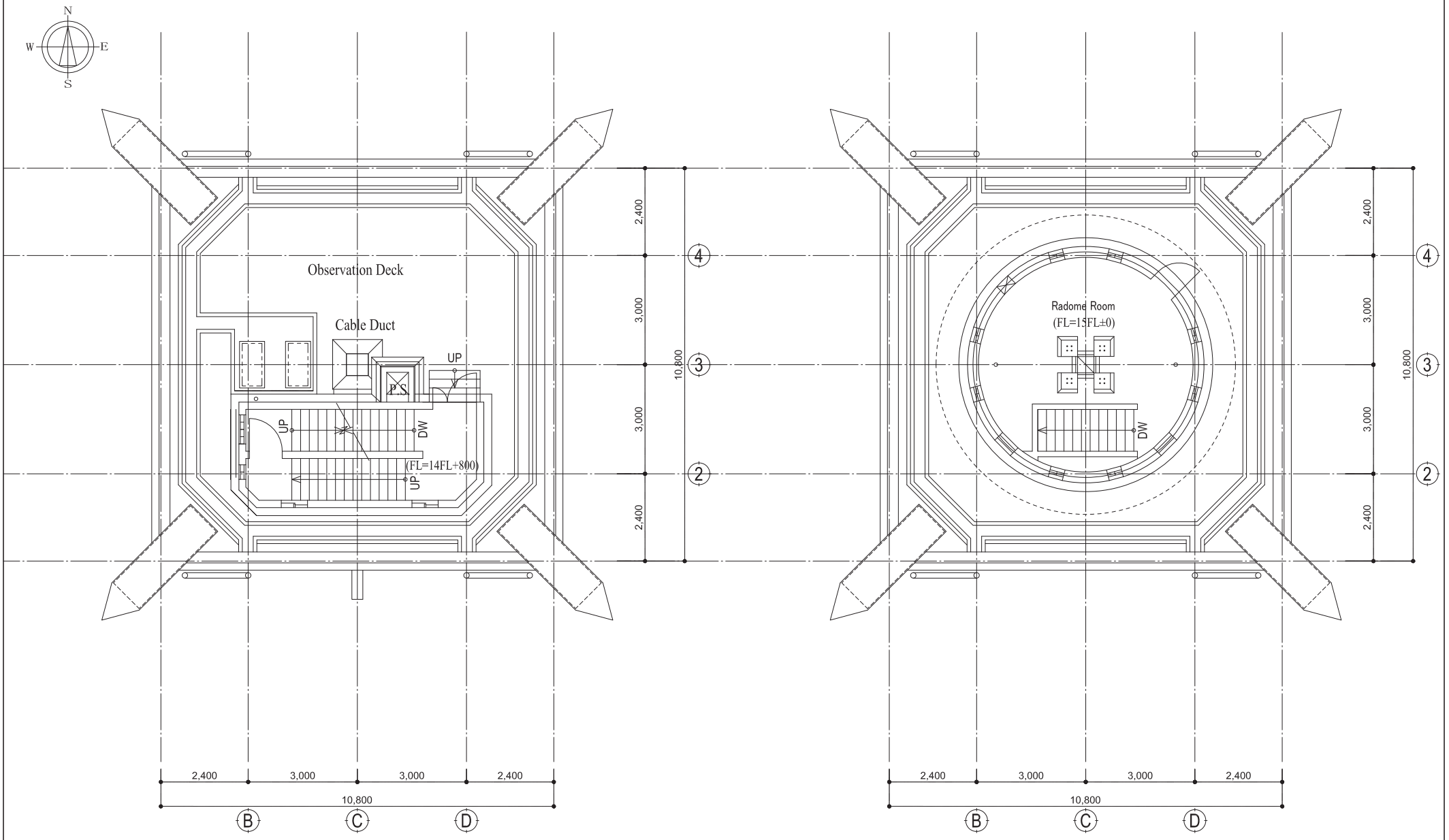

9, 11FL PLAN

10FL PLAN

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 5 | SCALE<br>1:100 | DRAWING No.<br>A - 06 |




| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 6 | SCALE<br>1:100 | DRAWING No.<br>A - 07 |




14FL PLAN

15FL PLAN

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>FLOOR PLAN 7 | SCALE<br>1:100 | DRAWING No.<br>A - 08 |

CONSORTIUM OF
INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),
JAPAN WEATHER ASSOCIATION (JWA) AND
CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII)

THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN

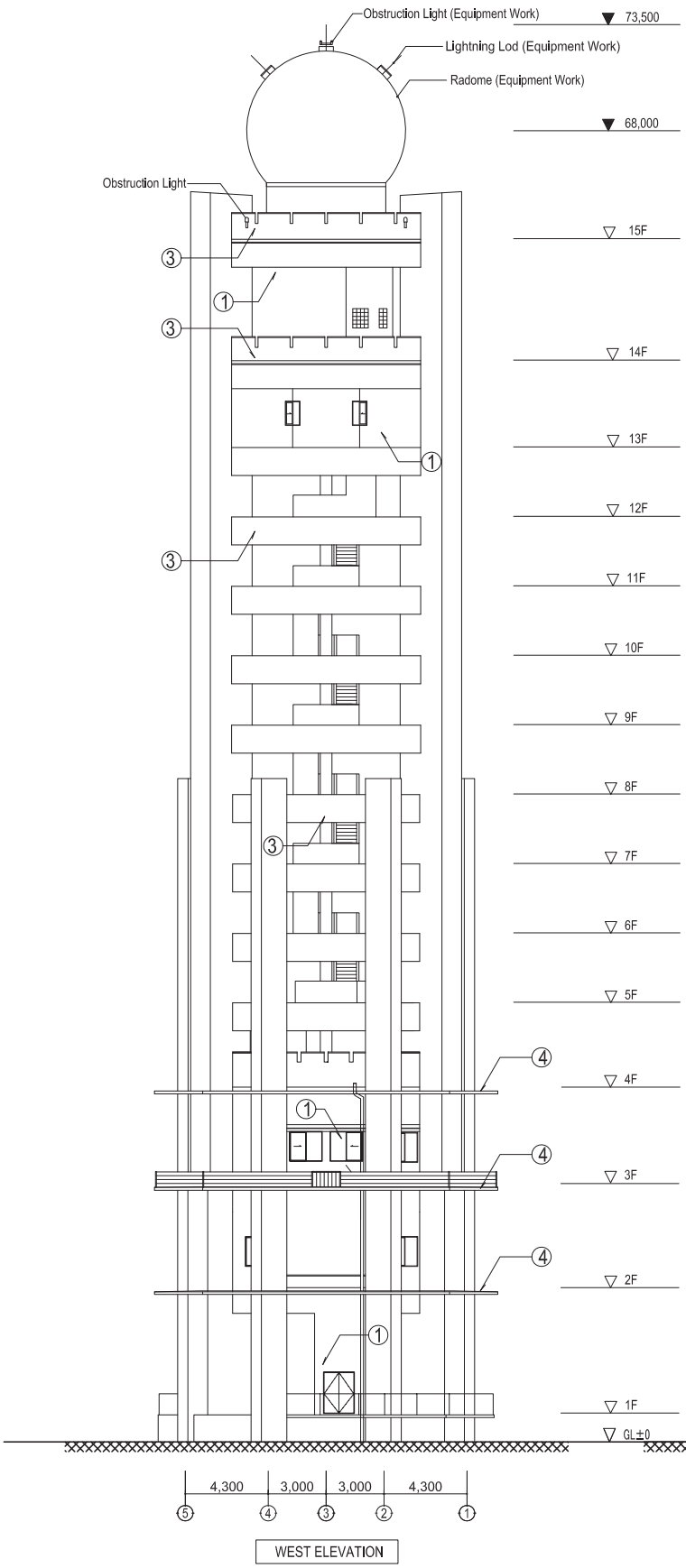
DRAWING TITLE
ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 1

SCALE
1:250

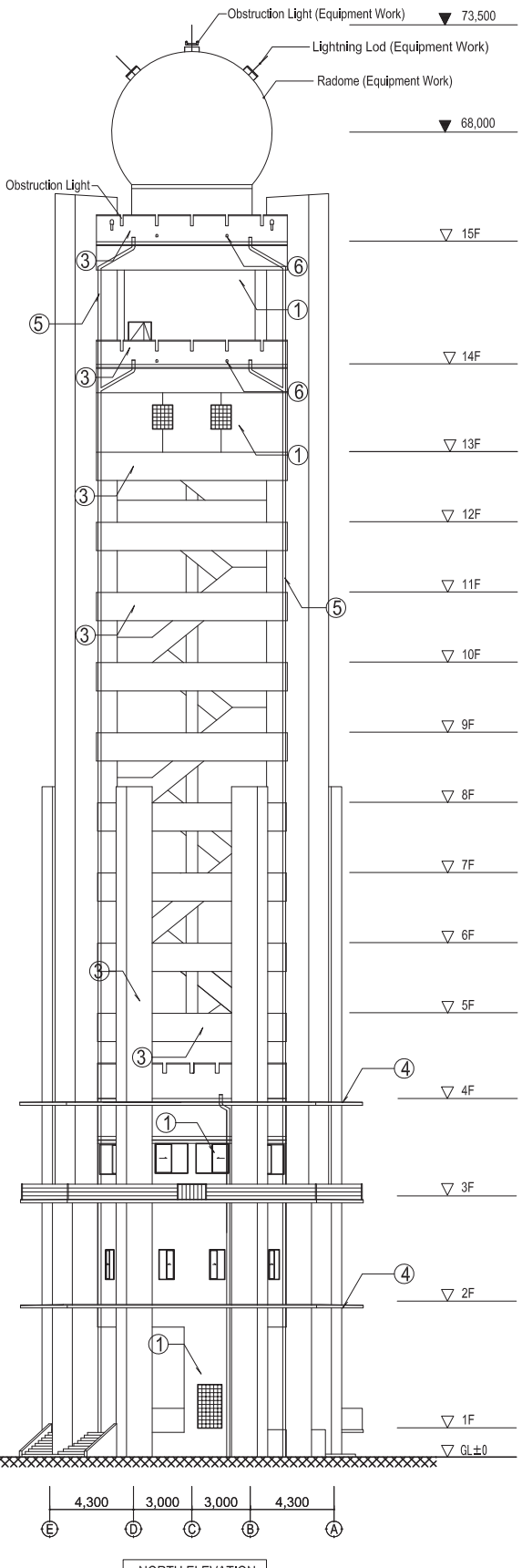
DRAWING No.
A - 09

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




NORTH ELEVATION

CONSORTIUM OF
INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),
JAPAN WEATHER ASSOCIATION (JWA) AND
CTI ENGINEERING INTERNATIONAL CO., LTD. (CTI)

THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN

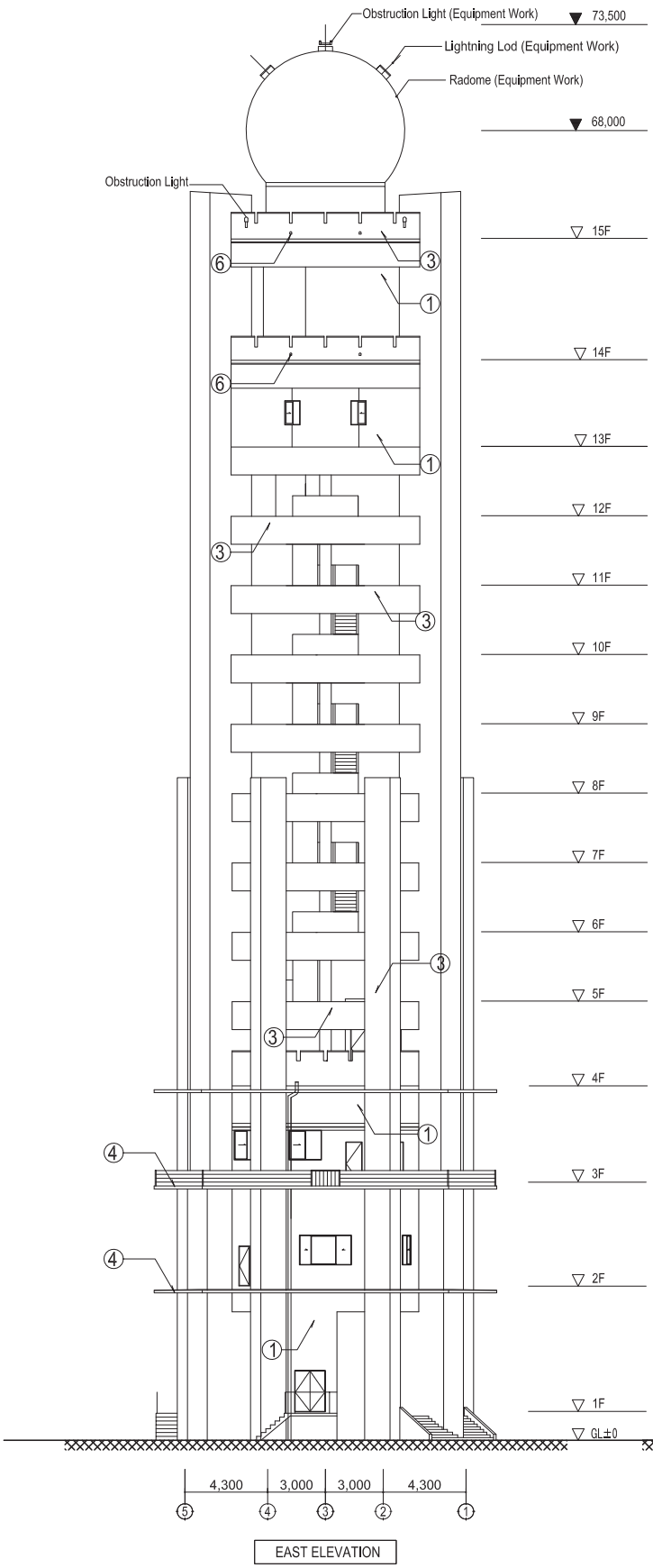
DRAWING TITLE
ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 2

SCALE
1:250

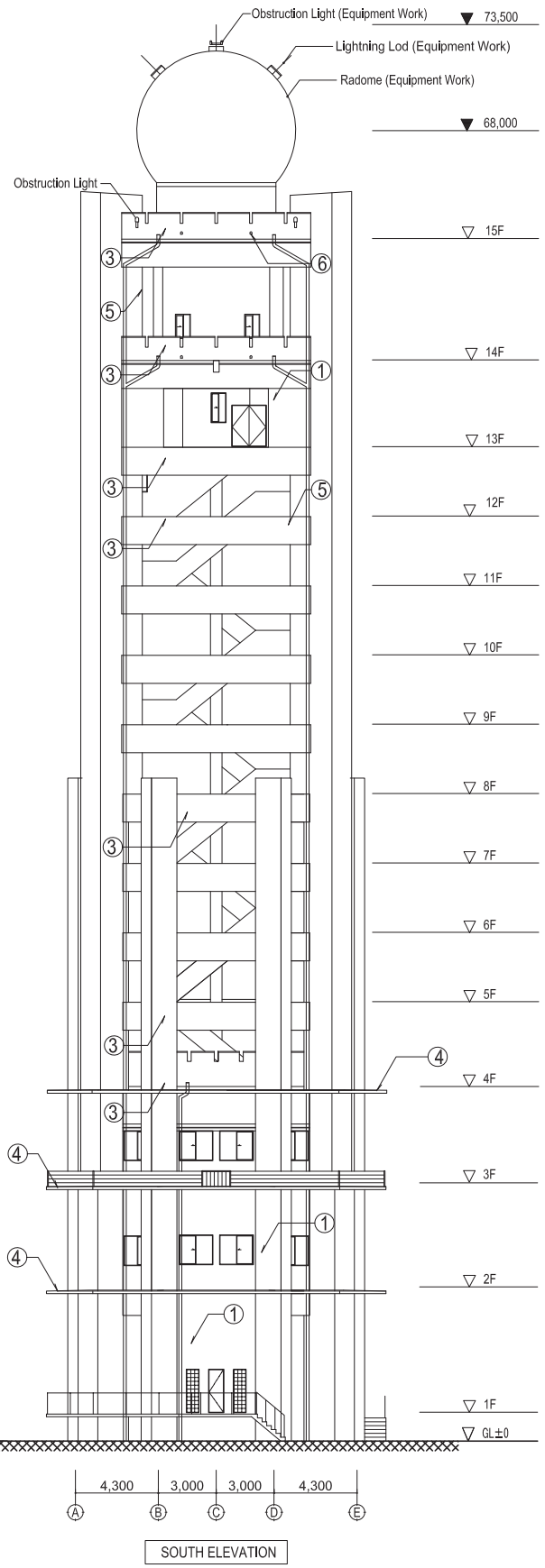
DRAWING No.
A - 10

LEGEND

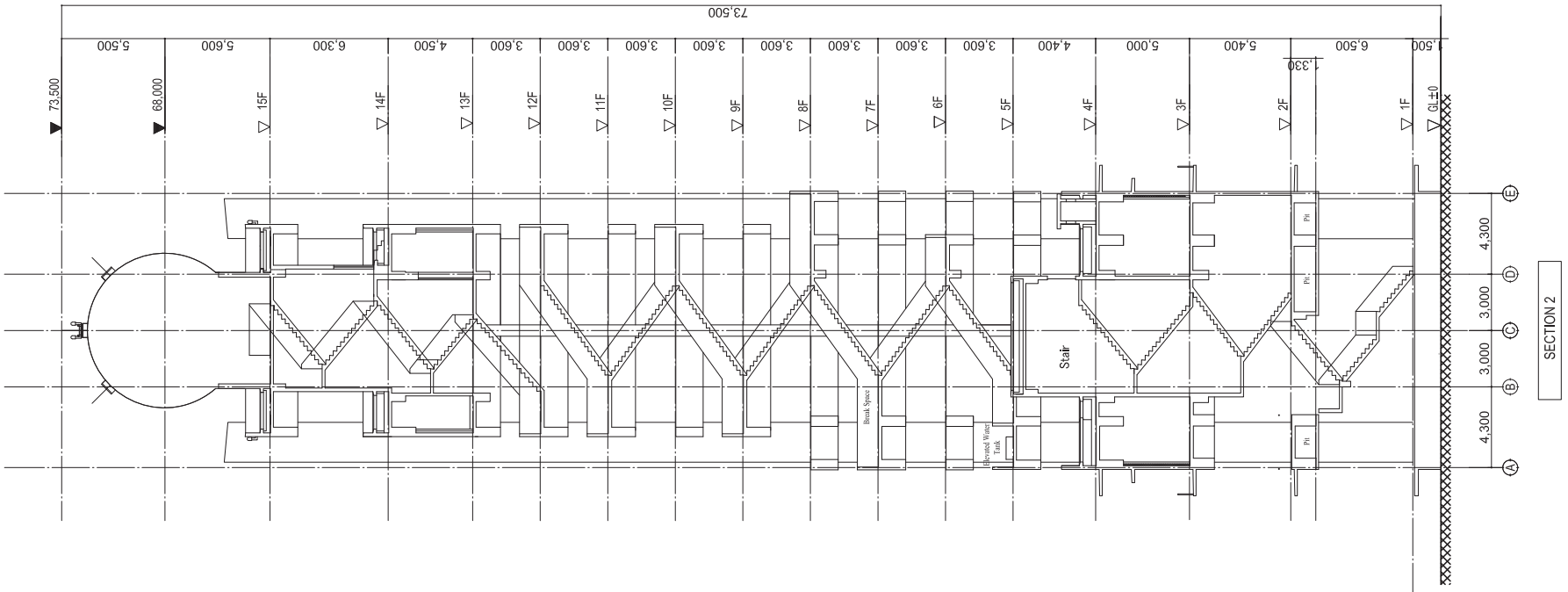
| | |
|---|---|
| ① | C.S. Mortar t=25 Spray Tile |
| ② | C.S. Mortar t=25 |
| ③ | Fair-faced Concrete, Mortar Mending, Spray Tile |
| ④ | Waterproof Mortar t=30, ERP |
| ⑤ | Rain Leader Pipe: Galvanized Steel Pipe 150A, Spray Tile |
| ⑥ | Overflow Pipe: Galvanized Steel Pipe 100A, Spray Tile |

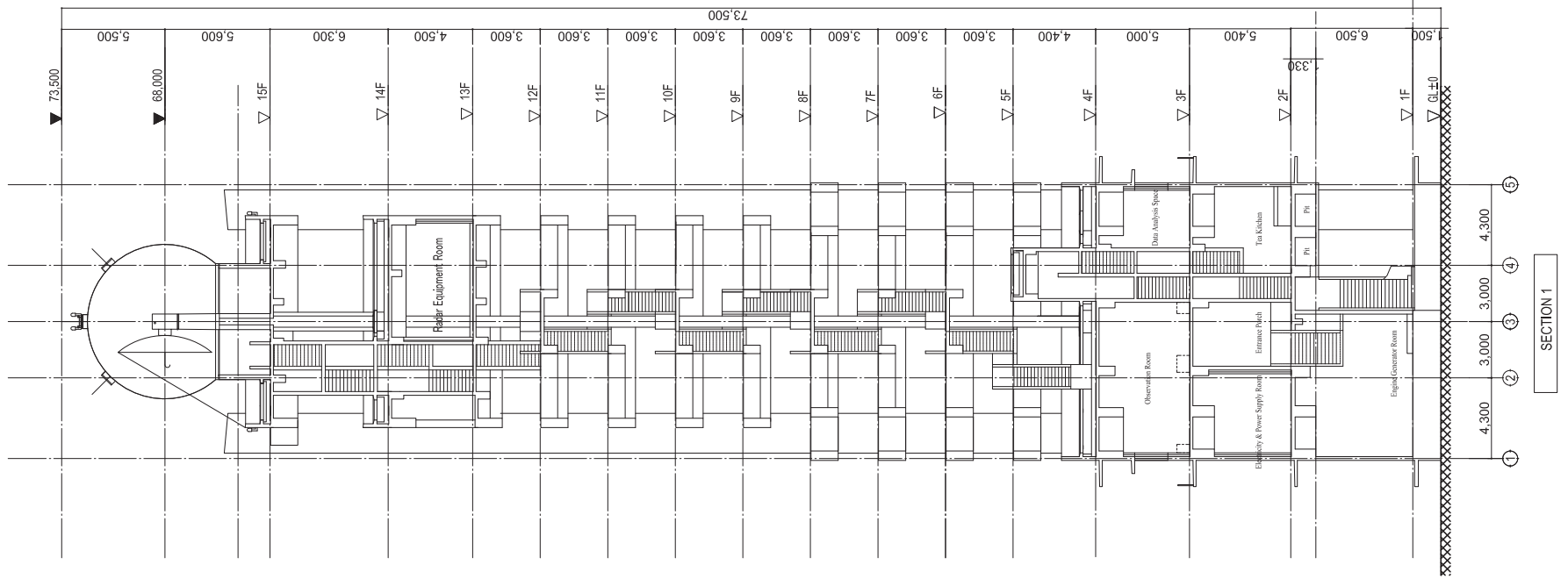



EAST ELEVATION

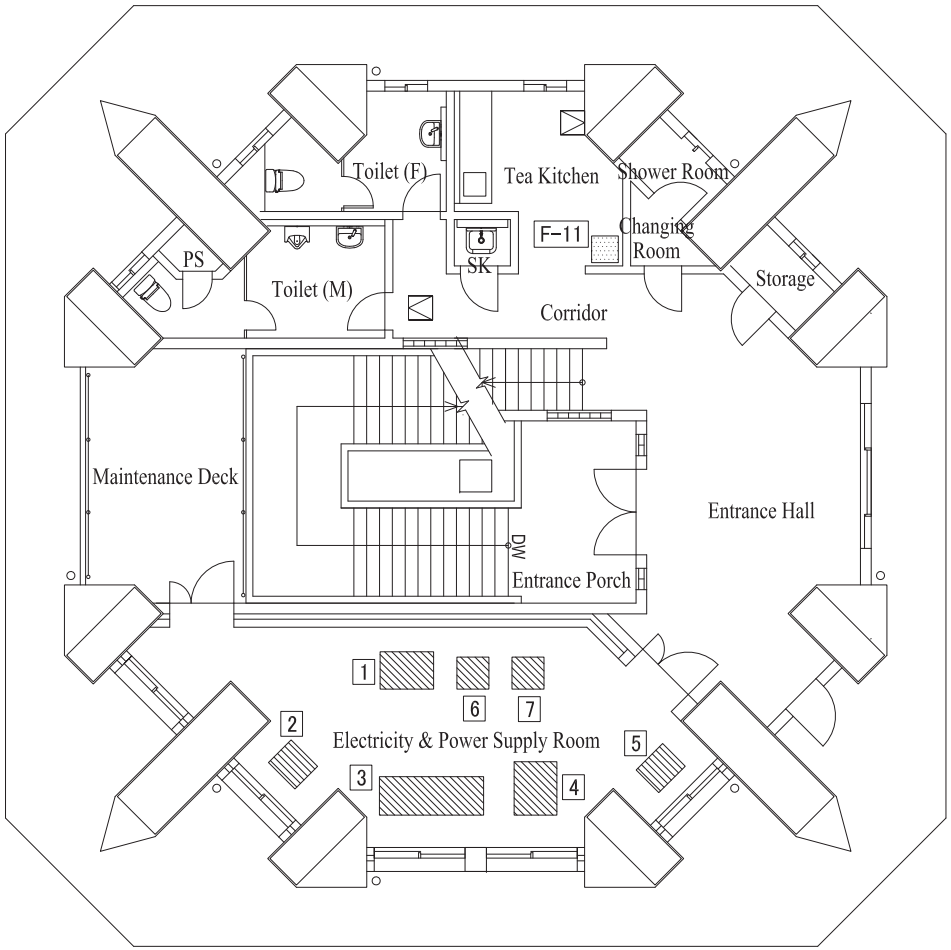



SOUTH ELEVATION




| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>SECTION | SCALE<br>1:250 | DRAWING No.<br>A - 11 |




2FL PLAN

EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Radar AVR |
| 2 | Isolation Transformer |
| 3 | Power Supply Capacitor |

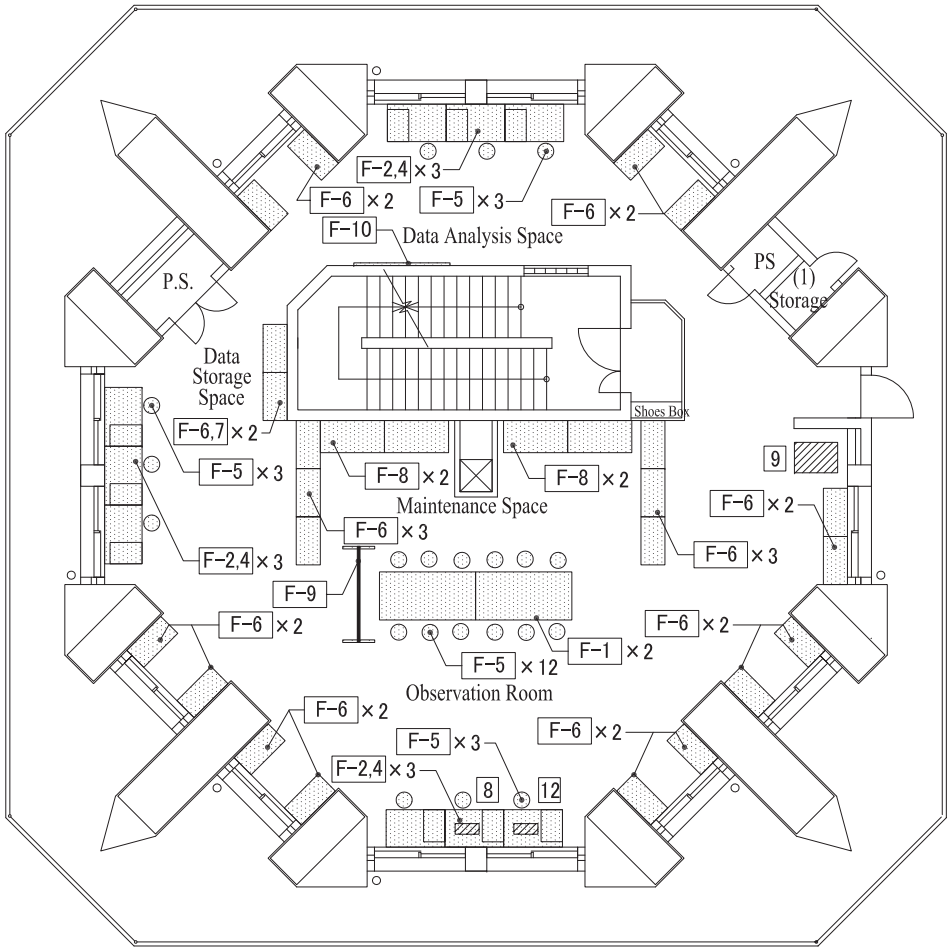
EQUIPMENT (CONSTRUCTION WORK)

| | |
|---|---|
| 4 | AVR |
| 5 | Isolation Transformer |
| 6 | AVR for Wind Profiler System |
| 7 | Isolation Transformer for Wind Profiler System |

FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-11 | Water Dispenser |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>EQUIPMENT LAYOUT 1 | SCALE<br>1:100 | DRAWING No.<br>EQ - 01 |



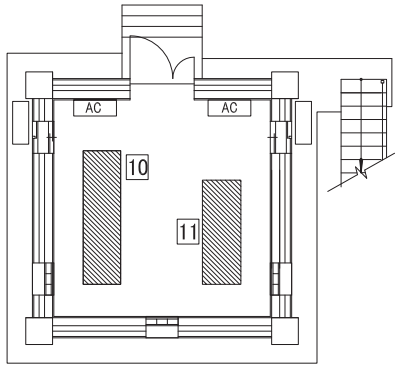

3FL PLAN

EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 8 | Data Analyzing Unit |
| 9 | Wind Profilling Signal Processing Unit |
| 10 | Transmitter / Receiver |
| 11 | Power Supply Capacitor |
| 12 | Colour Printer |

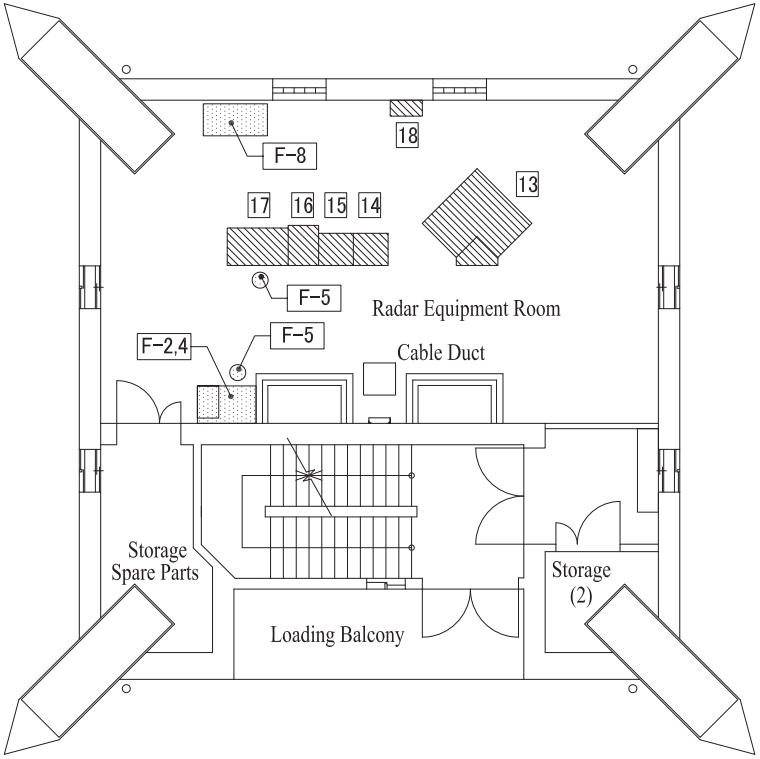
FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-1 | Meeting Table (W900 × L1,800) |
| 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 |
| F-8 | Shelves (Double Hinged Doors) H1,800 |
| F-9 | White Board : W1,800 × H900 |
| F-10 | Pin Board |




WIND PROFILER CONCRETE SHELTER

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>EQUIPMENT LAYOUT 2 | SCALE<br>1:100 | DRAWING No.<br>EQ - 02 |


13FL PLAN

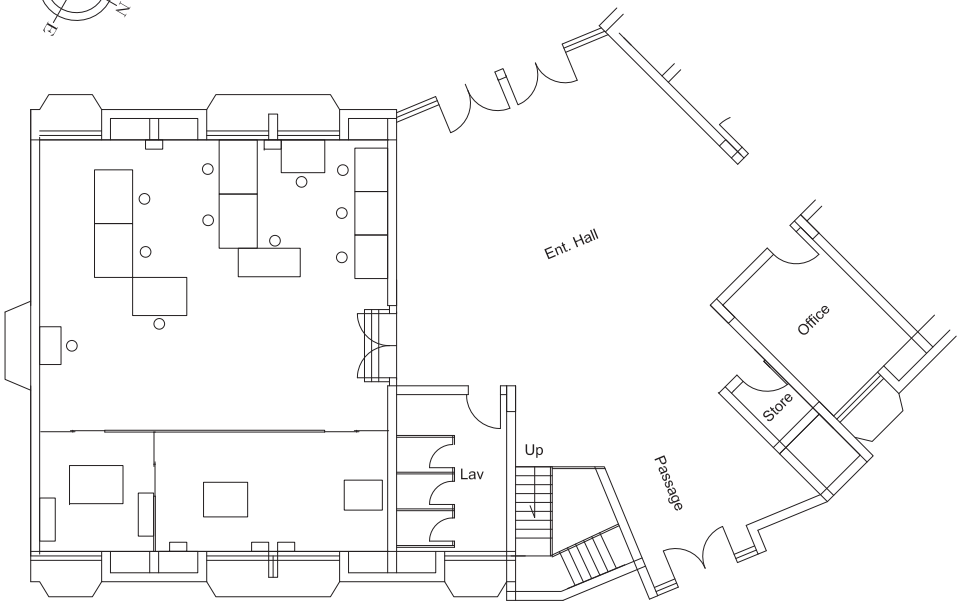
EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 13 | Transmitter |
| 14 | Antenna Controller & Dehydrator |
| 15 | DRSP |
| 16 | Data & Protocol Converter |
| 17 | Radar TASK Controller |
| 18 | Radar Power Maintenance Panel |

FURNITURE (CONSTRUCTION WORK)

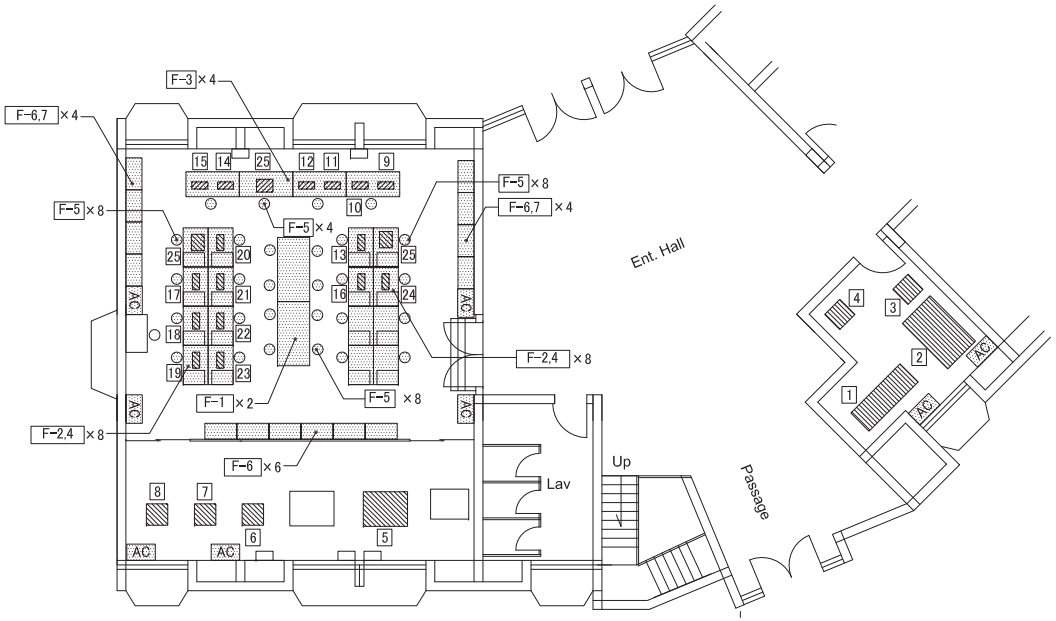
| | |
|---|---|
| F-2 | Pedestal-free Desk (W1,100 × D700) |
| F-4 | Drawer Unit with Casters |
| F-5 | Chair |
| F-8 | Shelves(Double Hinged Doors) H1,800 |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ISLAMABAD METEOROLOGICAL RADAR TOWER BUILDING<br>EQUIPMENT LAYOUT 3 | SCALE<br>1:100 | DRAWING No.<br>EQ - 03 |



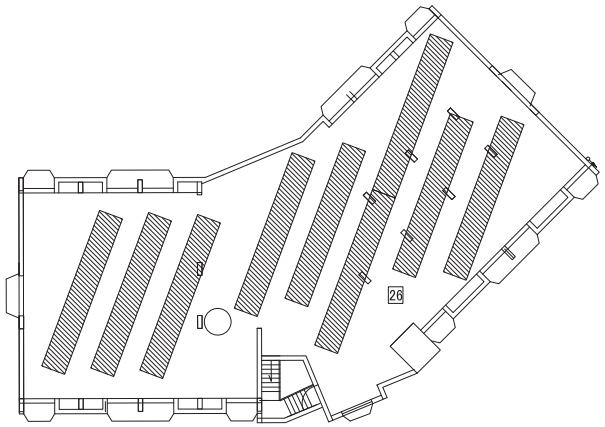

Existing Equipment and Furniture Layout Plan

GFL PLAN




Proposed Equipment and Furniture Layout Plan

GFL PLAN




Proposed Equipment Layout Plan

ROOF PLAN

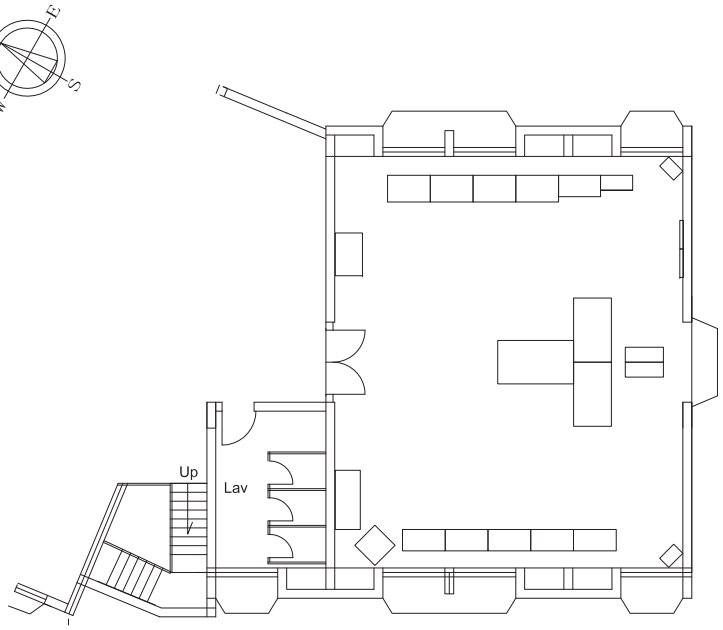
FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-1 | Meeting Table (W900 × L1,800) |
| F-2 | Pedestal Desk (W1,100 × D700) |
| F-3 | Pedestal Desk (W1,500 × 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)

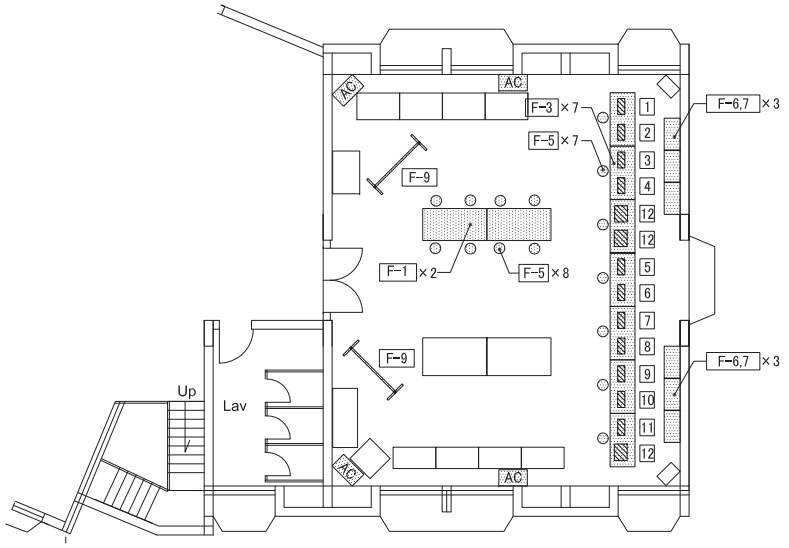
| | |
|---|---|
| 1 Power Supply Capacitor | 14 Computer Cluster Administrative Unit 1 |
| 2 Solar Power Controller | 15 Computer Cluster Administrative Unit 2 |
| 3 Isolation Transformer | 16 Meteorological Data Communication Network Management Unit |
| 4 Automatic Voltage Regulator | 17 Weather Guidance Processer (Temperature 1) |
| 5 Computer Cluster | 18 Weather Guidance Processer (Temperature 2) |
| 6 WIS Unit | 19 Weather Guidance Processer (Wind 1) |
| 7 Communication Equipment Rack | 20 Weather Guidance Processer (Wind 2) |
| 8 GTS Message Switch | 21 Weather Guidance Processer (Humidity 1) |
| 9 Control Unit 1 | 22 Weather Guidance Processer (Humidity 2) |
| 10 Control Unit 2 | 23 Weather Guidance Processer (Precipitation 1) |
| 11 Control Unit 3 | 24 Weather Guidance Processer (Precipitation 2) |
| 12 Control Unit 4 | 25 Colour Printer |
| 13 Data Ingestion & Storage Unit | 26 Solar Panel |
| | AC Air-Conditioning Indoor Unit |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD ISLAMABAD HEAD OFFICE<br>SPECIALIZED MEDIUM RANGE FORECASTING CENTER<br>EQUIPMENT LAYOUT 4 | SCALE<br>1:150<br>1:300 | DRAWING No.<br>EQ - 04 |



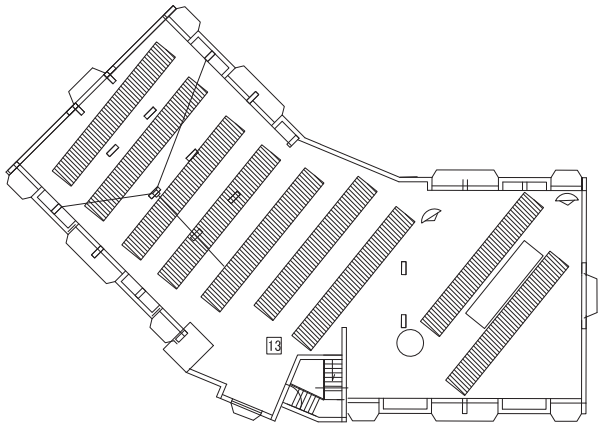

Existing Equipment and Furniture Layout Plan

1FL PLAN




Proposed Equipment and Furniture Layout Plan

1FL PLAN




Proposed Equipment Layout Plan

ROOF PLAN

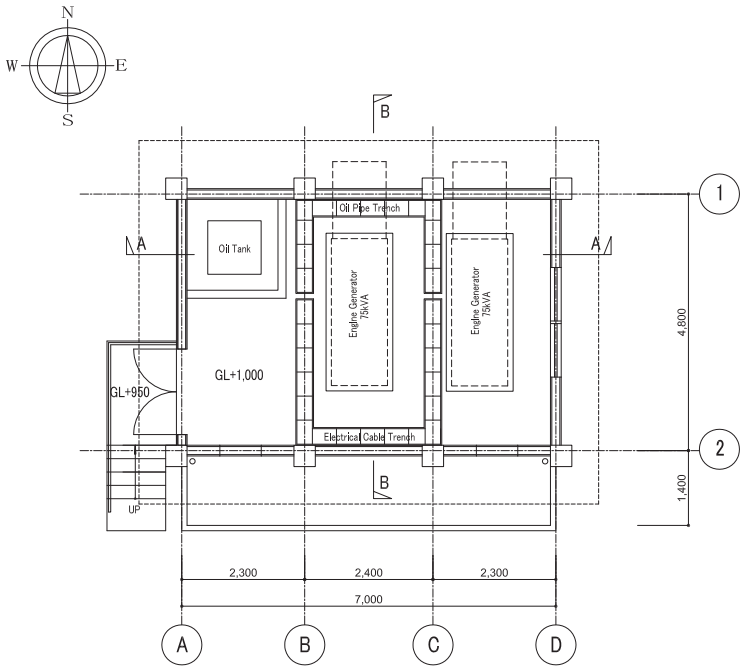
FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-1 | Meeting Table (W900 × L1,800) |
| F-3 | Pedestal Desk (W1,500 × D700) |
| F-5 | Chair |
| F-6 | Lateral Filling Cabinet H1,100 |
| F-7 | Cabinet (Double Hinged Doors) H1,000 |
| F-9 | White Board : W1,800 × H900 |

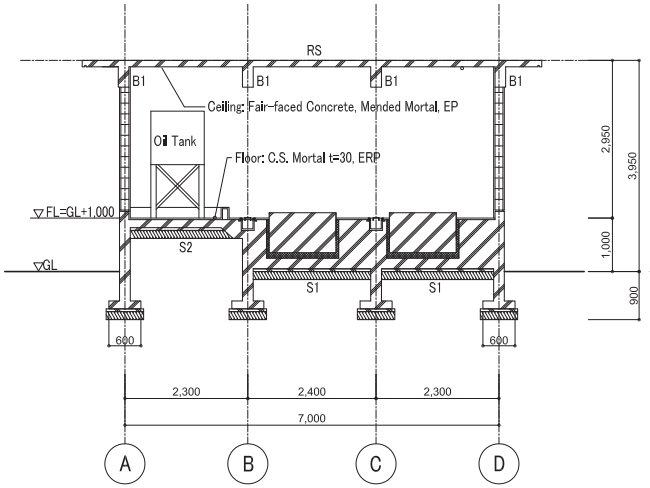
EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Data Analyzing Unit |
| 2 | Severe Storm and Doppler Velocity Indicator |
| 3 | Accumulated Rainfall Processor |
| 4 | Meteorological Product Display |
| 5 | Composite Processor |
| 6 | Meteorological Data Archiving Unit |
| 7 | Product Retrieval Unit |
| 8 | Doppler Velocity Indicator |
| 9 | Low Pressure Tracking Monitor |
| 10 | Wind Profiling Data Management Unit |
| 11 | Wind Profiling Data Processing Unit |
| 12 | Colour Printer |
| 13 | Solar Panel |
| AC | Air-Conditioning Indoor Unit |

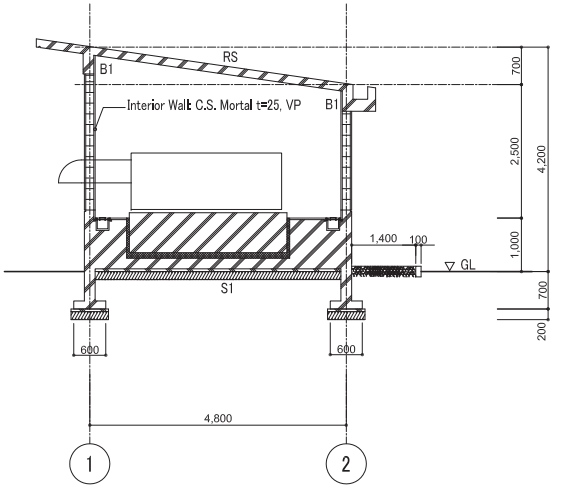
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD ISLAMABAD HEAD OFFICE<br>NATIONAL WEATHER FORECASTING CENTER<br>EQUIPMENT LAYOUT 5 | SCALE<br>1:150<br>1:300 | DRAWING No.<br>EQ - 05 |



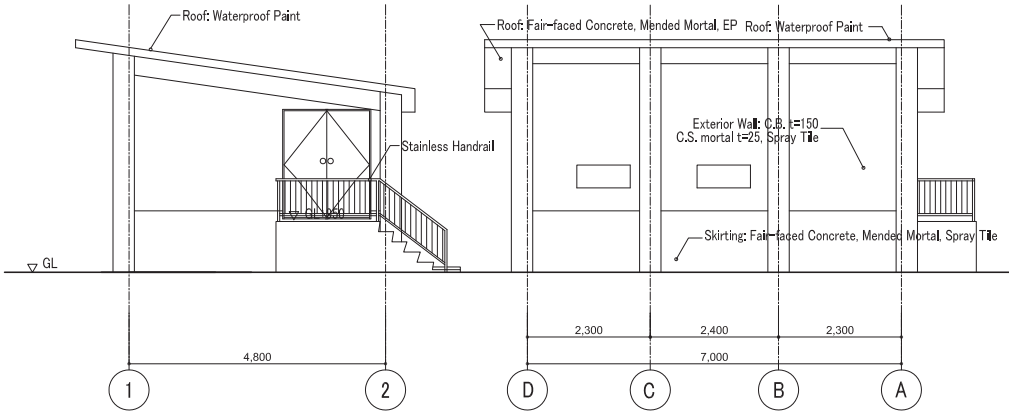

FLOOR PLAN SCALE 1:100




SECTION A-A SCALE 1:100



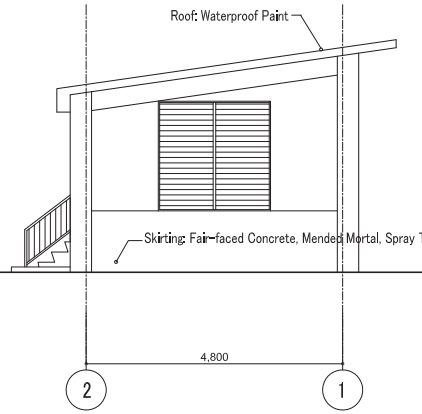

SECTION B-B SCALE 1:100



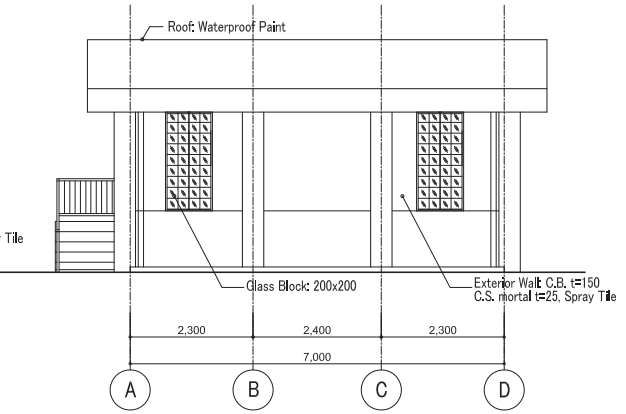

WEST ELEVATION SCALE 1:100




NORTH ELEVATION SCALE 1:100

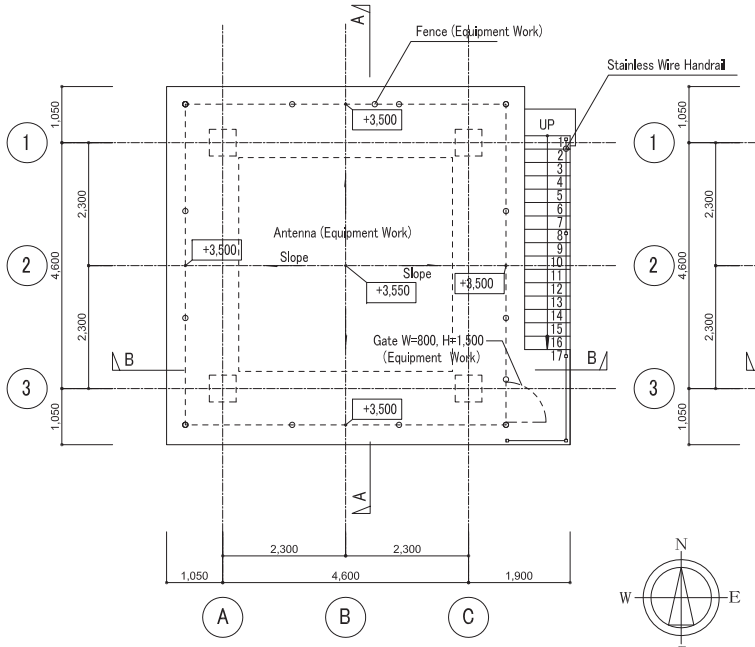



EAST ELEVATION SCALE 1:100

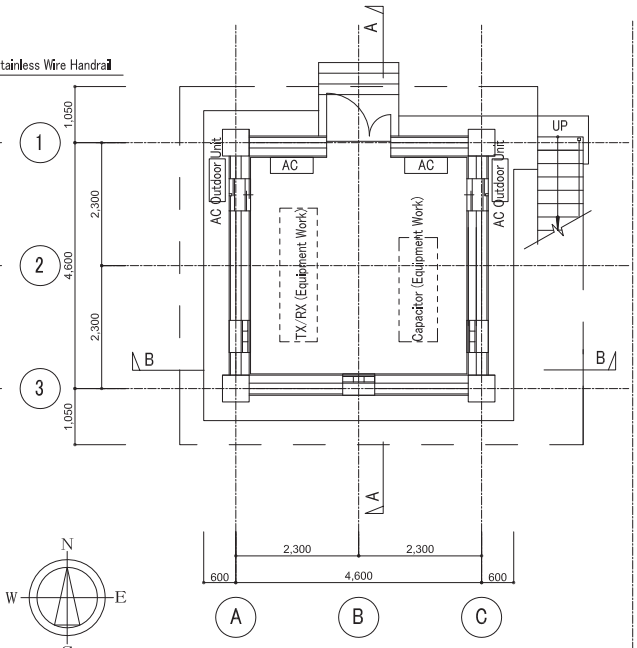



SOUTH ELEVATION SCALE 1:100

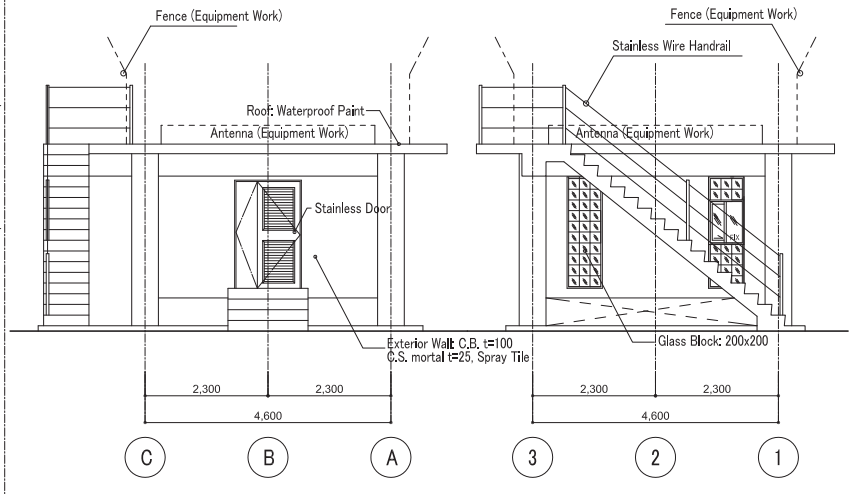
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ANCILLARY FACILITY IN PMD ISLAMABAD HEAD OFFICE<br>POWER BACK-UP SHED | SCALE<br>1:100 | DRAWING No.<br>EQ - 06 |




ROOF FLOOR PLAN SCALE 1:100



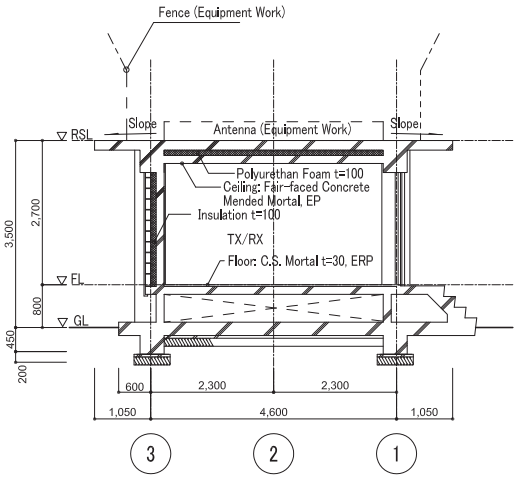

FLOOR PLAN SCALE 1:100



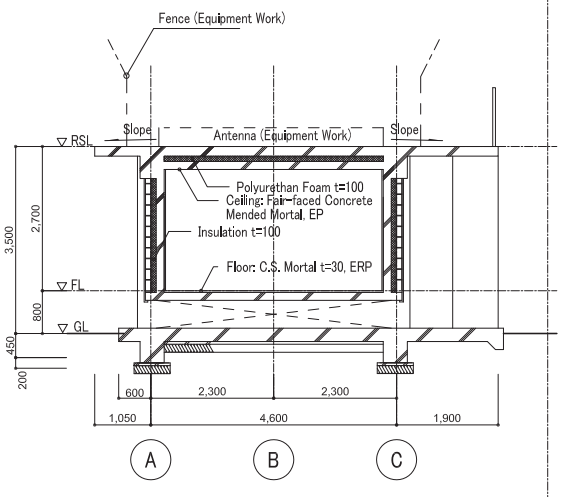

NORTH ELEVATION SCALE 1:100



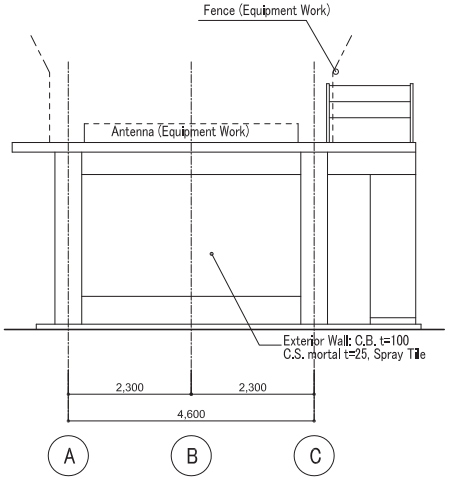

EAST ELEVATION SCALE 1:100



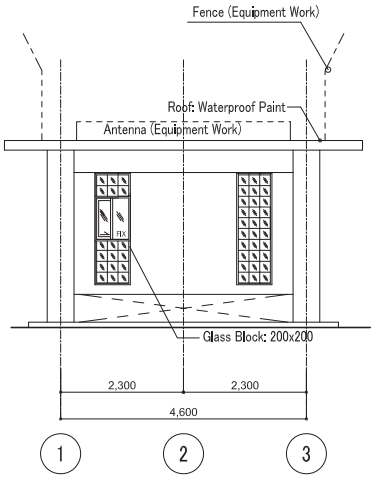

SECTION A-A SCALE 1:100




SECTION B-B SCALE 1:100

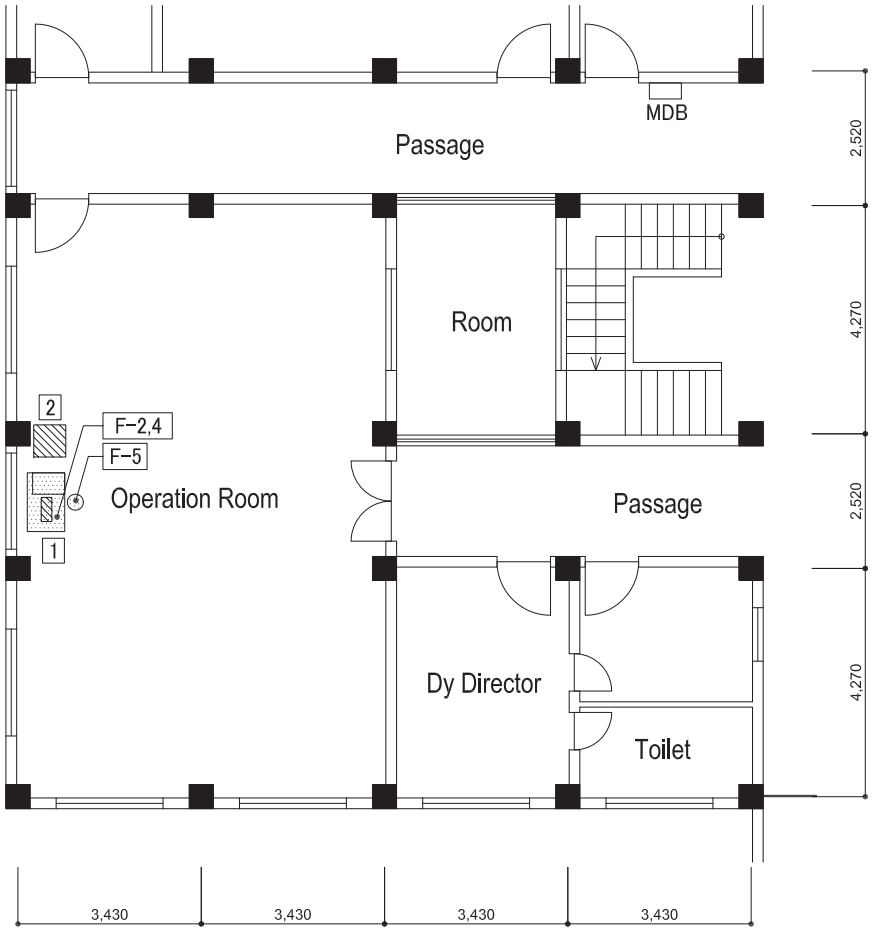



SOUTH ELEVATION SCALE 1:100




WEST ELEVATION SCALE 1:100

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ANCILLARY FACILITY IN PMD ISLAMABAD HEAD OFFICE<br>WIND PROFILER ANTENNA FOUNDATION AND CONCRETE SHELTER | SCALE<br>1:100 | DRAWING No.<br>EQ - 07 |



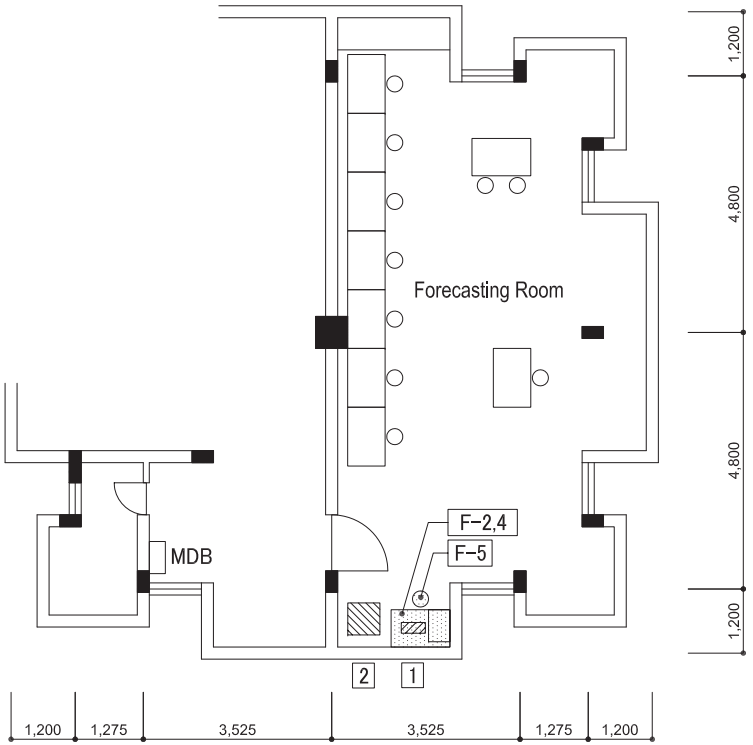

EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Weather Bulletin Receiving Terminal |
| 2 | Hybrid Power Manager/Uninterruptible Power Unit |

FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-2 | Pedestal Desk (W1100 × D700) |
| F-4 | Drawer Unit with Casters |
| F-5 | Chair |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD LAHORE REGIONAL METEOROLOGICAL CENTER<br>EQUIPMENT LAYOUT 6 | SCALE<br>1:100 | DRAWING No.<br>EQ - 08 |



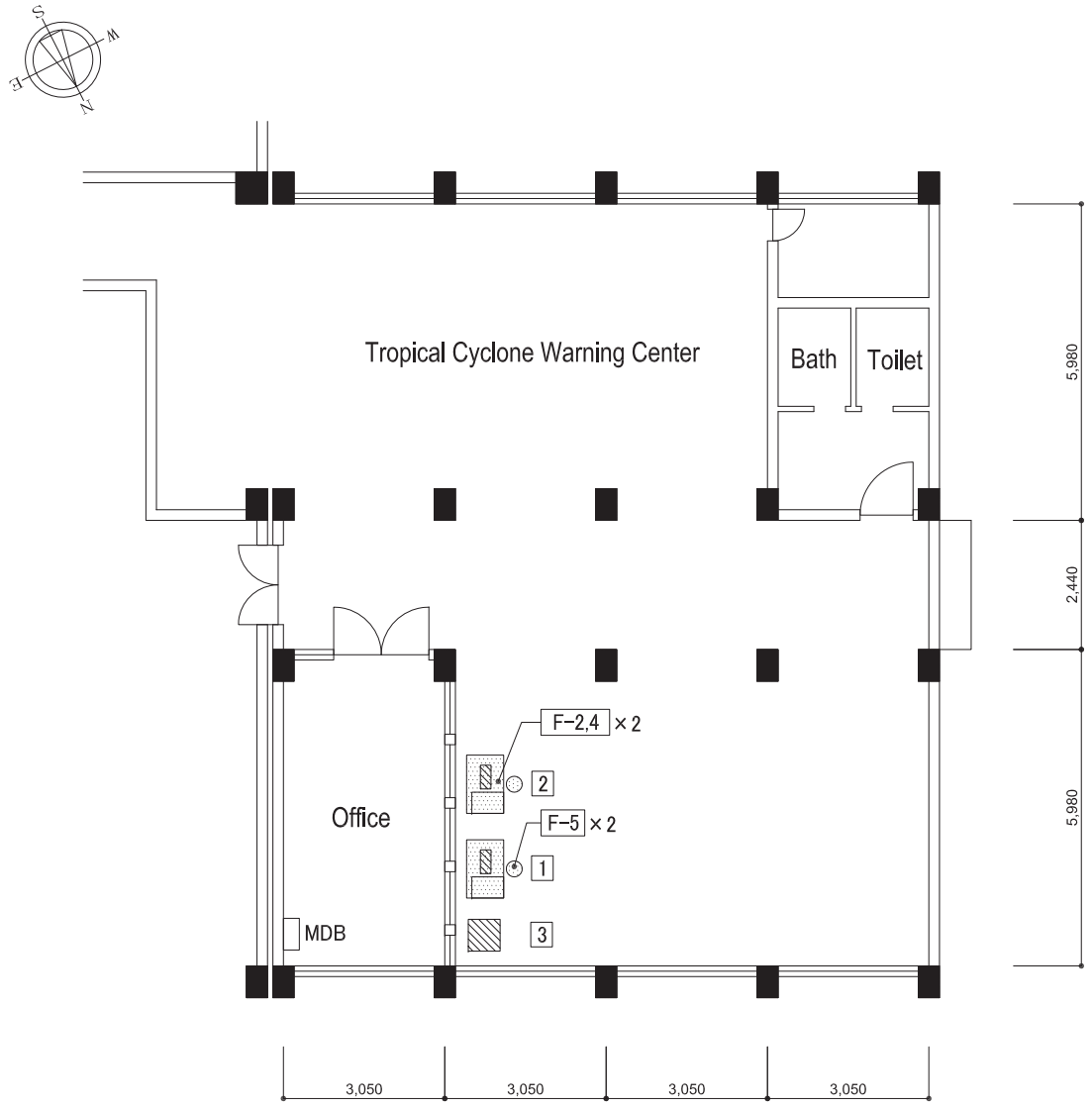

EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Weather Bulletin Receiving Terminal |
| 2 | Hybrid Power Manager/Uninterruptible Power Unit |

FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-2 | Pedestal Desk (W1100 × D700) |
| F-4 | Drawer Unit with Casters |
| F-5 | Chair |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD LAHORE FLOOD FORECASTING DIVISION<br>EQUIPMENT LAYOUT 7 | SCALE<br>1:100 | DRAWING No.<br>EQ - 09 |



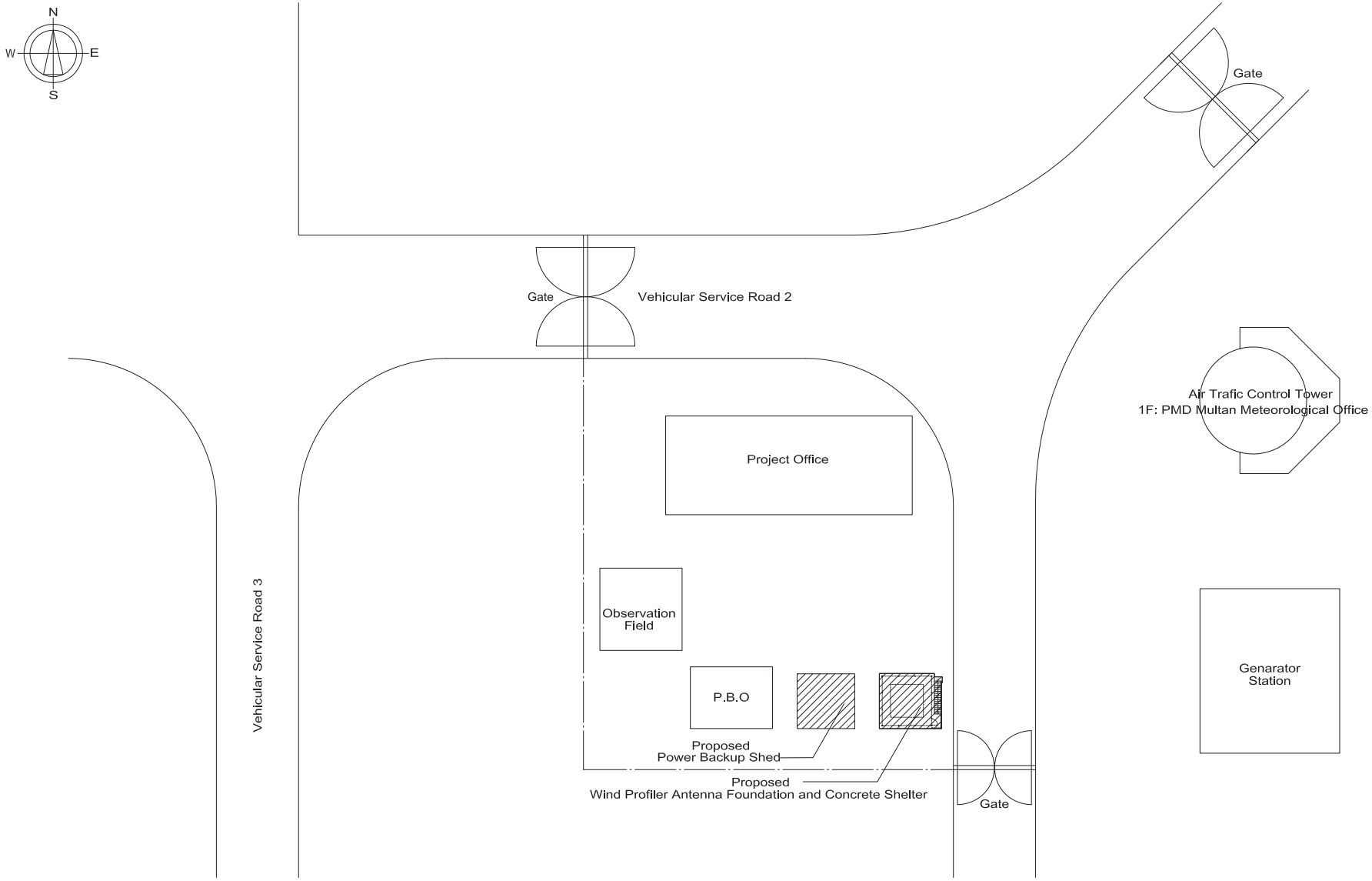

EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Weather Bulletin Receiving Terminal |
| 2 | Data Input Unit |
| 3 | Hybrid Power Manager/Uninterruptible Power Unit |

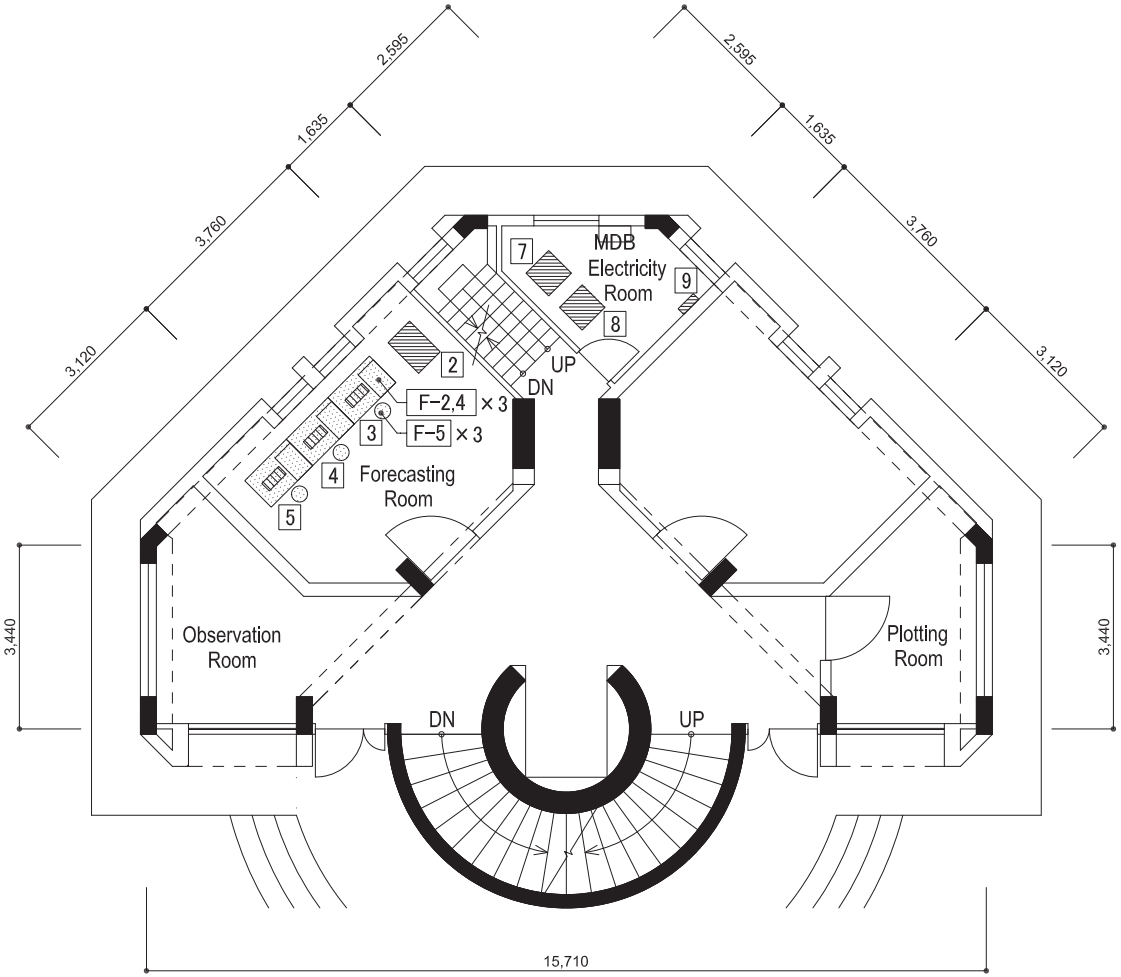
FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-2 | Pedestal Desk (W1100 × D700) |
| F-4 | Drawer Unit with Casters |
| F-5 | Chair |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD KARACHI TROPICAL CYCLONE WARNING CENTER<br>EQUIPMENT LAYOUT 8 | SCALE<br>1:100 | DRAWING No.<br>EQ - 10 |




| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD MULTAN METEOROLOGICAL OFFICE<br>SITE PLAN | SCALE<br>1:500 | DRAWING No.<br>EQ - 11 |



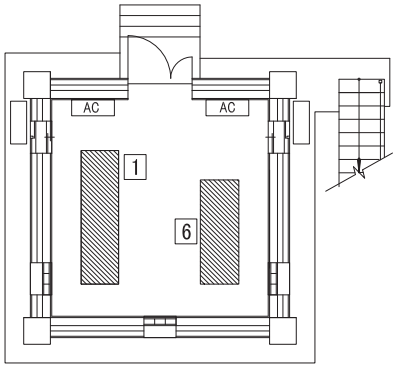

AIRPORT CONTROL TOWER

EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Tramsmitter / Receiver |
| 2 | Wind Profiling Signal Processing Unit |
| 3 | Wind Profiling Data Processing Unit |
| 4 | Weather Bulletin Receiving Terminal |
| 5 | Colour Printer |
| 6 | Power Supply Capacitor |
| 7 | Isolation Transformer |
| 8 | Automatic Voltage Regulator |
| 9 | Solar Power Controller |

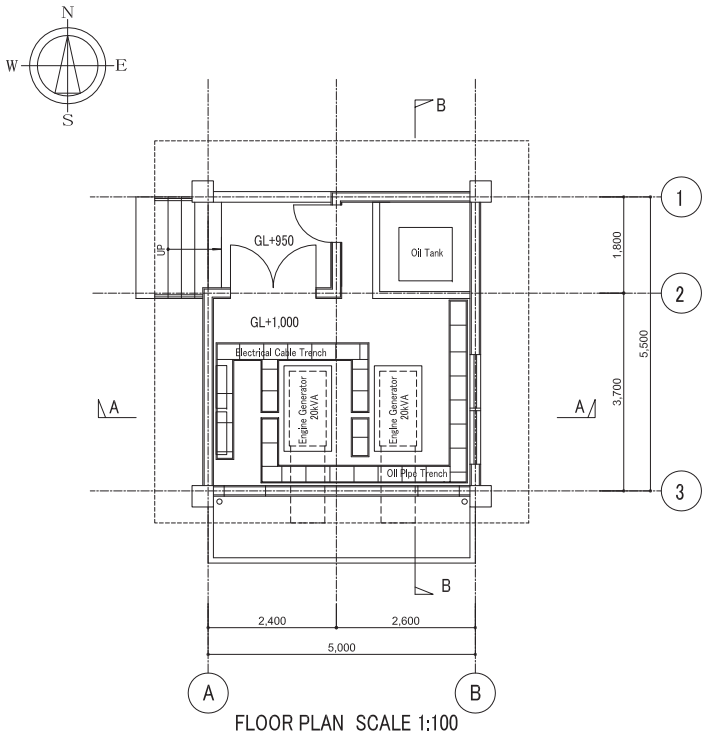
FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-2 | Pedestal Desk (W1100 × D700) |
| F-4 | Drawer Unit with Casters |
| F-5 | Chair |

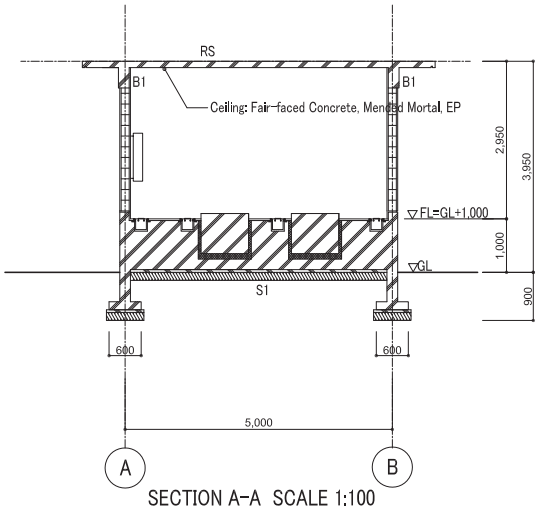



WIND PROFILER CONCRETE SHELTER

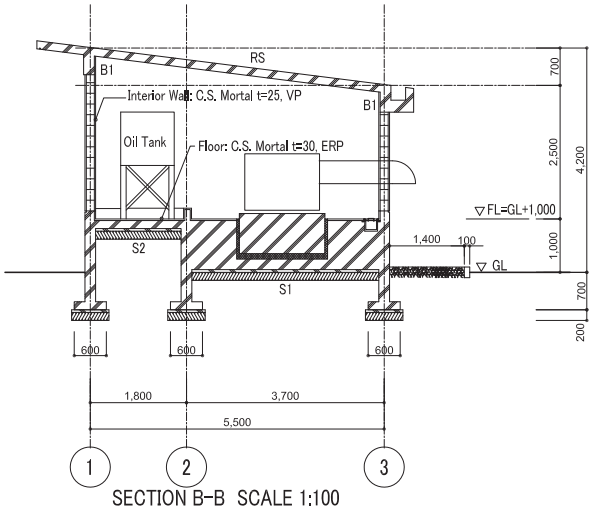
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD MULTAN METEOROLOGICAL OFFICE<br>EQUIPMENT LAYOUT 9 | SCALE<br>1:100 | DRAWING No.<br>EQ - 12 |



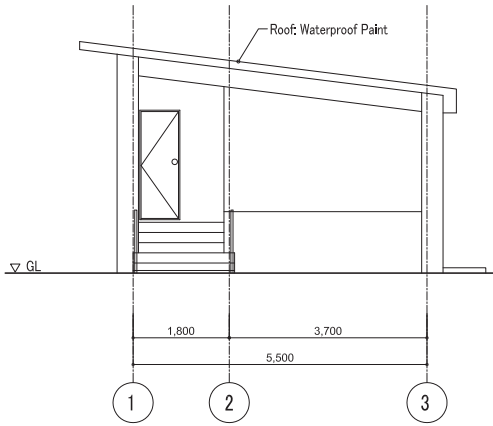

FLOOR PLAN SCALE 1:100



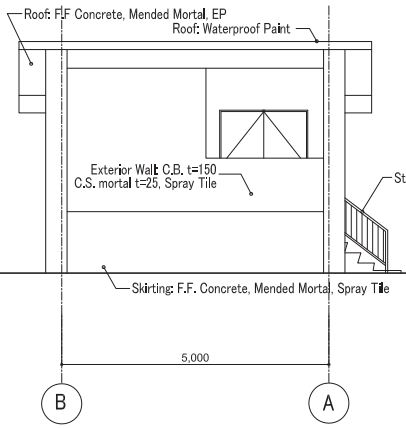

SECTION A-A SCALE 1:100



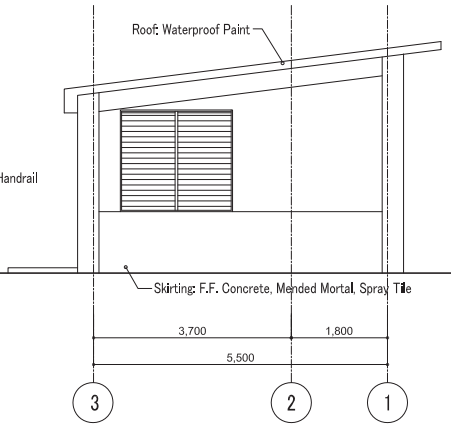

SECTION B-B SCALE 1:100



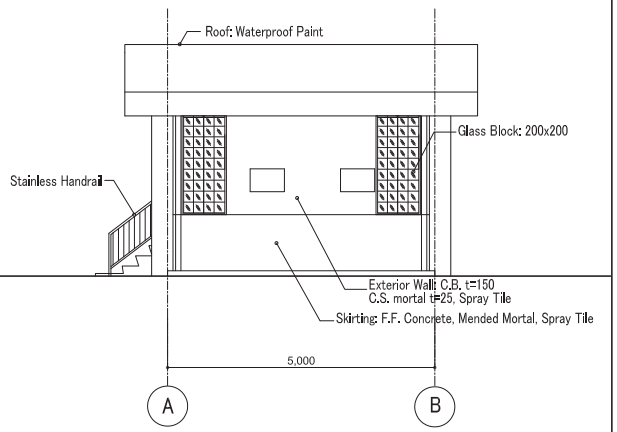

WEST ELEVATION SCALE 1:100




NORTH ELEVATION SCALE 1:100

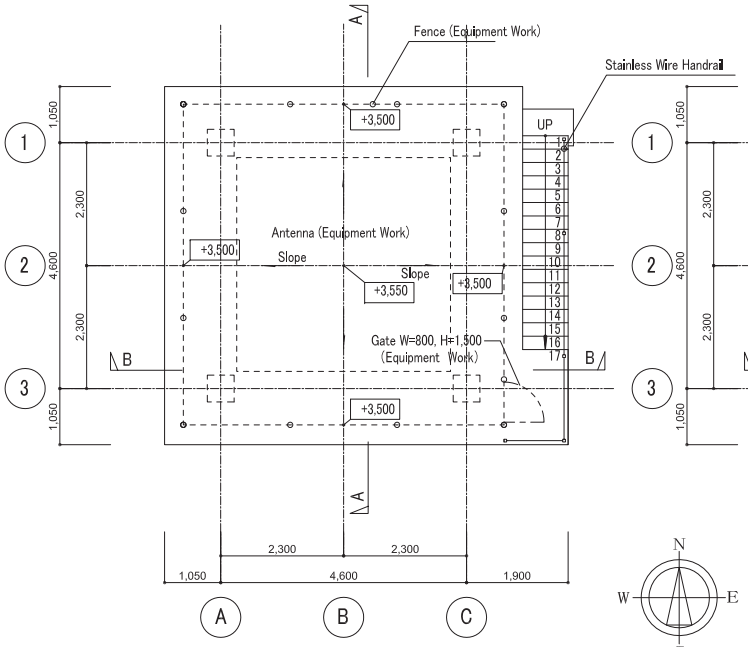



EAST ELEVATION SCALE 1:100

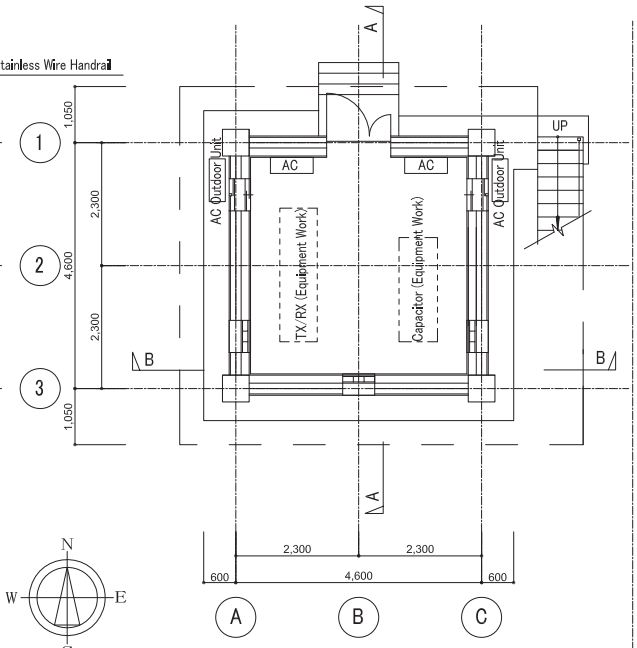



SOUTH ELEVATION SCALE 1:100

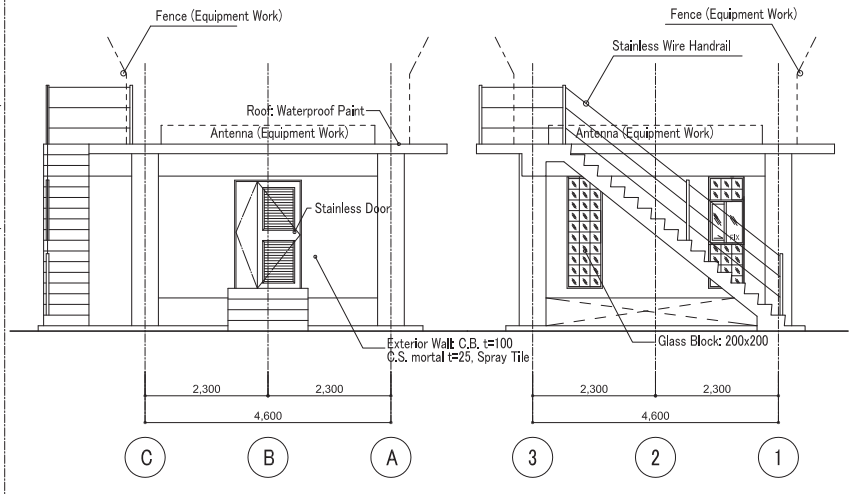
| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ANCILLARY FACILITY IN PMD MULTAN METEOROLOGICAL OFFICE<br>POWER BACK-UP SHED | SCALE<br>1:100 | DRAWING No.<br>EQ - 13 |




ROOF FLOOR PLAN SCALE 1:100



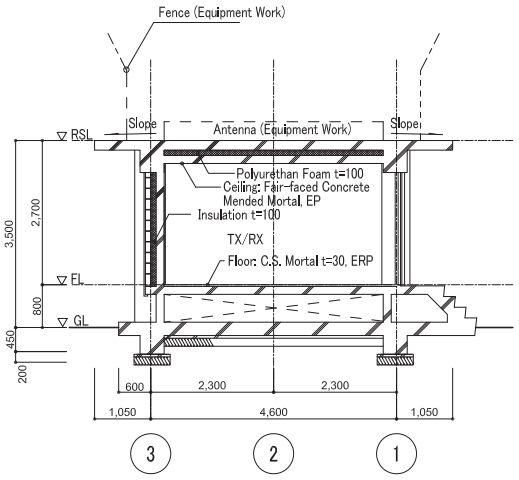

FLOOR PLAN SCALE 1:100



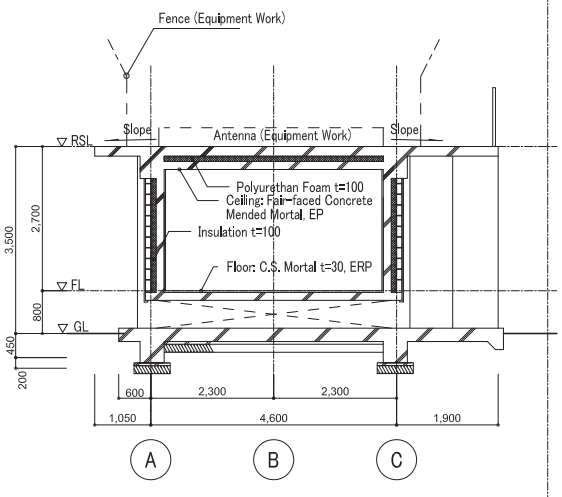

NORTH ELEVATION SCALE 1:100



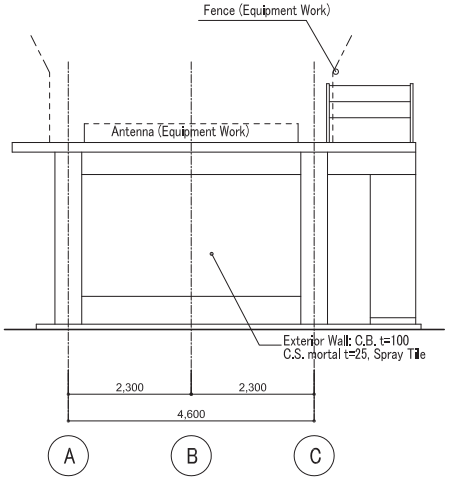

EAST ELEVATION SCALE 1:100



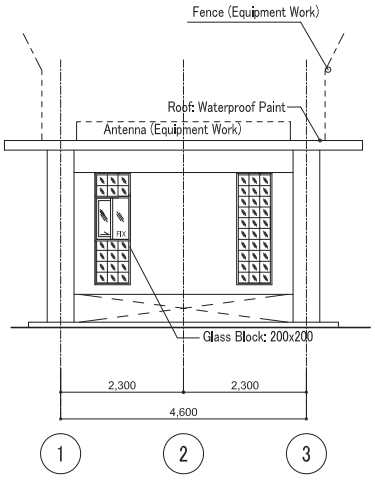

SECTION A-A SCALE 1:100




SECTION B-B SCALE 1:100

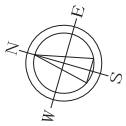


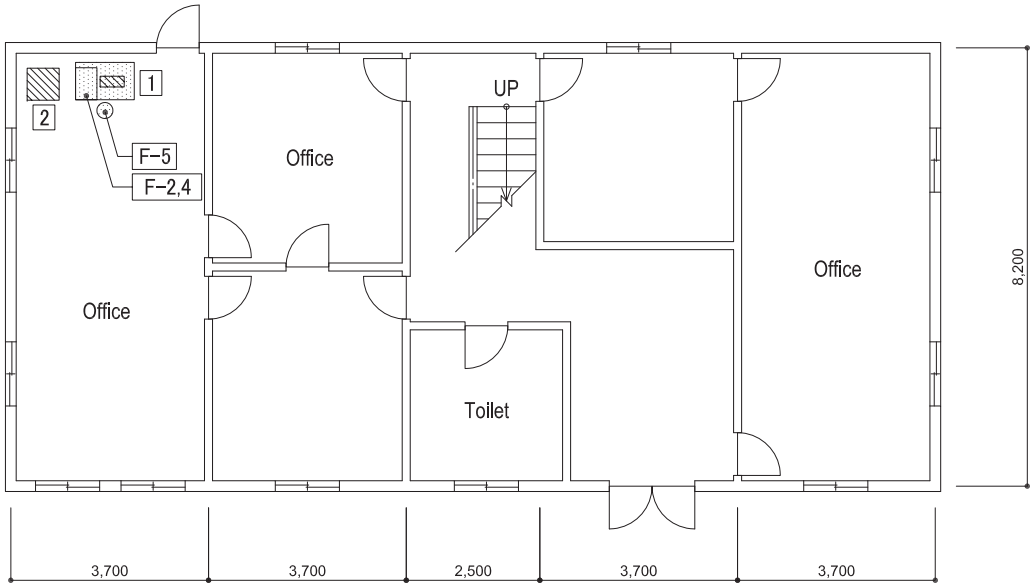

SOUTH ELEVATION SCALE 1:100




WEST ELEVATION SCALE 1:100

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>ANCILLARY FACILITY IN PMD MULTAN METEOROLOGICAL OFFICE<br>WIND PROFILER ANTENNA FOUNDATION AND CONCRETE SHELTER | SCALE<br>1:100 | DRAWING No.<br>EQ - 14 |




EQUIPMENT (EQUIPMENT WORK)

| | |
|---|---|
| 1 | Weather Bulletin Receiving Terminal |
| 2 | Hybrid Power Manager/Uninterruptible Power Unit |

FURNITURE (CONSTRUCTION WORK)

| | |
|---|---|
| F-2 | Pedestal Desk (W1100 × D700) |
| F-4 | Drawer Unit with Casters |
| F-5 | Chair |

| | | | | |
|---|---|---|---|---|
| CONSORTIUM OF<br>INTERNATIONAL METEOROLOGICAL CONSULTANT INC. (IMC),<br>JAPAN WEATHER ASSOCIATION (JWA) AND<br>CTI ENGINEERING INTERNATIONAL CO., LTD. (CTII) | THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM IN THE ISLAMIC REPUBLIC OF PAKISTAN | DRAWING TITLE<br>PMD GILGIT METEOROLOGICAL OFFICE<br>EQUIPMENT LAYOUT 10 | SCALE<br>1:100 | DRAWING No.<br>EQ - 15 |

## 2-2-4 Implementation Plan

### 2-2-4-1 Implementation Policy

The Project covers many fields, including procurement and installation of meteorological and communication equipment, construction work, etc. For the successful completion of the Project, close coordination will be required among all parties.

1) Implementing agency for the Project

The responsible government agency of Pakistan for the implementation of the Project is the PMD under the supervision of the Secretary Aviation Division, Cabinet Secretariat. The PMD, 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 Pakistan and the Government of Japan and the Grant Agreement (G/A) between the Government of the Pakistan 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 PMD and a Japanese consulting firm having its principal office in Japan and recommended by the 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 Pakistan with the PMD and prepare tender documents including technical specifications, drawings, diagrams, etc. in Japan. In addition, the Consultant, instead of the PMD, will conduct a tender and supervise the Project implementation for the successful completion of the Project as a project 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 PMD.

### 2-2-4-2 Implementation Conditions

< Conditions for the Installation of the Equipment >

The meteorological radar system, computing equipment and other sophisticated equipment with electric and electronic circuits will be installed in the radar tower building. 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 (auto voltage regulator: 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 PMD staff, specialized highly skilled engineers are required as on-the-job trainers to ensure that the PMD 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 Pakistani side for the implementation of the Project are as follows.

Table49: Major Undertakings to be done by the PMD under Implementation of the Project

| No | Items | To be covered by Japan's Grant Aid | To be covered by Pakistan (PMD) |
|---|---|---|---|
| | General Items | | |
| 1 | To undertake all necessary institutional and juridical procedures in Pakistan. | | ● |
| 2 | To undertake the Environmental Impact Assessment procedures in Pakistan, if required. | | ● |
| 3 | To handle duty (Tax) exemption procedures and to take necessary measures as well as provide requisite legal and/or administrative documentations for customs clearance to customs broker/forwarder to be employed by Contractor 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 PMD Islamabad 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 Pakistan 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 Pakistan and stay therein for the smooth and uninterrupted performance of their work (i.e. to secure the appropriate Visa including its extension/s required by the recipient country in connection thereof). | | ● |
| 8 | To exempt Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the 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 sites for temporary facilities such as a contractor's office, workshop, building materials storage, etc. needed for the construction work. | | ● |
| 14 | To demolish the existing building in premises of the PMD Islamabad Head Office in order to secure and allocate ample space for the construction of a new Radar Tower Building. | | ● |
| 15 | To obtain necessary permissions for the construction of the Radar Tower Building in the PMD Islamabad Head Office. | | ● |
| 16 | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) for the Radar Tower Building in the PMD Islamabad Head Office. | | ● |
| 17 | To install the required step-down transformers as well as service entrance connections for the commercial power supply at the PMD Islamabad Head Office for the Radar Tower Building. | | ● |
| 18 | To provide incidental facilities, such as water supply, telephone lines and internet provision, for the Radar Tower Building in the PMD Islamabad Head Office. | | ● |
| 19 | To provide temporary facilities for the availability or accessibility of electricity, water, etc. for the construction work. | | ● |
| 20 | To construct the Radar Tower Building, including<br>a) Architectural and civil works<br>b) Electrical works including a lightning protection system<br>c) Air-conditioning and Ventilation works<br>d) Plumbing works | ● | |
| 21 | To procure and install standard furniture for the Radar Tower Building | ● | |
| 22 | To undertake incidental outdoor works such as gardening, fencing, constructing gates, boundary walls and exterior lighting in and around the sites, if necessary. | | ● |
| 23 | To provide On-the-job Trainings (Initial Trainings) by the contractor on the operation and maintenance of the Radar Tower Building as well as its inherent facilities for the PMD. | ● | |
| 24 | To shoulder dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any. | | ● |
| 25 | To provide the contractor's written guarantee to the PMD for the Radar Tower Building 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 provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) for Specialized Medium Range Weather Forecasting | | ● |

| | | | |
|---|---|---|---|
| | Center (SMRFC) in the PMD Islamabad Head Office. | | |
| 29 | To provide reliable and high-speed Internet environment at the Specialized Medium Range Weather Forecasting Center (SMRFC) and each Project site for establishment of a Virtual Private Network (VPN). | | ● |
| 30 | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply for the wind profiler system in the PMD Islamabad Head Office and the PMD Multan Meteorological Office. | | ● |
| 31 | To obtain the required frequency(s) for the meteorological radar system and the wind profiler system(s). | | ● |
| 32 | To set up new assigned IP addresses under the Project in the existing computing equipment in the Specialized Medium Range Weather Forecasting Center (SMRFC). | | ● |
| 33 | To migrate the PMD's own data to the computing equipment to be procured under the Project, if necessary. | | ● |
| 34 | To install software(s) procured/to be procured by the PMD on the computing equipment to be procured under the Project, if required. | | ● |
| 35 | To secure ample and strategically located space/s at the existing facilities for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project. | | ● |
| 36 | To procure, install and adjust the required Equipment (including the lightning protection system) for the Project implementation. | ● | |
| 37 | To procure and install furniture for the Equipment to be procured under the Project. | ● | |
| 38 | To conduct the commissioning for the total system. | ● | |
| 39 | To shift and adjust the existing computing equipment, if required. | | ● |
| 40 | To provide On-the-job Trainings (Initial Trainings) by the contractor on the operation and maintenance of the Equipment for the PMD. | ● | |
| 41 | To shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any. | | ● |
| 42 | To provide the contractor's written guarantee to the PMD 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 | | |
| 43 | To renovate the existing gates, boundary walls and exterior lighting in and around the sites, if required. | | ● |
| 44 | To assign staff necessary for the smooth operation and maintenance of the Equipment. | | ● |
| 45 | To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment. | | ● |
| 46 | To provide adequate maintenance of the Radar Tower Building constructed under the Project so that they can function effectively. | | ● |
| 47 | To operate and maintain, and properly and effectively utilize the facilities constructed and the Equipment procured under the Project. | | ● |
| 48 | To allocate the necessary budget and personnel for the appropriate conduct of meteorological radar observation and forecasting works. | | ● |
| 49 | To periodically update all the operation/antivirus/application software. | | ● |

### 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 PMD and the contractor.
d) To ensure the safety of project implementation as its top priority through the earlier/advance detection of severe weather phenomena.

2) Consultant Supervision

a) The Consultant will dispatch at least one responsible and highly capable personnel to Pakistan during each implementation stage of the Project.
b) Consultant technical specialists will be dispatched to Pakistan for installation guidance, inspection work, and 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 and instead of the PMD.
d) Qualified engineer(s) will be dispatched for data transmission tests in Pakistan.

3) Scope of Work for Supervision

a) The Consultant, in coordination with the PMD, will prepare the contract in accordance with JICA standards; select a Japanese primary contractor through tendering; and recommend the nominated contractor to the Government of Pakistan.
b) The Consultant will inspect and approve shop-drawings, system drawings & the diagrams and material samples submitted by the contractor, and verify the performance and function of all the 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 PMD, the Embassy of Japan in Pakistan, the JICA Pakistan 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 the implementation costs 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 from the PMD Head Office in Islamabad, the temperature could reach up to more than 30°C. In this regard, the ambient and concrete temperatures 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.

Table50: Quality Control Plan

| Work | Work Type | Control Item | Method | Remarks |
|---|---|---|---|---|
| Structural Work | Concrete work | Fresh concrete<br>Concrete strength | Slump, air volume, temperature<br>Comprehensive strength test<br>Chloride Quantity Test<br>Alkali Aggregate Reactivity Test | Concrete strength test will be conducted at a public test institution.<br>Chloride quantity test and alkali aggregate reactivity test will be conducted in Japan (a test institute is not available in Pakistan). |
| | Reinforcing work | Reinforcing bar<br>Arrangement | Tensile test, mill sheet check<br>Bar arrangement check<br>Factory inspection sheet check | Tensile test of reinforcing bar will be conducted by a private laboratory. |
| | 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,<br>Installation accuracy | Factory inspection sheet check<br>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 Pakistan 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 Pakistan. 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 Pakistan 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 Pakistan. Some construction materials imported from the Association of Southeast Asian Nations (ASEAN) are marketed throughout Pakistan. As these imported materials can be easily procured locally, they are considered as locally procurable products. In order to ensure the easy maintenance of the radar tower building, locally available materials will be utilized for its construction.

2) Procurement Plan of Construction Materials

[1] Structural Work

An ordinary portland cement packed in a 50kg bag, which is also locally manufactured, can be procured.

Concrete coarse aggregate can be obtained from quarries located in Margalla hills in the suburbs of Islamabad and fine arrogate can be obtained from quarries located in the Attock District. The main materials for the structural works, such as fresh concrete, plywood for form works, and 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, and etc. used for the exterior and interior of a building are imported and, as such, are readily available in the local market. For the proposed buildings, airtight aluminum and steel doors & windows, treated for salt-corrosion, are required.

[3] Air-Conditioning and Plumbing Work

Imported air-conditioning equipment, exhaust fans, sanitary-fixtures, and etc. are popular in Pakistan. As a result, those products can be procured in the local market and will be used with a view to ease repair and maintenance. Large air-conditioning units and exhaust fans are also available in the local market.

[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 be procured in Pakistan for the convenience of repair and maintenance. Custom-made building equipment such as control panels, power distribution boards and switch boards imported from ASEAN countries can also be procured in the local market.

Table51: Major Materials Procurement Plan (Architectural Work)

| Materials | Local Market | | Procurement Plan | | |
|---|---|---|---|---|---|
| | Condition | Import | Pakistan | 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 (general type) | ○ | | ○ | | |
| 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 Pakistan
△ : Available in the local market in Pakistan but model and quantity are limited
× : Difficult to procure in Pakistan

Table52: Major Materials Procurement Plan (Mechanical and Electrical Work)

| Work type | Materials | Local Market | | Procurement Plan | | |
|---|---|---|---|---|---|---|
| | | Condition | Import | Pakistan | Third Country | Japan |
| Air-conditioning work | Air conditioner | △ | | ○ | | |
| | Heat exchanger | △ | | ○ | | |
| | 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 | △ | | ○ | | |
| | Wire, cable | ○ | | ○ | | |
| | Conduit (PVC) | ○ | | ○ | | |
| | Conduit (Steel) | ○ | | ○ | | |
| | Cable-rack | ○ | | ○ | | |
| | Telephone system | △ | | ○ | | |
| | Isolation Transformer | △ | Japan | | | ○ |
| | AVR | △ | Japan | | | ○ |
| | Fire alarm system | ○ | | ○ | | |
| | Diesel engine generator | ○ | | ○ | | |
| | Lightning protection | ○ | | ○ | | |

○ : Easy to procure in Pakistan
△ : Available in the local market in Pakistan but model and quantity are limited
× : Difficult to procure in Pakistan

3) Transportation Plan

The equipment shipped from overseas to Pakistan is to be unloaded at the Karachi Port, a main port in Pakistan, and then transported to each Project site by land. The required number of days and the schedule of vessels from major international ports to the Karachi Port are indicated in the following table.

Table53: Scheduled Vessels to the Karachi Port

| Country | Name of Port | Schedule | Number of Days |
|---|---|---|---|
| Japan | Yokohama, Tokyo, Nagoya, Kobe | 6 ships/week | Approx. 30days |
| Australia | Sydney | 1 ship/week | Approx. 40days |
| EU Countries | Antwerp, Rotterdam, Hamburg, etc. | 2 ships/week | Approx. 40days |
| United States of America | East Coast (New York) | 1 ship/week | Approx. 22days |
| | West Coast (Long Beach) | 2 ships/week | Approx. 48days |

＜Import and Duty Exemption Procedures＞

For the import of equipment from overseas, two-stage procedures indicated in the table below are required. For the acquisition of the Tax Exemption Certificate for the Imported Goods, approximately one month is required to process it after the submission of the required documents to the Federal Board of Revenue (FBR). It is important that the required procedures must be commenced as soon as possible.

Table54: Required Procedures for Tax Exemption and Custom Clearance

| Required Procedures | Office Concerned | Submission Time | Required Period | Required Documents to be submitted by Pakistan Meteorological Department (PMD) | Applicant |
|---|---|---|---|---|---|
| Tax Exemption Certificate for the Imported Goods | Federal Board of Revenue (FBR) | Immediately after the signing of the Exchange of Notes | 1 month | Exchange of Notes: 1 photocopy | PMD |
| Custom Clearance | Custom Office | Immediately after a shipment's arrival at a port | 10 days | Shipping Documents<br>· Shipping Invoice: 1 original<br>· Bill of Lading: 1 original<br>· Packing List: 1 original<br>Tax Exemption Certificate issued by FBR: 1 photocopy | |

<Inland Transport>

The equipment unloaded at the Karachi Port is to be transported to the Project sites in Multan and Islamabad via a container-trailer. The longest road is approximately 1,800km which requires 4-5 days to traverse. While the road condition is not so bad, the equipment must be kept in a locked container from Karachi to Multan since there is a high risk of theft during transportation. In some sections of the country, countermeasures for safe transportation of the equipment, such as avoidance of night driving, may be required. For the Meteorological Data Trunk Communication Systems, they are to be transported to Islamabad once for connection and operation check through the use of local communication lines before they are brought to each Project site in Gilgit, Lahore, Multan and Karachi respectively through a domestic courier company.

Figure12: Inland Transport Route

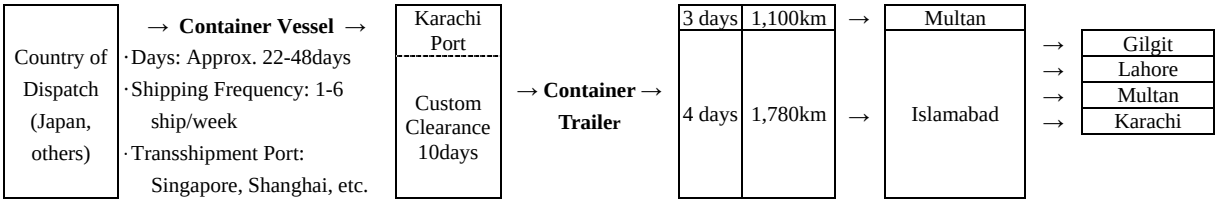



Figure13: Transportation Period to Project Site

### 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 PMD. 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.

Table55: Operation and Maintenance Training (OJT)

| Component | Islamabad | | Lahore | | Karachi | Multan | Gilgit |
|---|---|---|---|---|---|---|---|
| | PMD Islamabad Head Office | Meteorological Office in New Benazir Bhutto International Airport (NBBIA) | PMD Lahore Regional Meteorological Center | PMD Lahore Flood Forecasting Division | PMD Karachi Tropical Cyclone Warning Center | PMD Multan Meteorological Office | PMD Gilgit Meteorological Office |
| SMRFC (Specialized Medium Range Weather Forecasting Center) Weather Forecasting & Development System<br>• Computer Cluster<br>• Operation Console Unit<br>• Computer Network Unit<br>• Power Back-up Equipment<br>• Software | ○ | - | - | - | - | - | - |
| Meteorological Data Trunk Communication System<br>• Computer Network Equipment<br>• Software | ○ | - | ○ | ○ | ○ | ○ | ○ |
| GTS Message Switch System<br>• Computer Network Equipment<br>• Software | ○ | - | - | - | - | - | - |
| S-Band Doppler Pulse Compression Solid State Radar System<br>• Power Supply Unit<br>• Antenna<br>• Radar Unit<br>• Meteorological Radar Transmission Unit<br>• Computer Network Unit<br>• Power Back-up Equipment<br>• Software | ○ | - | - | - | - | - | - |
| Meteorological Radar Data Display System<br>• Power Unit | ○ | ○ | - | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| • Computer Network Unit<br>• Software | | | | | | | |
| Wind Profiler System<br>• Power Supply Unit<br>• Antenna<br>• Radar Unit<br>• Data Transmitting Equipment<br>• Computer Network Equipment<br>• Software | ○ | - | - | - | - | ○ | - |

Apart from the Operation and Maintenance Training (OJT), technology transfer through practical installation and adjustment works to be carried out by the PMD 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 PMD staff themselves is important to have further familiarization and technical knowledge. In case of a down in the system, disassembling the system and software reinstallation by the PMD staff may be required. Therefore, all the significant parts of technology transfer must be completed during the installation work period.

### 2-2-4-8 Technical Cooperation

<Soft Component>

Majority of the PMD's technical staff is proficient in the use of computers and computerized meteorological observation equipment. Unfortunately, none of them have the practical experience in operating a digital meteorological radar system which is planned to be procured under the Project as Islamabad's existing meteorological radar system is of the analog type. In addition, they do not have ample experience and technical knowledge in weather guidance (rainfall, temperature, humidity and wind speed) through the weather forecast & development system to be established in the SMRFC for high accuracy medium range weather forecasts to be prepared through the utilization of the global NWP products made by meteorological agencies in developed countries. For the smooth operation and maintenance of the digital meteorological radar system, 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>

The Soft Component Targets are as follows.

- Inspection, adjustment, minor fault finding, remedy and recovery (replacement of spare parts & consumables, and etc.), and major fault countermeasures (report to the Consultant and Manufacturer and collection of technical advice, and etc.) to be appropriately carried out by the PMD.
- Prompt and appropriate meteorological radar operation and maintenance utilizing the meteorological radar system manual summary and the meteorological radar system maintenance & management record book.
- 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 forecasting.
- Preparation of individual Weather Forecasting Guidance for each element in consideration of meteorological characteristics for forecasting.

<Soft Component Outputs>

Soft Component Outputs are as follows.

Table56: Soft Component Outputs

| No. | Item | Output |
|---|---|---|
| 1 | Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery (replacement of spare parts & consumables, etc.), and Major Fault Countermeasures | Acquisition of technical know-how on appropriate inspection, adjustment, minor fault finding, remedy and recovery.<br>1) Routine maintenance using measuring instruments and tools.<br>2) Practice of replacing spare parts into the actual system and the subsequent confirmation of system operation.<br>3) Practice of fault finding, remedy (replacement of spare parts & consumables, etc.) and recovery.<br>Acquisition of know-how on major fault countermeasures (report to the Consultant and Manufacturer and collection of technical advice, etc.). |
| 2 | Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing the Meteorological Doppler Radar System Manual Summary and the Meteorological Radar System Maintenance & Management Record Book | Technical knowledge acquisition of prompt and appropriate meteorological Doppler radar operation and maintenance utilizing the meteorological Doppler radar system manual summary and the meteorological radar system maintenance & management record book. |
| 3 | Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode | Commencement 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. |
| 4 | Preparation of Weather Forecasting Guidance through the use of the observed data and NWP value | Technical knowledge acquisition on the preparation and operation of individual Weather Forecasting Guidance for each element in consideration of meteorological characteristics for forecasting. |

<Means of Verification for Outputs Achievement>

Means of verification for outputs achievement of the Soft Component are as follows.

Table57: Soft Component Indicators

| No. | Item | Objectively Verifiable Indicators | Means of Verification |
|---|---|---|---|
| 1 | Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery and Major Fault Countermeasures | Inspection, adjustment, minor fault finding, remedy and recovery, and major fault countermeasures are carried out appropriately by the PMD. | 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. |
| 2 | Prompt and Appropriate | Meteorological Doppler radar | · Evaluation of the frequency of usage of the |

| | | | |
|---|---|---|---|
| | Meteorological Doppler Radar Operation and Maintenance utilizing the Meteorological Radar System Manual Summary and the Meteorological Radar System Maintenance & Management Record Book | operation and maintenance utilizing the meteorological radar system manual summary and the meteorological radar system maintenance & management record book are implemented promptly and appropriately. | · meteorological Doppler radar system manual summary.<br>· Confirmation of indication (daily, weekly, monthly) in the meteorological radar system maintenance & management record book. |
| 3 | Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode Sequence & Schedule | 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. |
| 4 | Preparation of Weather Forecasting Guidance through the use of the observed data and NWP value | Preparation and Operation of individual Weather Forecasting Guidance for each element in consideration of meteorological characteristics for forecasting. | Confirmation of the improvement of weather forecast accuracy (decrease in RMSE) through the elimination of systematic errors of NWP values as a result of (by) preparation and operation of the Guidance Formula. |

<Scheduled Activities of Soft Component>

Scheduled Activities of Soft Component are as follows.

Table58: 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 technicians in the PMD have no practical experience of adjusting and fault finding in a digital meteorological radar system, it is imperative that the PMD technicians should acquire such capability. | Indicated in the table below | Routine maintenance using measuring instruments and tools. | Expert Consultant on meteorological radar adjustment and fault finding: 1.17 Man-Months. (Period of Technology Transfer in Pakistan: 35days)<br><br>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. | | |
| | | | | Production of operation and maintenance manual. | | Manual on major fault countermeasures. |
| 2. Preparation of Meteorological Doppler Radar System Manual Summary and Meteorological Radar System Maintenance & Management Record Book | An engineer capable of meteorological radar operation and maintenance. | Since technicians in the PMD have no practical experience of operating and maintaining a digital meteorological radar system, it is imperative that the PMD technicians should obtain the capability to conduct meteorological radar operation and maintenance utilizing the meteorological Doppler radar system manual summary and the meteorological radar system maintenance | Indicated in the table below | Discussion with the PMD technicians. | Expert Consultant on meteorological radar operation and maintenance: 1.17 Man-Months (Period of Technology Transfer in Pakistan: 35 days)<br><br>Direct Support | 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<br>• Date and time of occurrence of system failure/trouble<br>• Cause/s of system failure/trouble (abnormal noise, part degradation, etc.)<br>• Repair procedures implemented<br>• Name and quantity of replaced parts |
| | | | | Production of the meteorological Doppler radar system manual summary. | | |
| | | | | Production of the meteorological radar system maintenance & management record book. | | |
| | | | | Utilization of the meteorological Doppler radar system manual and the meteorological radar | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | & management record book. | | system maintenance & management record book by the PMD technicians. | | ➧ Name of engineer/s who perform/s the repair /troubleshooting |
| 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 Pakistan | Since technicians in the PMD have no practical experience CAPPI observation using a digital meteorological Doppler radar system and has no capability in preparing sequences & schedules for Intensity Mode and Doppler Mode, it is imperative that the PMD technicians should obtain the capability to prepare sequences & schedules for meteorological radar observation with an awareness of its importance. | Indicated in the table below | Discussion with the PMD technicians and lecture.<br>Identification of Clutter of meteorological radar system and Blind Area at antenna elevation angle (0.5 interval degree, between 1-3 degree).<br>Preparation of Blind Area at antenna elevation angle (0.5 interval degree, between 1-3 degree).<br>Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode.<br>Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode. | Expert Consultant on meteorological radar observation: 1.0 Man-Month (Period of Technology Transfer in Pakistan: 30 days)<br>Direct Support | Sequence & Schedule for Intensity Mode and Doppler Mode |
| 4. Preparation of Weather Guidance | An engineer who can prepare NWP and Weather Guidance | Since technicians in the PMD have no practical experience of preparation and operation of the statistical analysis program utilizing the observed data and NWP value, it is imperative that the PMD technicians should acquire the techniques on the preparation and operation of the statistical analysis program. | Indicated in the table below | Discussion and analysis with the PMD technicians on the forecasting elements in order to understand the meteorological characteristics.<br>Lecture on Weather Forecasting Guidance.<br>Preparation of Weather Forecasting Guidance Program (Lecture and Practical Training).<br>Operation and accuracy verification of Weather Forecasting Guidance (Practical Training and Discussion).<br>Examination of accuracy and the need of tuning of Weather Forecasting Guidance. | Expert Consultant on Weather Forecasting Guidance : 0.53 Man-Month (Period of Technology Transfer in Pakistan: 16 days)<br>Direct Support | Weather Forecasting Guidance Program and Accuracy Verification Document |

Table59: Target Personnel in the PMD for the Technology Transfer in the Soft Component

| Technology Transfer of No. 1 & 2 | | Technology Transfer of No. 3 & 4 | |
|---|---|---|---|
| Electronic Technician Section: Position | Number | Forecasting Section: Position | Number |
| Chief Engineer | 1 | Meteorologist in Weather Forecasting Center | 15 |
| Electronic Engineer | 1 | Meteorologist in NWP Division | 5 |
| Assistant Electronic Engineer | 1 | | |
| Mechanics | 4 | | |
| Sub Electronic & Mechanic Engineer | 8 | | |
| Professional Assistant | 2 | | |
| Assistant Programmer | 1 | | |

<Soft Component Product>

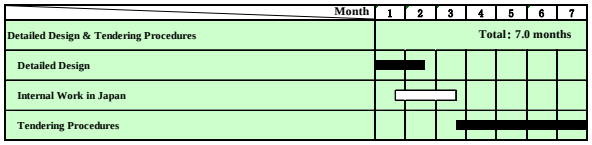
Soft Component Products are as follows.

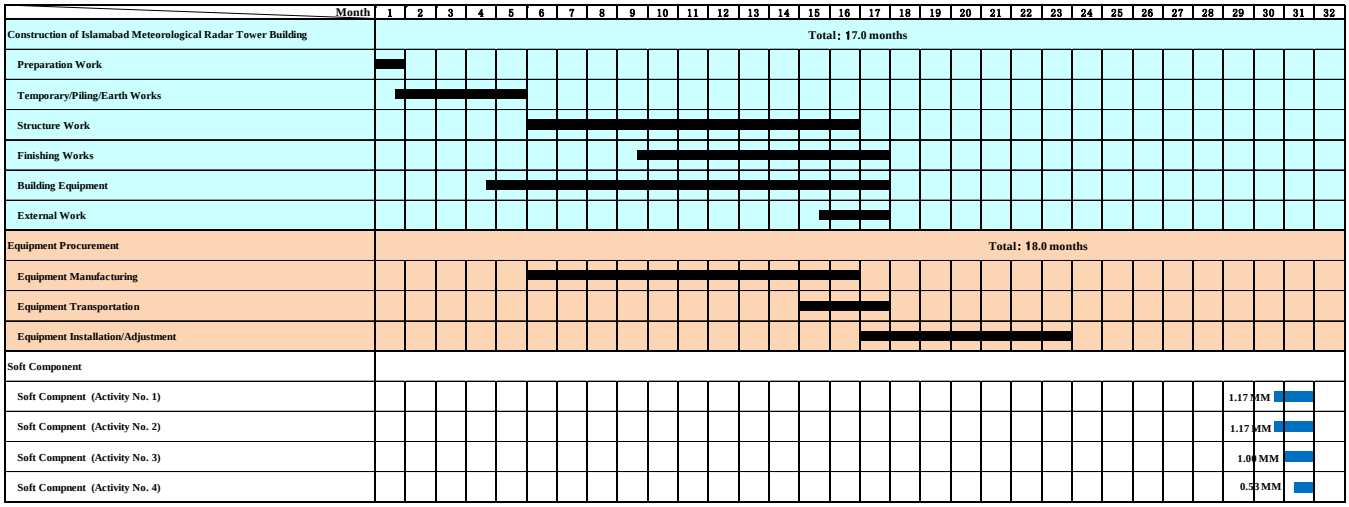
Table60: Soft Component Products in Technology Transfer

| 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 countermeasures. | | 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 |
| Weather Forecasting Guidance Program, Accuracy Verification Document | | | 10 |
| Output Name | Content | Submission Time | No. of Pages |
| Soft Component Completion Report | • Scheduled Activities and Actual Achievement<br>• Scheduled Outputs and Achievement<br>• Factors which influence Achievement of Outputs<br>• Recommendation<br>• Outputs | Completion of Soft Component | 50 |

## 2-2-4-9 Implementation Schedule

Table61: Implementation Schedule



## 2-3 Obligations of the Recipient Country

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

Table62: Major Undertakings to be done by the PMD under Implementation of the Project

| No | Items |
|---|---|
| | General Items |
| 1 | To undertake all necessary institutional and juridical procedures in Pakistan. |
| 2 | To undertake the Environmental Impact Assessment procedures in Pakistan, if required. |
| 3 | To handle duty (Tax) exemption procedures and to take necessary measures as well as provide requisite legal and/or administrative documentations for customs clearance to customs broker/forwarder to be employed by Contractor 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 PMD Islamabad 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 Pakistan and stay therein for the smooth and uninterrupted performance of their work (i.e. to secure the appropriate Visa including its extension/s required by the recipient country in connection thereof). |
| 6 | To exempt Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the 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 Building |
| 10 | To clear, level and reclaim the land prior to the commencement of construction work. |
| 11 | To secure sufficient spaces at the respective Project sites for temporary facilities such as a contractor's office, workshop, building materials storage, etc. for the construction work. |
| 12 | To demolish the existing building in premises of the PMD Islamabad Head Office in order to secure and allocate ample space for the construction of a new Radar Tower Building. |
| 13 | To obtain necessary permissions for the construction of the Radar Tower Building in the PMD Islamabad Head Office. |
| 14 | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) for the Radar Tower Building in the PMD Islamabad Head Office. |
| 15 | To install the required step-down transformers as well as service entrance connections for the commercial power supply at the PMD Islamabad Head Office for the Radar Tower Building. |
| 16 | To provide incidental facilities, such as water supply, telephone line and internet provision, for the Radar Tower Building in the PMD Islamabad Head Office. |
| 17 | To provide temporary facilities for the availability or accessibility of electricity, water, etc. for the construction work. |
| 18 | To undertake incidental outdoor works such as gardening, fencing, constructing gates, boundary walls and exterior lighting in and around the sites, if necessary. |
| 19 | To shoulder dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any. |

| | |
|---|---|
| | 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 provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) for the Specialized Medium Range Weather Forecasting Center (SMRFC) in the PMD Islamabad Head Office. |
| 23 | To provide reliable and high-speed Internet environment at the SMRFC and at each Project site for the establishment of a Virtual Private Network (VPN). |
| 24 | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply for the wind profiler system in the PMD Islamabad Head Office and the PMD Multan Meteorological Office. |
| 25 | To obtain the required frequency(s) for the meteorological radar system and the wind profiler system(s). |
| 26 | To set up new assigned IP addresses under the Project in the existing computing equipment in the SMRFC. |
| 27 | To migrate the PMD's own data to the computing equipment to be procured under the Project, if necessary. |
| 28 | To install software(s) procured/to be procured by the PMD on the computing equipment to be procured under the Project, if required. |
| 29 | To secure ample and strategically located space/s at the existing facilities for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project. |
| 30 | To shift and adjust the existing computing equipment, if required. |
| 31 | To shoulder dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any. |
| | After the completion of the Project |
| 32 | To renovate the existing gates, boundary walls and exterior lighting in and around the sites, if required. |
| 33 | To assign staff necessary for the smooth operation and maintenance of the Equipment. |
| 34 | To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment. |
| 35 | To provide adequate maintenance of the Radar Tower Building constructed under the Project, so that they can function effectively. |
| 36 | To operate and maintain, and properly and effectively utilize the facilities constructed and the Equipment procured under the Project. |
| 37 | To allocate the necessary budget and personnel for appropriate meteorological radar observation and forecasting works. |
| 38 | To periodically update all the operation/antivirus/application software. |

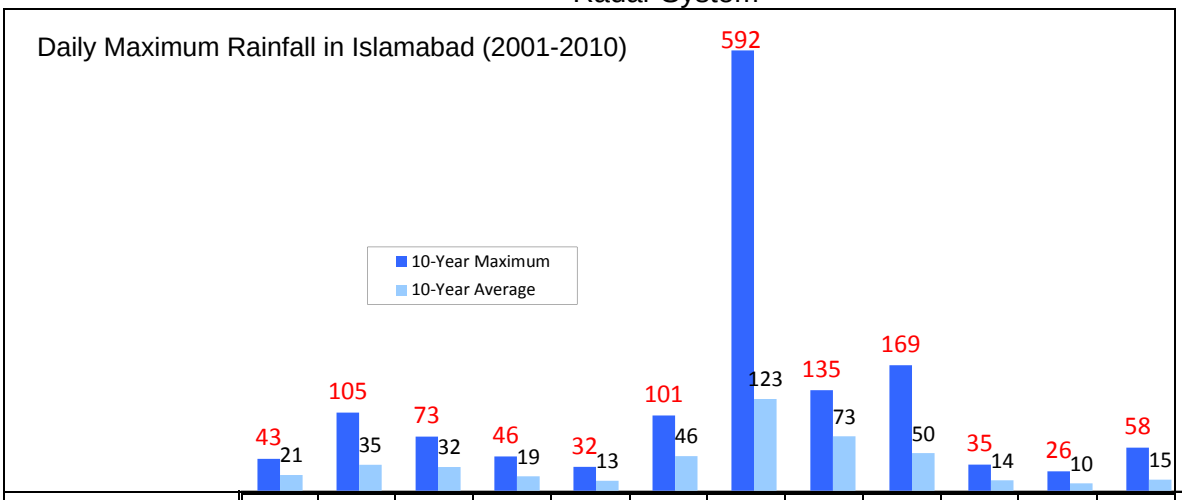
## 2-4 Project Operation Plan

(1) Operational and Maintenance Plan for the Equipment

1) Operational Plan of the Meteorological Radar System

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

Table63: Estimated Annual Operation Hours of the proposed Islamabad Meteorological Radar System




| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | **Annual Operation Hours** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Operation hours/day | 3 | 6 | 6 | 3 | 3 | 12 | 24 | 24 | 12 | 3 | 3 | 6 | |
| Days/month | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |
| Operation hours/month | 93 | 168 | 186 | 90 | 93 | 360 | 744 | 744 | 360 | 93 | 90 | 186 | **3,207** |

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

The PMD has a plan to establish the Specialized Medium Range Weather Forecasting Center (SMRFC) at the PMD Islamabad Head Office and conduct the medium-range weather forecasting (3-10 days). The Figure below shows the organizational chart of the SMRFC to be established. It is divided into five sections such as the National Weather Forecasting Center, the Numerical Weather Prediction Division, etc., and are supervised by an Additional Director General. A Radar Maintenance & Operation Division is also planned to be included in the SMRFC and twenty engineers for the Islamabad Meteorological Radar System will be allocated.

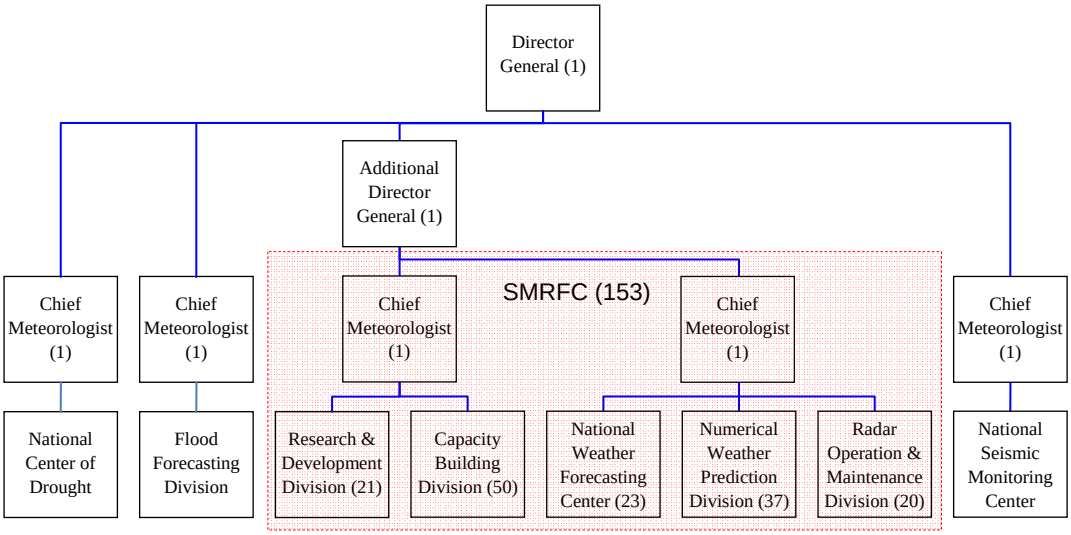



Figure14: Planned Organization of the SMRFC

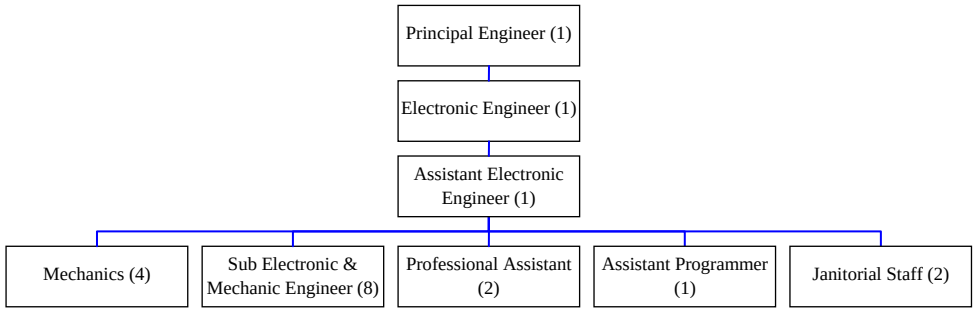



Figure15: Planned Organization of the PMD Islamabad Meteorological Radar Station

3) Operational and Maintenance Plan for the Equipment

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

- Technical training for the PMD 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 PMD
- Establishment of the technical and financial self-reliance of the PMD

(2) Operational 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 PMD: (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 implementation of the daily cleaning of the building leaves 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.

Table64: Outline of Regular Inspection for the Building

| | Items of Maintenance Work | Frequency |
|---|---|---|
| Exterior | Repair and repainting of external walls | Repair: every 5 years,<br>Repaint: every 15 years |
| | Inspection and repair of roofs | Inspection: every year<br>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<br>Others: as required |

It is important that the regular preventive maintenance of the building equipment is carried out before the equipment fails or requires repair or before the replacement of part(s). The life of the building equipment can be significantly extended through proper operation and regular inspection, lubrication, adjustment and cleaning. These regular inspections can prevent equipment failure and accidents. Regular inspection, the replacement of consumables and the 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 PMD, 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.

Table65: Life Expectancy of Building Equipment

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

## 2-5 Project Cost Estimate

### 2-5-1 Estimate of the Project Capital Cost

The required project capital costs for the Project to be borne by the Government of Pakistan/PMD have been estimated and are shown in the following tables.

**Estimated Total Project Capital Cost**: 59,482,000 PKR (approx. 65 Million JP Yen)

Table66: Project Capital Cost already incurred by the Government of Pakistan/PMD

| No. | Items | Capital Cost (PKR) |
|---|---|---|
| 1 | To construct 2-Storey Building (SMRFC: Specialized Medium Range Weather Forecasting Center) | 15,938,000 |
| 2 | To procure PC terminals and peripherals for SMRFC | 7,687,000 |
| 3 | To shoulder the miscellaneous cost (electricity, petrol, etc.) | 1,613,000 |
| 4 | To shoulder the manpower cost (staff salary, allowance, etc.) | 881,000 |
| 5 | To procure a vehicle | 1,400,000 |
| 6 | To procure library book | 40,000 |
| 7 | To shoulder other items | 90,000 |
| | Total | 27,649,000 |

Table67: Estimated Project Capital Cost to be borne by the Government of Pakistan/PMD

| No. | Items | Capital Cost (PKR) |
|---|---|---|
| 1. | To pay bank commission for issuance of the Authorization to Pay (A/P) and FED etc. to the Consultant and the Contractor. | 8,700,000 |
| 2. | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) for the Islamabad Radar Tower Building in the PMD Islamabad Head Office. | 300,000 |
| 3. | To install the required step-down transformers as well as service entrance connections for the commercial power supply at the PMD Islamabad Head Office for the Radar Tower Building. | 1,800,000 |
| 4. | To provide water supply for the Radar Tower Building in the PMD Islamabad Head Office. | 100,000 |
| 5. | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) for the Specialized Medium Range Weather Forecasting Center (SMRFC) in the PMD Islamabad Head Office. | 300,000 |
| 6. | To provide reliable and high-speed Internet environment at the SMRFC and at each Project site for the establishment of a Virtual Private Network (VPN). | 1,000,000 |
| 7. | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply for the wind profiler system in the PMD Islamabad Head Office. | 300,000 |
| 8. | To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply for the wind profiler system in the PMD Multan Meteorological Office. | 300,000 |
| 9. | To shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, etc. | 500,000 |
| 10. | To shoulder the miscellaneous expenditures such as library books, petrol, telephone, application fee (obtaining the required frequencies for the meteorological radar system & the wind profiler systems, and the construction permissions of a new Radar Tower Building). | 2,500,000 |
| 11. | To shoulder manpower cost (staff salary, allowance, etc.) | 16,033,000 |
| | Total | 31,833,000 |

Applied Exchange Rate: US$ 1 = 99.27 JP Yen, 1 PKR= 1.094 JP Yen

### 2-5-2 Estimate of the Project Annual Recurrent Cost

(1) Project Annual Recurrent Cost to be borne by the Government of Pakistan/PMD

The estimated annual recurrent costs (considered 5% of the annual inflation rate) for all the systems procured under the Project to be borne by the PMD 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 PMD
- Appropriate operation in accordance with the operations manuals
- Regular and proper maintenance according to the maintenance manuals

## Table68: Estimated Annual Recurrent Cost of the PMD Islamabad Head Office

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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Islamabad Meteorological Radar Tower** | | | | | | | | | | | | | |
| 1 | Antenna | Grease (16kgs/can, For AZ/EL) | 1 | 0 | 0 | 0 | 0 | 28,600 | 0 | 0 | 0 | 0 | 36,500 | Every 5 years |
| | | Timing belt (For AZ/EL) | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26,500 | 0 | 0 | Every 8 years |
| 2 | Antenna controller | AC fan | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45,900 | Every 10 years |
| 3 | Transmitter | AC fan | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 367,100 | Every 10 years |
| 4 | Receiver | AC fan | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45,900 | Every 10 years |
| 5 | Printer | Printer ink cartridge | 2 | 8,200 | 8,600 | 8,200 | 8,200 | 8,200 | 8,200 | 8,200 | 8,200 | 8,200 | 8,200 | |
| | | Paper (500sheets/1set) | 4 | 1,900 | 2,000 | 2,100 | 2,200 | 2,300 | 2,400 | 2,500 | 2,600 | 2,800 | 2,900 | |
| 6 | Compact UPS | Battery | 3 | 0 | 0 | 33,100 | 0 | 0 | 38,300 | 0 | 0 | 44,300 | 0 | Every 3 years |
| 7 | Power Supply Capacitor | AC fan | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71,200 | Every 10 years |
| | | Arrester | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 105,900 | Every 10 years |
| 8 | Diesel Engine Generator | Oil seal | 2 | 0 | 4,700 | 4,900 | 5,200 | 5,400 | 5,700 | 6,000 | 6,300 | 6,600 | 6,900 | Every 1 year |
| | | Filter | 2 | 0 | 0 | 18,200 | 0 | 20,000 | 0 | 22,100 | 0 | 24,300 | 0 | Every 2 years |
| | | Battery for Engine start | 2 | 0 | 0 | 0 | 0 | 0 | 24,000 | 0 | 0 | 0 | 29,200 | Every 5 years |
| | **National Weather Forecasting Centre and Specialized Medium Range Forecasting Centre (SMRFC)** | | | | | | | | | | | | | |
| 1 | Product Monitor | CD for data storage (20sheets/1set) | 15 | 31,800 | 33,400 | 35,000 | 36,800 | 38,600 | 40,500 | 42,600 | 44,700 | 46,900 | 49,300 | |
| 2 | Printer | Printer ink cartridge | 6 | 24,700 | 25,900 | 27,200 | 28,600 | 30,000 | 31,500 | 33,100 | 34,800 | 36,500 | 38,300 | |
| | | Paper (500sheets/1set) | 12 | 5,600 | 5,900 | 6,200 | 6,500 | 6,900 | 7,200 | 7,600 | 7,900 | 8,300 | 8,800 | |
| 3 | Photo Copy | Toner | 1 | | 11,100 | 11,700 | 12,300 | 12,900 | 13,500 | 14,200 | 14,900 | 15,600 | 16,400 | Every 1 year |
| | | Drum | 1 | 0 | 0 | 38,900 | 0 | 42,900 | 0 | 47,300 | 0 | 52,100 | | Every 2 years |
| | | Paper (500sheets/1set) | 20 | 9,400 | 9,900 | 10,400 | 10,900 | 11,400 | 12,000 | 12,600 | 13,200 | 13,900 | 14,600 | |
| 4 | Compact UPS | Battery | 12 | 0 | 0 | 132,300 | 0 | 0 | 153,200 | 0 | 0 | 177,300 | 0 | Every 3 years |
| 5 | Wind Profiler Transmitter | AC Fan | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 94,900 | Every 10 years |
| 6 | Power Supply Capacitor | AC fan | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71,200 | Every 10 years |
| | | Arrester | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 109,500 | Every 10 years |
| 7 | Diesel Engine Generator | Oil seal | 2 | 0 | 4,700 | 4,900 | 5,200 | 5,400 | 5,700 | 6,000 | 6,300 | 6,600 | 6,900 | Every 1 year |
| | | Filter | 2 | 0 | 0 | 18,200 | 0 | 20,000 | 0 | 22,100 | 0 | 24,300 | 0 | Every 2 years |
| | | Battery for Engine start | 2 | 0 | 0 | 0 | 0 | 22,900 | 0 | 0 | 0 | 0 | 29,200 | Every 5 years |
| | | Sub total (PKR) | | 81,600 | 106,200 | 351,300 | 115,900 | 255,500 | 342,200 | 224,300 | 165,400 | 467,700 | 1,158,800 | |

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 | 1,451,618 | 1,524,199 | 1,600,409 | 1,680,429 | 1,764,451 | 1,852,673 | 1,945,307 | 2,042,572 | 2,144,701 | 2,251,936 | *1 |
| 2 | Fuel cost | Fuel consumption of DEG | 1 | 874,944 | 918,691 | 964,626 | 1,012,857 | 1,063,500 | 1,116,675 | 1,172,509 | 1,231,134 | 1,292,691 | 1,357,326 | *2 |
| 3 | Water supply charge | | 1 | 12,000 | 12,600 | 13,230 | 13,892 | 14,586 | 15,315 | 16,081 | 16,885 | 17,729 | 18,616 | *3 |
| 4 | Special maintenance | System brush-up by manufacture's | 1 | 0 | 0 | 1,037,600 | 0 | 0 | 1,201,200 | 0 | 0 | 1,390,500 | 0 | For 5 days at site |
| 5 | Radome | Caulking repair | 1 | 23,500 | 24,700 | 25,900 | 27,200 | 28,600 | 30,000 | 31,500 | 33,100 | 34,800 | 36,500 | |
| 6 | Pest-control | Exterminating vermination | 1 | 21,200 | 22,200 | 23,300 | 24,500 | 25,700 | 27,000 | 28,400 | 29,800 | 31,300 | 32,900 | |
| 7 | Communication charge | Data/Internet communication | 1 | 480,000 | 504,000 | 529,200 | 555,660 | 583,443 | 612,615 | 643,246 | 675,408 | 709,179 | 744,638 | |
| | | Sub total (PKR) | | 2,863,262 | 3,006,390 | 4,194,265 | 3,314,538 | 3,480,280 | 4,855,478 | 3,837,043 | 4,028,899 | 5,620,900 | 4,441,916 | |
| | | **Total (PKR)** | | **2,944,862** | **3,112,590** | **4,545,565** | **3,430,438** | **3,735,780** | **5,197,678** | **4,061,343** | **4,194,299** | **6,088,600** | **5,600,716** | |
| | | **Total (JPY)** | | **¥2,516,976** | **¥2,660,333** | **¥3,885,098** | **¥2,931,998** | **¥3,192,974** | **¥4,442,460** | **¥3,471,233** | **¥3,584,871** | **¥5,203,932** | **¥4,786,937** | |

Estimate of annual electricity charge

| | | | |
|---|---|---|---|
| Annual power consumption of Meteorological Radar | (kWh) | 57,508 | (100% of Actual consumption) |
| Annual power consumption of Wind Profiler | (kWh) | 83,462 | (100% of Actual consumption) |
| Annual power consumption of Other Equipment | (kWh) | 59,707 | (85% of Actual consumption, 15% supplied by solar panel) |
| Total annual power consumption | (kWh) | 200,677 | |
| Annual power consumption by commercial power (88%) | (kWh) | 176,596 | |
| Annual power consumption by DEG (12%) | (kWh) | 24,081 | |
| Annual fuel consumption | (Litter) | 7,947 | |

Fuel consumption of DEG = 0.33 Litter/kWh

| | | | |
|---|---|---|---|
| *1 Annual electricity charge of commercial power | (PKR) | 1,451,618 | Electrical charge = 8.22 PKR/kWh |
| *2 Annual fuel cost of DEG | (PKR) | 874,944 | Fuel cost = 110.10 PKR/Litter |
| *3 Annual water supply charge | (PKR) | 12,000 | Exchange rate 1.17 PKR/JPY |

## Table69: Estimated Annual Recurrent Cost of the PMD Multan Meteorological Office

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 | Product Monitor | CD for data storage (20sheets/1set) | 1 | 2,100 | 2,200 | 2,300 | 2,500 | 2,600 | 2,700 | 2,800 | 3,000 | 3,100 | 3,300 | |
| 2 | Printer | Printer ink cartridge | 1 | 4,100 | 4,300 | 4,500 | 4,800 | 5,000 | 5,300 | 5,500 | 5,800 | 6,100 | 6,400 | |
| | | Paper (500sheets/1set) | 1 | 500 | 500 | 500 | 500 | 600 | 600 | 600 | 700 | 700 | 700 | |
| 3 | Wind Profiler Transmitter | AC Fan | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 94,900 | Every 10 years |
| 4 | Power Supply Capacitor | AC fan | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71,200 | Every 10 years |
| | | Arrester | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54,800 | Every 10 years |
| 5 | Diesel Engine Generator | Oil seal | 2 | 0 | 3,700 | 3,900 | 4,100 | 4,300 | 4,500 | 4,700 | 5,000 | 5,200 | 5,500 | Every 1 year |
| | | Filter | 2 | 0 | 0 | 13,000 | 0 | 14,300 | 0 | 15,800 | 0 | 17,400 | 0 | Every 2 years |
| | | Battery for Engine start | 2 | 0 | 0 | 0 | 0 | 17,200 | 0 | 0 | 0 | 0 | 21,900 | Every 5 years |
| | | Sub total (PKR) | | 6,700 | 10,700 | 24,200 | 11,900 | 44,000 | 13,100 | 29,400 | 14,500 | 32,500 | 258,700 | |

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 | 421,860 | 442,960 | 465,100 | 488,360 | 512,780 | 538,420 | 565,340 | 593,600 | 623,280 | 654,450 | *1 |
| 2 | Fuel cost | Fuel consumption of DEG | 1 | 254,273 | 266,987 | 280,336 | 294,353 | 309,070 | 324,524 | 340,750 | 357,787 | 375,677 | 394,461 | *2 |
| 3 | Water supply charge | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | *3 |
| 4 | Communication charge | Data/Internet communication | 1 | 96,000 | 100,800 | 105,840 | 111,132 | 116,689 | 122,523 | 128,649 | 135,082 | 141,836 | 148,928 | |
| | | Sub total (PKR) | | 772,133 | 810,747 | 851,276 | 893,845 | 938,539 | 985,467 | 1,034,739 | 1,086,469 | 1,140,793 | 1,197,839 | |
| | | **Total (PKR)** | | **778,833** | **821,447** | **875,476** | **905,745** | **982,539** | **998,567** | **1,064,139** | **1,100,969** | **1,173,293** | **1,456,539** | |
| | | **Total (JPY)** | | **¥665,669** | **¥702,091** | **¥748,270** | **¥774,141** | **¥839,777** | **¥853,476** | **¥909,521** | **¥940,999** | **¥1,002,815** | **¥1,244,905** | |

Estimate of annual electricity charge

| | | | |
|---|---|---|---|
| Annual power consumption of Equipment | (kWh) | 58,320 | (75% of Actual consumption, 25% supplied by solar panel) |
| Total annual power consumption | (kWh) | 58,320 | |
| Annual power consumption by commercial power (88%) | (kWh) | 51,322 | |
| Annual power consumption by DEG (12%) | (kWh) | 6,998 | |
| Annual fuel consumption | (Litter) | 2,309 | |

Fuel consumption of DEG = 0.33 Litter/kWh

| | | | |
|---|---|---|---|
| *1 Annual electricity charge of commercial power | (PKR) | 421,864 | Electrical charge = 8.22 PKR/kWh |
| *2 Annual fuel cost of DEG | (PKR) | 254,273 | Fuel cost = 110.10 PKR/Litter |
| *3 Annual water supply charge | (PKR) | 0 | Exchange rate = 1.17 PKR/JPY |

## Table70: Estimated Annual Recurrent Cost of the PMD Karachi Tropical Cyclone Warning Center

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 | Compact UPS | Battery | 2 | 0 | 0 | 22,100 | 0 | 0 | 25,500 | 0 | 0 | 29,500 | 0 | Every 3 years |
| | | Sub total (PKR) | | 0 | 0 | 22,100 | 0 | 0 | 25,500 | 0 | 0 | 29,500 | 0 | |

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 | 17,844 | 18,736 | 19,673 | 20,657 | 21,689 | 22,774 | 23,913 | 25,108 | 26,364 | 27,682 | *1 |
| 2 | Communication charge | Data/Internet communication | 1 | 96,000 | 100,800 | 105,840 | 111,132 | 116,689 | 122,523 | 128,649 | 135,082 | 141,836 | 148,928 | |
| | | Sub total (PKR) | | 113,844 | 119,536 | 125,513 | 131,789 | 138,378 | 145,297 | 152,562 | 160,190 | 168,200 | 176,610 | |
| | | **Total (PKR)** | | **113,844** | **119,536** | **147,613** | **131,789** | **138,378** | **170,797** | **152,562** | **160,190** | **197,700** | **176,610** | |
| | | **Total (JPY)** | | **¥97,303** | **¥102,168** | **¥126,165** | **¥112,640** | **¥118,272** | **¥145,980** | **¥130,395** | **¥136,915** | **¥168,974** | **¥150,949** | |

Estimate of annual electricity charge

| | | | |
|---|---|---|---|
| Annual power consumption of Equipment | (kWh) | 2,171 | (75% of Actual consumption, 25% supplied by solar panel) |

Electrical charge = 8.22 PKR/kWh

| | | | |
|---|---|---|---|
| *1 Annual electricity charge of commercial power | (PKR) | 17,844 | |

Exchange rate = 1.17 PKR/JPY

## Table71: Estimated Annual Recurrent Cost of the Meteorological Office in the New Benazir Bhutto International Airport, the PMD Lahore Regional Meteorological Center, the PMD Lahore Flood Forecasting Division and the PMD Gilgit Meteorological Office

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 | Compact UPS | Battery | 1 | 0 | 0 | 11,000 | 0 | 0 | 12,800 | 0 | 0 | 14,800 | 0 | Every 3 years |
| | | Sub total (PKR) | | 0 | 0 | 11,000 | 0 | 0 | 12,800 | 0 | 0 | 14,800 | 0 | |

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 | 9,854 | 10,347 | 10,864 | 11,407 | 11,978 | 12,577 | 13,205 | 13,866 | 14,559 | 15,287 | *1 |
| 2 | Communication charge | Data/Internet communication | 1 | 96,000 | 100,800 | 105,840 | 111,132 | 116,689 | 122,523 | 128,649 | 135,082 | 141,836 | 148,928 | |
| | | Sub total (PKR) | | 105,854 | 111,147 | 116,704 | 122,539 | 128,667 | 135,100 | 141,854 | 148,948 | 156,395 | 164,215 | |
| | | **Total (PKR)** | | **105,854** | **111,147** | **127,704** | **122,539** | **128,667** | **147,900** | **141,854** | **148,948** | **171,195** | **164,215** | |
| | | **Total (JPY)** | | **¥90,474** | **¥94,997** | **¥109,149** | **¥104,734** | **¥109,972** | **¥126,410** | **¥121,243** | **¥127,306** | **¥146,321** | **¥140,355** | |

Estimate of annual electricity charge

| | | | |
|---|---|---|---|
| Annual power consumption of Equipment | (kWh) | 1,199 | (75% of Actual consumption, 25% supplied by solar panel) |

Electrical charge = 8.22 PKR/kWh

| | | | |
|---|---|---|---|
| *1 Annual electricity charge of commercial power | (PKR) | 9,854 | |

Exchange rate = 1.17 PKR/JPY

The estimated project annual recurrent cost for the Project to be borne by the Government of Pakistan/PMD after the completion of the Project is summarized and is shown in the following table.

**Estimated Project Annual Recurrent Cost**: 17,335,000 PKR (approx. 17 Million JP Yen)

Table72: Estimated Project Annual Recurrent Cost to be borne by the Government of Pakistan/PMD

| No. | Description | Recurrent Cost (PKR) |
|---|---|---|
| 1 | Pay & Allowance of Staff | 10,700,000 |
| 2 | Electricity Charges | 1,950,000 |
| 3 | Water and Gas Charges | 400,000 |
| 4 | Telephone, Fax, Leased Lines, Internet Connections | 1,500,000 |
| 5 | Spare Parts, Consumables and Special Maintenance of the Systems | 900,000 |
| 6 | Radar Radome caulking repair and exterminating vermination for the facilities | 450,000 |
| 7 | Consumables, Stationary, etc. | 100,000 |
| 8 | Books & Journals | 35,000 |
| 9 | Contingencies | 300,000 |
| 10 | P.O.L. Charges (for engine generators, vehicles, etc.) | 1,000,000 |
| | Total | **17,335,000** |

(2) Annual Budget Trends

In order to secure the estimated recurrent cost of the Project, PC-1 Form must be approved by the Executive Committee of the National Economic Council (ECNEC). And if PC-4 Form (Completion of the Project) is approved right after the completion of the Project, the budget necessary for the operation and maintenance of the system will be secured without much difficulty. Since there are differences between the budget described in the PC-1 Form and the amount of aid from Japan, and between the originally planned items and the object items of the Preparatory Survey, the re-approval of the revised PC-1 Form is required. The Pakistani side has a plan to obtain the approval of the PC-1 Form before the conclusion of the Exchange of Notes. In addition, the Secretary Aviation Division, Cabinet Secretariat, as the supervising ministry of the PMD, and the Economic Affairs Division (EAD), acting as a liaison with aid agencies, have committed to the Preparatory Survey Team to allocate the required budget for the Project. Therefore, it has been assessed that there is no problem in this regard. The following table indicates the movement of the PMD budget.

Table73: Movement of the PMD Annual Budget (In Thousand Rs)

| Year | Budget | Comparison with the previous year (%) |
|---|---|---|
| 2008 | 394,991 | - |
| 2009 | 417,880 | 105.8 |
| 2010 | 451,327 | 108.0 |
| 2011 | 578,825 | 128.3 |
| 2012 | 680,347 | 117.5 |

Budget for Public Sector Development Programme is not included