Pakistan Meteorological Department
The Islamic Republic of Pakistan

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR THE INSTALLATION OF WEATHER SURVEILLANCE RADAR AT MULTAN
IN
THE ISLAMIC REPUBLIC OF PAKISTAN

March 2018

JAPAN INTERNATIONAL COOPERATION AGENCY

INTERNATIONAL METEOROLOGICAL CONSULTANT INC.

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PREFACE

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

The survey team held a series of discussions with the officials concerned of the Government of the Islamic Republic of Pakistan, and conducted a 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.

March, 2018

Kunihiro YAMAUCHI
Director General,
Global Environment Department
Japan International Cooperation Agency

Summary

Summary

1. Outline of the Country

The Islamic Republic of Pakistan has a population of 207 million (Pakistan Bureau of Statistics, 2017 Census) with an annual growth rate of 2.4%, and it is expected to become a country with the world's fourth largest population next to India, China and the United States in 2050. The national GDP is about 271 billion US dollars (2014 World Bank) and the real economic growth rate is 4.71% (Pakistan Economic Survey 2015-16).

2. Background of the Project

The Government of Pakistan adopted a national approach toward the strengthening of disaster prevention systems focusing on disaster prevention and damage mitigation such as the promulgation of the National Disaster Management Ordinance (NDMO), the establishment of the National Disaster Management Authority (NDMA) and the formulation of a National Disaster Management Plan under JICA's assistance. In the National Disaster Management Plan, a Multi-Hazard Early Warning System Plan aiming for the establishment and maintenance of the appropriate forecasting/warning system was proposed. For the successful implementation of the Plan, the enhancement of the PMD's observation and forecasting capabilities will be a key point as well as the development of human resources in the field of disaster prevention, dissemination of disaster prevention knowledge to the people and the establishment of flood control facilities, etc. 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.

The PMD currently has four meteorological radar systems (in Islamabad, Karachi, Dera Ismail Khan and the Rahimyar Khan) which had been installed under the Grant Aid of Japan and three meteorological radar systems (in Lahore, Sialkot, Mangra) in the eastern boundary which had been installed under the assistance of the Asian Development Bank. Due to the functional deterioration of the Islamabad, Karachi, Dera Ismail Khan and the Rahimyar Khan meteorological radar systems, the replacement of the Islamabad and Karachi meteorological radar systems with a new meteorological radar systems (S-Band) are being implemented by the Grant Aid of Japan. Since the PMD is unable to accurately observe the rain clouds that cause concentrated torrential rain in the wide area of Punjab Province and the thunderstorm accompanied by cumulonimbus and heavy rain around the Sulaiman Range during the Monsoon season invading Pakistan from India, it is actually difficult for PMD to appropriately reflect heavy rain information in flood forecasting and warnings. Moreover, in order to complement the observation range of the Dera Ismail Khan and the Rahimyar Khan Meteorological Radar Systems, which have almost become obsolete and likely to stop further operation, there is a dire need to create a tangible alternate solution to the problem. It is worth to mention that Multan city is in close proximity with the Indian border and

beyond the border, there is scanty meteorological data available to the PMD. As a result, the PMD is facing great difficulty in the issuance of timely weather/flood forecasts and warning to the public. Therefore, it is urgently necessary to establish a new meteorological radar system in Multan.

3. Outline Design of the Study and Contents of the Project

In July 2015, the Government of the Islamic Republic of Pakistan made a request to the Government of Japan for a Grant Aid for “The Project for Installation of Weather Surveillance Radar at Multan in the Islamic Republic of Pakistan” (hereinafter referred to as "the Project"). In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Installation of a Weather Surveillance Radar at Multan (hereinafter referred to as the “Preparatory Survey”). The Japan International Cooperation Agency (hereinafter referred to as “JICA”) sent the Preparatory Survey Team to Pakistan in order to conduct the Preparatory Survey from July 8 to August 26, 2017. The Team had a series of discussions with the officials concerned from the Government of Pakistan, conducted surveys and collected necessary and pertinent information and data for the Project. In addition, the Team conducted further studies, including a feasibility study focusing on the justification and scope of the Project paying particular attention to the present situation in Pakistan from various perspectives such as the operation & maintenance capabilities of the PMD, best equipment arrangement plan, etc.

JICA sent the Preparatory Survey Team again to Pakistan from February 7 to February 18, 2018 in order to explain and discuss the outline design & draft survey report. During the course of discussions and field surveys, it was confirmed that the requested items are indeed required for the Project in consideration of the Project’s objectives and effects.

As a consequence of the further study 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.

Table 1: Object Items of the Preparatory Survey

Component	Multan Meteorological Radar Observation Station	National Weather Forecasting Centre, PMD Islamabad Head Office	Meteorological Office in the Multan International Airport, PMD Multan	Flood Forecasting Division (FFD), PMD Lahore
Procurement and Installation of Equipment				
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	-	-	-
Meteorological Radar Central Processing System	-	1	-	-

Meteorological Radar Data Display System	1	1 (including Radar Picture Composite Processor and Radar Web Server)	1	1
Meteorological Data Communication System	1	-	1	-
Construction of Radar Tower Building				
Radar Tower Building	1	-	-	-
Technical Training	Initial operation guidance included in the contract of the manufacturer			
Soft Component				

4. Project Evaluation

4-1 Relevance

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

The overall objective of the Project is to reduce the devastation arising from meteorological disasters. This could be achieved by improving the PMD's capabilities of meteorological observation and forecast/warning in preparation for heavy rain. Floods caused by heavy rain are extreme manifestations of nature that may lead to immeasurable loss and distress for quite a number of people and have also become determining factors for the significant set-back of the national economy. To accurately observe weather phenomena causing heavy rain, the establishment of a meteorological radar system in Multan located in the central part of Punjab, where approximately 53% of the population of Pakistan is concentrated, makes it possible to improve the accuracy of the PMD's forecasts and warnings. Needless to say, it will enable the PMD to make further contributions in mitigating the damages due to natural disasters (mainly floods). Therefore, the population to be benefited both directly and indirectly by the Project will be the whole nation of Pakistan (approx. 207 million based on the Pakistan Bureau of Statistics, 2017 Census). 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 2.4% and will be the 4th largest country in the world after India, China and the United States in 2050. The table below indicates the population of the respective administrative districts.

Table 2: Administrative District and Population of Pakistan

No.	Administrative District	Capital	Population (2017)
1	Balochistan	Quetta	12,344,408
2	Khyber Pakhtunkhwa	Peshawar	30,523,371
3	Punjab	Lahore	110,012,442
4	Sindh	Karachi	47,886,051
5	Islamabad Capital Territory	Islamabad	2,006,572
6	Federally Administered Tribal Areas	Peshawar	5,001,676
7	Azad Jammu and Kashmir	Muzaffarabad	-
8	Gilgit-Baltistan	Gilgit	-
		Total	207,774,520

Source (Population (2017)): Pakistan Bureau of Statistics

2) Objectives of the Project

The key objective of the Project is the effective mitigation and reduction of the devastation caused by disasters brought about by hazardous meteorological phenomena such as heavy rain through the improvement of the weather & flood information and forecasts & warnings released by the PMD by strengthening their monitoring capability of hazardous weather phenomena through the provision of technical support and the establishment of an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Doppler Meteorological Radar System at Multan in the Punjab Province including the associated Meteorological Radar Central Processing System, Meteorological Radar Data Display Systems and Meteorological Data Communication Systems under the Project. Moreover, the Project would substantially contribute to the mitigation of the adverse effects of natural disasters and effectively safeguard the basic human needs of the Pakistani people.

3) Development Plan of Pakistan

The enhancement and modernization of the meteorological services in Pakistan are urgent issues to alleviate the negative impact of severe weather and to ensure the people's safety as well as to significantly contribute to the sustainable development of the country. From the viewpoint of the PMD, in order to contribute to the achievement of the government goals indicated in "Vision 2025", which is the long-term national development policy of Pakistan, and the National Disaster Management Plan (NDMP), the Ten Year Development Plan of the PMD (a step towards modernization) has been formulated in 2016 by the PMD.

"Vision 2025" is a national development policy for the whole country published in August 2014 by the Ministry of Planning, Development & Reform. "Vision 2025" declares that Pakistan will enter the upper middle income country group by 2025 and sets numerical targets of 25. The numerical targets include increasing the per capita national income from US$1,299 to US$ 4,200 and reducing the population's poverty ratio from the current 49% to 20%. In addition, the declaration statement in "Vision 2025" that it will become one of the world's top ten economic nations by total GDP by 2047, which celebrates the 100th anniversary of independence of the country, is included as a long-term goal.

The National Disaster Management Plan (NDMP) is a guideline for strengthening and modernizing the disaster-prevention sector in Pakistan and is one of the major achievements in support of disaster management measures of Pakistan by the Government of Japan. The NDMP is also a pillar of support by donor organizations in the area of disaster prevention.

In the document, "Reducing Vulnerability and Exposure to Disasters," published by the United Nations ESCAP/UNISDR, the disasters that occurred every year between 2004 and 2010 have pushed down Pakistan's GDP by US$ 20 billion compared with no disasters in 2011. In view of such reports, the significance of promoting disaster reduction is considered to be very high for the sustainable development of the country.

Since the modernization of a meteorological radar observation network in Pakistan is mentioned in the first chapter (Chapter 1) of the Ten Year Development Plan of the PMD as one of the top priority implementation items, this Project agrees with the national development plan and disaster prevention plan, and in the first five years of the National Flood Protection Plan IV (Ten Year Plan) approved by the Government of Pakistan in May 2017, the upgrade and expansion of the PMD's existing meteorological radar observation network and the flood forecasting & warnings are indicated. Based on the above, this project is consistent with the national development plan and disaster prevention plan of the country.

4) Aid Policy of Japan

Japan and Pakistan have developed congenial bilateral relations and have commemorated the sixtieth anniversary of the establishment of diplomatic ties between the two countries in 2012. Japan's major aid policy in Pakistan is the "establishment of a stable and sustainable society through economic growth." Pakistan is expected to have the fourth largest population in the world after India, China and the United States by 2050. In order to fully realize its potential, it is imperative to build up a stable and sustainable society through private-sector-led economic growth while ensuring a stable economy. The Government of Japan focuses on the following three priority areas for the realization of the aid policy indicated above.

1. Development of an economic foundation
2. Ensuring human security and improvement of social foundation
3. Stability and balanced development in the border area

Under the second priority area, the provision of aid for the "strengthening of disaster prevention capability against frequent natural disasters" is stated as one of Japan's important roles. Specifically, the establishment of an early warning system, the strengthening of disaster preparedness on a community level and the human resource development plan of disaster management organizations are included. It is truly significant to strengthen the meteorological monitoring system and improve disaster prevention capabilities in the whole of Pakistan through the Grant Aid from Japan as it is in congruence with Japanese priorities in terms of international cooperation.

4-2 Effectiveness

1) Quantitative indicators

Table 3: Achievement Indicators

Indicators	Present (Baseline in 2017)	Target (2025)
Enhancement of Severe Weather Monitoring Capability	Spatial resolution and observation intervals of the existing 143 surface observation stations in Pakistan: 74.6 km mesh on average at 60 minute observation intervals.	・ Spatial resolution and observation intervals of precipitation data in the radar detection range between 300-400 km: 1 km mesh at 10 minute observation intervals. ・ Spatial resolution and observation intervals of wind speed & direction data in the radar detection range within 200 km: 1 km mesh at 10 minute observation intervals.
	Observation of thunderstorm accompanying the development of cumulonimbus and rain cloud of severe weather using the meteorological satellite: 30 minute intervals.	Observation intervals of rainfall intensity, location, track, wind velocity of thunderstorm accompanied by cumulonimbus and rain cloud of severe weather caused by monsoon in the radar detection range: 10 minute observation intervals.
Enhancement of Heavy Rain Monitoring Capability	Observation only by using the existing surface observation stations (automatic observation systems: 60 minute intervals.	Observation intervals of rainfall intensity, location, development of rain distribution, and movement in the radar detection range: 10 minute observation intervals.

2) Qualitative indicators

a) Enable the provision of additional Information (in addition to the manual aeronautical observation) to the airport operators on weather conditions such as cumulonimbus, etc. detected by the radar systems to aircraft operations in the area surrounding the Multan International Airport.

b) Enable the provision of heavy rain information/advisory/warning indicating the area(s) identified and the area(s) located in the direction of rain cloud movement by the radar observation data which has/have received rainfall of over 50 mm within the last 1 hour, and 75 mm within the last 3 hours and based on synoptic trends to the government agencies concerned with disaster management and mass media.

c) Enable the disaster management authorities (NDMA and its allied disaster management authorities in provinces and districts) to issue prompt evacuation orders and commence necessary countermeasures against disasters and evacuation activity and support for disaster victims in a timely manner.

d) Enable the PMD to operate radar observation for prevention of secondary disasters and securing safety during rescue activities.

e) Enable the provision of accurate weather information to users engaged in industries such as transportation, tourism and agriculture by the PMD to promote the implementation of disaster mitigation measures and reducing economic losses.

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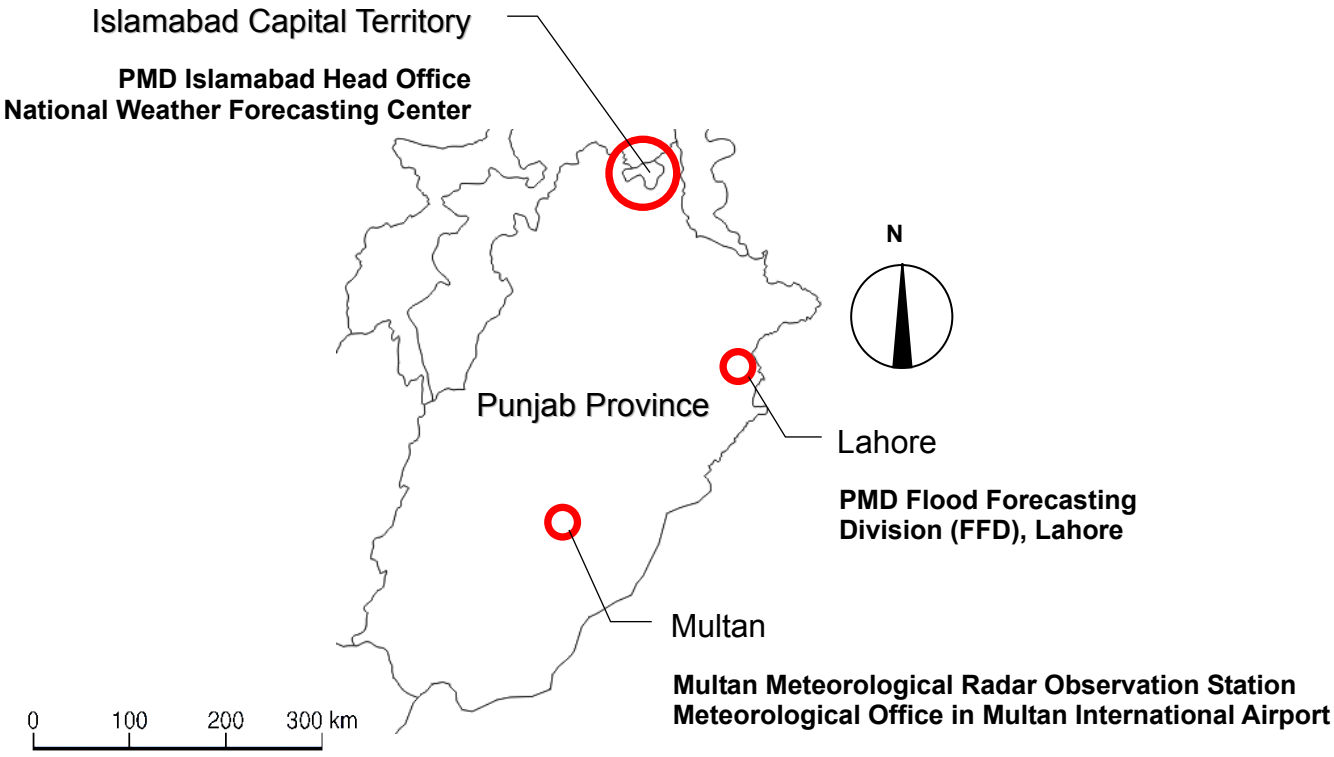
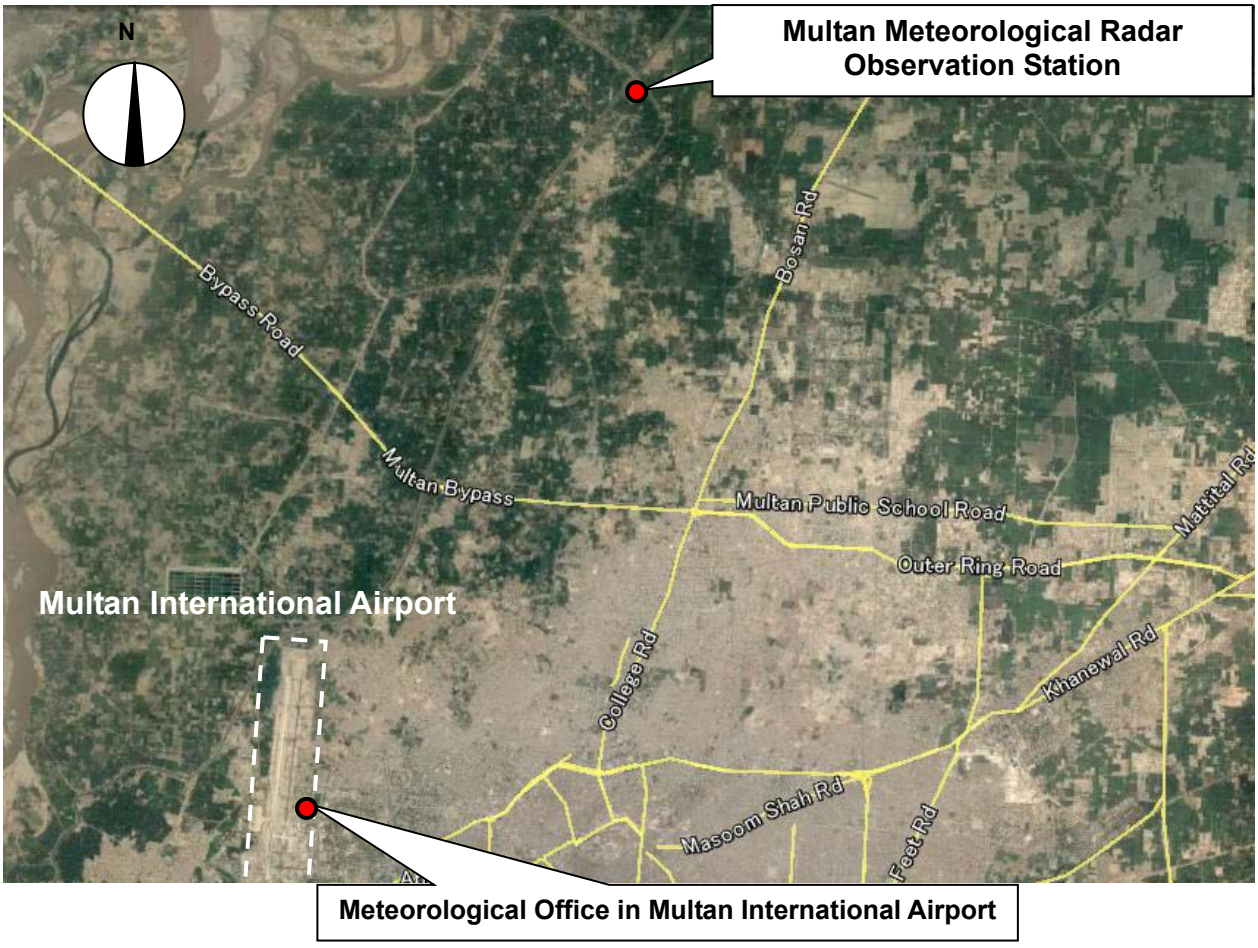
■ Islamic Republic of Pakistan





Multan Meteorological Radar Tower Building

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Chapter 1 Background of the Project

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ABBREVIATIONS

ASEAN : Association of Southeast Asian Nations
ASTM : American Society for Testing and Materials
AVR : Automatic Voltage Regulator
BCP : Building Code of Pakistan
CAA : Civil Aviation Authority
CAPPI : Constant Altitude Plan Position Indicator
CPEC : China-Pakistan Economic Corridor
EAD : Economic Affairs Division
ECNEC : Executive Committee of the National Economic Council
EIA : Environmental Impact Assessment
EIRP : Equivalent Isotopically Radiated Power
EPA : Environmental Protection Agency
FAB : Frequency Allocation Board
FBR : Federal Board of Revenue
FFD : Flood Forecasting Division
GDP : Gross Domestic Product
GST : General Sales Tax
IEE : Initial Environmental Examination
IEEE : Institute of Electrical and Electronic Engineers
IP-VPN : Internet Protocol Virtual Private Network
ITCZ : Inter Tropical Convergence Zone
ITU : International Telecommunication Union
JGS : Japanese Geotechnical Society
JICA : Japan International Cooperation Agency
MEPCO : Multan Electric Power Company
MRMC : Multan Regional Meteorological Centre
MTBF : Mean Time between Failure
MTTR : Mean Time to Repair
NDMA : National Disaster Management Authority
NDMO : National Disaster Management Ordinance
NDMP : National Disaster Management Plan
NOC : No Objection Certificate
OFDM : Orthogonal Frequency Division Multiplexing
OJT : On-the-Job Training
PDMA : Province Disaster Management Authority
PMD : Pakistan Meteorological Department
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 1,500 km 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. In addition, with mountains as high as 8,000 meters and the Indus River running through the country longitudinally, floods, flash floods and landslides occur everywhere once heavy rain falls. Especially for Pakistan, flooding is one of the most catastrophically damaging natural disasters, triggered by severe monsoon torrential rains which cause flooding of farms, collapse of houses, loss of electricity, landslide and loss of many lives, thereby, heavily impacting the national economy.

Pakistan receives most of its rain during the monsoon season from June to October. It is related to a large scale phenomenon called the Inter Tropical Convergence Zone (ITCZ) which moves toward the north and the south across the equator. It means that the cumulonimbi of the ITCZ or tropical depressions bring about torrential rain, hail, strong wind, etc. As shown in the figure on the right, the ITCZ moves up to Pakistan, the northernmost position in July, while it is located over the South Indian Ocean in January. Thus, the peak of the monsoon season in Pakistan is in July and August since the cumulonimbi of the ITCZ often brings about torrential rain.

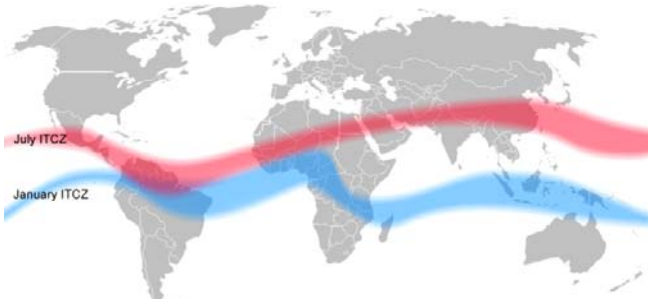


Figure 1: Seasonal Position of the Inter Tropical Convergence Zone (ITCZ)

In recent years, large-scale flooding has occurred consecutively in 2010, 2011, 2012, the recent most devastating catastrophes that occurred in the country was the Indus River Flood in 2010 (killed or missing: over 2,000; affected people: over 20 million; total damage: approx. US$9,500 million) and the flood which occurred mainly in Sindh province in 2011 (killed or missing: over 500; affected people: over 5 million). The Indus River Flood in 2010 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. 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. 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 Pakistan Meteorological Department (hereinafter referred to as 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.

1-2 Natural Disasters in Pakistan

The figure below shows the proportion of the number of disasters and killed & affected people by natural disasters between 1982 and 2016 in Pakistan. Since floods account for about 60% of the number of disasters, about 70% of the killed people and more than 90% of the affected people, the reduction of damage by the floods caused by the concentrated torrential rains during the monsoon season is a very urgent issue for Pakistan.

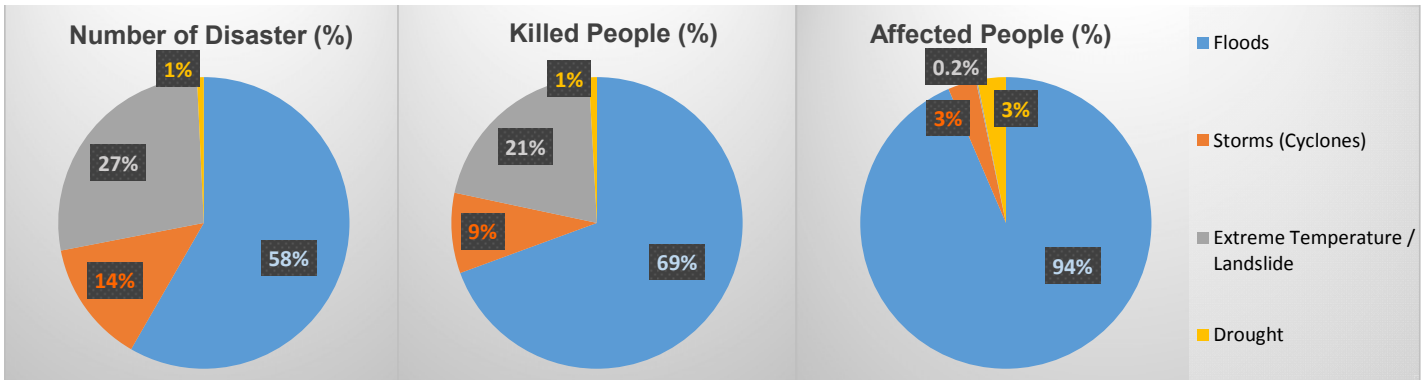


Figure 2: Percentage of Number of Disaster, Killed People and Affected People in Pakistan between 1982 and 2016

Data Source: Emergency Events Database (EM-DAT)

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 2016. As can be seen from these tables, flash floods and landslides occur mainly in the northern part of the country including the Khyber Pakhtunkhwa and Gilgit Baltistan. On the other hand, floods occur everywhere, particularly the Khyber Pakhtunkhwa state in the northern area, the Punjab state in the central area, the Sindh and Balochistan states are more vulnerable.

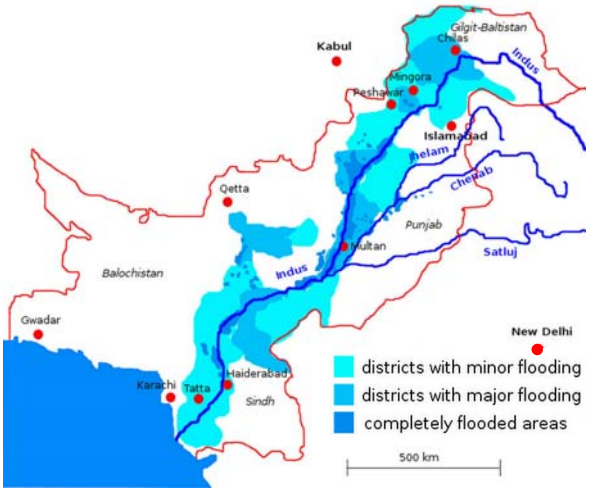


Figure 3: Flood Distribution

Data Source: PMD

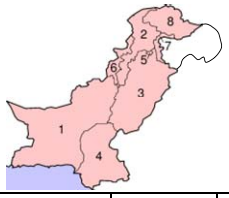


Table 1: Natural Disasters Occurred in Pakistan (2001-2016)
<Flood/Flash Flood/Landslide>

Year	Disaster Type	Killed/ Missing	Affected People	Administrative District 8 Gilgit Baltistan	2 Khyber Pakhtunkhwa	7 Azad Jammu and Kashmir	5 Islamabad Capital Territory	6 Federally Administered Tribal Areas	3 Punjab	1 Balochistan	4 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		■						
2011	Flood	509	5,400,755								■
2012	Flood	506	5,050,564		■	■			■	■	■
	Flash Flood	12				■					
	Landslide	153				■					
2013	Flood	268	1,497,782		■	■			■	■	■
2014	Flood	255	2,530,673			■			■		
2015	Flood	298	1,572,423		■	■	■	■	■	■	■
	Flash Flood	69	5,067		■					■	
2016	Flood	231	5,085	■	■	■		■	■	■	■
	Flash Flood	199	5,710	■	■	■				■	■

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

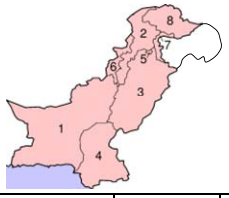


Table 2: Natural Disasters Occurred in Pakistan (2001-2016)
<Storm>

Year	Disaster Type	Killed/ Missing	Affected People	Administrative District 8 Gilgit Baltistan	2 Khyber Pakhtunkhwa	7 Azad Jammu and Kashmir	5 Islamabad Capital Territory	6 Federally Administered Tribal Areas	3 Punjab	1 Balochistan	4 Sindh
2001	Storm	4	500						■		
2002	Storm	14	12						■		
2003	Storm	51	2,557							■	■
2005	Storm	58						■			
2014	Storm	16	83		■						
2016	Storm	34	191		■	■	■	■	■		

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

1-3 Importance of Multan in Weather Observation

Most of the rain clouds that bring about torrential rain in the Monsoon season invade Pakistan from India, about 80% of which rise northward, bringing heavy rains to the north causing floods. The figure on the right shows the distribution map of mean annual precipitation in Pakistan. The precipitation in the northern area 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 basins. In addition to this, heavy rainfall by thunderstorm accompanied by cumulonimbus and in the heavy rain area around the Sulaiman Range (total length: 450 km; highest peak: Takht-e-Sulaiman with an altitude of 3,487 m in Balochistan Province) flows into the Indus river, Sutlej river, Ravi river, Chenab river, Jhelum river, etc. which further increase the scale of floods in the central and southern areas of Pakistan. Currently, the PMD is unable to accurately observe the rain clouds that cause concentrated torrential rain in the wide area of Punjab Province and the thunderstorm accompanied by cumulonimbus and heavy rain around the Sulaiman Range during the Monsoon season invading Pakistan from India. As a result, it is actually difficult for the PMD to appropriately reflect heavy rain information in its flood forecasting and warnings. As shown in the figure on the right, Multan is located at the best position to observe the approach of rain clouds of severe weather caused by monsoon, thunderstorm accompanied by cumulonimbus and heavy rain around the Sulaiman Range.

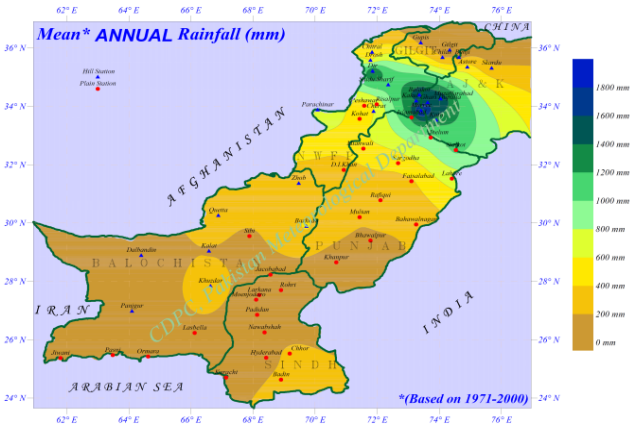


Figure 4: Distribution Map of Mean Annual Precipitation in Pakistan

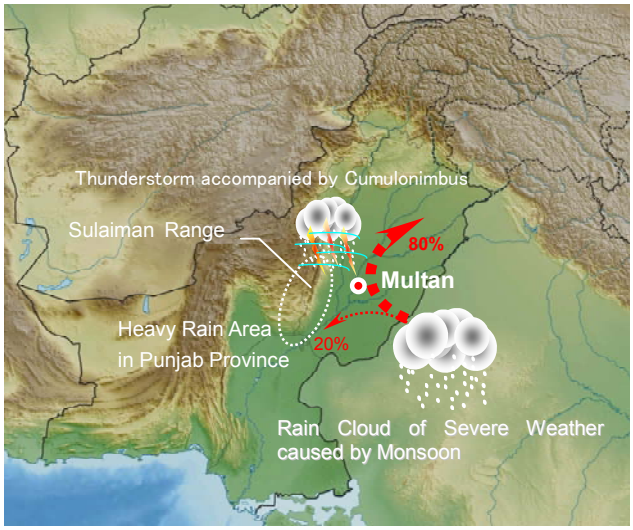


Figure 5: Position Map of Multan and Meteorological Phenomena in Punjab Province

1-4 Typical Precipitation Events during the Monsoon Season in Pakistan

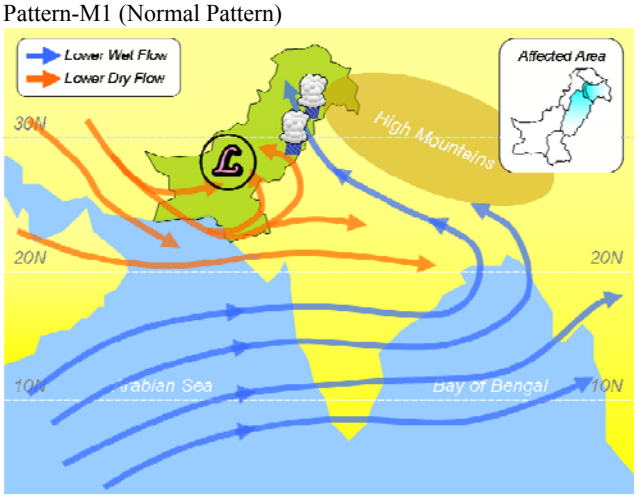
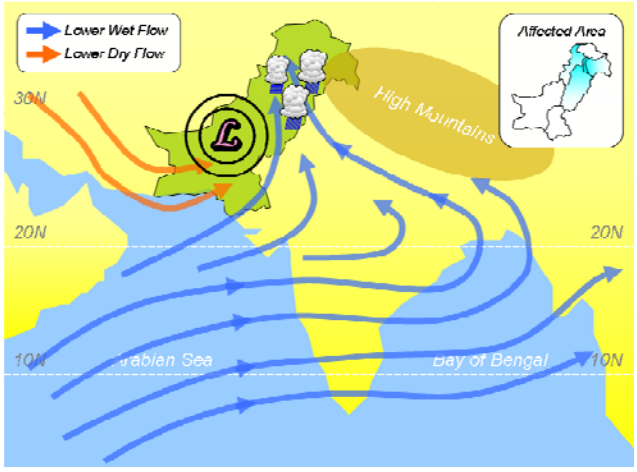
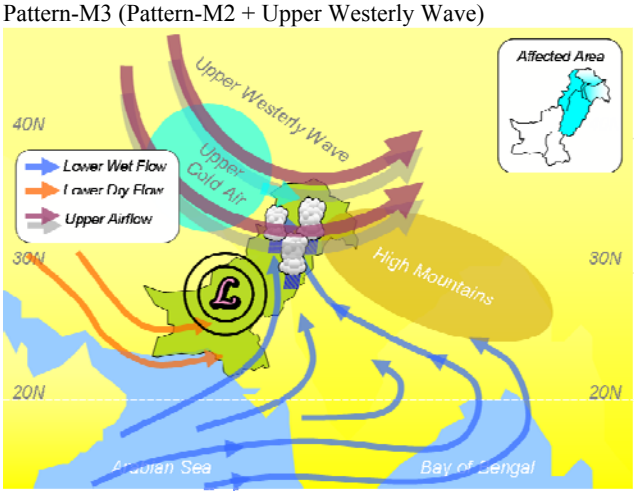
The tables below show the typical precipitation events causing floods during the Monsoon Season and their details including mechanism and influence on Pakistan.

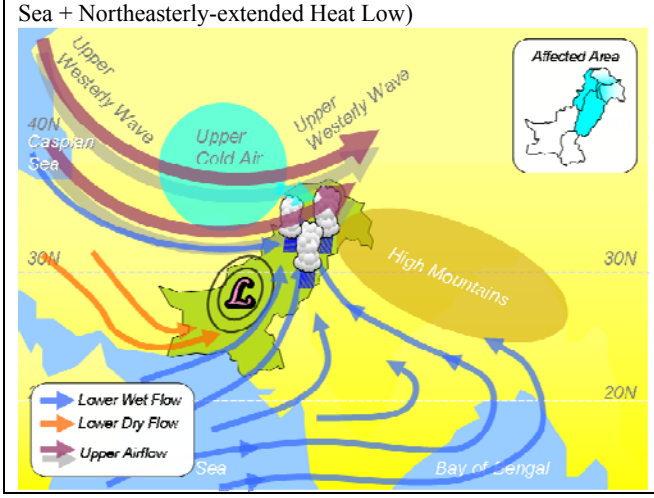
Table 3: Typical Precipitation Events in Monsoon Season in Pakistan

Season of each Event
Peak Season of Each Event

Summer Monsoon

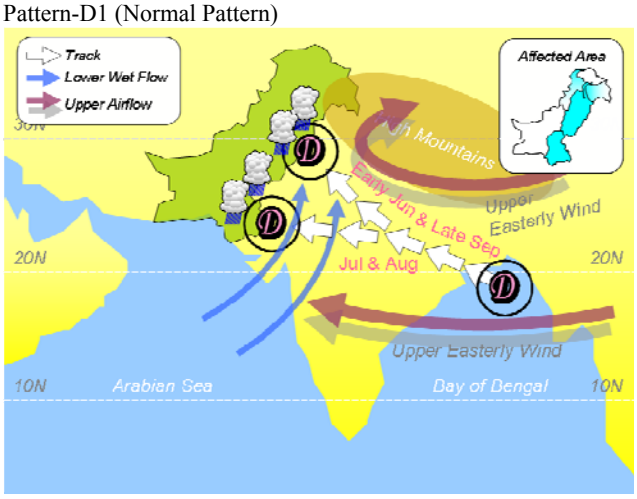
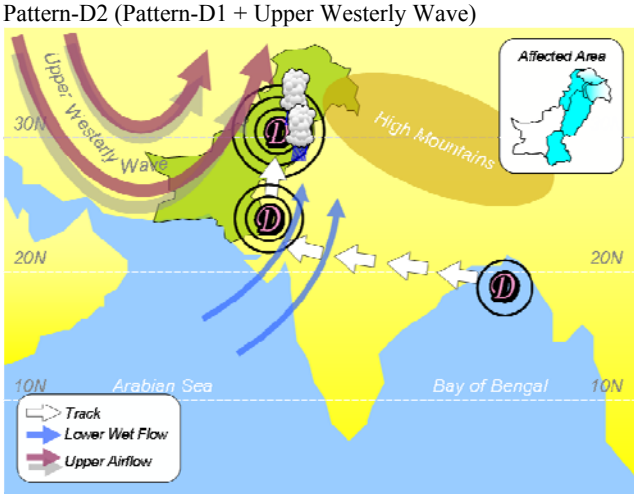
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					←	═	═	→			

Pattern-M1 (Normal Pattern) 	Mechanism: 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. More rainfall is expected in the mountainous area due to the orographic effect.
Pattern-M2 (Pattern-M1 + Intense Heat Low) 	Mechanism: 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. More rainfall is expected in the mountainous area due to the orographic effect.
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. 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. In this weather pattern, very much localized rainfall is expected.

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. 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. More rainfall is expected in the mountainous area due to the orographic effect.

1-5 The Existing Meteorological Radar Systems in Pakistan

Information on the existing Meteorological Radar Systems in Pakistan is indicated in the table shown in the next page.

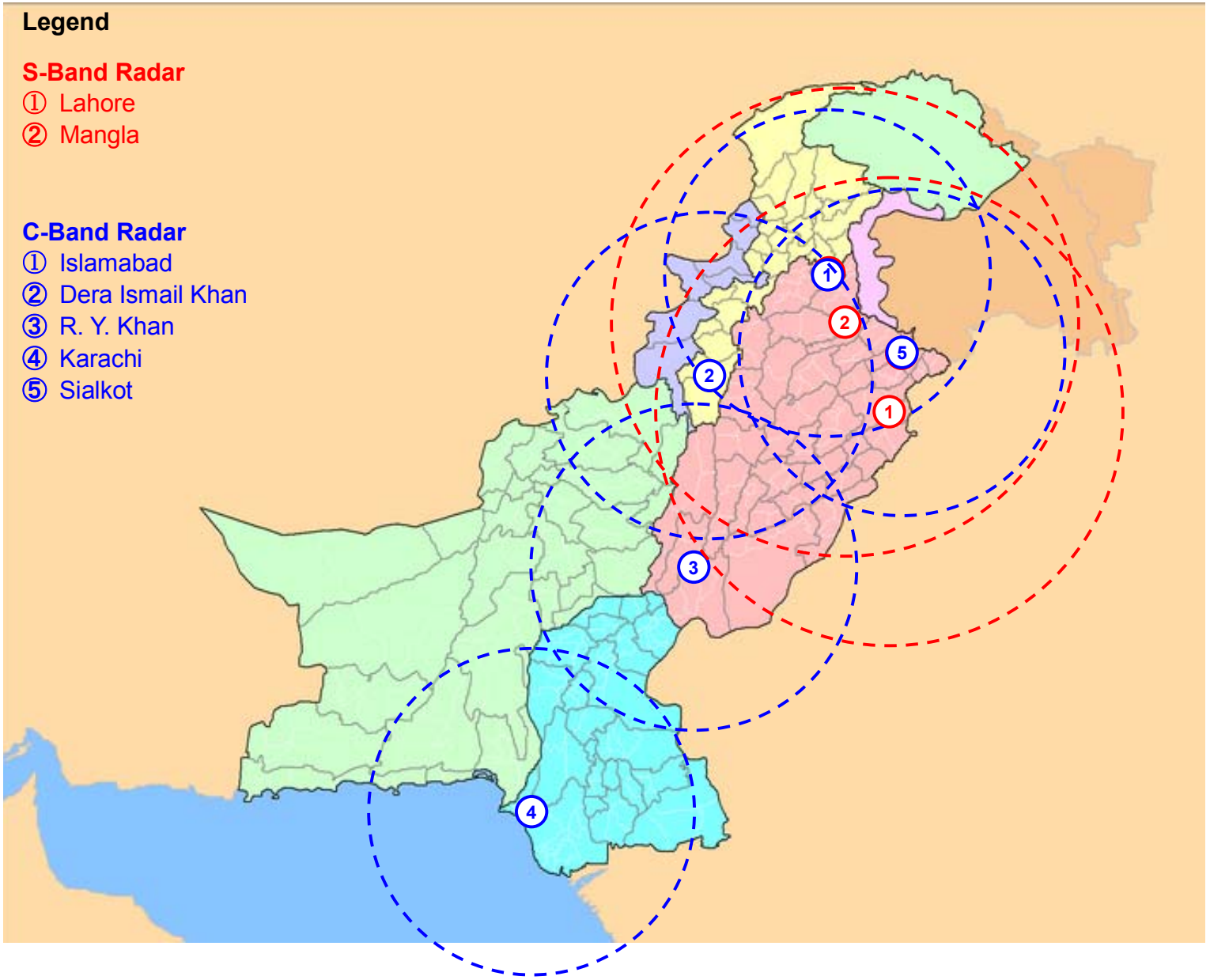


Figure 6: Existing Meteorological Radars (as of February 2018)

Data Source: PMD

Table 4: The Existing Meteorological Radar Systems (as of February 2018)

Radar Station Name	Location Latitude Longitude	Financial Support	Frequency Band	Type (Conventional/ Doppler/ Multi Parameter)	Antenna Diameter	Transmission Type (Magnetron/ Klystron/ Solid State)	Country of Origin Manufacturer	Installation Month & Year	Method of Observation Data Transmission to the Islamabad National Forecasting Centre	Observation Data Processing System	Working Condition (as of August 2017)
Islamabad	N33º 41' E67º 05'	Government of Japan (Grant Aid)	C-Band	Conventional	4 m	Magnetron (Remaining Spare: 0)	Japan Japan Radio Company (JRC)	March 1991	Direct Web Site Uploading	JRC Software	In operation
Karachi	N24º 55' E67º 05'	Government of Japan (Grant Aid)	C-Band	Conventional	4 m	Magnetron (Remaining Spare: 1)	Japan Japan Radio Company (JRC)	March 1991	Direct Web Site Uploading	JRC Software	In operation
Dera Ismail Khan	N31º 49' E70º 56'	Government of Japan (Grant Aid)	C-Band	Conventional	4 m	Magnetron (Remaining Spare: 1)	Japan Japan Radio Company (JRC)	March 1999	Direct Web Site Uploading	JRC Software	Under suspension (It would be made functional by placing the parts from the Islamabad & Karachi Radars)
Rahimyar Khan	N28º 26' E70º 19'	Government of Japan (Grant Aid)	C-Band	Conventional	4 m	Magnetron (Remaining Spare: 0)	Japan Japan Radio Company (JRC)	March 1999	Direct Web Site Uploading	JRC Software	In operation
Lahore	N31º 33' E74º 20'	Asia Development Bank (ADB)	S-Band	Doppler	8 m	Magnetron (Remaining Spare: 0)	USA Enterprise Electronics Corporation (EEC)	1997	Direct Web Site Uploading	Edge Software	In operation
Sialkot	N32º 31' E74º 32'	Asia Development Bank (ADB)	C-Band	Doppler	4 m	Magnetron (Remaining Spare: 0)	USA Enterprise Electronics Corporation (EEC)	2005	Direct Web Site Uploading	Edge Software	In operation
Mangla	N33º 04' E73º 38'	Asia Development Bank (ADB)	S-Band	Doppler	8 m	Magnetron (Remaining Spare: 0)	USA Enterprise Electronics Corporation (EEC)	2004	Direct Web Site Uploading	Edge Software	In operation

1-6 Ten Year Development Plan of the PMD

The enhancement and modernization of the meteorological services in Pakistan are urgent issues to alleviate the negative impact of severe weather and to ensure the people's safety as well as to significantly contribute to the sustainable development of the country. From the viewpoint of the PMD, in order to contribute to the achievement of the government goals indicated in "Vision 2025", which is the long-term national development policy of Pakistan, and the National Disaster Management Plan (NDMP), the Ten Year Development Plan of the PMD (a step towards modernization) has been formulated in 2016 by the PMD. The modernization of a meteorological radar observation network in Pakistan is mentioned in the first chapter (Chapter 1) of the Ten Year Development Plan of the PMD as one of the top priority implementation items. The detailed information on the latest modernization plan currently made by the PMD is indicated in the next page.

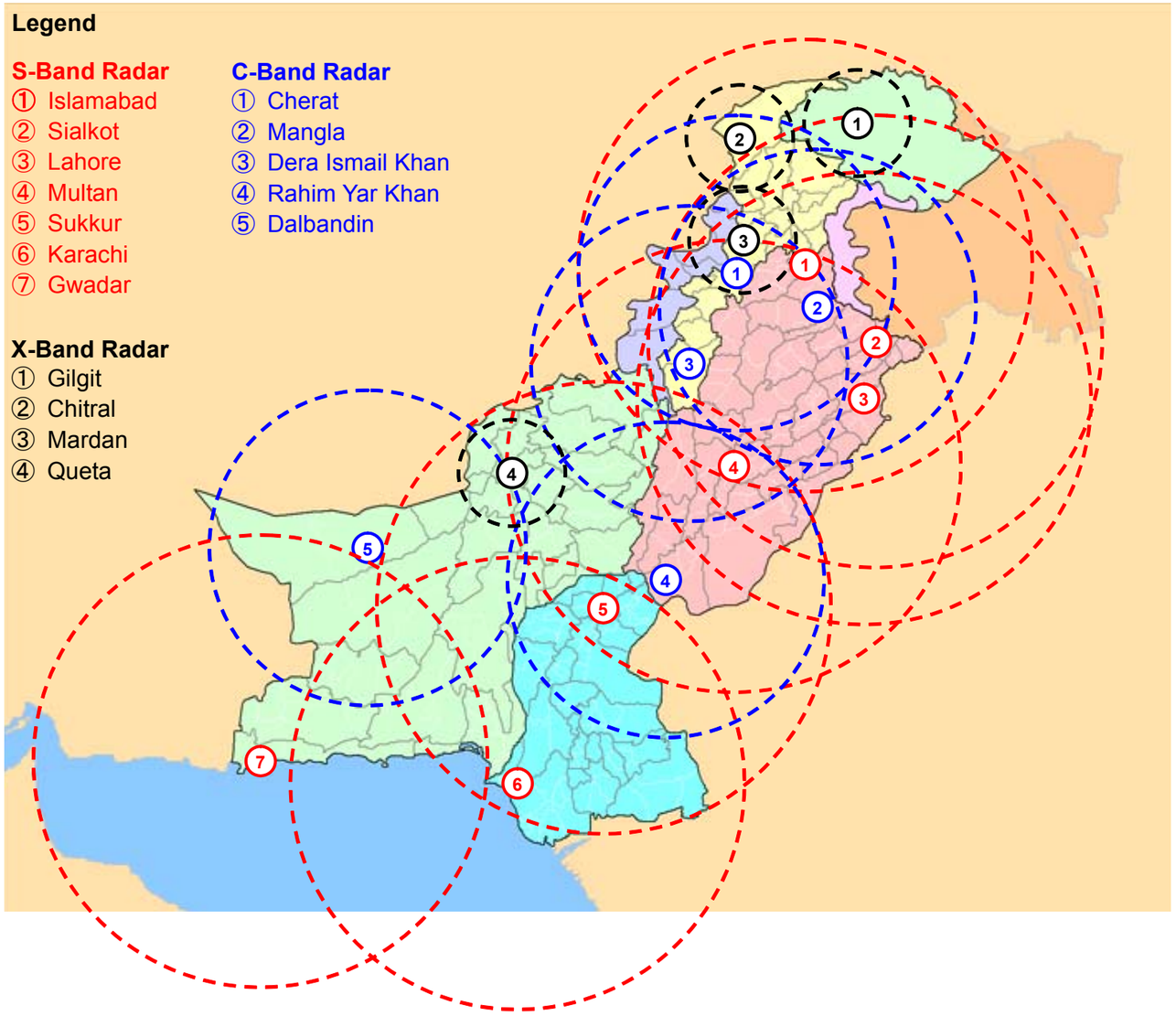


Figure 7: Meteorological Radar Observation Network in Pakistan (as of February 2018)

Data Source: PMD

Table 5: Modernization Plan of Meteorological Radars
Covering the Nationwide Meteorological Radar Observation Network (as of February 2018)

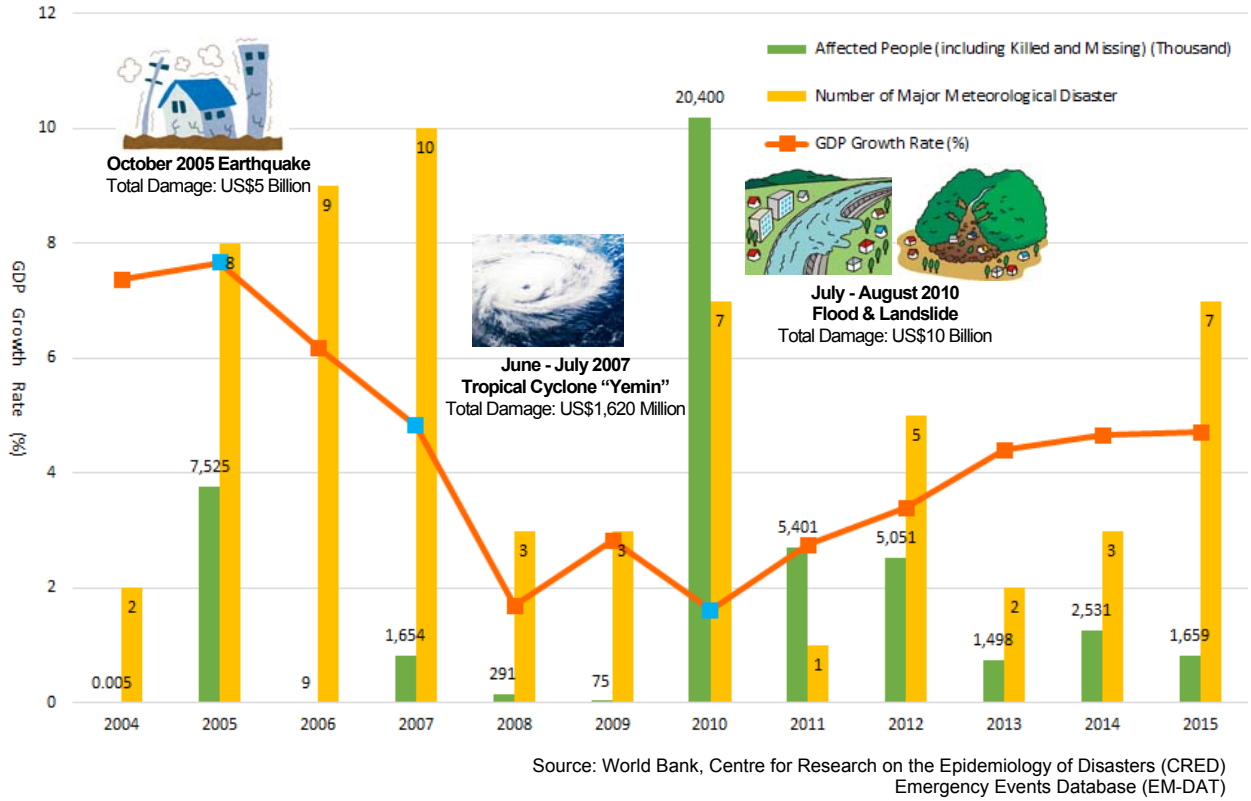
No.	Station Name	Remarks
①	Islamabad	Existing C-Band Ordinary Radar: is being replaced with an S-Band Pulse Compression Solid State Doppler Radar to be provided under the Japan's Grant Aid.
②	Sialkot	Existing C-Band Doppler Radar: to be replaced with an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar through the assistance of the Government of Punjab Province.
③	Lahore	Existing S-Band Doppler Radar: to be hopefully replaced with an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
④	Multan	The preliminary works for the establishment of an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar to be provided under the Japan's Grant Aid is currently at the initial stages.
⑤	Sukkur	It is hoped that the existing Rahim Yar Khan C-Band Ordinary Radar be replaced with an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar in Sukkur through the kind assistance of the Government of Japan.
⑥	Karachi	Existing C-Band Ordinary Radar: is being replaced with an S-Band Pulse Compression Solid State Doppler Radar to be provided under the Japan's Grant Aid.
⑦	Gwadar	Plan to be newly established with a S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
①	Cherat	Plan to be newly established with a C-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
②	Mangla	Existing S-Band Doppler Radar: it is still functional and operational.
③	Dera Ismail Khan	Existing C-Band Ordinary Radar: to be replaced with a C-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
④	Rahim Yar Khan	Existing C-Band Ordinary Radar: it would be made functional and operational by utilizing the useful parts from the Islamabad & Karachi Radars.
⑤	Dalbandin	Plan to be newly established with a C-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
①	Gilgit	Plan to be newly established with an X-Band Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
②	Chitral	Plan to be newly established with an X-Band Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.
③	Mardan	To be newly established with an X-Band Dual Polarization (Polarimetric) Meteorological Doppler Radar (made in China) financed by the Government of Pakistan and to be completed in June 2018.
④	Queeta	Plan to be newly established with an X-Band Dual Polarization (Polarimetric) Meteorological Doppler Radar financed by the World Bank.

Data Source: PMD

1-7 Negative Impact on the Development of the Pakistani Economy

Pakistan has a population of 207 million (Pakistan Bureau of Statistics, 2017 Census) with an annual growth rate of 2.4%, and it is expected to become a country with the world's fourth largest population next to India, China and the United States in 2050. The national GDP is about 271 billion US dollars (2014 World Bank) and the real economic growth rate is 4.71% (Pakistan Economic Survey 2015-16).

The figure below shows the GDP growth rate of Pakistan. It shows that the GDP growth rate drops in the year after Pakistan suffered from serious catastrophic damages caused by a natural disaster. In 2008, the GDP growth rate fell drastically to 1.7% from the previous year since Cyclone "Yemin" hit Pakistan in 2007. The total damages were estimated to be worth around 1,620 million US dollars. In addition, since the Indus River Flood in 2010, which is one of the most devastating catastrophes in Pakistani history, occurred and caused unimaginable damages to almost the entire nation, the GDP growth rate also dropped to 1.6% in that same year. Furthermore, it has been observed that there is a tendency for the GDP growth rate to drop in inverse proportion to the number of the major meteorological disaster and the affected people (including killed and missing). These dips on the rate of the country's economic growth clearly demonstrate that the damages caused by meteorological disasters interfere with the socio-economic development of Pakistan. It is also important to highlight that the damages in the southern area of Pakistan have serious negative impacts on the economic development of the whole country since the Sindh state is the second-most populous state and its GDP accounts for about 30% of the country's GDP.



Source: World Bank, Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT)

Figure 8: GDP Growth Rate of Pakistan and Meteorological Disaster

1-8 Brief Summary on the Request for the Project by Pakistan

The Government of Pakistan adopted a national approach toward the strengthening of disaster prevention systems focusing on disaster prevention and damage mitigation such as the promulgation of the National Disaster Management Ordinance (NDMO), the establishment of the National Disaster Management Authority (NDMA) and the formulation of a National Disaster Management Plan under JICA's assistance. In the National Disaster Management Plan, a Multi-Hazard Early Warning System Plan aiming for the establishment and maintenance of the appropriate forecasting/warning system was proposed. For the successful implementation of the Plan, the enhancement of the PMD's observation and forecasting capabilities will be a key point as well as the development of human resources in the field of disaster prevention, dissemination of disaster prevention knowledge to the people and the establishment of flood control facilities, etc. 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.

The PMD currently has four meteorological radar systems (in Islamabad, Karachi, Dera Ismail Khan and the Rahimyar Khan) which had been installed under the Grant Aid of Japan and three meteorological radar systems (in Lahore, Sialkot, Mangra) in the eastern boundary which had been installed under the assistance of the Asian Development Bank. Due to the functional deterioration of the Islamabad, Karachi, Dera Ismail Khan and the Rahimyar Khan meteorological radar systems, the replacement of the Islamabad and Karachi meteorological radar systems with a new meteorological radar systems (S-Band) are being implemented by the Grant Aid of Japan. Since the PMD is unable to accurately observe the rain clouds that cause concentrated torrential rain in the wide area of Punjab Province and the thunderstorm accompanied by cumulonimbus and heavy rain around the Sulaiman Range during the Monsoon season invading Pakistan from India, it is actually difficult for PMD to appropriately reflect heavy rain information in flood forecasting and warnings. Moreover, in order to complement the observation range of the Dera Ismail Khan and the Rahimyar Khan Meteorological Radar Systems, which have almost become obsolete and likely to stop further operation, there is a dire need to create a tangible alternate solution to the problem. It is worth to mention that Multan city is in close proximity with the Indian border and beyond the border, there is scanty meteorological data available to the PMD. As a result, the PMD is facing great difficulty in the issuance of timely weather/flood forecasts and warning to the public. Therefore, it is urgently necessary to establish a new meteorological radar system in Multan.

In July 2015, the Government of the Islamic Republic of Pakistan made a request to the Government of Japan for a Grant Aid for "The Project for Installation of Weather Surveillance Radar at Multan in the Islamic Republic of Pakistan" (hereinafter referred to as "the Project"). In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Installation of a Weather Surveillance Radar at Multan (hereinafter referred to as the "Preparatory Survey"). The Japan International Cooperation Agency (hereinafter referred to as "JICA") sent the Preparatory Survey Team to Pakistan in order to conduct the Preparatory Survey from July 8 to August 26, 2017. The Team had a

series of discussions with the officials concerned from the Government of Pakistan, conducted surveys and collected necessary and pertinent information and data for the Project. In addition, the Team conducted further studies, including a feasibility study focusing on the justification and scope of the Project paying particular attention to the present situation in Pakistan from various perspectives such as the operation & maintenance capabilities of the PMD, best equipment arrangement plan, etc.

JICA sent the Preparatory Survey Team again to Pakistan from February 7 to February 18, 2018 in order to explain and discuss the outline design & draft survey report. During the course of discussions and field surveys, it was confirmed that the requested items are indeed required for the Project in consideration of the Project's objectives and effects.

As a consequence of the further study 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.

Table 6: Object Items of the Preparatory Survey

Component	Multan Meteorological Radar Observation Station	National Weather Forecasting Centre, PMD Islamabad Head Office	Meteorological Office in the Multan International Airport, PMD Multan	Flood Forecasting Division (FFD), PMD Lahore
Procurement and Installation of Equipment				
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	-	-	-
Meteorological Radar Central Processing System	-	1	-	-
Meteorological Radar Data Display System	1	1 (including Radar Picture Composite Processor and Radar Web Server)	1	1
Meteorological Data Communication System	1	-	1	-
Construction of Radar Tower Building				
Radar Tower Building	1	-	-	-
Technical Training	Initial operation guidance included in the contract of the manufacturer			
Soft Component				

During the study period indicated above, a comparison between a steel structure and a reinforced concrete structure for a radar tower building was conducted since steel structure radar tower buildings (Japan: for a C-Band radar system) are available in Japan and other overseas countries. Key points considered were construction cost, undertakings to be borne by the Pakistan side, possible technical issues during construction works, construction period and etc. As a consequence of the comparison, it was decided that

a reinforced concrete structure will be the best option to be used for the construction of the Multan Radar Tower Building due to the following reasons: (1) a steel structure building is uncommon in Pakistan; (2) construction cost and expenditures for the Pakistan side will be cheaper; (3) and, finally, taking into account the Pakistani side expression of their strong demand to use a reinforced concrete structure.

Table 7: Comparison between a Steel Structure and a Reinforced Concrete Structure for Radar Tower Building

Items of Comparison	Steel Structure Radar Tower Building	Reinforced Concrete Structure Radar Tower Building
Structure	Steel pipe truss structure is required (Total Weight: 250 Tons).	Reinforced concrete structure which is commonly used in Pakistan.
Procurement of the Main Structural Materials	Import of main structural materials from Japan or Third Countries (south-eastern Asia) is required.	100% local procurement.
Utilization of a Local Construction Company for the Radar Tower Building Construction	■ No possibility to utilize a local construction company as a sub-construction company under a Japanese prime contractor for the construction of the main structure of the Radar Tower Building. ■ Specialized steel workers of Japan or a third country are necessary for the steel structures erection.	Since the reinforced concrete structure is commonly used in Pakistan, the utilization of a local construction company as a sub-construction company under a Japanese prime contractor for the construction of all of the Radar Tower Building is highly possible.
Necessity of Marine Transportation of the Main Structural Materials	Marine transportation of the main structural materials from overseas is indispensable and marine transport cost is quite high.	Not required.
Custom Clearance & Duty	Custom clearance and duty exemption or paying tax by the recipient country is required	Not required.
Inland Transport in Pakistan for Construction Materials	Since inland transport of the steel pipe truss structure (Total Weight: 250 Tons) from the Karachi Seaport is required, inland transportation cost is quite high.	Since aggregate (sand and gravel) can be procured near the project site, inland transport cost is not high.
Total Construction Period after signing of the contract	18-19 months	19 months
Corrosion on the Main Structures including Stairs Structures	Due to the provision of high corrosion treatment to the steel materials and appropriate supervision, salt corrosion on the main structures is less likely.	Due to appropriate supervision, salt corrosion is less likely.
Periodic Painting	Periodic painting to the construction materials (bolts, nuts, connection parts, etc.) which are not provided with high corrosion treatment is required.	Periodic painting is not indispensable.
Material Storage Space and Crane Vehicle	Since there is no space to temporarily store steel frames on the proposed Project Site in Multan, it is required to secure a provisional space located near the site, a 20 tons sized crane for unloading/loading and a 100 tons sized crane for the steel structure erection.	A compact/middle size crane vehicle and a tower crane are widely utilized for the construction of reinforced concrete structure buildings.

1-9 Project Site Location Information

Table 8: Project Site Location Information

Name of Site	Proposed Project Site for the Multan Meteorological Radar Observation Station	National Weather Forecasting Centre、PMD Islamabad Head Office	Meteorological Office in the Multan International Airport, PMD Multan	Flood Forecasting Division (FFD), PMD Lahore
Latitude	N30º 18'21.8"	N 24º 55'58.9"	N30º 11'53.91"	N 31º 32'33.1"
Longitude	E71º 28'21.7"	E 67º 08'32.8"	E71º 25'24.54"	E 74º 19'29.5"
Altitude	124 m	39 m	122 m	163 m

1-10 Stability of Commercial Power

Stability tests measuring commercial power through 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, and etc. are indispensable for the Project.

Table 9: Stability of Commercial Power (Measured by a Power Quality Analyzer)

Name of Site		Proposed Project Site for construction of the Multan Meteorological Radar Tower Building
Commercial Power (Voltage: Nominal)		230V, 50Hz, Single-phase 3-wire
Voltage (V)	Max.	223.7
	Min.	88.8
	Average	176.9
Frequency (Hz)	Max.	50.7
	Min.	49.3
Frequency of Electric Outage	May - October	Twice/day (Approx. for 6 - 12 hour/s / 1 power stoppage)
	November - April	Once/day (Approx. for 2 hours / 1 power stoppage)
Frequency of instantaneous voltage drop below 150 V	Daytime	Six times/hour
	Nighttime	Twice/hour

1-11 Existing Internet Connection

Table 10: Internet Connection of PMD

Site	PMD Islamabad Head Office		PMD Gilgit Meteorological Office	PMD Multan Meteorological Office
Service Provider	NTC	NAYATEL	NTC	NTC
Connection Type	Optical Fiber (Shared line)	Optical Fiber (Shared line)	DSL (Shared line)	DSL (Shared line)
Fixed IP Address	○	○	×	×
Contract Speed (bps)	10 M	3 M (Spare line)	1 M	1 M

Site	PMD Flood Forecasting Division, Lahore	PMD Lahore Regional Meteorological Centre	PMD Karachi Tropical Cyclone Warning Center	Meteorological Office Karachi International Airport
Service Provider	NTC	NTC	NTC	NTC
Connection Type	Optical Fiber (Shared line)	Optical Fiber (Shared line)	Optical Fiber (Shared line)	Optical Fiber (Shared line)
Fixed IP Address	○	○	○	×
Contract Speed (bps)	4 M	2 M	4 M	2 M

1-12 Natural Conditions of Multan

Multan, the proposed Project Site for the construction of the Multan Meteorological Radar Tower Building, is the sixth biggest city in Pakistan. Since it is located to the east of the Chenab River in the Indus River tributary and at the centre on the map of Pakistan, it is a key hub of traffic that collects land, rail and airways. Since it is very hot in the summer, sandstorms also occur. The maximum temperature in the summer between 1981 and 2010 is 50 degrees, the lowest temperature in winter is -1.6 degrees, and the annual mean precipitation is 210 mm. The highest monthly rainfall amount of 217 mm was recorded in August 1992. The following table show the local climate of Multan between 1981-2010.

Table 11: Local Climate of Multan between 1981-2010

Month	Precipitation (mm)							Sunshine	Mean Temp. (°C)	Maximum Temperature (°C)			
	Mean	Wettest Month		Rainy Days	Heaviest fall in 24 hrs.					Mean	Highest		
		Amount	Year		Extreme	Date	Year	Hours			Extreme	Date	Year
January	7.6	37.9	2005	1.2	30.9	01	2005	197.9	12.9	20.5	28.3	25	1990
February	15.5	87.8	2007	2.6	44.3	13	2007	198.9	16.0	23.5	32.2	10	1993
March	18.4	55.4	2006	3.1	50.1	26	2006	243.9	21.2	28.8	39.5	23	2010
April	14.2	61.5	1995	3.2	38.5	06	1985	272.2	28.4	35.9	44.7	19	2010
May	11.9	47.0	1983	2.2	51.0	06	2010	287.0	33.2	41.0	50.0	28	2010
June	13.1	68.9	1986	1.9	47.1	30	2007	259.8	35.4	42.1	49.8	08	1994
July	49.6	209.5	1993	3.6	83.4	25	2010	255.0	34.0	39.1	47.5	01	1995
August	41.8	217.3	1992	2.8	127.0	19	1992	269.1	32.4	37.5	42.7	03	1998
September	24.6	201.5	1992	1.5	88.5	08	1992	267.9	30.9	36.6	42.5	26	1987
October	5.6	112.5	1997	0.7	23.5	10	1997	261.1	26.4	34.1	40.3	01	2000
November	1.2	15.2	1981	0.5	12.6	10	1999	234.3	20.2	28.6	35.0	01	1999
December	5.7	77.9	2008	1.2	34.5	20	2008	208.7	14.8	22.9	29.5	03	1998
Annual	210.7	513.2	1992	24.5	127.0	19/08	1992	2,952.5	25.3	32.5	50.0	28/05	2010

Data Source: PMD

1-13 Topographic and Geotechnical Surveys

The topographic and geotechnical surveys indicated in the following tables were implemented by a local contractor consigned by the Preparatory Survey Team.

Table 12: Topographic Survey

Required Works	• Position of the existing building, observation facility, observation field • Bearing survey of the magnetic north • Calculation of the area planned
	• Plane surveying (0.5 m contour line) - Position of the existing facilities (electrical lines, water lines, telephone lines, sewage, public roads, fences, vegetation, trees: more than 4 m height, streetlights, manholes and other features)
	• Longitudinal profile and cross section - Indication of ground level at intervals of 10 m - Public roads, ponds, river and each water level - Setting bench marks
Required Products	• Plane surveying map • Longitudinal profile and cross section • AutoCAD data file in CD-ROM

Table 13: Geotechnical Survey

Boring (All core boring)	Required number of borings: 3 Maximum depth of borings: 40 m (Borings shall be extended to a more suitable bearing layer for a building construction even if borings have reached more than a depth of 40 m. After reaching the bearing layer, borings shall be continued to a depth of at least 5 m.)
Collecting soil samples	• Undisturbed soil sampling: 3 samples (at different levels) × 3 holes • Disturbed soil sampling: 3 samples (at different levels) × 3 holes • Adoption of standard: ASTM or JGS-Japanese geotechnical society
Standard Penetration Test	At intervals of every 1 m till the bottom of each borehole
Laboratory Testing	Density Test of Soil Particle, Particle Size Distribution, Specific Gravity, Water Content , Liquid Limits, Plastic Limits, Unconfined Compression Test and Consolidation Test
Required Products	Geotechnical Survey Report: expected soil bearing capacity and calculation of consolidation coefficient

Table 14: Geotechnical Survey Result of the Proposed Project Site for Multan Meteorological Radar Observation Station

Boring No.	Depth (m)	Soil Type	N-value
BH-1	0.0-2.0	Fine sand	5
	2.0-4.0	Silty sand	6
	4.0-18.0	Silty sand	12
	18.0-40.0	Silty sand	>50
BH-2	0.0-2.0	Sandy shale	8
	2.0-21.0	Silty sand	8-32
	21.0-40.0	Silty sand	>50
BH-3	0.0-3.5	Silty sand	7-9
	3.5-22.5	Silty sand	8-35
	22.5-40.0	Silty sand	>50

1-14 Consideration for Environmental Conservation

The Project would be assessed as category C in the environmental and social consideration guidelines of JICA.

Since it was confirmed by the PMD with the Environmental Protection Agency (EPA) in the Punjab Province that an Environmental Impact Assessment (EIA) permit is not required for implementation of the Project, the PMD has prepared Initial Environmental Examination (IEE) on the Project “Installation of Weather Surveillance Radar at Multan in the Islamic Republic of Pakistan” and submitted it to the EPA for obtaining the No Objection Certificate (NOC).

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal

The damages and adverse effects caused by natural disasters in Pakistan are mitigated and reduced through the improvement of the general infrastructure of Pakistan via PMD's improved capability for meteorological observation, forecast/warning accuracy, and ability to promptly and timely disseminate weather information (forecast/warning) to the proper channels and to all the stakeholders.

2-1-2 Project Objective

The key objective of the Project is to enable the PMD to be capable in providing highly accurate meteorological observations on the wide area of the Punjab Province and India side, and to ensure the stable and sustained supply of weather and flood forecast/warnings to the general public through the establishment of a new meteorological radar system in Multan.

2-1-3 Basic Concept of the Project

The PMD will be able to greatly contribute to the mitigation and reduction of the devastations generated by disasters caused by hazardous meteorological phenomena such as heavy rain through the improvement of the weather & flood information and forecasts & warnings released by the PMD by means of strengthening their monitoring capability of hazardous weather phenomena through the provision of technical support and the establishment of S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Doppler Meteorological Radar System at Multan in the Punjab Province including the associated Meteorological Radar Central Processing System, Meteorological Radar Data Display Systems and Meteorological Data Communication Systems under the Project.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Policy of the Project

a) To design a meteorological observation system to contribute to natural disaster (mainly flood 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 severe weather conditions 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 design the equipment so that the meteorological radar system assumes a significant role in the severe weather detecting network of Pakistan.
b) To ensure that the equipment is compatible with and meets the technical requirements of the World Meteorological Organization (WMO).
c) To ensure that the equipment is suitable for the routine observation and forecasting work of the PMD.
d) To design the Multan 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.
e) To design the Multan 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.
f) To design the system in such a way that all the data produced by the Multan Meteorological Radar System are delivered to the National Weather Forecasting Centre, PMD Islamabad Head Office and Flood Forecasting Division (FFD), Lahore every 10 minutes.
g) To design the system so that it is within the PMD's capability to operate, maintain and repair.
h) To select equipment for which spare parts and consumables can be easily procured and replaced.
i) To select reliable and durable equipment suitable for the local environment.
j) To minimize the recurrent costs of the PMD for the operation, maintenance and repair of the equipment.
k) To ensure the accuracy of radar data through meticulous adjustment and proper calibration (optimization of radar ZR relation parameter for rainfall calculation).
l) To design the equipment so as to minimize lightning damage.

m) To have the necessary power supply back-up equipment (diesel generator, radar power backup unit, auto voltage regulator, etc.) for performing around-the-clock meteorological services 24 hours a day, 365 days a year.
n) To design the equipment to operate using 230V Single Phase 2-Wire/400V 3-Phase 4-Wire ±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 radar tower buildings by the design wind pressure is not more than 1/1000 of the height of radar tower building.
c) To adopt the design wind pressure: 6kN/m^2 and the seismic zone factor: Z=0.15 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.
h) To adapt to the routine work system and implementation method of the PMD.

(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

Meteorological data should be transmitted and received even during the occurrence of very heavy rains. A maintenance staircase is located at the centre 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 the rainy season.

3) Flood

The proposed Project Site in Multan for construction of Multan Meteorological Radar Tower Building is located very near to the irrigation canal (width: approximately 20 m). Therefore, the ground floor of the radar tower building will be built high enough to minimize any possible damage due to flooding.

4) Lightning

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

- Installation of lightning rod(s) at the top of the Radome
- Installation of roof-ridge lightning conductors at the Radome Roof and the Observation Deck
- Installation of a down grounding conductor at the centre of the Radar Tower Building
- Installation of a down lightning conductor at each of the 4 major columns of the Radar Tower Building
- Adoption of a Ring Earth Electrode Method

5) Wind

For calculation of the design wind pressure: 6kN/m^2 of the Building Code of Pakistan-Seismic Provisions-2007 will be utilized.

6) Earthquake

For calculation of the seismic zone factor: Z=0.15 and the importance factor (I) = 1.25 of the Building Code of Pakistan-Seismic Provisions-2007 will be applied.

7) Load Bearing Layer

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

Table 15: Foundation Type of the proposed Multan Meteorological Radar Tower Building

	Multan 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 building:

- 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 lightening required.
- Usage of LED for artificial lightening.
- Incorporation of solid-state parts into the radar system to reduce the cost and frequency of parts replacement.

(6) Design Policy for Equipment & Building Grade

To ensure the uninterrupted dissemination of forecasts and warnings to the public, the equipment and the radar tower 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 made in Japan. The Project components consist of the procurement and installation of meteorological observation & communication equipment as well as the associated construction work (a radar tower building), and it is very important to ensure synergy between them. Since Pakistan experiences monsoon season from June to October, it is necessary to consider the influence of rainfall in the course of the implementation schedule in the construction and equipment installation stages.

2-2-2 Basic Plan

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

Table 16: Equipment and Facilities Determined from the Preparatory Survey

Component	Multan Meteorological Radar Observation Station	National Weather Forecasting Centre, PMD Islamabad Head Office	Meteorological Office in the Multan International Airport, PMD Multan	Flood Forecasting Division (FFD), PMD Lahore
Procurement and Installation of Equipment				
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	-	-	-
Meteorological Radar Central Processing System	-	1	-	-
Meteorological Radar Data Display System	1	1 (including Radar Picture Composite Processor and Radar Web Server)	1	1
Meteorological Data Communication System	1	-	1	-
Construction of Radar Tower Building				
Radar Tower Building	1	-	-	-

(1) Equipment Plan

1) S-Band Pulse Compression Solid State Dual Polarization Meteorological Doppler Radar System

A meteorological radar system is the only system able to observe in real time the occurrence, movement, distribution and intensity of rainfall, and meteorological phenomena related to rainfall, and to provide quantitative measurements over a large area in real time. In order to ensure stable operation, there is a strong demand that a meteorological radar uses solid state components instead of klystrons and magnetrons which are currently being used and which requires periodic replacement and maintenance & inspections due to their shorter operation life.

The S band radar system has several important characteristics, including lower attenuation by rain and the atmosphere than other types of radar, and the ability to transmit at high power, providing a “long range”, “real time” system.

A meteorological Doppler radar system transmits a single type of radio wave and measures the Doppler frequency in addition to the amplitude information, from which the Doppler velocity of raindrops to the

radar system is able to be measured. A dual polarization meteorological Doppler radar system enables the transmission of two types of radio waves which are vertical and horizontal in polarization and obtains various parameters from the signals that are reflected from the raindrops for accurate rainfall estimates, as polarization parameters are closely related with raindrop shape and their drop-size distribution.

Frequency of the S-Band Pulse Compression Solid State Dual Polarization Meteorological Doppler Radar System (wave length: approx. 10 cm) designed to be able to observe a rain cloud in the theoretical observation range with 450 km radius is the Centre Frequency (S-Band), ±5MHz band width to be allocated by the Frequency Allocation Board (FAB) for the PMD. Technical features of the proposed S-Band Pulse Compression Solid State Dual Polarization Meteorological Doppler Radar System (Antenna: approx. 8.5 m diameter, Beam width: not wider than 1.0 degree at -3dB point without Radome) are as follows.

Table 17: Major Features of the proposed S-Band Pulse Compression Solid State Dual Polarization Meteorological Doppler Radar System

Frequency	S-Band (2.7GHz-2.9GHz)
Frequency Band Width	10 MHz (Centre Frequency ±5 MHz)
Wavelength	Approx. 10 cm
Detectable Maximum Range of Precipitation Intensity 1 mm/h	450 km or more
Detectable Maximum Range of Wind Velocity	200 km
Observable Maximum Wind Speed	More than 70 m/s
Transmission Peak Power	10 kW + 10 kW
Dual-polarization Function	Available
Doppler Function	Available
Accumulated Rainfall	Available
Rainfall Data by using Dual-polarization Function	0 - 250 mm/h rainfall intensity quantitative data

In order to accomplish the project targets, the proposed radar system must be S-Band Pulse Compression Solid State Dual Polarization Meteorological Doppler Radar System with approximately 8.5 m diameter antenna (antenna beam angle: not wider than 1 degree) and 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 200 km radius. This will help the PMD to monitor the movement and development of severe weather systems in preparation for a more accurate and timely weather forecast and warning. The Doppler mode is essential to allow for more accurate forecasting and longer forecast prediction times.

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

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

Figure of the "Composite Picture of the Meteorological Radar Observation Network in Pakistan" after the completion of the Project is attached hereunder.

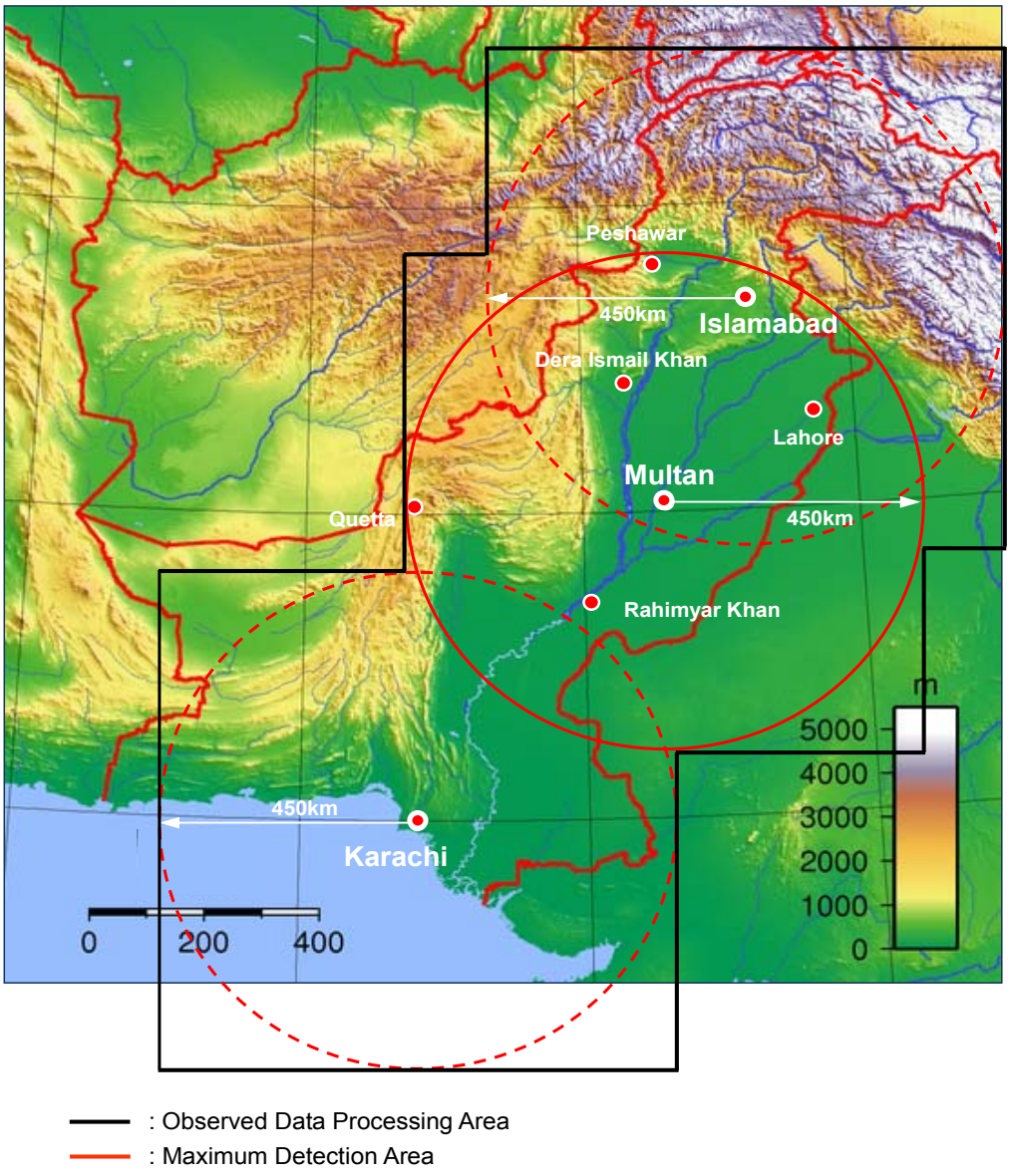


Figure 9: Composite Picture
of the Meteorological Radar Observation Network in Pakistan

2) Meteorological Radar Central Processing System

In order to remotely operate, control and maintain the Multan Radar Observation Station at the National Weather Forecasting Centre, PMD Islamabad Head Office, a system with the following functions is indispensable.

1. Remote control of the radar system
2. Operation monitoring of the radar system
3. Monitoring of the radar observation data for quality control
4. Alteration of the radar system configurations
5. Collection and archive of all the radar observation raw data
6. Adjustment of the signal processing
7. Radar picture composition processing
8. Remote control of air conditioning systems in the radar equipment room
9. Remote control of engine generators
10. Monitoring of the operation environment (equipment and room temperature) in the radar equipment room
11. Security monitoring in the radome room and the radar equipment room
12. Provision of the radar products for posting on the PMD Web site

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 Multan Meteorological Radar Tower Building, the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore 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 longtime 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 not more than 1.0 km mesh.

4) Meteorological Data Communication System

Since all of the meteorological radar data produced by the Multan Meteorological Radar System must be delivered to the National Weather Forecasting Centre, PMD Islamabad Head Office every 10 minutes in view of CAPPI mode observation, the following meteorological data communications are required.

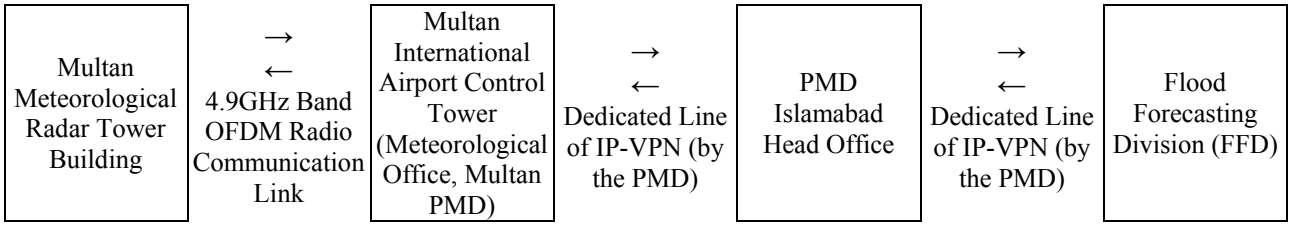


Figure 10: Required Meteorological Data Communications for Transmitting Observational Data of the Multan Meteorological Radar System

In order to transmit observation data of the Multan Meteorological Radar System to the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore, the 12.8 km distance between the Multan Meteorological Radar Tower Building and the Multan International Airport Control Tower (Meteorological Office, Multan PMD) will be connected by a 4.9 GHz digital high-speed communication system (Orthogonal Frequency Division Multiplexing: OFDM).

Since the 4.9 GHz band has been allocated for the disaster management purpose in Pakistan and the Equivalent Isotopically Radiated Power (EIRP = Transmission Power + Antenna Gain) is greater than the 4.9 GHz band than in the 5 GHz band, it is possible to reduce rain attenuation so that there is no problem for a long distance communication. It is also advantageous in avoiding interference with other communication equipment in the future. Given the above, a 4.9GHz Band high-speed communication link (OFDM) should be used.

Table 18: Features of 4.9GHz Band OFDM Transmission System

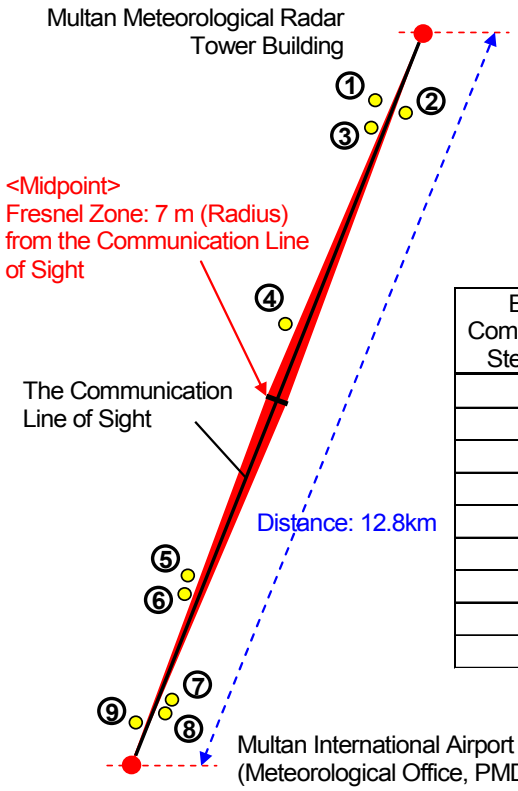
Items	4.9GHz Band OFDM Radio Communication Link
Frequency	4.9GHz Band (4,910-4,990MHz)
Data Transmission Rate (Max.)	6Mbps-300Mbps
Transmission Power	Max 100 mW
Modulation Method	BPSK/QPSK/16QAM/64QAM
Power Consumption	Not more than 13W
Communication Fee	Free
Reliability and Durability	High
Maintainability	Easy
Maintenance Cost	Low
Radio Interference	There is almost no possibility of interference

The OFDM transmission system of the 4.9GHz Band has the following advantages.

- No interference from other ordinary Wi-Fi devices.

- Provides a data rate of up to 300Mbps.
- The specifications and modulation standard of an OFDM radio communication equipment is based on the International Standard IEEE802.11j (IEEE: The Institute of Electrical and Electronic Engineers under the International Telecommunication Union, ITU).
- The system has a 10Base-T/100Base-T Ethernet Interface and runs the TCP/IP protocol for easy networking and expandability.
- The system has a two-way communication function for data collection and remote control & monitoring of the system.
- Deploying a microwave system allows the use of a high gain antenna which is smaller and lighter than an ordinary Yagi antenna.
- No attenuation by rain virtually is available.
- The advantage of OFDM radio has robustness against multi pass fading and narrow band interference.

In order to establish a 4.9GHz Band OFDM Radio Communication Link at about 12.8 km between the Multan Meteorological Radar Tower Building and the Multan International Airport Control Tower (Meteorological Office, Multan PMD), confirmation of the existing obstructions which are higher than the tropical trees (about 20 m in height) and located around the Communication Line of Sight was conducted. As a result, the existing 9 truss structure communication towers were confirmed, but since there is no one in contact with the Fresnel Zone of OFDM Radio Communication Link, it was judged that there is no problem in establishing a radio communication link. The approximate positions of the existing communication steel towers and the distance from the Communication Line of Sight are summarized in the figure attached at the right side.



Existing Communication Steel Tower	Distance to the Communication Line of Sight
①	289m
②	132m
③	39m
④	102m
⑤	75m
⑥	22m
⑦	58m
⑧	71m
⑨	53m

Figure 11: Positions of the Existing Communication Steel Tower and the Distance from the Communication Line of Sight

In addition, between the Meteorological Office in the Multan International Airport and the National Weather Forecasting Centre, as well as the National Weather Forecasting Centre and the Flood Forecasting Division (FFD), the virtual

dedicated links (Internet Protocol Virtual Private Network: IP-VPN) which are planned to be established by the PMD will be used. The existing shared links the PMD currently uses and the required virtual dedicated links (Internet Protocol Virtual Private Network: IP-VPN) for transmitting observation data of the Multan Meteorological Radar System to be additionally established by the PMD are indicated in the following table.

Table 19: Dedicated Link to Be Newly Established by the PMD for Transmitting Observational Data of the Multan Meteorological Radar System

Condition	Existing Shared Link	Additional Dedicated Link to be Established by the PMD
Site	National Weather Forecasting Centre, PMD Islamabad Head Office	
Connection Type	Shared Link of Internet Optical Fiber Connection	Dedicated Link of IP-VPN Optical Fiber Connection
Fixed IP Address	○	○
Contract Speed (bps)	10 M (Effective Speed: approx. 50% of the Contract Speed)	4 M + 4 M (Effective Speed: approx. 50% of the Contract Speed)
Site	Meteorological Office in the Multan International Airport, PMD Multan	
Connection Type	Shared Link of Internet DSL Connection	Dedicated Link of IP-VPN DSL Connection
Fixed IP Address	×	○
Contract Speed (bps)	1 M (Effective Speed: approx. 50% of the Contract Speed)	4 M (Effective Speed: approx. 50% of the Contract Speed)
Site	Flood Forecasting Division (FFD), PMD Lahore	
Connection Type	Shared Link of Internet Optical Fiber Connection	Dedicated Link of IP-VPN Optical Fiber Connection
Fixed IP Address	○	○
Contract Speed (bps)	4 M (Effective Speed: approx. 50% of the Contract Speed)	4 M (Effective Speed: approx. 50% of the Contract Speed)

Since an IP-VPN has some advantages such as "definition of routing path, quick fault detection and switching alternative path" as indicated in the following figure, an IP-VPN also gives subscribers stable and fast data communication. Although the data communication speed of the IP-VPN depends upon the number of users and frequency of use, the network speed is hardly significantly affected by the

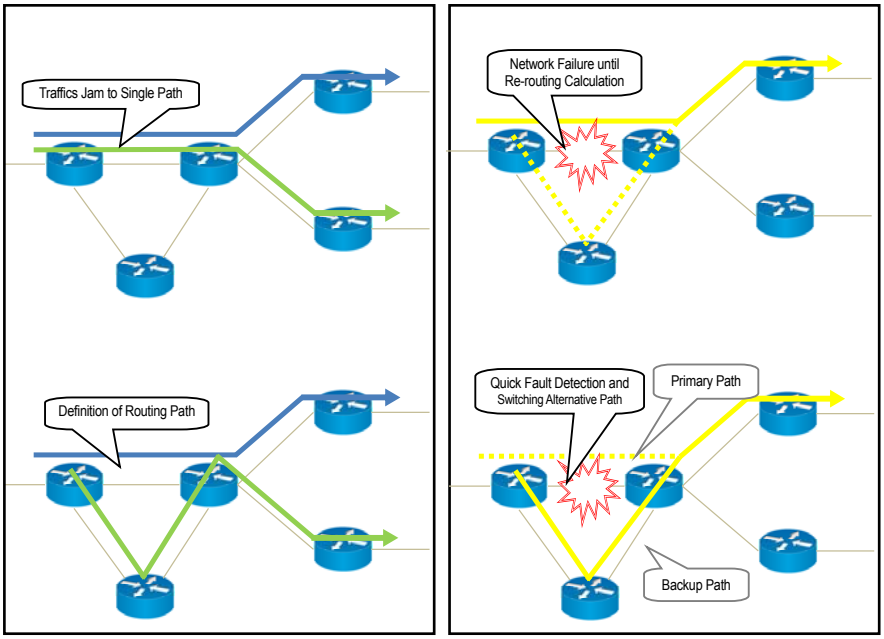


Figure 12: Definition of Routing Path and Quick Fault Detection & Switching Alternative Path

usage of other subscribers since an IP-VPN is only utilized by certain subscribers of the closed network of telecommunications carriers using Internet Protocol. Furthermore, it is possible to decrease the threat of cyber-attacks due to the utilization of an IP-VPN.

The required data communication speed, data volume of Long & Short Range Observation and duration of the radar data transmission (selectable radar observation schedule for the radar data transmission within 10 minutes) by the Meteorological Data Communication System and IP-VPN are indicated in the following tables.

Table 20: Data Volume of Long Range Observation (S-Band: 450 km)

Item	Unit	Azimuth Resolution Angle (Number of Azimuth Sectors)					
		0.7° (360°/0.7=512)			1.0° (360°/1.0=360)		
		Range Resolution Length (Number of Range Sectors)					
		150 m (3000)	300 m (1500)	500 m (900)	150 m (3000)	300 m (1500)	500 m (900)
Header Data Volume	byte	512					
Observation Data Volume (Azimuth Sectors × Range Sectors×2byte)	byte	3,072,000	1,536,000	921,600	2,160,000	1,080,000	648,000
Total Angle Data Volume (Azimuth Sectors × 32 byte)	byte	16,384			11,520		
Single Scan Data Volume of Long Range Observation (A)*1	byte	3,088,896	1,552,896	938,496	2,172,032	1,092,032	660,032

*1 Single Scan Data Volume of Long Range Observation (A): Data type: Radar Reflectivity (Z)

Table 21: Data Volume of Short Range Observation (S-Band: 200 km)

Item	Unit	Azimuth Resolution Angle (Number of Azimuth Sectors)					
		0.7° (360°/0.7=512)			1.0° (360°/1.0=360)		
		Range Resolution Length (Number of Range Sectors)					
		150 m (1333)	300 m (667)	500 m (400)	150 m (1333)	300 m (667)	500 m (400)
Header Data Volume	byte	512					
Observation Data Volume (Azimuth Sectors × Range Sectors×2byte)	byte	1,364,992	683,008	409,600	959,760	480,240	288,000
Total Angle Data Volume (Azimuth Sectors × 32 byte)	byte	16,384			11,520		
Single Scan Data Volume of Short Range Observation (B) *2	byte	8,291,328	4,199,424	2,558,976	5,830,752	2,953,632	1,800,192
Compressed (C) *3	byte	6,218,496	3,149,568	1,919,232	4,373,064	2,215,224	1,350,144

*2 Single Scan Data Volume of Short Range Observation (B): Radar Reflectivity (Z), Doppler Velocity (V) , Spectrum Width (W), Differential Reflectivity (ZDR), Differential Phase Shift (φDP), Polarimetric Correlation Coefficient (ρHV)

*3 Compressed Single Scan Data Volume of Short Range Observation: (B) × 0.75 (at least 25% decrease)

Table 22: Effective Speed of Communication Line (S-Band) Required to Transmit Radar Data in 10 Minutes at 2 rpm of Antenna Rotation (S-Band)

Antenna Rotation (rpm)	Number of observations for 10 minutes (Nos.)	Radar Observation Schedule (Nos/10 min)		Effective speed of communication line necessary to transmit radar data in 10 minutes (kbps)					
				Azimuth Resolution Angle (Number of Azimuth Sectors)					
				0.7° (360°/0.7=512)			1.0° (360°/1.0=360)		
		Long Range Observation	Short Range Observation	Range Resolution Length (Number of Range Sectors)					
				150 m	300 m	500 m	150 m	300 m	500 m
2	15	2	10	1,780	901	549	1,252	634	386
		2	11	1,942	983	599	1,366	691	421
		2	12	2,104	1,065	649	1,480	749	456
		2	13	2,266	1,147	699	1,594	807	491
		3	9	1,699	860	523	1,195	605	368
		3	10	1,861	942	573	1,309	662	403
		3	11	2,023	1,024	623	1,422	720	438
		3	12	2,185	1,106	673	1,536	778	473
		4	8	1,617	818	498	1,137	575	350
		4	9	1,779	900	548	1,251	633	385
		4	10	1,941	982	598	1,365	691	420
		4	11	2,103	1,064	648	1,479	748	456

: Radar observation schedule that cannot transmit radar data within 10 minutes at the effective speed of 2048 kbps

The “Schematic Diagram of the PMD Multan Meteorological Observation & Data Communication Network System” is attached hereunder.

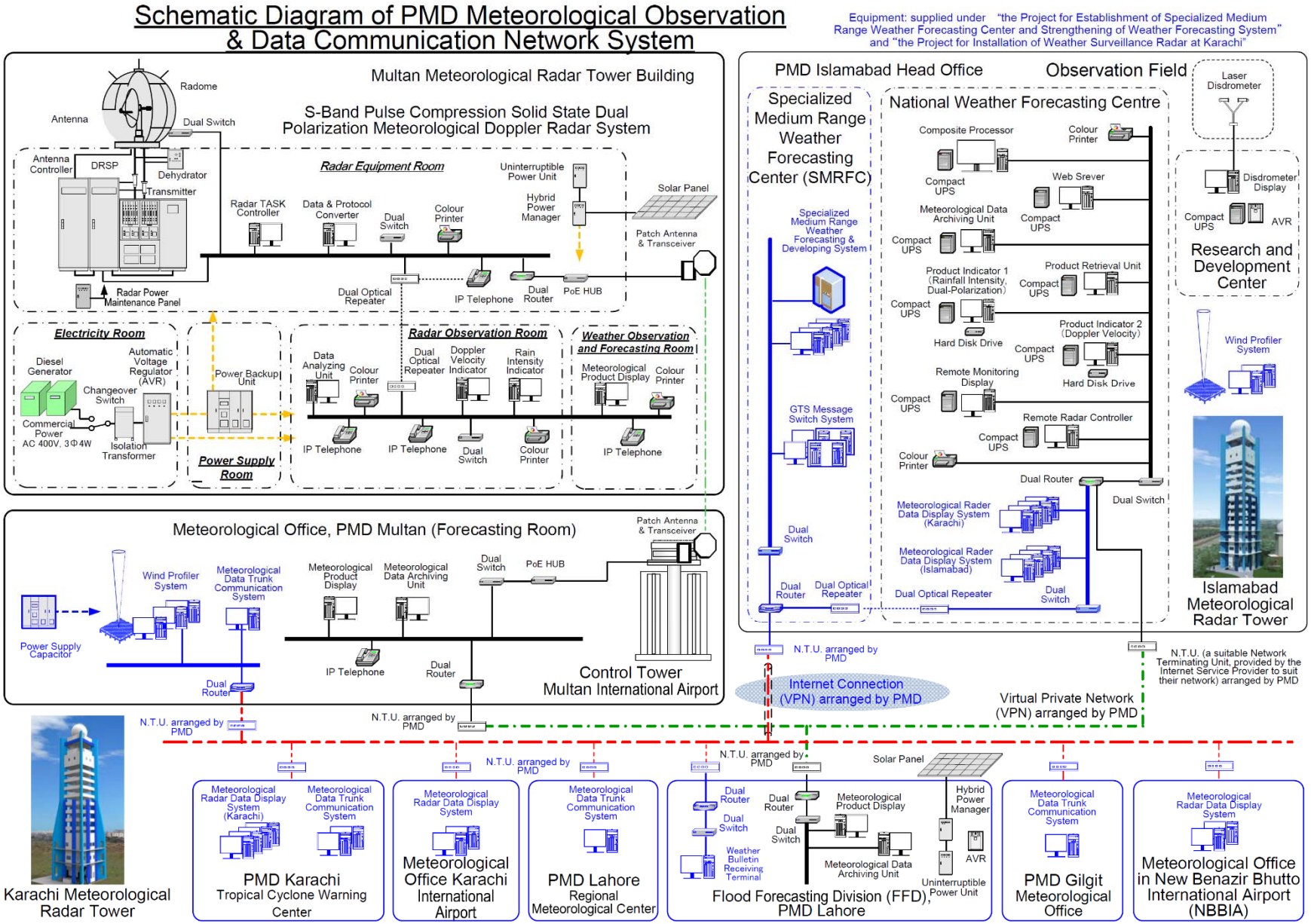


Figure 13: Schematic Diagram of PMD Meteorological Observation & Data Communication Network System

(2) Major Equipment List

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

Table 23: Main Equipment Components

Component	Multan Meteorological Radar Observation Station	National Weather Forecasting Centre, PMD Islamabad Head Office	Meteorological Office in the Multan International Airport, PMD Multan	Flood Forecasting Division (FFD), PMD Lahore
Procurement and Installation of Equipment				
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System including Isolation Transformer, Power Supply Capacitor, Power Back-up System, Lightning System Measuring Equipment and Spare Parts	1	-	-	-
Meteorological Radar Central Processing System	-	1	-	-
Meteorological Radar Data Display System	1	1 (including Radar Picture Composite Processor and Radar Web Server)	1	1
Meteorological Data Communication System	1	-	1	-

Major Equipment List

S-Band Pulse Compression Solid State Dual Polarization Meteorological Doppler Radar System

Name of Site: Multan Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
Radome	1 set	For protecting the radar antenna assembly (a parabolic dish reflector) and the maintenance personnel from severe weather conditions and lightning attacks
Antenna	1 set	For radiating radar beam into the atmosphere and receiving scatter waves while rotating the parabola antenna in azimuth and elevation direction
Antenna Controller	1 set	For rotating the parabolic dish reflector and for controlling the antenna in azimuth and elevation by both horizontal and vertical drive motor units
Transmitter	1 set	For amplifying pulse-modulated power with stable frequency and transmitting the power to the antenna
Digital Receiver and Signal Processor (DRSP)	1 set	For receiving, pulse compression and processing echo signal from the Antenna For suppressing unnecessary echo such as clutter signals reflected from the ground. For sending ingest data to the radar TASK controller
Dehydrator	1 set	For supplying dried and pressurized air into the wave-guide to reduce wave propagation loss
Wave-guide Configuration	1 set	For feeder line propagation of the wave traveling between the antenna and TX/RX
Radar TASK Controller	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
Dual Switch-1		1 set	For connecting all the computer equipment with LAN
Dual Switch-2		1 set	
Color Printer		1 set	For printing radar image
Dual Optical Repeater		1 set	For converting electrical signal and optical signal on LAN for protection against surges
Isolation Transformer		1 set	For protecting each equipment from surges in voltage in the main power
Automatic Voltage Regulator (AVR)		1 set	For supplying constant or regulated voltage to the radar system
Power Backup System		1 set	For supplying uninterrupted power to the radar system when power failure occurs
Polarimetric Test Horn Device		1 set	For maintenance of the system
Spectrum Analyzer		1 set	
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	
Portable Power Supply Unit		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	
	Solid-state power amplifier	2 sets	
	Fan unit for radar equipment	2 sets	
	LAN Arrester	2 sets	
	Obstruction light	2 sets	
	Stabilized local oscillator (STALO)	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 Central Processing System

Name of Site: National Weather Forecasting Centre, PMD Islamabad Head Office		
Equipment	Quantity	Purpose
Remote Radar Controller	1 set	To control radar observation
Remote Monitoring Display	1 set	To monitor the radar tower building and radar system
Compact UPS	2 sets	For supplying back-up AC power to the computer equipment to enable the proper shutdown of the system in case of power failure
Laser Disdorometer	1 set	For maintenance of the system
Spare Parts LAN Arrester	2 sets	For maintenance of the system
Service Manuals	2 sets	For maintenance of the system

Meteorological Radar Data Display System

Name of Site: Multan Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
Rainfall Intensity Indicator	1 set	For generating radar products (Rainfall Intensity, Dual-Polarization) from observed radar data and displaying
Doppler Velocity Indicator	1 set	For generating radar products (Doppler Velocity) from observed radar data and displaying
Data Analyzing Unit	1 set	For analyzing weather phenomena by observed radar data
Meteorological Product Display	1 set	For generating radar products from observed radar data and displaying
Colour Printer	3 sets	For printing radar image
Dual Switch-3	1 set	For connecting all the computer equipment with LAN
Dual Optical Repeater	1 set	For converting electrical signal and optical signal on LAN for surge protection
IP Telephone	4 sets	For voice communication through IP network
Spare Parts LAN Arrester	3 sets	For maintenance of the system
Service Manuals	2 sets	For maintenance of the system

Meteorological Radar Data Display System

Name of Site: National Weather Forecasting Centre, PMD Islamabad Head Office		
Equipment	Quantity	Purpose
Composite Processor	1 set	For generating composite pictures from incoming data of all the radar stations
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
Product Indicator 1 (Rainfall Intensity, Dual-Polarization)	1 set	For generating radar products (Rainfall Intensity, Dual-Polarization) from observed radar data and displaying
Product Indicator 2 (Doppler Velocity)	1 set	For generating radar products (Doppler Velocity) from observed radar data and displaying
Radar Web Server	1 set	For output radar product to Web
Colour Printer	2 sets	For printing radar image
Dual Switch-4	1 set	For connecting all the computer equipment with LAN
Dual Router-1	1 set	For forwarding data packets between computer networks
Compact UPS	6 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
Spare Parts LAN Arrester	6 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 the Multan International Airport, PMD Multan		
Equipment	Quantity	Purpose
Meteorological Product Display	1 set	For generating radar products from observed radar data and displaying
Meteorological Data Archiving Unit	1 set	For archiving observed radar data
Dual Router-2	1 set	For forwarding data packets between computer networks
IP Telephone	1 set	For voice communication through IP network
Spare Parts LAN Arrester	2 sets	For maintenance of the system
Service Manuals	2 sets	For maintenance of the system

Meteorological Radar Data Display System

Name of Site: Flood Forecasting Division (FFD), PMD Lahore		
Equipment	Quantity	Purpose
Meteorological Product Display	1 set	For generating radar products from observed radar data and displaying
Meteorological Data Archiving Unit	1 set	For archiving observed radar data
Dual Switch-5	1 set	For connecting all the computer equipment with LAN
Dual Router-3	1 set	For forwarding data packets between computer networks
Automatic Voltage Regulator (AVR)	1 set	For supplying constant or regulated voltage to the 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 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

Meteorological Data Communication System

Name of Site: Multan Meteorological Radar Observation Station		
Equipment	Quantity	Purpose
OFDM Wireless Transceiver (4.9GHz) Antenna	1 set	To receive and transmit meteorological information and observed data
PoE HUB	1 set	To supply electric power to OFDM Wireless Transceiver over Ethernet cable
Dual Router-4	1 set	For forwarding data packets between computer networks
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 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
Service Manuals	2 sets	For maintenance of the system

Meteorological Data Communication System

Name of Site: Meteorological Office in the Multan International Airport, PMD Multan			
Equipment		Quantity	Purpose
OFDM Wireless Transceiver (4.9GHz) Antenna		1 set	To receive and transmit meteorological information and observed data
PoE HUB		1 set	To supply electric power to OFDM Wireless Transceiver over Ethernet cable
Dual Switch-6		1 set	For connecting all the computer equipment with LAN
Spare Parts	OFDM Wireless Transceiver (4.9GHz) Antenna	1 set	For maintenance of the system
	PoE HUB	1 set	
Service Manuals		2 sets	For maintenance of the system

(3) Basic Plan of the Facility

1) Proposed Construction Site

Since it is necessary to secure the extent of approximately 50 m × 60 m for establishing the Multan Meteorological Radar Observation Station with consideration of the required space for construction of the radar tower building and future expansion such as establishing the regional center, a part (200 feet (61 m) × 170 feet (52 m)) of the land owned by the Punjab Irrigation Department as shown in the figure on the right and below was transferred to the PMD.

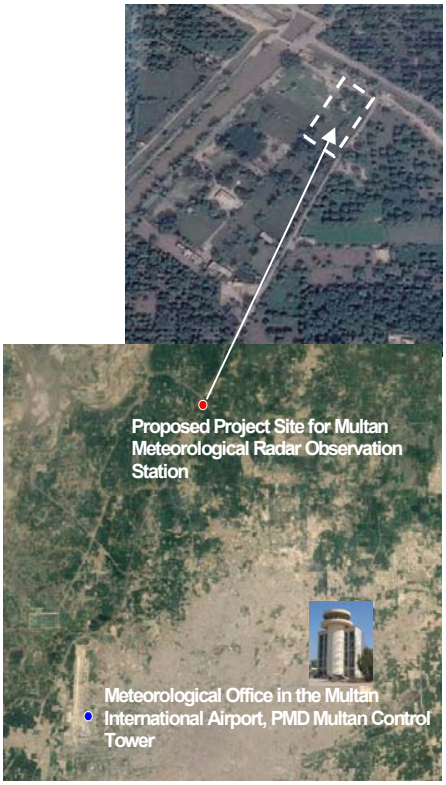


Figure 14: Proposed Construction Site Plan for Multan Meteorological Radar Observation Station

The outline and current situation of the infrastructures of the proposed Project Site for Multan Meteorological Radar Tower Building are as follows.

Table 24: Outline and Current Situation of the Infrastructures of the Proposed Project Site for the Multan Meteorological Radar Tower Building

Study Items	The Proposed Project Site for Multan Meteorological Radar Tower Building
Picture of Proposed Site	 
Latitude (N) Longitude (E)	N30º 18'21.8" E71º 28'21.7"
Altitude	124 m
Area of the Proposed Project Site	3,180 m^2
Enough Space for Radar Tower Construction	Enough space available
Access Road	Available (No problem)
Description Outline of the Premises	2 m lower than the frontal road
Infrastructures	
Commercial Power Supply	400V、3-phase 4-wire、50Hz
Public Water Supply System	Not available
Public Sewerage System	Not available
Telephone Line	Not available
Internet Access	Available (by tethering of the mobile telephone network)
Mobile Phone Service	Available

2) Architectural Design

[1] Floor Plan

The floor plan is virtually symmetrical, making possible a structural design that is safe and void 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 greater flexibility since there are no obstructing structures such as columns and beams protruding into the internal staircase (which will also serve as an evacuation route). Construction methods and materials follow local practice and the building is of standard grade in 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.

Table 25: Calculation Base of Each Room in the Proposed Meteorological Radar Tower Building

Name of the Room	Multan Meteorological Radar Tower Building Floor Area (m^2)	Room Function	Calculation Base
10 FL			
Radome Room	35.78	Installation space for radar antenna apparatus.	Maintenance space for radar antenna apparatus. Room area depends upon radome base of 7.0 m in diameter.
5 FL			
Radar Equipment Room including Spare Parts Storage	90.56	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, maintenance box, maintenance cabinet, measuring instrument cabinet, air-conditioning units, etc.	Operation and maintenance space for all the apparatuses described in the left column. For installation of all the required equipment, at least 90 m^2 is required.
Storage 6	6.39	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
4 FL			
Radar Observation Room	158.27	For the following equipment and furniture. • weather observation terminals • data analysis terminal • VoIP exchange • optical repeater • dual switch • printer • IP telephone • UPS for PCs • desk for the terminal • filing cabinets • white board • data storage cabinets for keeping observation records and observed data of the radar system for analysis • cabinets for maintenance instruments and operation & maintenance manuals	• Radar observation space • Installation space for all the equipment described in the left column • Space for data analysis terminal, desk and data storage cabinets • Working space • Space for keeping all data secured • Space for maintenance instruments, measuring equipment • Space for spare parts and consumables of the equipment
Storage 5	6.49	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
3 FL			
Electricity & Power Supply Room	48.20	For isolation transformers, power distribution boards, cable rack, test terminals, AVR, etc. For radar power back-up system and control rack.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column.
Toilet (F) 3 Toilet (M) 3	10.50 6.92	(F) European Style Commode: 1+Wash Basin: 1 (M) European Style Commode: 1+ Urinal:1+ Wash Basin: 1 Slop Sink: 1	—
Tea Kitchen 2	8.27	Kitchen: 1	—
Changing Room 2	2.41	Changing space after taking a shower.	—
Shower Room	3.63	Space for taking a shower.	—

2			
Storage 3	5.28	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
Storage 4	4.74	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
2 FL			
Duty Officer Room 1	27.59	Working space for a Duty Officer for 24 hours operation of the Multan Regional Meteorological Centre (MRMC).	Necessary space for the routine work and work break
Duty Officer Room 2	26.62	Working space for a Duty Officer for 24 hours operation of the Multan Regional Meteorological Centre (MRMC).	Necessary space for the routine work and work break
Toilet (F) 2 Toilet (M) 2	7.52 7.20	(F) European Style Commode: 1+Wash Basin: 1 (M) European Style Commode: 1+ Urinal:1+ Wash Basin: 1	—
Changing Room 1	2.11	Changing space after taking a shower.	—
Shower Room 1	2.93	Space for taking a shower.	—
1 FL			
MRMC Control Room 1	25.85	Working space for operation of the Multan Regional Meteorological Centre (MRMC).	Necessary space for the routine work of 1 personnel of the PMD estimated according to the existing facility as reference.
Rest Room	5.03	European Style Commode: 1+Wash Basin: 1	—
MRMC Control Room 2	19.33	Working space for operation coordination of the Multan Regional Meteorological Centre (MRMC).	Necessary space for the routine work of 1 personnel of the PMD estimated according to the existing facility as reference.
Weather Observation & Forecasting Room	37.22	Working space for meteorological surface observation and forecasting.	Necessary space for the routine work of 3 personnel of the PMD estimated according to the existing facility as reference.
MRMC Operation & Administration Room	30.98	Working space for operation and administration at the Multan Regional Meteorological Centre (MRMC).	Necessary space for the routine work of 2 personnel of the PMD estimated according to the existing facility as reference.
Toilet (F) 1 Toilet (M) 1	7.97 7.64	(F) European Style Commode: 1+Wash Basin: 1 (M) European Style Commode: 1+ Urinal:1+ Wash Basin: 1 Slop Sink: 1	—
Tea Kitchen 1	11.94	Kitchen: 1	—
Engine Generator Room	65.28	For 125kVA engine generators: 2, oil tank & oil pump: 1, automatic change-over switch, etc.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column.
Pump Room	8.99	Water reservoir tank: 1 Pump for water reservoir tank: 2	For maintenance space and installation space for Water reservoir tank: approx. 9 m^2 required.
Storage 1	2.95	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
Storage 2	1.92	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.

[2] Sectional Plan

I. Height of the Radar Tower Building

<Restrictions on the construction of high-rise buildings in the surrounding area of the Multan Meteorological Radar Observation Station>

It is being considered that urban development in Multan be accelerated. The buildings which were already constructed are unavoidable. However, it is necessary to take appropriate measures in Multan in order to restrict the height of any buildings that could hamper radar observation.

Since the Project is planned to be implemented under Japan's Grant Aid and as one of the National Projects of Pakistan, the Preparatory Survey Team recommended that it is necessary to strictly control construction restrictions on high-rise buildings exceeding 40 m prescribed by the Multan Development Authority in the surrounding area of Multan Meteorological Radar Observation Station (at least within a 5 km radius from the Station) in order to prevent serious obstacles to radar observation in the future and the Pakistan side understood the necessity. Therefore, since the height of the top roof concrete slab of Multan Meteorological Radar Tower is to be designed as 40m from the ground level so that the radar observation will not be hampered even if a high-rise building is constructed in the surrounding area of the proposed Project Site in the future, accordingly the height of the weather radar antenna center will be 48 m.

<Investigation from Meteorological Data Communication>

In order to ensure that the Meteorological Data Communication System (wireless communication LAN) connecting between the Multan Meteorological Radar Tower Building and the Multan International Airport Control Tower for sending radar observation data to the PMD Islamabad Head Office can reliably transmit radar observation data, it is indispensable to secure an area (Fresnel Zone) required for radio waves to reach without any power loss. As shown in the following figure, the radio waves transmitted and received between the communication antennas not only advances one point straight but is transmitted and received through the ellipsoid path centered on the straight line. If an obstruction is available in this area, the required electric field intensity cannot be secured.

There is no existing obstructive facility between the Multan Meteorological Radar Tower Building and the Multan International Airport Control Tower. However, there are approximately 20 m high tropical rainforests. Considering their height, a minimum height of an antenna of the Meteorological Data Communication to be installed at the Multan Meteorological Radar Tower Building is 48 m. However, as shown in the figure below, since the antenna of the Meteorological Data Communication System will be installed at a height of 41 m, if in case that the communication is affected by the electric field intensity drops due to the tropical tree touching the Fresnel Zone, the PMD has agreed to negotiate with

the owner of the tree and cut the upper part of the tree.

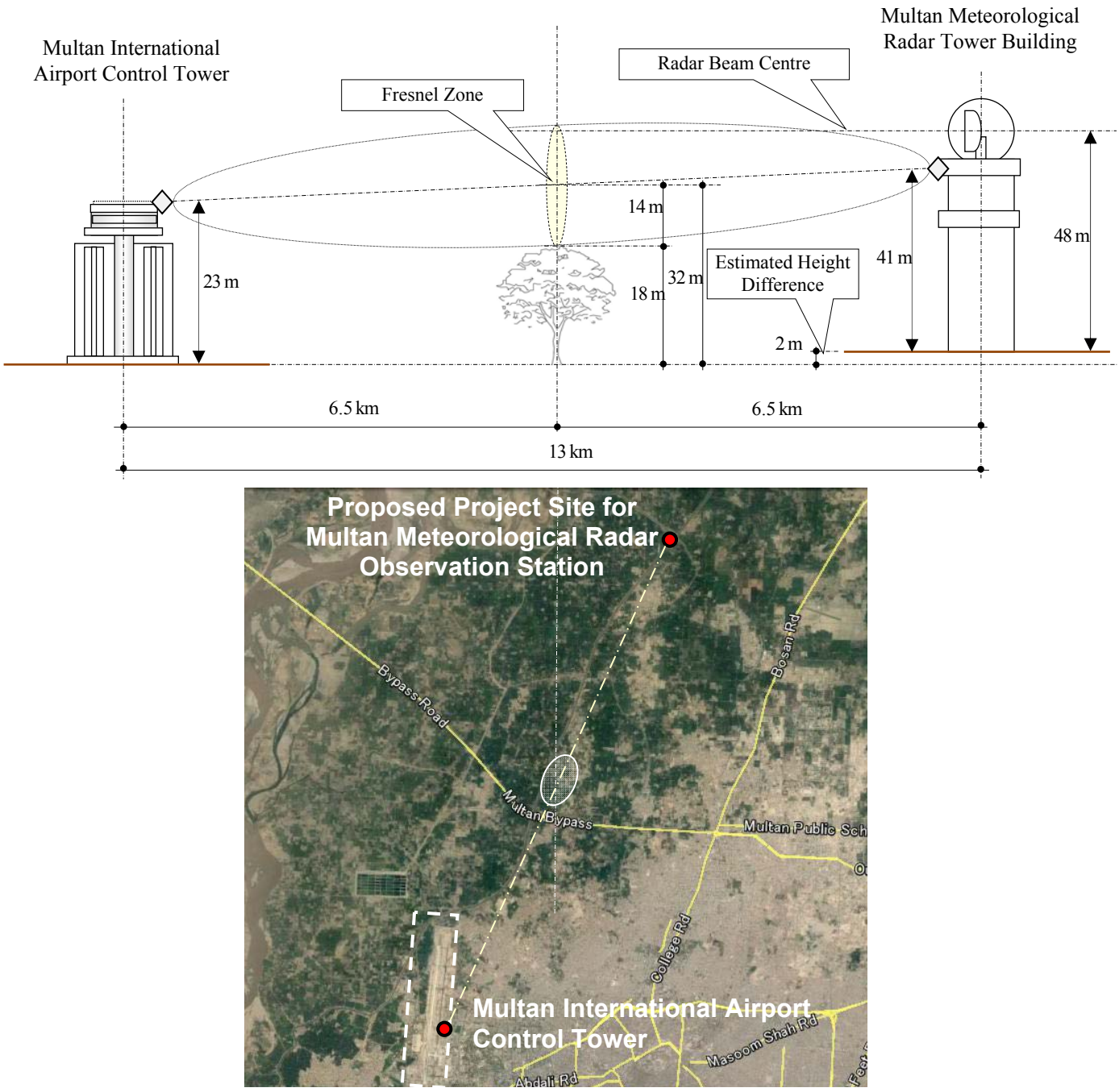


Figure 15: Relationship of Fresnel Zone of Meteorological Data Communication System and Radar Beam Center Height

<Investigation from meteorological radar observation>

Based on the result of investigation from the above Meteorological Data Communication System (radar antenna center height of the Multan Meteorological Radar System is 48 m), the radar beam exceeds the existing facilities shown in the table below, which may be obstructive to the radar observation. The

required antenna elevation angles which is necessary for that were calculated. As a result, as shown in the following table, it can be confirmed that the radar beam exceeds the existing obstructive facilities if the antenna elevation angle is about +0.5 to + 0.6 degrees. Since it is necessary to inevitably start the antenna elevation angle from about +0.5 degrees to avoid the radar beam hitting the ground due to the Multan Meteorological Radar Tower Building being planned to be built on the flatland, it is reasonable to set the radar antenna center height of the Multan Meteorological Radar System to 48 m.

In addition, several telecommunication steel towers which are unsurpassable and unavoidable obstructions for radar observation can be found around the proposed Project Site in Multan. Since these telecommunication steel towers are not completely solid structures, they are not considered major obstructions for radar observation.

It is technically possible to complement the shadow areas created by the identified obstructive facilities (including TV and telecommunication steel towers) in the radar detection range with the CAPPI (Constant Altitude PPI (Plan Position Indicator)) data. It is, unfortunately, an inescapable fact that the radar observation range will become shorter due to the higher elevation angle of the radar antenna to eliminate the shadow areas caused by the above identified obstructive facilities.

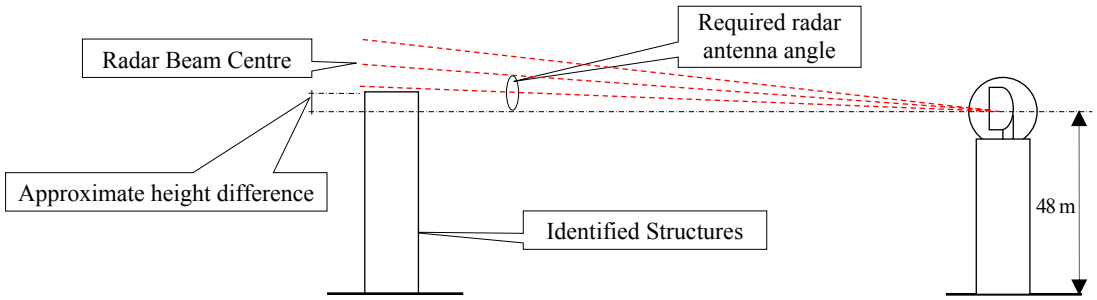


Figure 16: Relationship of Radar Antenna Center Height & Antenna Angle and Identified Obstructive Facility

The existing obstructive facilities around the proposed Project Site for the Multan Metrological Radar Observation Station in Multan are indicated in the following table.

Table 26: Existing Obstructive Facility to Radar Observations in Multan (as of August 2017)

Location Map No.	**1**	**2**
Name of the Existing Obstructive Facility	Shah Rukn-e-Alam	Multan International Airport Control Tower
Picture		
Number of Stories	-	7
Height	33 m	23 m
Latitude(N) Longitude(E)	N30º 11’56.87” E71º 28’18.20”	N30º 11’53.91” E71º 25’24.54”
Altitude	143 m	122 m
Distance from the proposed Project Site in Multan	Approx. 11.83 km	Approx. 12.83 km
Direction from the proposed Project Site in Multan	180.5º	201.6º
Approximate ground level difference	Approx. 143 m-124 m=19 m Ground level is 19 m higher than the proposed Project Site	Approx. 122 m-124 m=-2 m Ground level is 2 m lower than the proposed Project Site
Required radar antenna angle to eliminate the shadow area caused by the identified facility	Approx. +0.5°	Approx. +0.4°

Location Map No.	**3**	**4**
Name of the existing Obstructive Facility	Pakarab Fertilizer Limited	Nishtar Medical College
Picture		
Number of Stories	-	-
Height	64 m (Highest Facility in Multan)	40 m
Latitude(N) Longitude(E)	N30º 12’56.56” E71º 32’15.36”	N30º 12’13.75” E71º 26’28.25”
Altitude	131 m	126 m
Distance from the proposed Project Site in Multan	Approx. 11.88 km	Approx. 11.72 km
Direction from the proposed Project Site in Multan	148.2º	195.0º
Approximate ground level difference	Approx. 131 m-124 m=7 m Ground level is 7 m higher than the proposed Project Site	Approx. 126 m-124 m=2 m Ground level is 2 m higher than the proposed Project Site
Required radar antenna angle to eliminate the shadow area caused by the identified facility	Approx. +0.6°	Approx. +0.4°

Location Map No.	5	6
Name of the existing Obstructive Facility	State Bank of Pakistan	Multan TV Tower
Picture		
Number of Stories	-	-
Height	37 m	128 m
Latitude(N) Longitude(E)	N30º 12'06.21" E71º 27'16.63"	N30º 10'24.97" E71º 27'59.58"
Altitude	126 m	128 m
Distance from the proposed Project Site in Multan	Approx. 11.68 km	Approx. 14.67 km
Direction from the proposed Project Site in Multan	188.6º	182.3º
Approximate ground level difference	Approx. 126 m-124 m=2 m Ground level is 2 m higher than the proposed Project Site	Approx. 128 m-124 m=4 m Ground level is 4 m higher than the proposed Project Site
Required radar antenna angle to eliminate the shadow area caused by the identified facility	Approx. +0.4°	Approx. +0.8° (Since the telecommunication steel tower is not completely solid structures, it is not considered major obstructions for radar observation.)

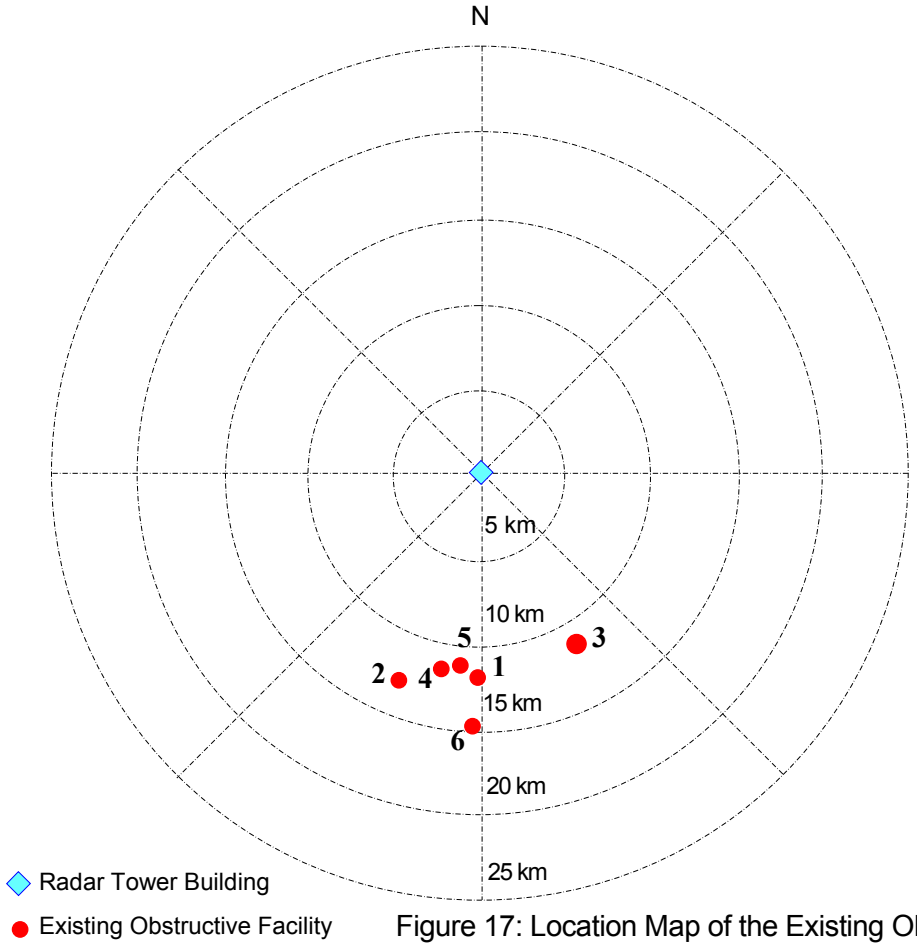


Figure 17: Location Map of the Existing Obstructions around the Proposed Project Site for Multan Meteorological Observation Station

The expected observation range of Multan Meteorological Radar System is shown below.

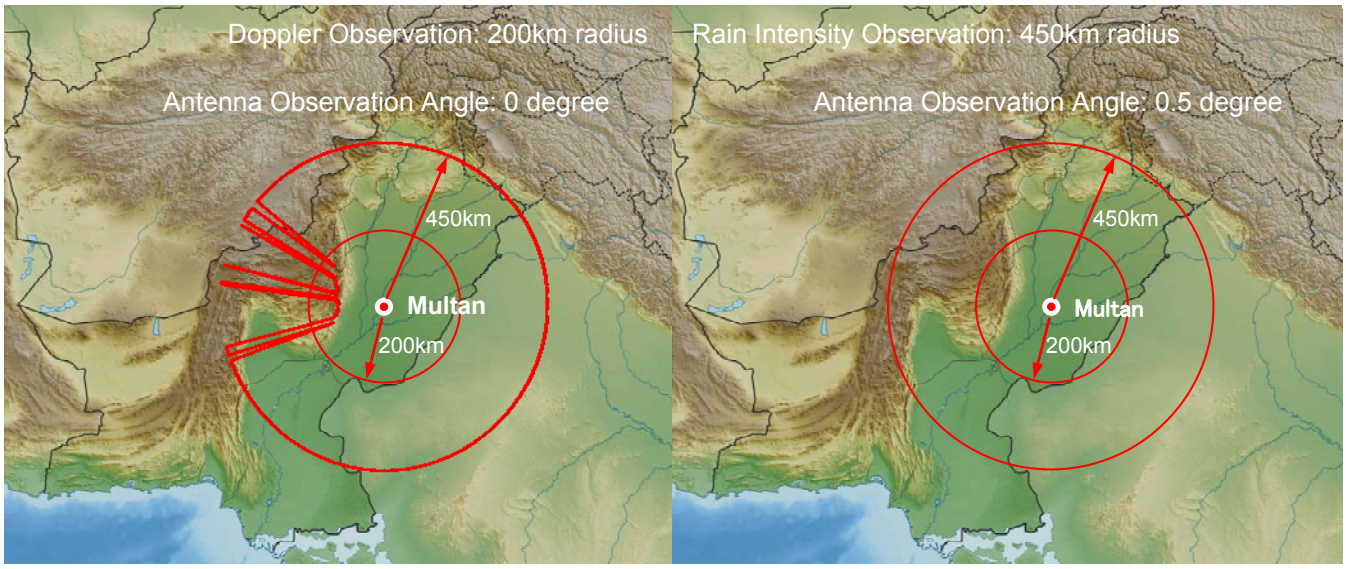


Figure 18: Expected Observation Range of Multan Meteorological Radar System
(No consideration of the existing obstructive facilities around the proposed Project Site in Multan)

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 Radar Observation Room)

a) Floor

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

b) External Walls

To combat the effects of local temperature and humidity, the external walls of the electricity room, the radar 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 radar 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 22 m is expected to reach approximately 2,100 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.

Table 27: Finishing Materials of the Proposed Meteorological Radar Tower Building

		Finishing Materials
Exterior Finishing	Observation Deck	Cement sand mortar base, Asphalt waterproofing, Insulation, Protection concrete, Base mortar, Cement tiles
	Roof Floor	Cement sand mortar base, Asphalt waterproofing, Insulation, Protection concrete, Base mortar, Cement tiles
	Walls	Concrete blocks Cement sand mortar base, Spray tile finish

Interior Finishing	Floors	Carpet tiles Vinyl tiles Porcelain tiles Cement sand mortar base, Epoxy resin paint finish
	Skirtings	Wooden skirting, Synthetic resin oil paint finish Cement sand mortar, Vinyl paint finish Cement sand mortar, Epoxy resin paint finish Porcelain tiles
	Walls	Cement Sand mortar base, Vinyl paint finish Glazed ceramic tiles Glass wool with glass cloth
	Ceilings	Acoustic panels (Grid ceiling system) Cement board (Grid ceiling system) Cement sand mortar base Emulsion paint finish Glass wool with glass cloth
Window and Door	Exterior	Aluminum windows Aluminum grilles Aluminum doors, Steel doors
	Interior	Aluminum doors, Steel doors, Wooden doors

Table 28: Basis 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=30 mm will be required. Asphalt waterproofing is the most reliable waterproofing material to be protected by protection concrete, cement sand mortar and cement tiles.	To be procured locally
	Walls	Reinforced concrete blocks will be applied. Concrete blocks are generally used locally and are considered highly reliable in terms of both ease and accuracy of construction.	
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 mortar (trowel-coated) will be applied primarily for its durability, and vinyl paint will be applied to avoid dirt. Glazed ceramic tiles will be laid in the toilets and the slop sink booth.	
	Ceilings	In order to enhance the environment and efficiency of air-conditioning, non-asbestos acoustic mineral boards will be used. Other rooms which will not require any ceiling board will be directly applied with emulsion paint finish on the cement and sand mortar.	
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 along with 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 by the design wind pressure must not be more than 1/1000 of the height of radar tower building. Due to this, the foundation structures must prevent the building differential settlement. The bearing layer and foundation of the Proposed Meteorological Radar Tower Building are indicated in the following table.

Table 29: Bearing Layer, Pile and Foundation of the Proposed Multan Meteorological Radar Tower Building

	Multan Meteorological Radar Tower Building
Depth of Bearing Layer	23.1 m
N value of Bearing Layer	Over 50
Piling	Required
Designed Pile Length	20.0 m
Required Number of the Designed Pile	27
Diameter of the Designed Pile	20 Piles: 1.2 m, 7 Piles: 1.0 m
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 constructed using 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.

Table 30: Weight of Meteorological Radar System Unit

Installation Place (Room Name)	Name of Meteorological Radar System Unit	Weight
Roof Top	Radome, Antenna, Pedestal and Base Ring	14.0 tons
Radar Equipment Room	Transmitter/Receiver, Signal Amplifier, Signal Processor, Antenna Controller, etc.	4.0 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

Cp: Pressure coefficient for the structure

Iw: Importance Factor

Qs: Wind stagnation pressure (kN/m^2)

$P=1.87\times3.6\times1.15\times0.78=6.04$kN/m^2 ≈6kN/m^2

Ce=1.87 Cq=3.60 Iw=1.15 Qs=0.78

d) Seismic load

For the calculation of the seismic load, the seismic zone factor in Multan (Zone 2A, Z = 0.15) 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.

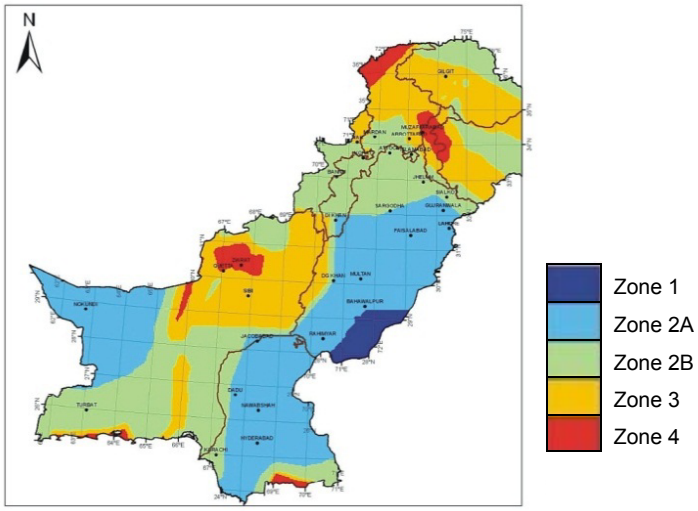


Figure 19: Seismic Zoning Map of Pakistan

V. Structural Building Material

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

- Concrete (conventional concrete)
  Design standard concrete strength: Fc= 21N/mm^2
- Cement: American Society for Testing and Materials (ASTM) or equivalent
- Deformed reinforcing bars : ASTM A615 Grade 60 or equivalent

[6] Electrical Facility Design

I. Power intake facility

Table 31: Power Intake Facility

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

II. Power generating facility

Table 32: Power Generating Facility

	Multan Meteorological Radar Tower Building
Number of Engine Generator	2
Capacity	125kVA
Output	400V, 3-phase 4-wire, 50Hz
Fuel Tank Capacity	1,500 liters

III. Trunk line and power facility

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

Table 33: Trunk Line and Power Facility

	Multan 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 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 LED due to low power consumption. The lighting levels in the various rooms will be approximately as shown below.

Table 34: Approximate Lighting Levels in the Various Rooms

	Multan Meteorological Radar Tower Building
Radome Room	200 Lx
Radar Equipment Room	300 Lx
Radar Observation Room	300 Lx
Engine Generator Room	200 Lx
Electricity & Power Supply Room	200 Lx
Pump Room	200 Lx
Entrance Hall	200 Lx
Duty Officer Room	200 Lx
MRMC Control Room	200 Lx
MRMC Operation & Administration Room	200 Lx
Weather Observation & Forecasting Room	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 radar observation room for the Project computing equipment.

V. Telephone system

A service terminal box, a relay terminal box and telephone sets will be installed inside the radar tower 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 radar observation room) and outside of the building entrance.

VII. Alarm system

An alarm panel will be installed in the radar 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 3rd 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 & power supply room and the engine generator room. An alarm system will be installed in the radar observation room.

[7] Water Supply, Drainage and Sanitary Fixture Design

I. Water supply system

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

II. Drainage system

Drainage will be divided into 2 systems - sewage and miscellaneous drainage. Sewage will primarily be treated in a septic tank and then be permeated 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 25 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.

Table 35: Fire Extinguisher

	Multan Meteorological Radar Tower Building
Radome Room	CO_2 type
Radar Equipment Room	CO_2 type
Radar 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, the radar observation room and the electricity & power supply room. Therefore, a substantial number of air-conditioning systems is indispensable. Package type air-conditioning systems have been selected to minimize any impact to the operation of the radar system if an air-conditioning system fails.

Table 36: Air-conditioning and Ventilation System

	Multan Meteorological Radar Tower Building
Radome Room	Fan forced ventilation
Radar Equipment Room	Air-conditioning system Heat exchange system
Radar Observation Room	Air-conditioning system Fan forced ventilation
Electricity & Power Supply Room	Air-conditioning system Fan forced ventilation
Duty Officer Room	Air-conditioning system Fan forced ventilation
MRMC Control Room	Air-conditioning system Fan forced ventilation
MRMC Operation & Administration Room	Air-conditioning system Fan forced ventilation
Weather Observation & Forecasting Room	Air-conditioning system Fan forced ventilation
Engine Generator Room	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>

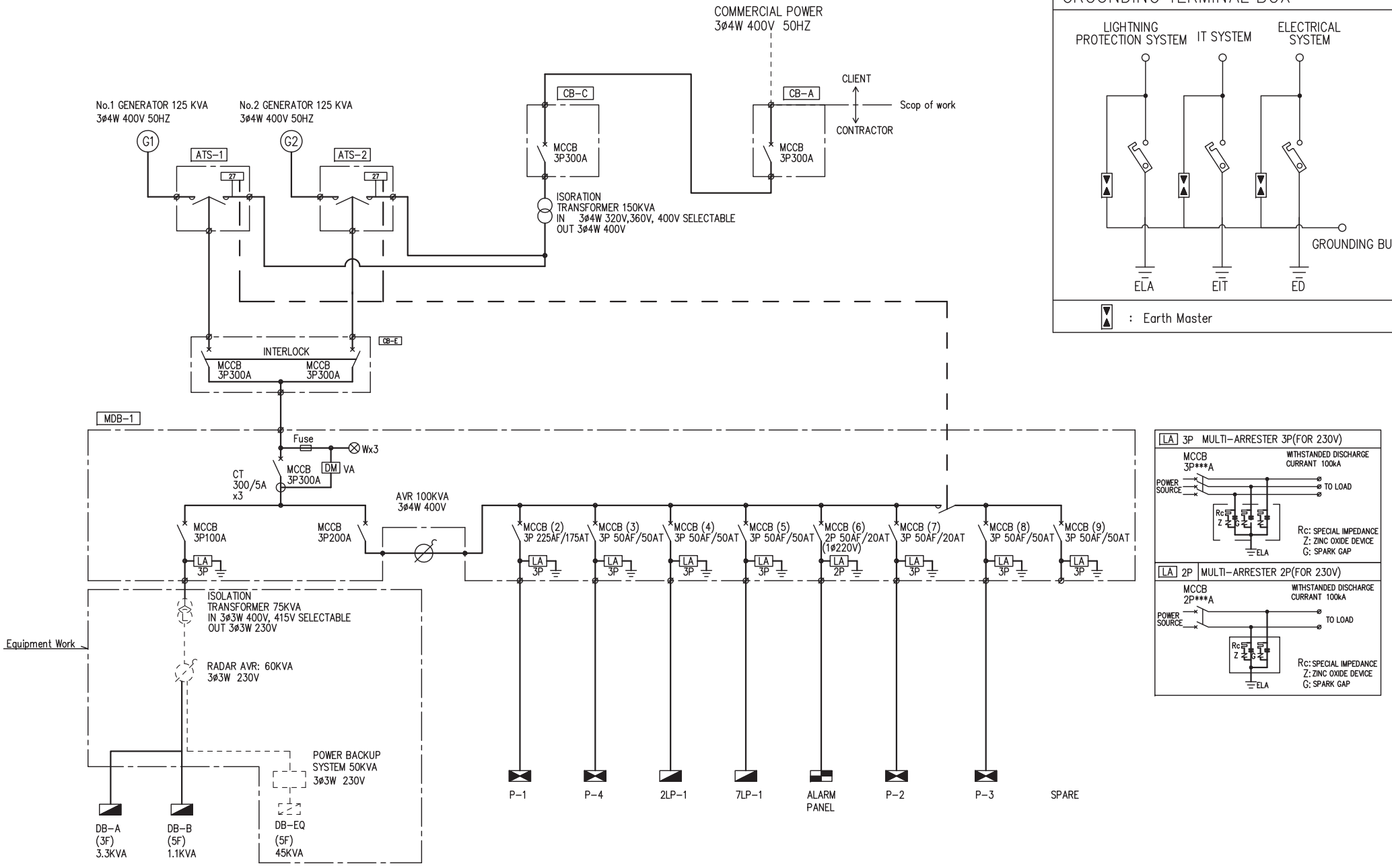
- Outside condition: temperature 40°C (maximum temperature: 50°C on May 28, 2010)
- Indoor condition: temperature 26°C humidity 40-60%
  In the radar equipment room and the electricity & power supply room: temperature 25°C humidity 40-60%

The following diagrams of the building equipment plan for the meteorological radar tower building can

be found in the subsequent pages immediately hereafter.

<Multan Meteorological Radar Tower Building>

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



GROUNDING TERMINAL BOX

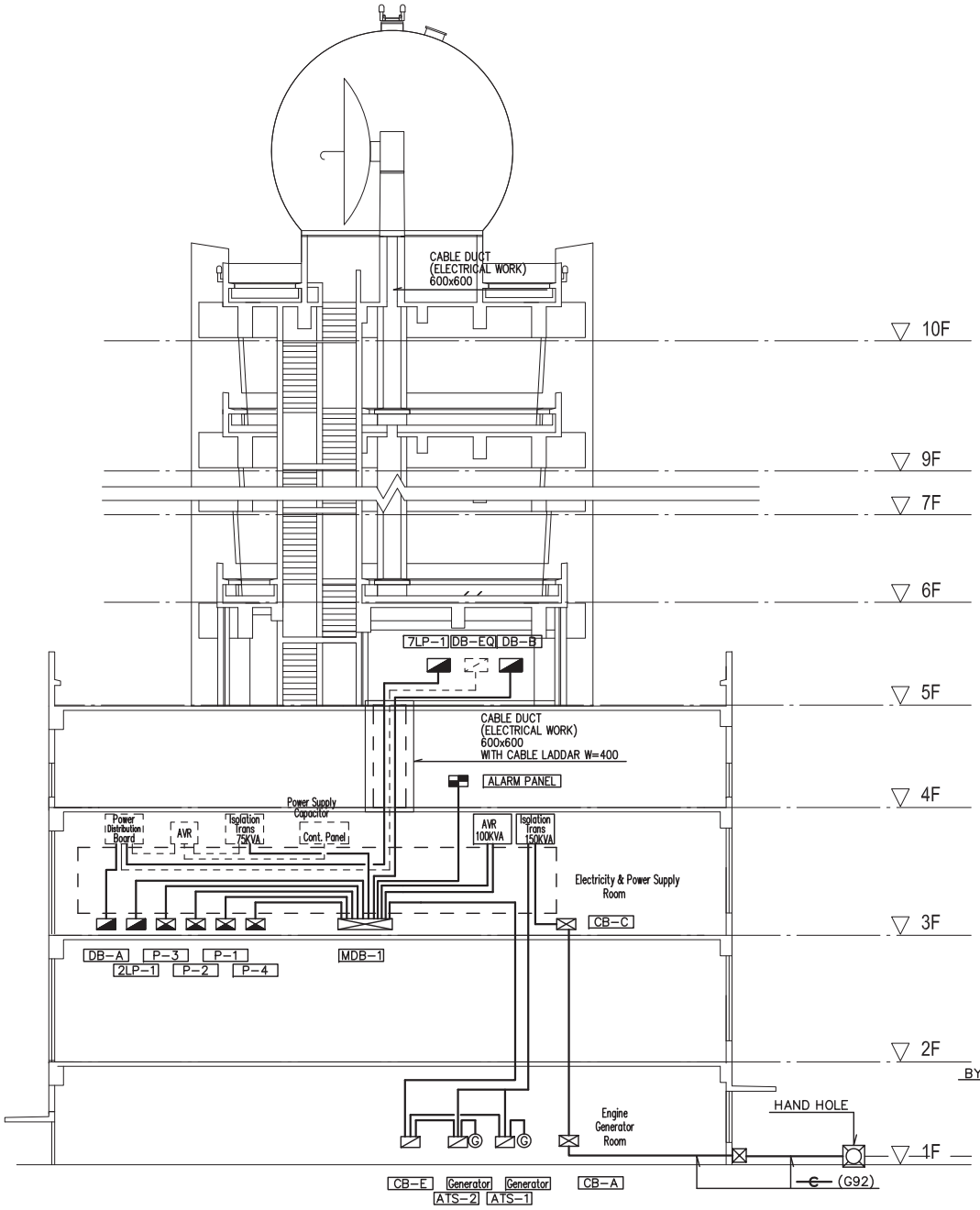
International Meteorological Consultant Inc.
Sankyo Meguro Bdg. 4F, 4-5-37, Kamiioosaki, Shinagawa-ku, Tokyo, 141-0021 Japan
Tel. +81-3-6431-9559 Fax. +81-3-6431-9759

THE PROJECT FOR INSTALLATION OF
WEATHERE SURVEILLAMCE RADAR AT MULTAN
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
POWER FEEDER SYSTEM

SCALE
NONE

DRAWING No.
SD - 01



POWER CABLE LIST

FROM	TO	CABLE SIZE	CONDUIT
CB-A	CB-C	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
CB-C	ISOLATION TRANS 150KVA	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ATS-1	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ATS-2	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
CB-E	MDB-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
MDB-1	ISOLATION TRANS 75KVA(EQUIP WORK)	XLPE/PVC 4C-30sq +E22sq	(G50) / CABLE LADDAR
MDB-1	P-1	XLPE/PVC 1C-4x70sq +E50sq	(G70) / CABLE LADDAR
MDB-1	P-2	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	P-3	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	P-4	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	2LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	7LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	ALARM PANEL	XLPE/PVC 2C- 6sq +E 6sq	(G32) / CABLE LADDAR
PowerDistributionBoard	DB-A	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDAR
PowerDistributionBoard	DB-B	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDAR
MDB-1	AVR 100kVA	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDAR
AVR 100kVA	MDB-1	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDAR

SPARE PARTS FOR LIGHTNING DAMAGE LIST

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

- - - - EQUIPMENT WORK

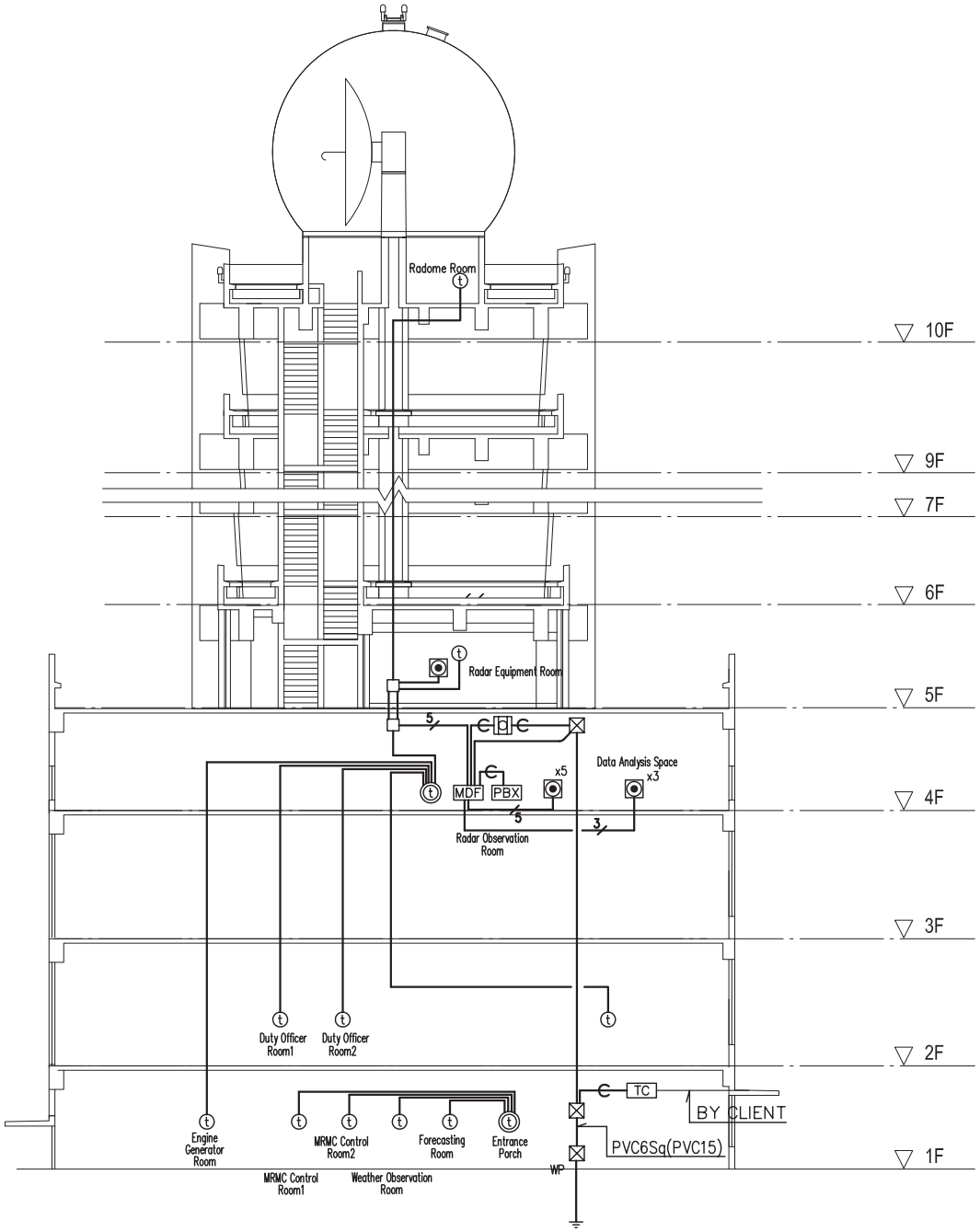
International Meteorological Consultant Inc.
Sankyo Meguro Bdg. 4F, 4-5-37, Kamiioosaki, Shinagawa-ku, Tokyo, 141-0021 Japan
Tel. +81-3-6431-9559 Fax. +81-3-6431-9759

THE PROJECT FOR INSTALLATION OF
WEATHERE SURVEILLAMCE RADAR AT MULTAN
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
POWER RISER SYSTEM

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

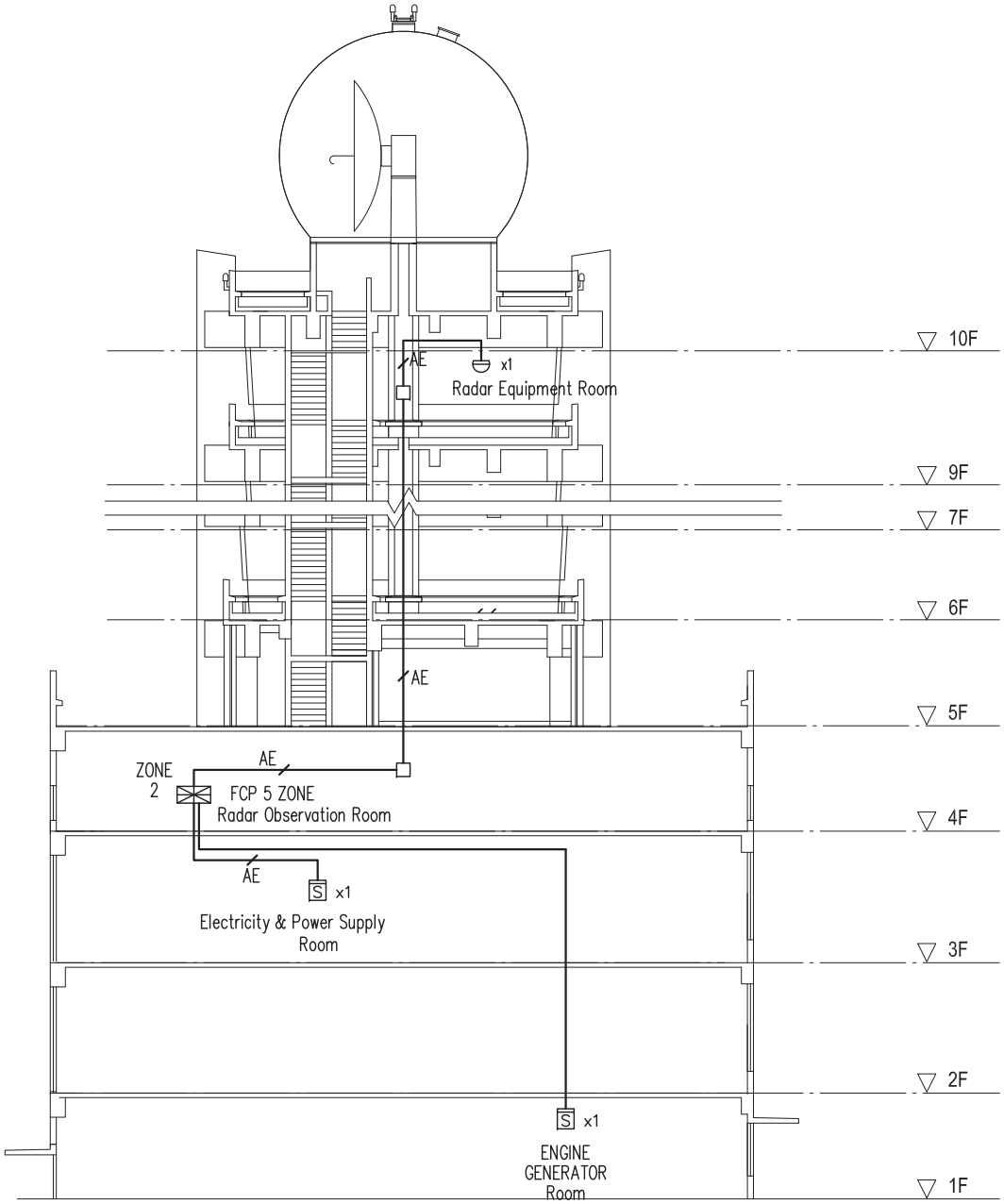
International Meteorological Consultant Inc.
Sankyo Meguro Bdg. 4F, 4-5-37, Kamiioosaki, Shinagawa-ku, Tokyo, 141-0021 Japan
Tel. +81-3-6431-9559 Fax. +81-3-6431-9759

THE PROJECT FOR INSTALLATION OF
WEATHERE SURVEILLAMCE RADAR AT MULTAN
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
INTERPHONE & TEL SYSTEM

SCALE
NONE

DRAWING No.
SD - 03

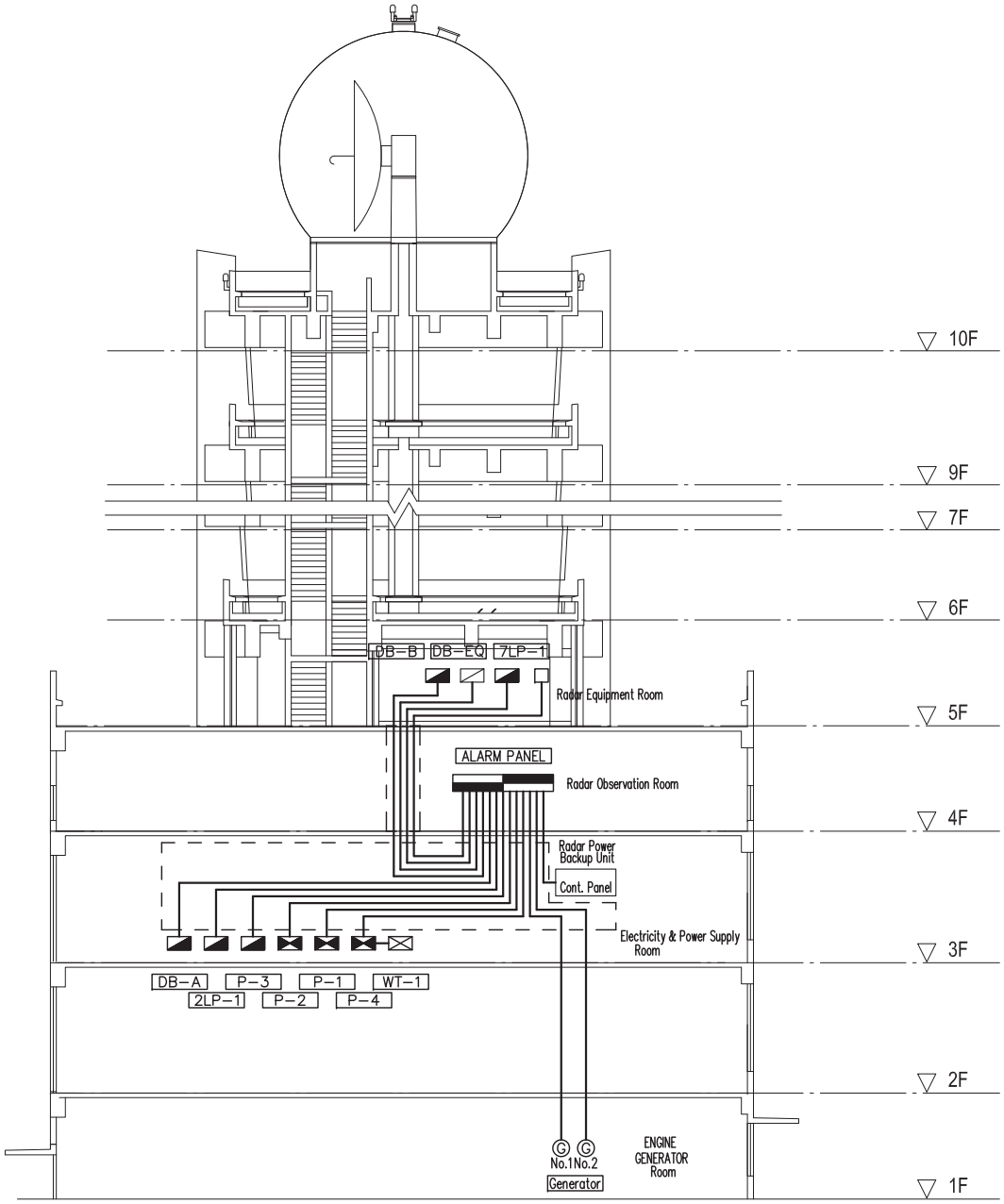


FIRE ALARM CONTROL PANEL 5 ZONE

SMOKE DETECTOR (PHOTO TYPE)

RATE OF RISE HEAT DETECTOR

International Meteorological Consultant Inc. Sankyo Meguro Bdg. 4F, 4-5-37, Kamiioosaki, Shinagawa-ku, Tokyo, 141-0021 Japan Tel. +81-3-6431-9559 Fax. +81-3-6431-9759	THE PROJECT FOR INSTALLATION OF WEATHERE SURVEILLAMCE RADAR AT MULTAN IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE MULTAN METEOROLOGICAL RADAR TOWER BUILDING FIRE ALARM SYSTEM	SCALE NONE	DRAWING No. SD - 04



☐ TEMPERATURE SWITCH
FOR ROOM TEMPERATURE ALARM

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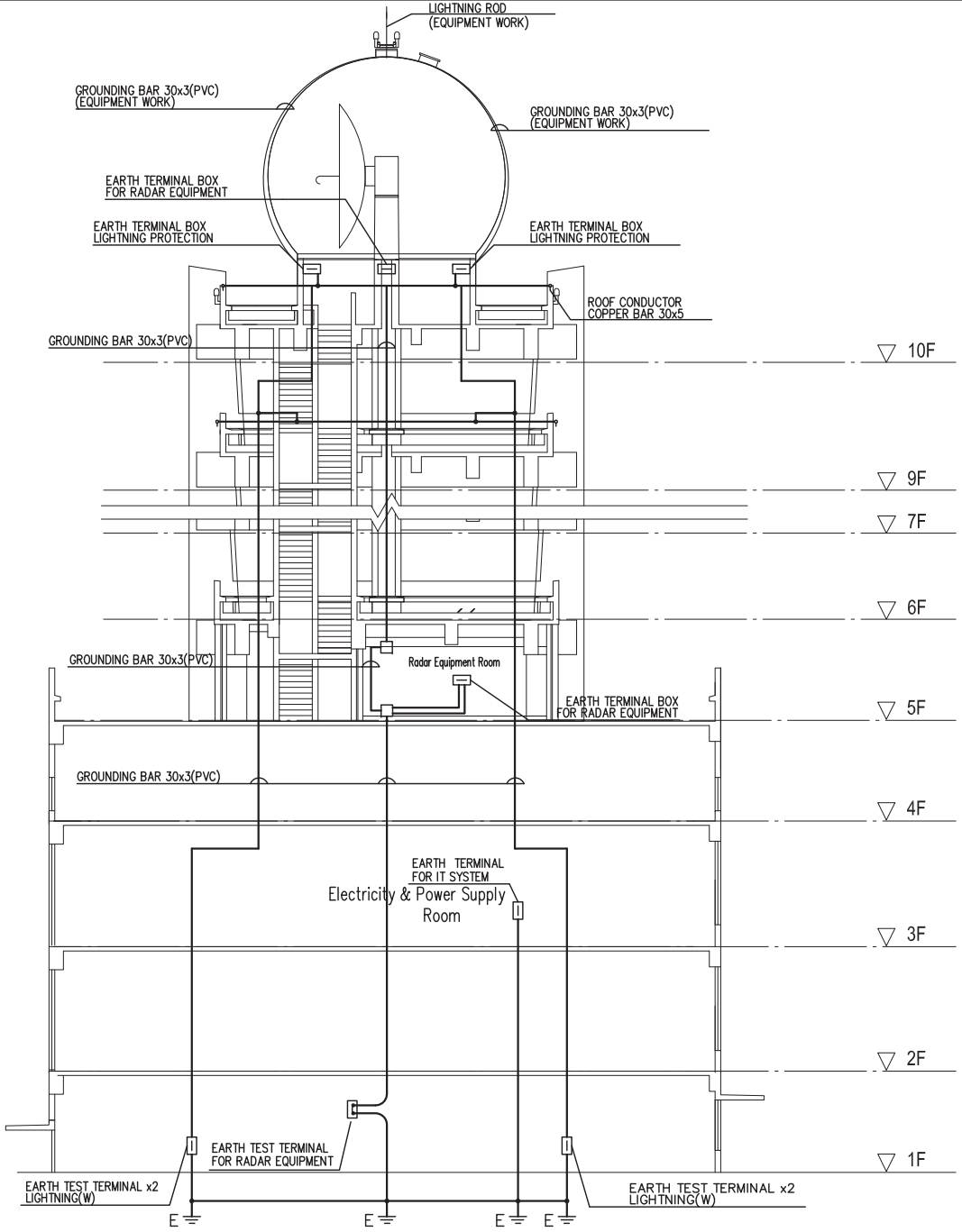

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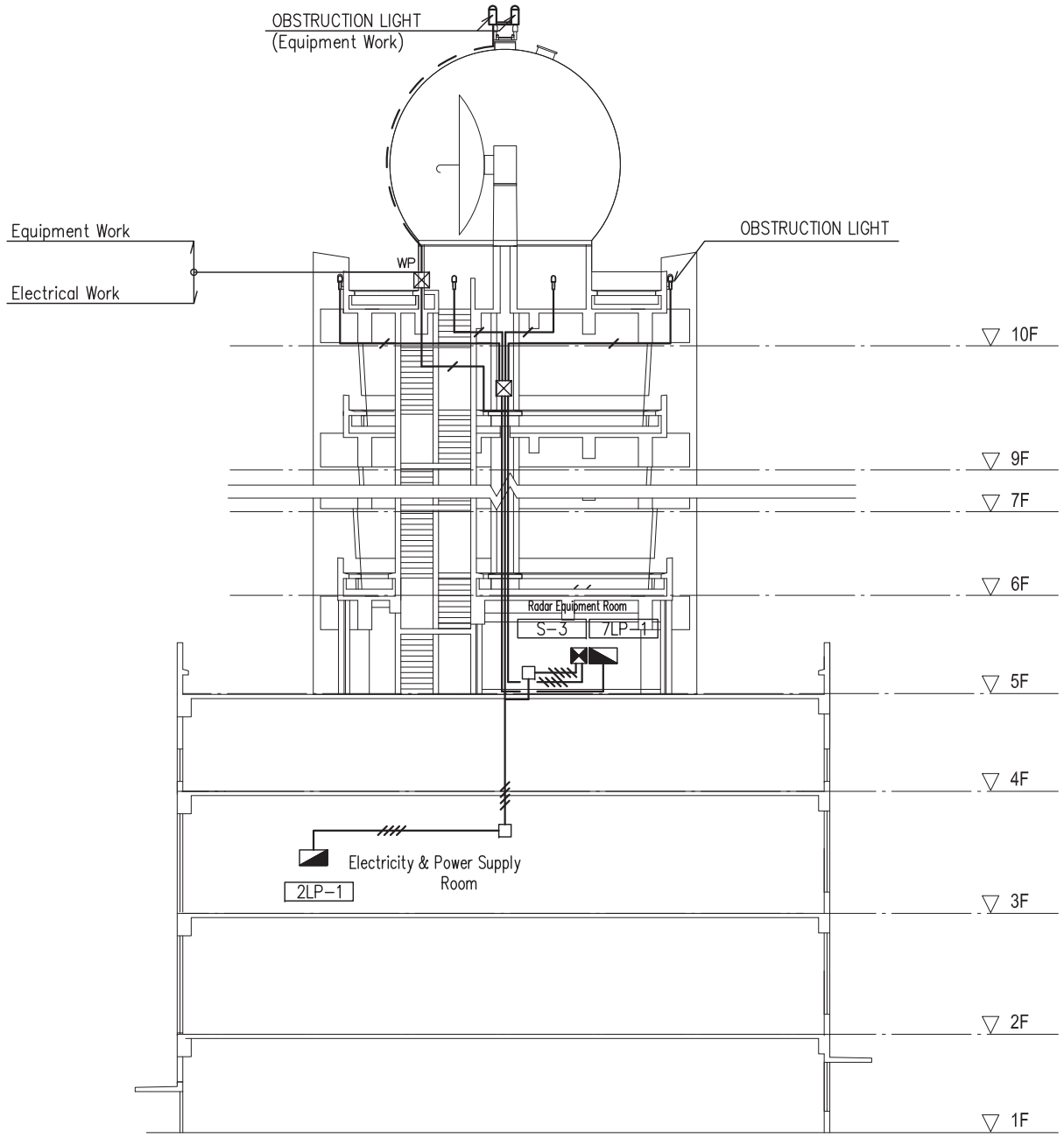

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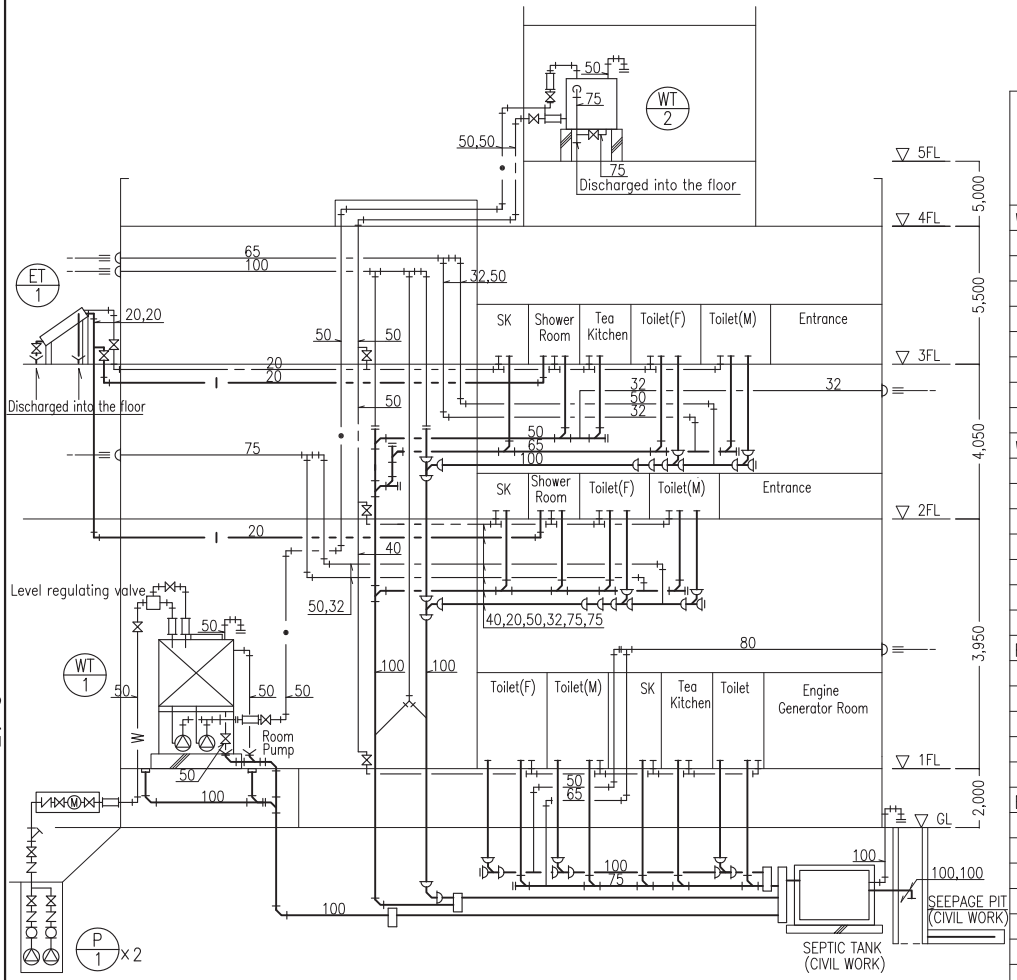

ITEM	1F					2F					3F										TOTAL	REMARK
	PUMP ROOM	TOILET(M)	TOILET(F)	TOILET	TEA KITCHEN	TOILET(M)	TOILET(F)	SHOWER ROOM	SERVICE		TOILET(M)	TOILET(F)	TEA KITCHEN	SHOWER ROOM	SERVICE							
WATER CLOSET		1	1			1	1				1	1									7	
LAVATORY		1	1			1	1				1	1									7	
PAPER HOLDER		1	1			1	1				1	1									7	
FAUCET	1	1	1		1	1	1		1		1	1	1		1						12	
MIRROR		1	1			1	1				1	1									7	
SHOWER HEAD								1						1							2	
KITCHEN SINK					1								1								2	
URINAL		1				1					1										3	
SERVICE SINK									1						1						2	

NO.	NAME	SPECIFICATION	Q'TY	POWER SUPPLY					LOCATION	REMARKS
				PHASE	VOLT (V)	FREQUENCY (Hz)	MOTOR (KW)	EMERGENCY POWER SUPPLY		
WT-1	POTABLE WATER	FPR Tank	1					○	1F Pump Room	RC FOUNDATION
	TANK / PUMP	Rated capacity 5.0 m^3								(CIVIL WORK)
		Dimension 2,500 x 1,500 x 1,515H								
		Accessories Manhole 600ø								
		Electrode 4P								
		Constant pressure type pump	2	3	230	50	1.1X2			
		50 ø x 270 l/min x 500 kpa x 2 pcs (1 spare)								
WT-2	POTABLE WATER	FRP tank	1						6FL Roof	RC FOUNDATION
	GRAVITY TANK	Rated capacity 2.0 m^3								(CIVIL WORK)
		Dimension 1,000 x 1,500 x 1,500H								
		Earthquake proof 2.0G(Wind -Proof type)								
		Accessories manhole 600 ø								
		Electrode 4P								
P-1	PUMP	Model : Deep Well Submerged Pump	2	3	230	50	1.9	○	Out door	Automatic-
		stainless steel								alternate operation
		32ø x 30 l/min x 1177 kpa								
		Accessories : Panel,Ball valve,Check valve								
		Automatic alternate operation								
ET-1	Solar powered water	Model : Natural circulation 2 circuits type	1						3F Balcony	
	heater	Dimension: Solar heater panel 2010x1250x80								
		Heat to collect Area : 2.5m^2								
		Water storage volume : 200 LIT								
ABC	FIRE EXTINGUISHER	ABC Dry chemical, wall hang	3						Each room	
		10 Lbs Discharge time 14 sec								
CO2	FIRE EXTINGUISHER	Carbon dioxicide, wall hang	5						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)								

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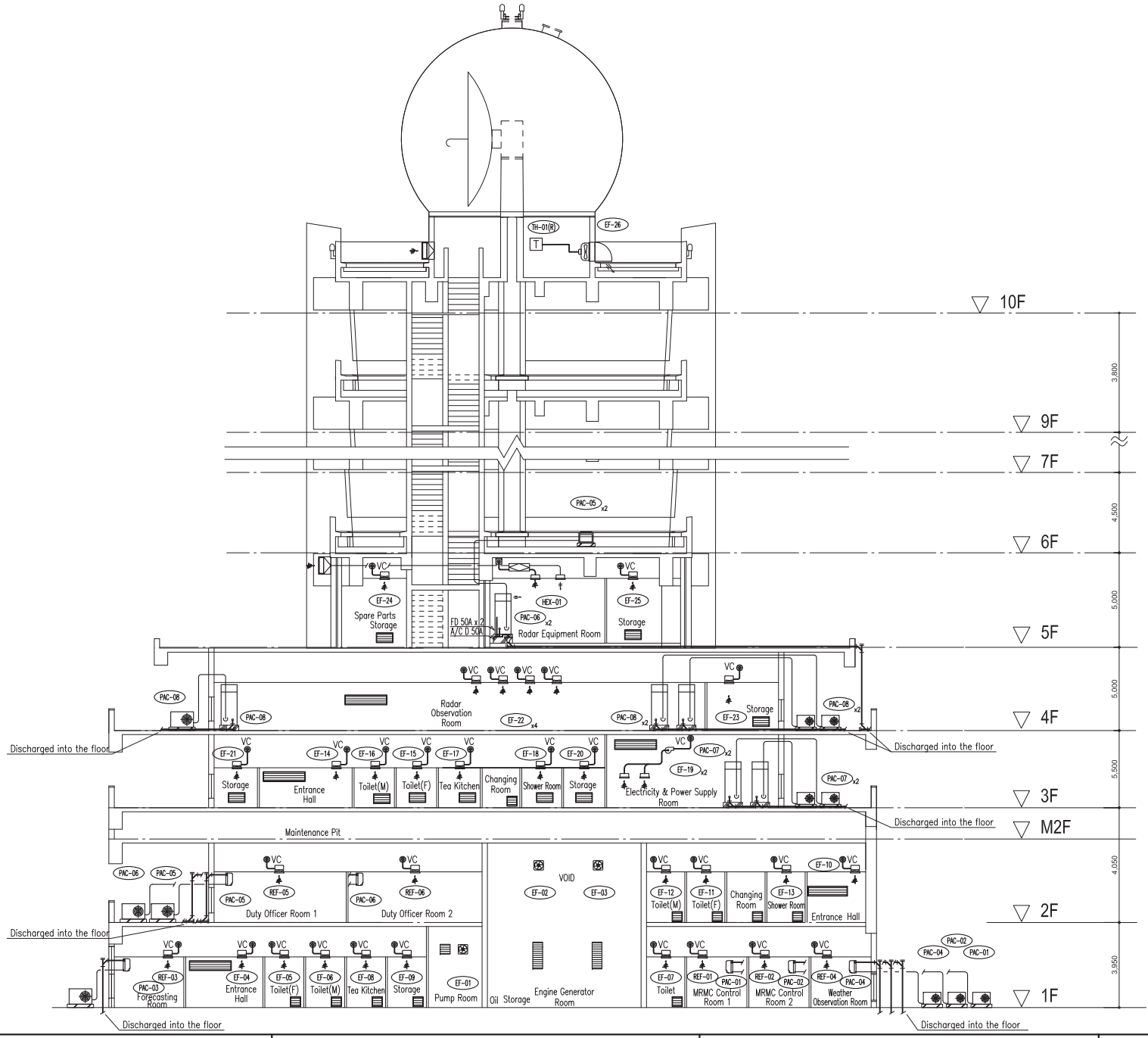
THE PROJECT FOR INSTALLATION OF
WEATHERE SURVEILLAMCE RADAR AT MULTAN
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
WATER SUPPLY & DRAINAGE SYSTEM

SCALE
NONE

DRAWING No.
SD - 08



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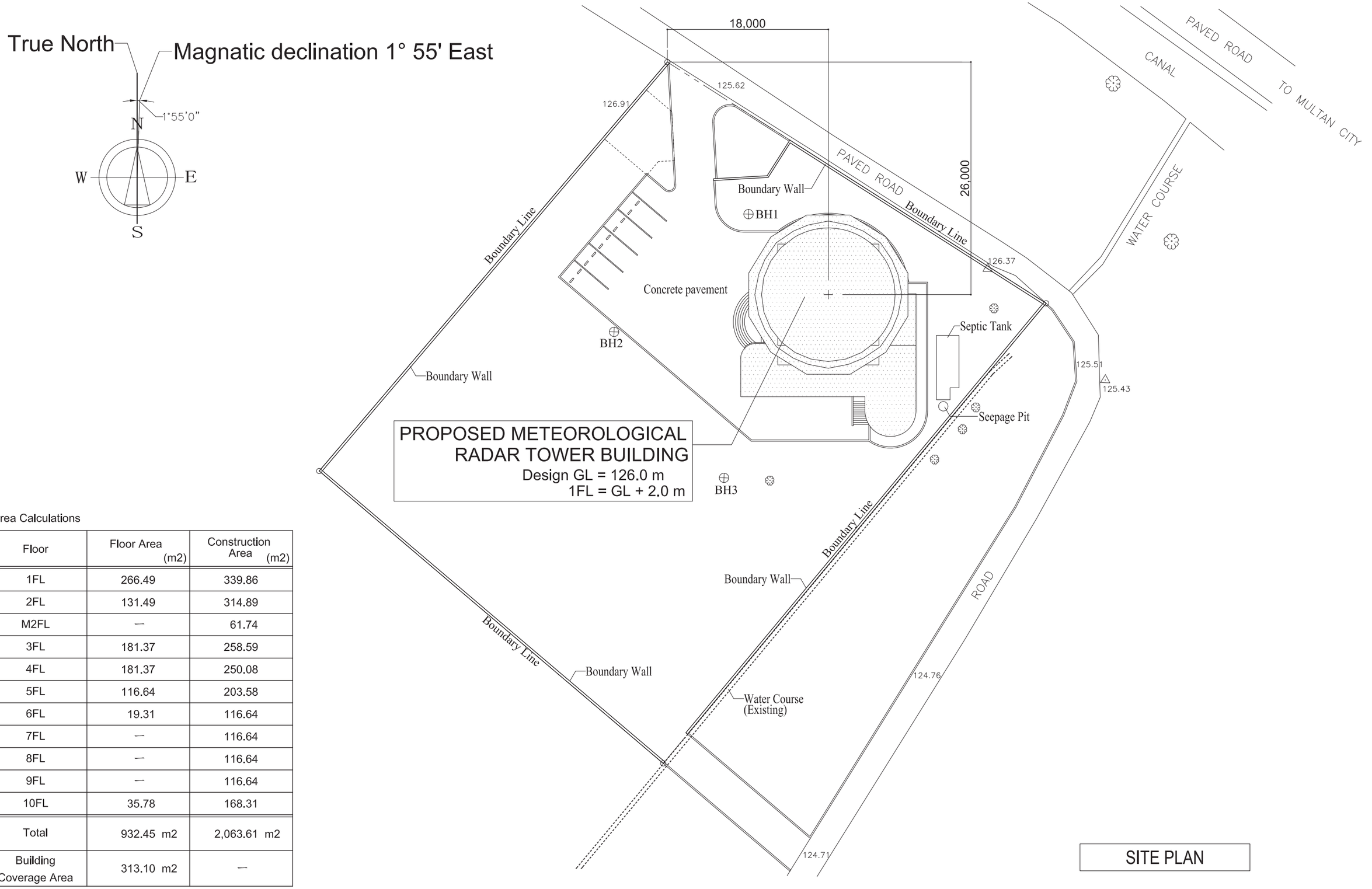
2-2-3 Outline Design Drawing

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

<Multan 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
- Floor Plan 8 : A-09
- Elevation 1 : A-10
- Elevation 2 : A-11
- Elevation 3 : A-12
- Section : A-13

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



Area Calculations

Floor	Floor Area (m2)	Construction Area (m2)
1FL	266.49	339.86
2FL	131.49	314.89
M2FL	—	61.74
3FL	181.37	258.59
4FL	181.37	250.08
5FL	116.64	203.58
6FL	19.31	116.64
7FL	—	116.64
8FL	—	116.64
9FL	—	116.64
10FL	35.78	168.31
Total	932.45 m2	2,063.61 m2
Building Coverage Area	313.10 m2	—

SITE PLAN

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THE PROJECT FOR INSTALLATION OF
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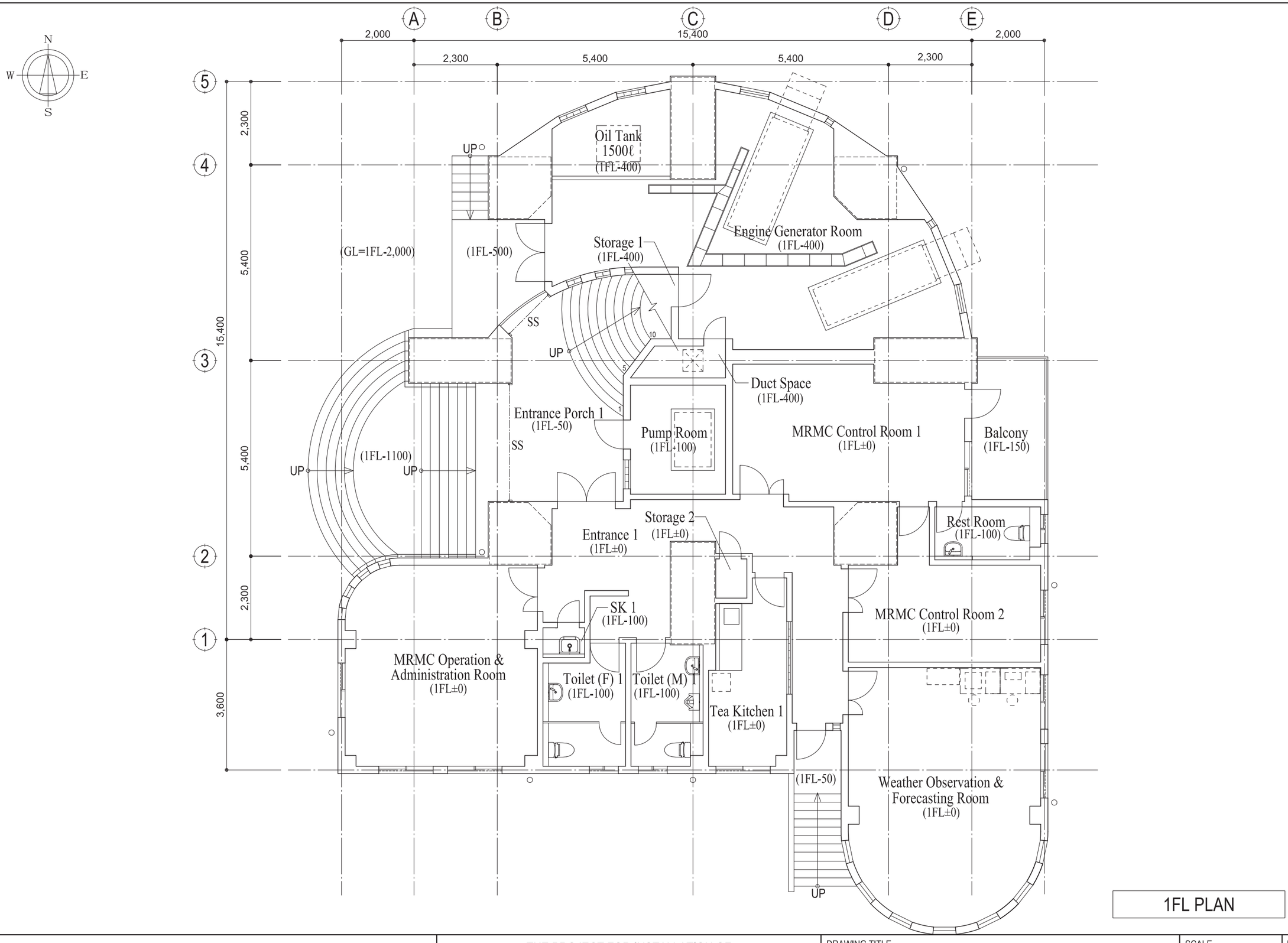
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
SITE PLAN

SCALE
1:400

DRAWING No.
A - 01



1FL PLAN

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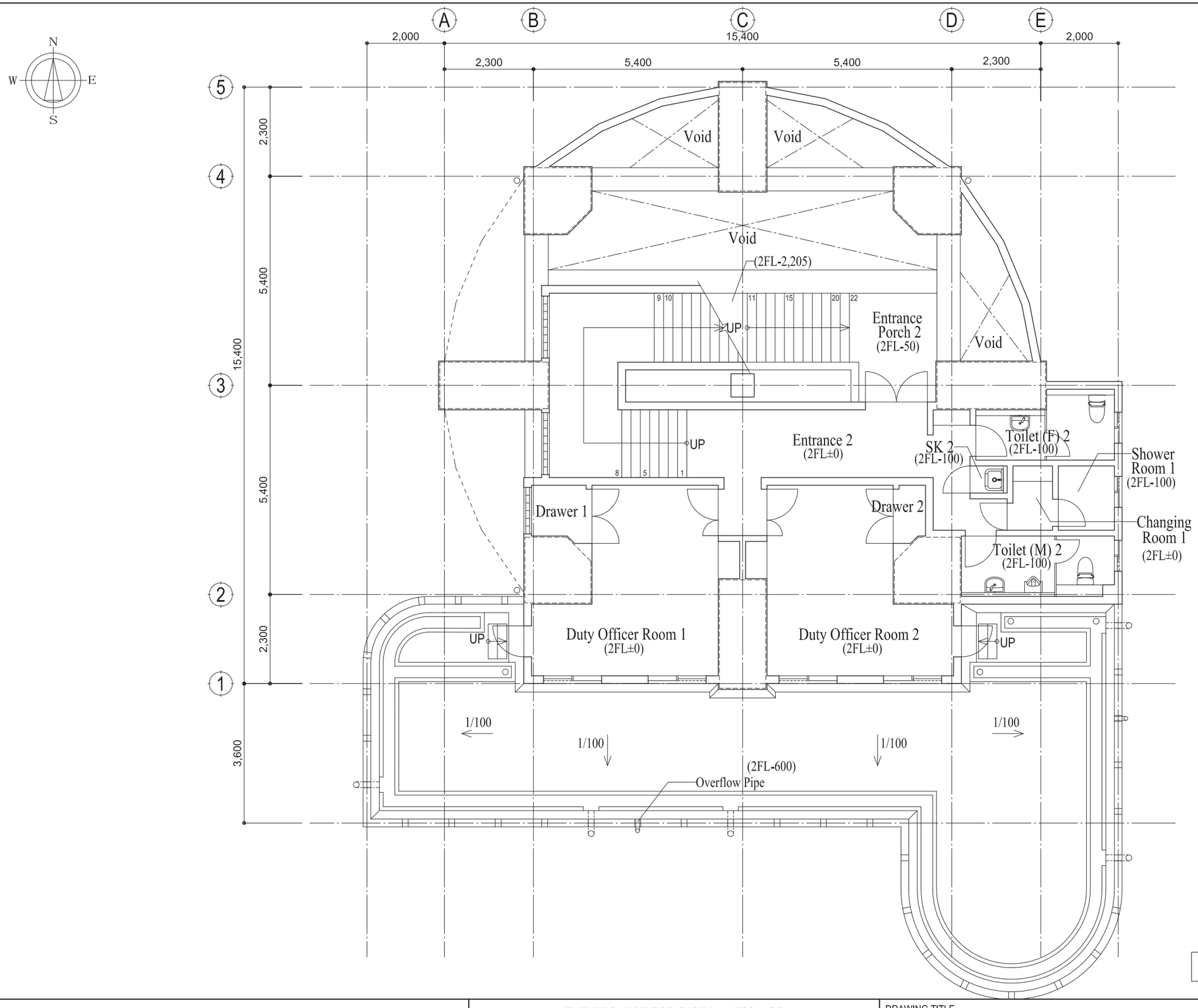
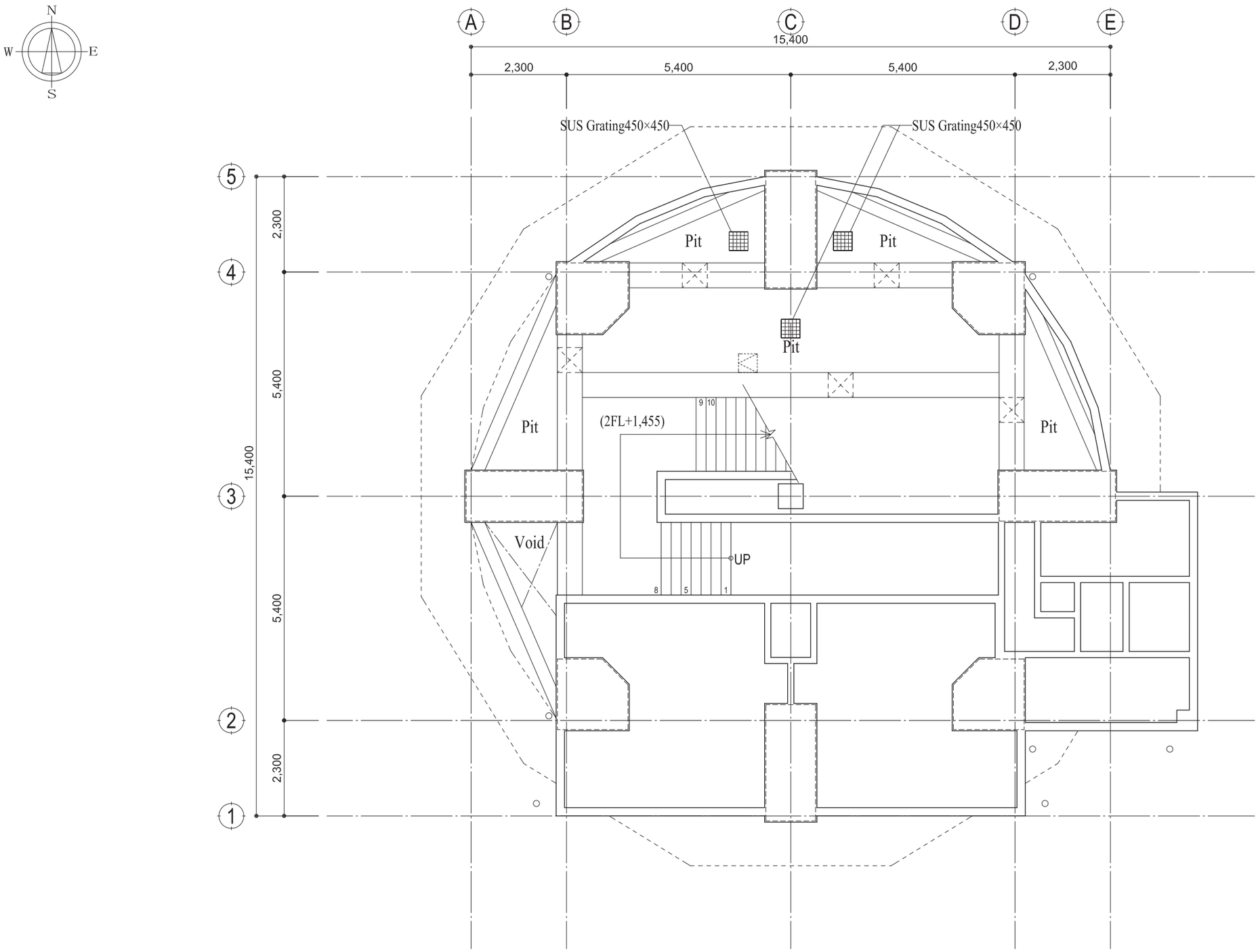


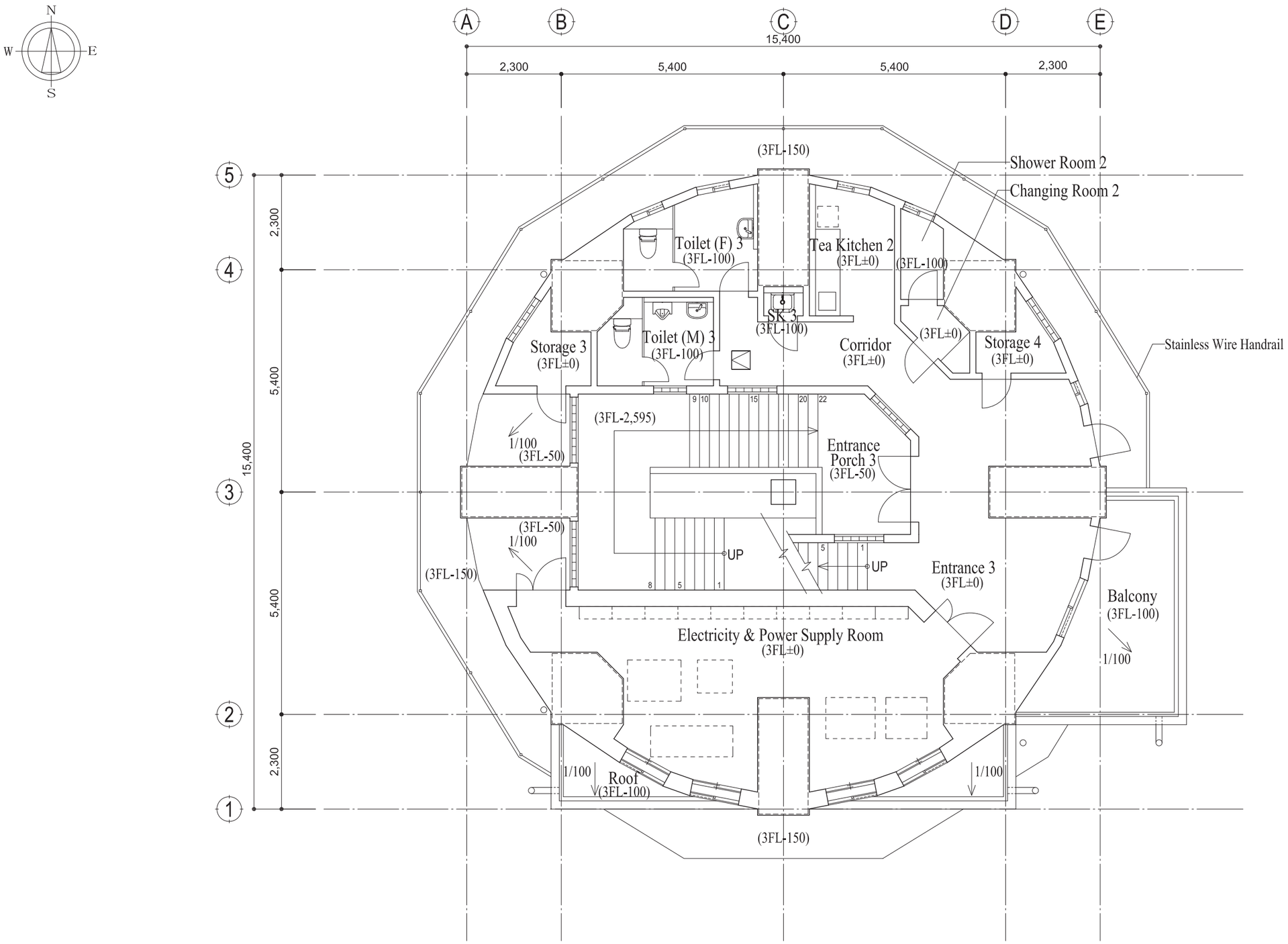
2FL PLAN

International Meteorological Consultant Inc. Sankyo Meguro Bdg. 4F, 4-5-37, Kamiosaki, Shinagawa-ku, Tokyo, 141-0021 Japan Tel. +81-3-6431-9559 Fax. +81-3-6431-9759	THE PROJECT FOR INSTALLATION OF WEATHERE SURVEILLAMCE RADAR AT MULTAN IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE MULTAN METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 2	SCALE 1:100	DRAWING No. A - 03



M2FL PLAN

International Meteorological Consultant Inc. Sankyo Meguro Bdg. 4F, 4-5-37, Kamiosaki, Shinagawa-ku, Tokyo, 141-0021 Japan Tel. +81-3-6431-9559 Fax. +81-3-6431-9759	THE PROJECT FOR INSTALLATION OF WEATHERE SURVEILLAMCE RADAR AT MULTAN IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE MULTAN METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 3	SCALE 1:100	DRAWING No. A - 04



3FL PLAN

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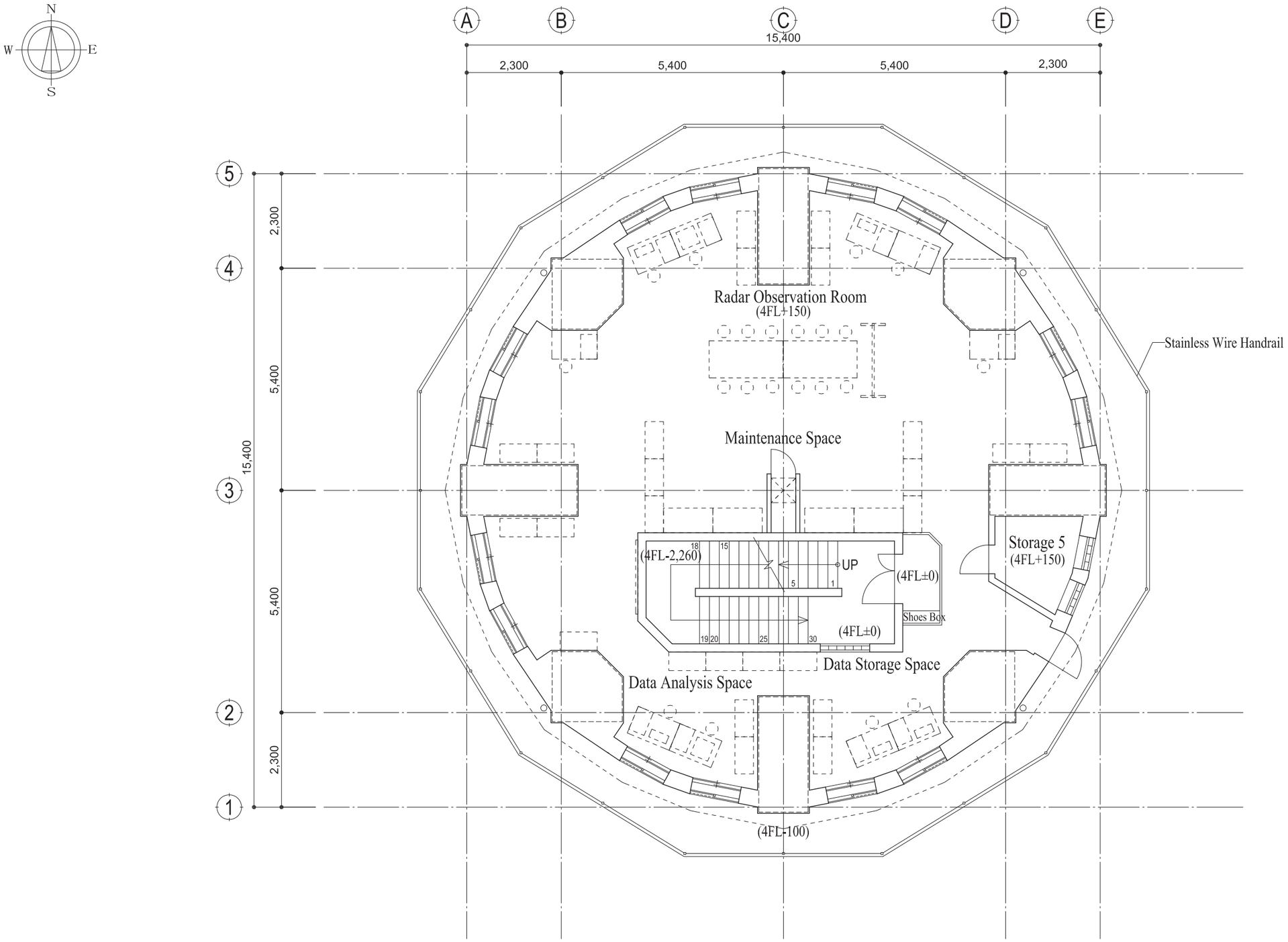
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 4

SCALE
1:100

DRAWING No.
A - 05



4FL PLAN

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THE PROJECT FOR INSTALLATION OF
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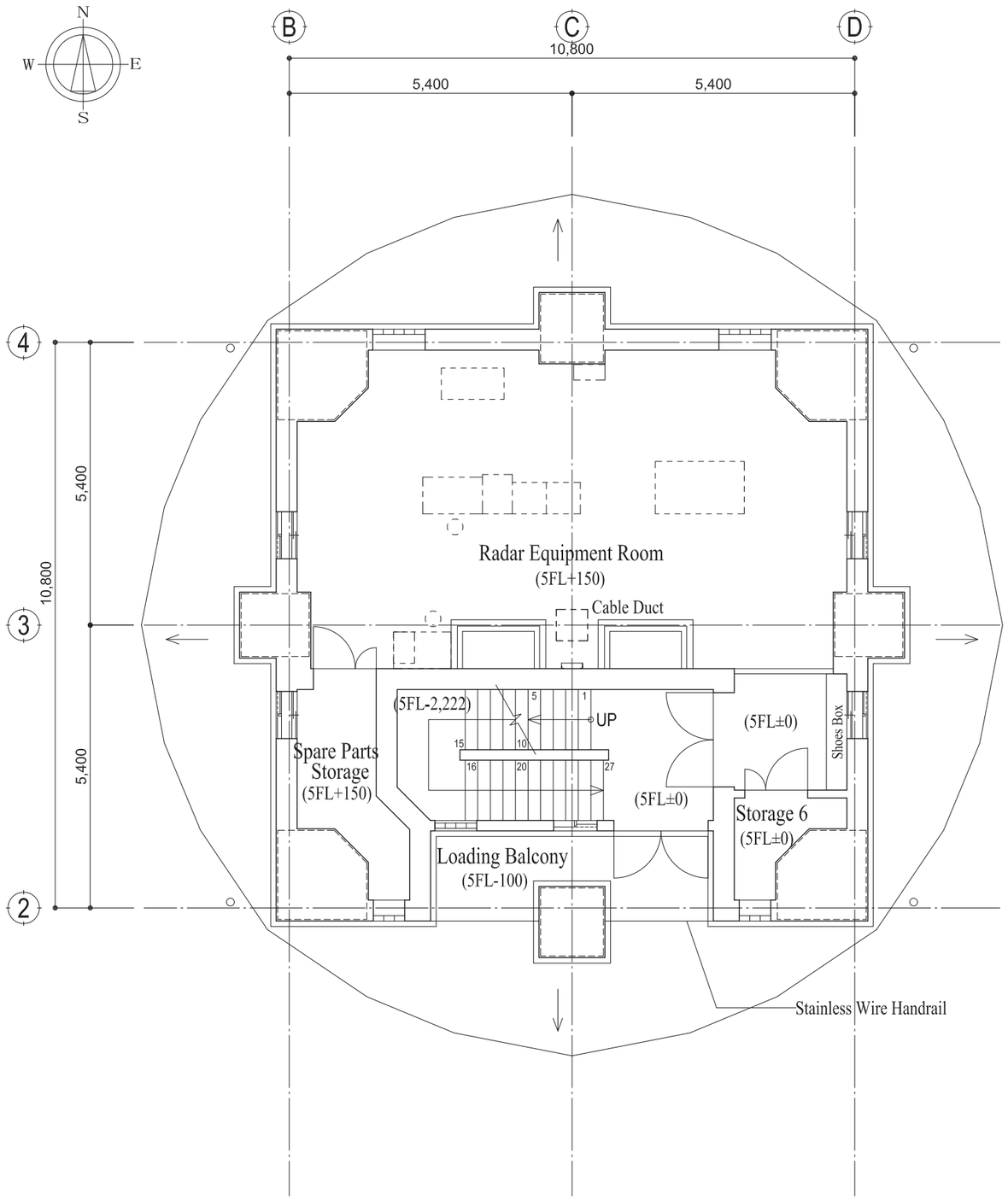
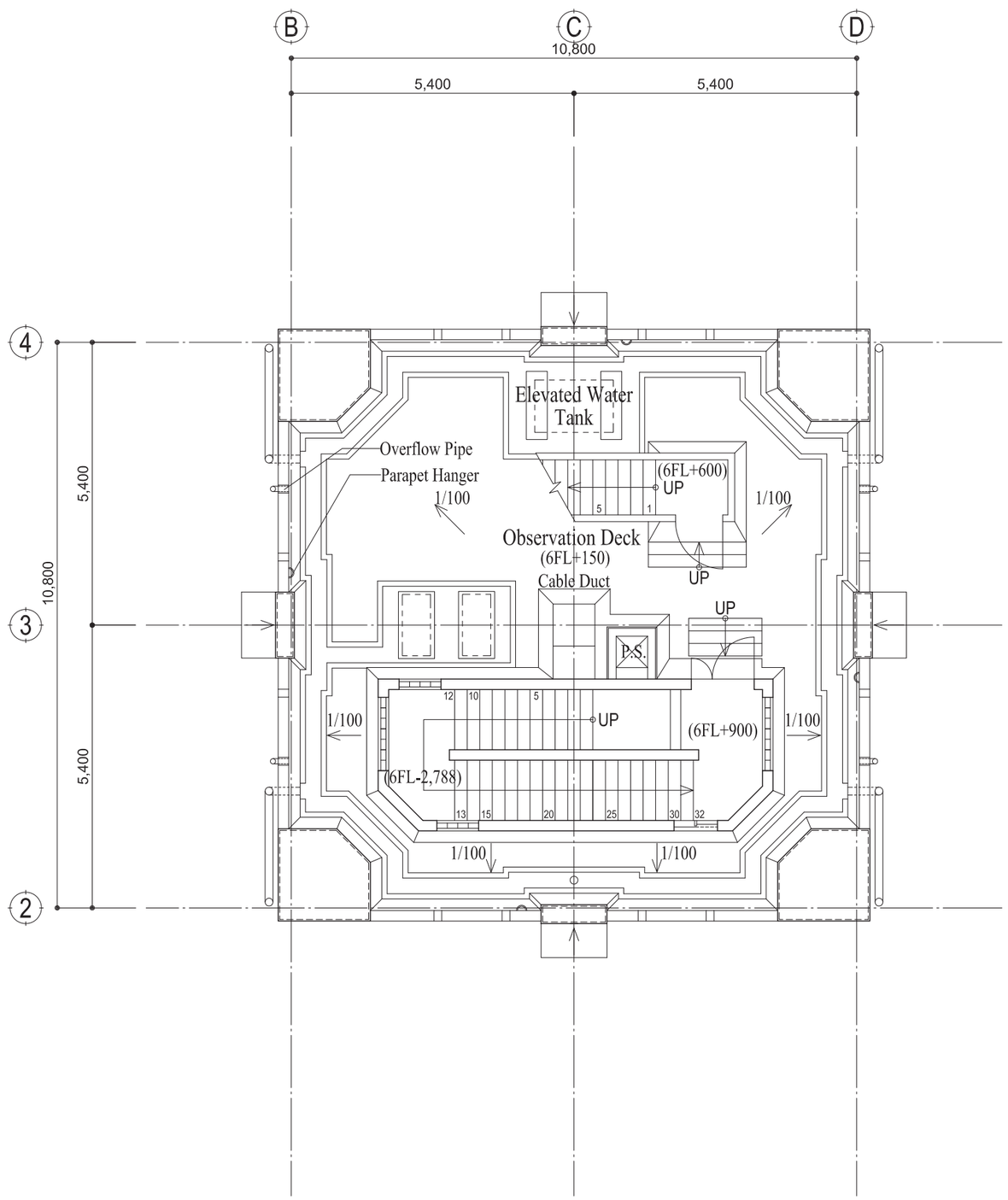
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 5

SCALE
1:100

DRAWING No.
A - 06



5FL PLAN



6FL PLAN

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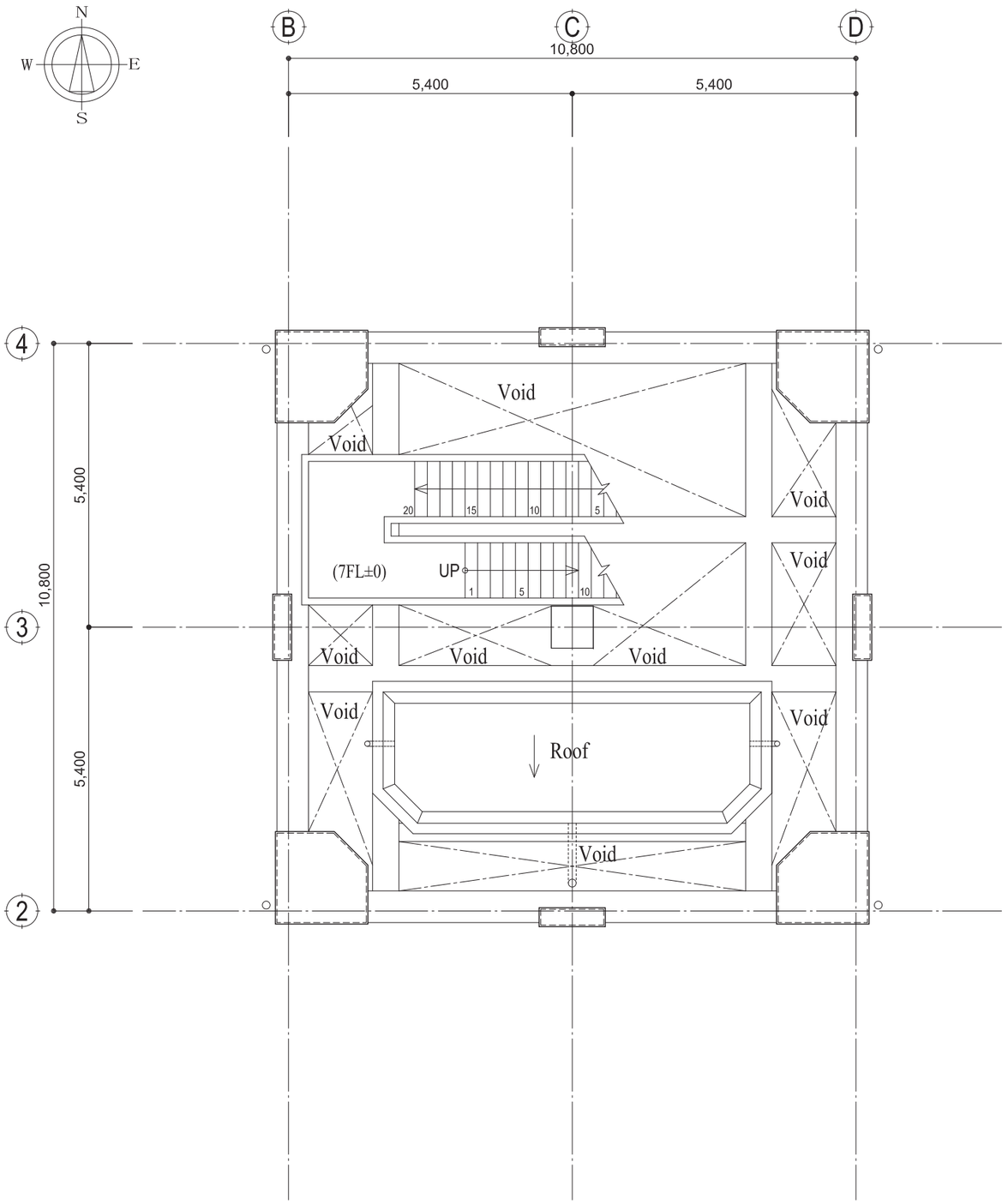
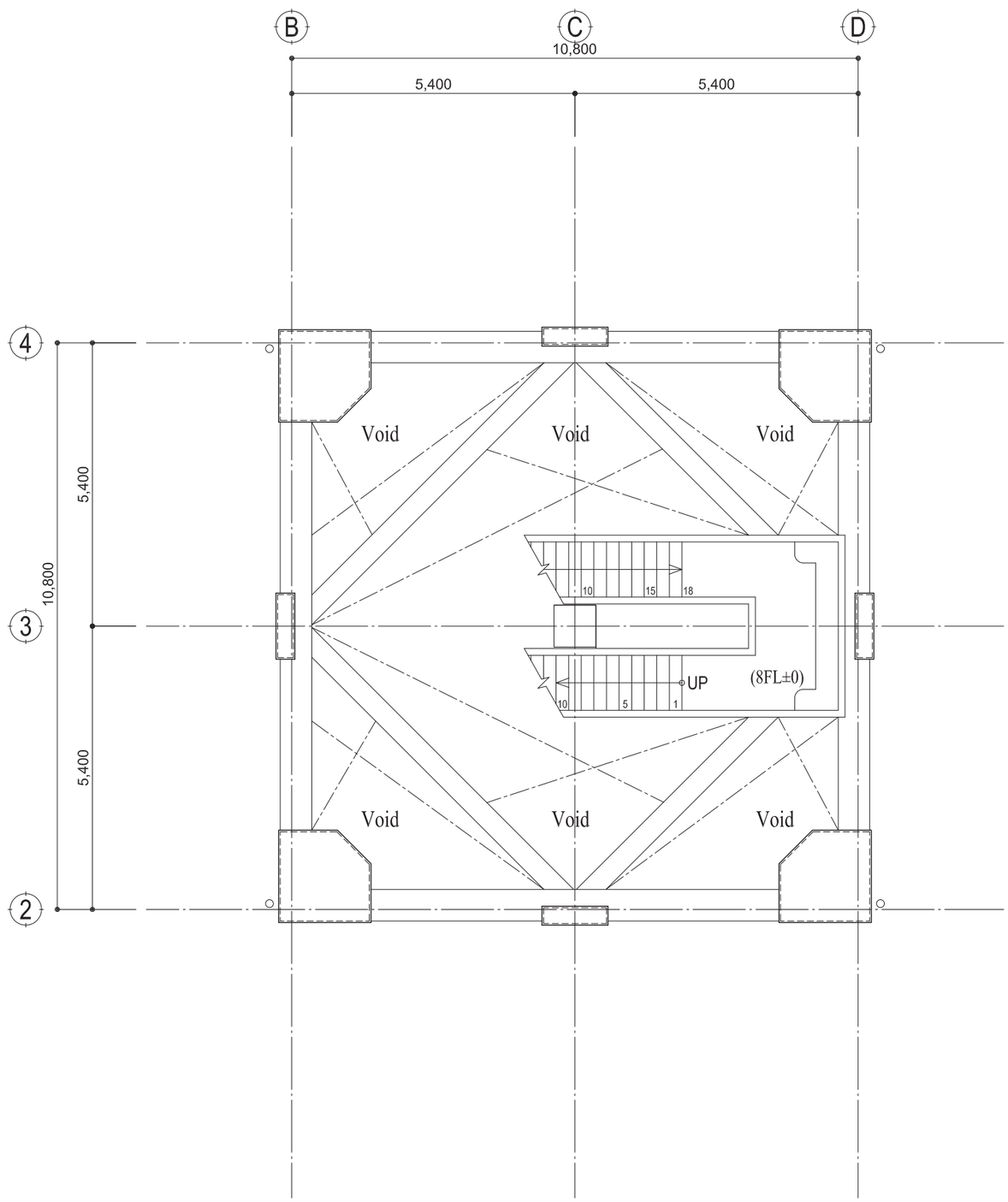


7FL PLAN



8FL PLAN

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THE PROJECT FOR INSTALLATION OF
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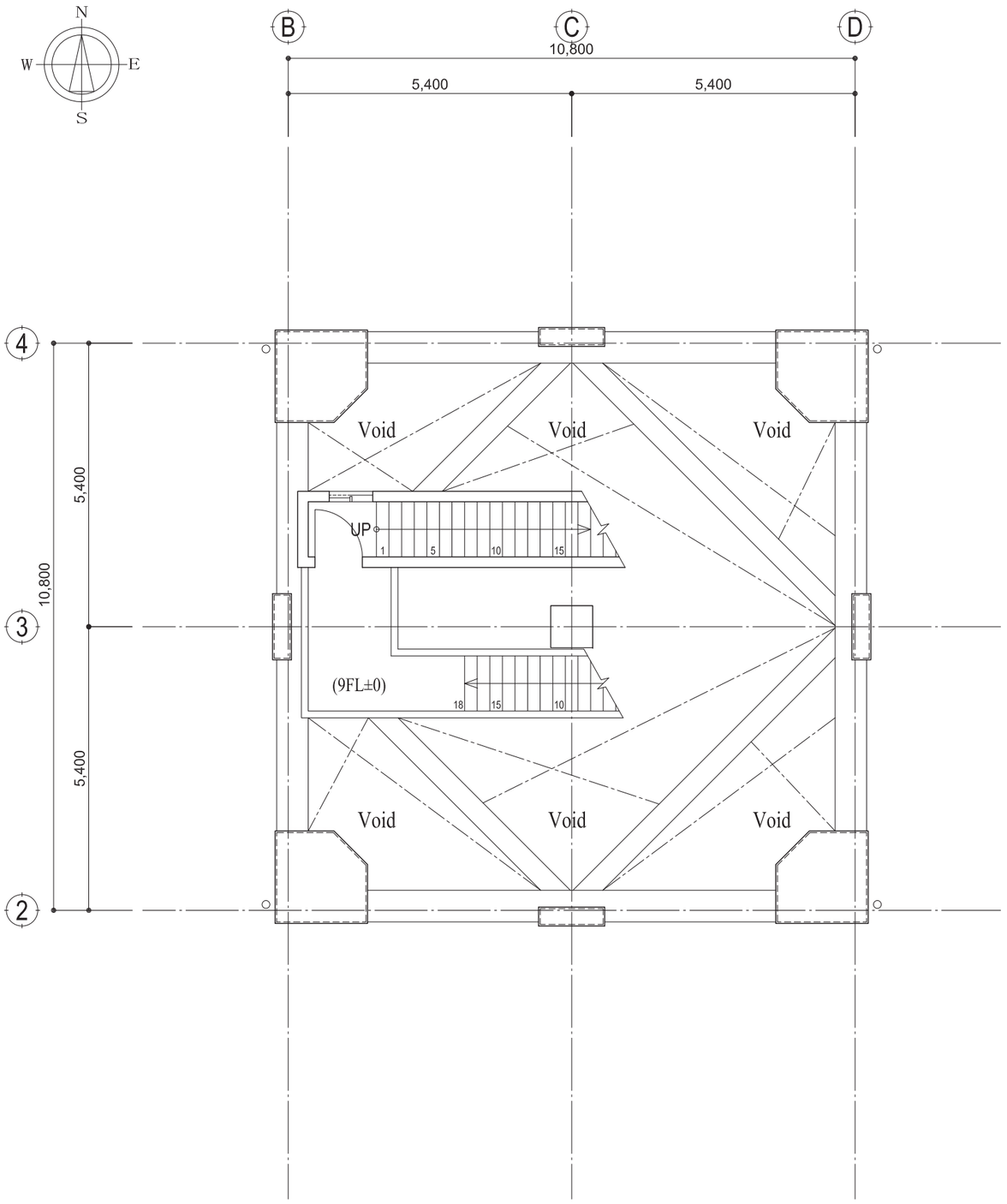
IN THE ISLAMIC REPUBLIC OF PAKISTAN

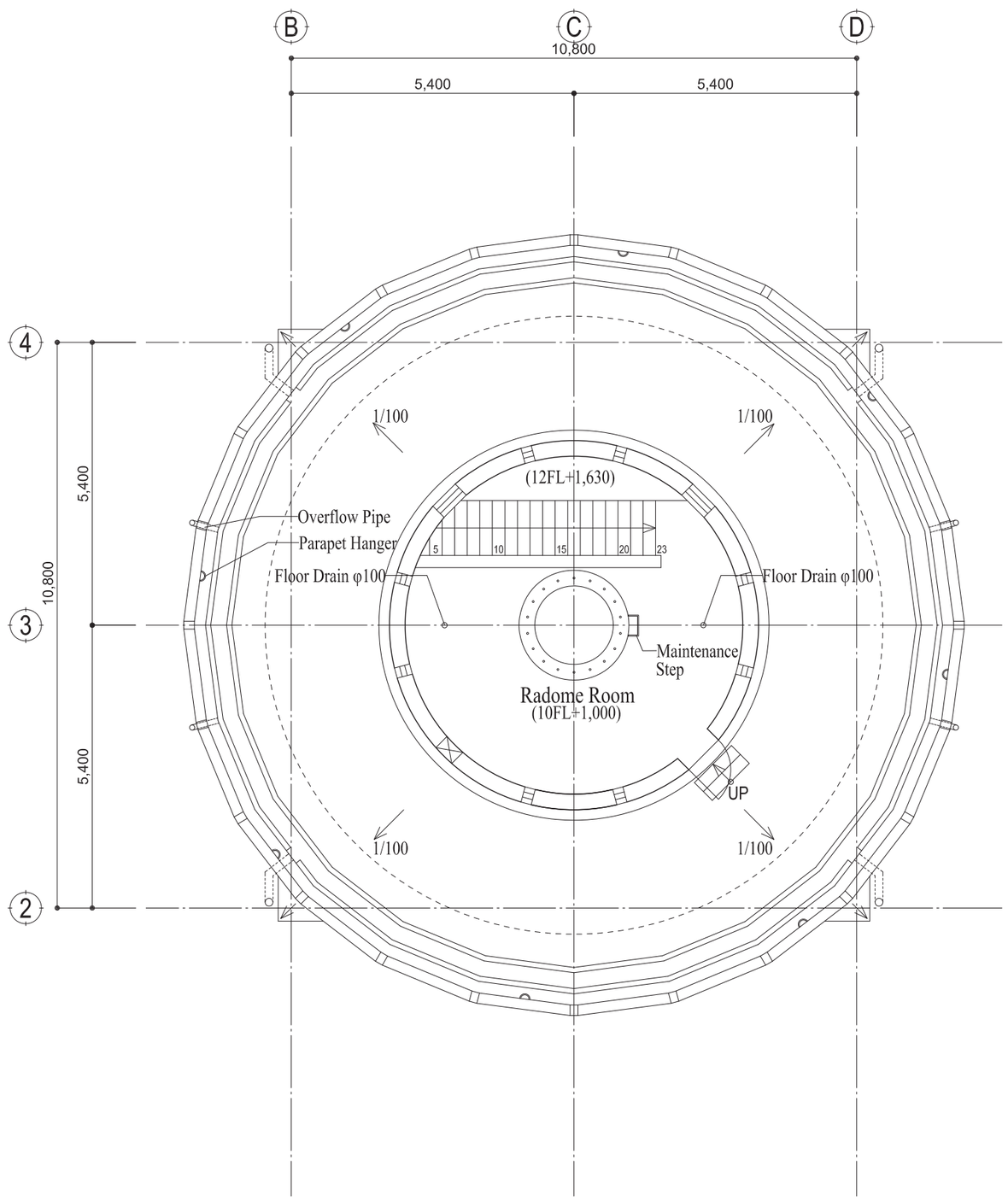
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 7

SCALE
1:100

DRAWING No.
A - 08



9FL PLAN



10FL PLAN

∩ : Parapet Hanger

⊥ : Overflow pipe

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Sankyo Meguro Bdg. 4F, 4-5-37, Kamiosaki, Shinagawa-ku, Tokyo, 141-0021 Japan
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THE PROJECT FOR INSTALLATION OF
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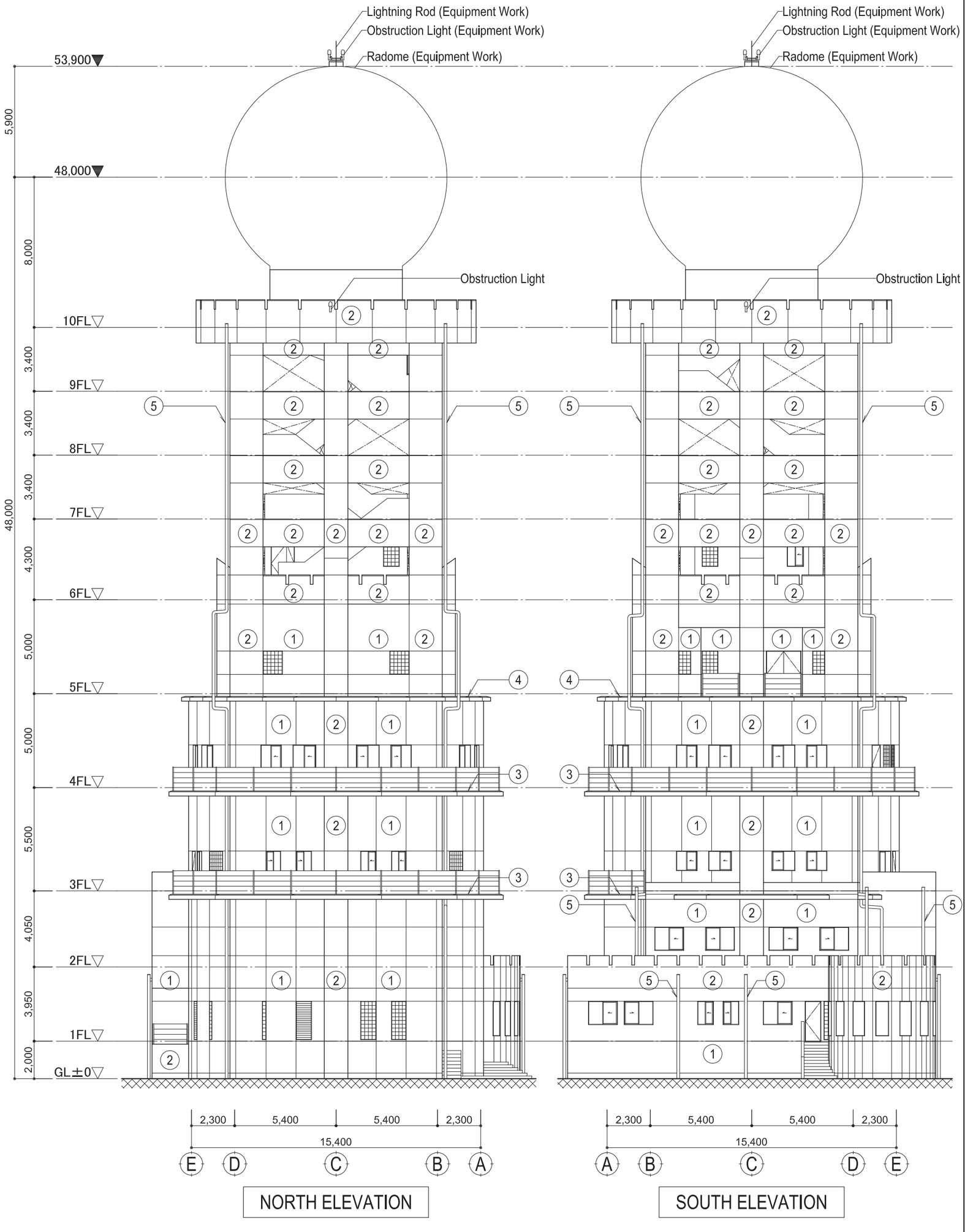
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 8

SCALE
1:100

DRAWING No.
A - 09

LEGEND

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



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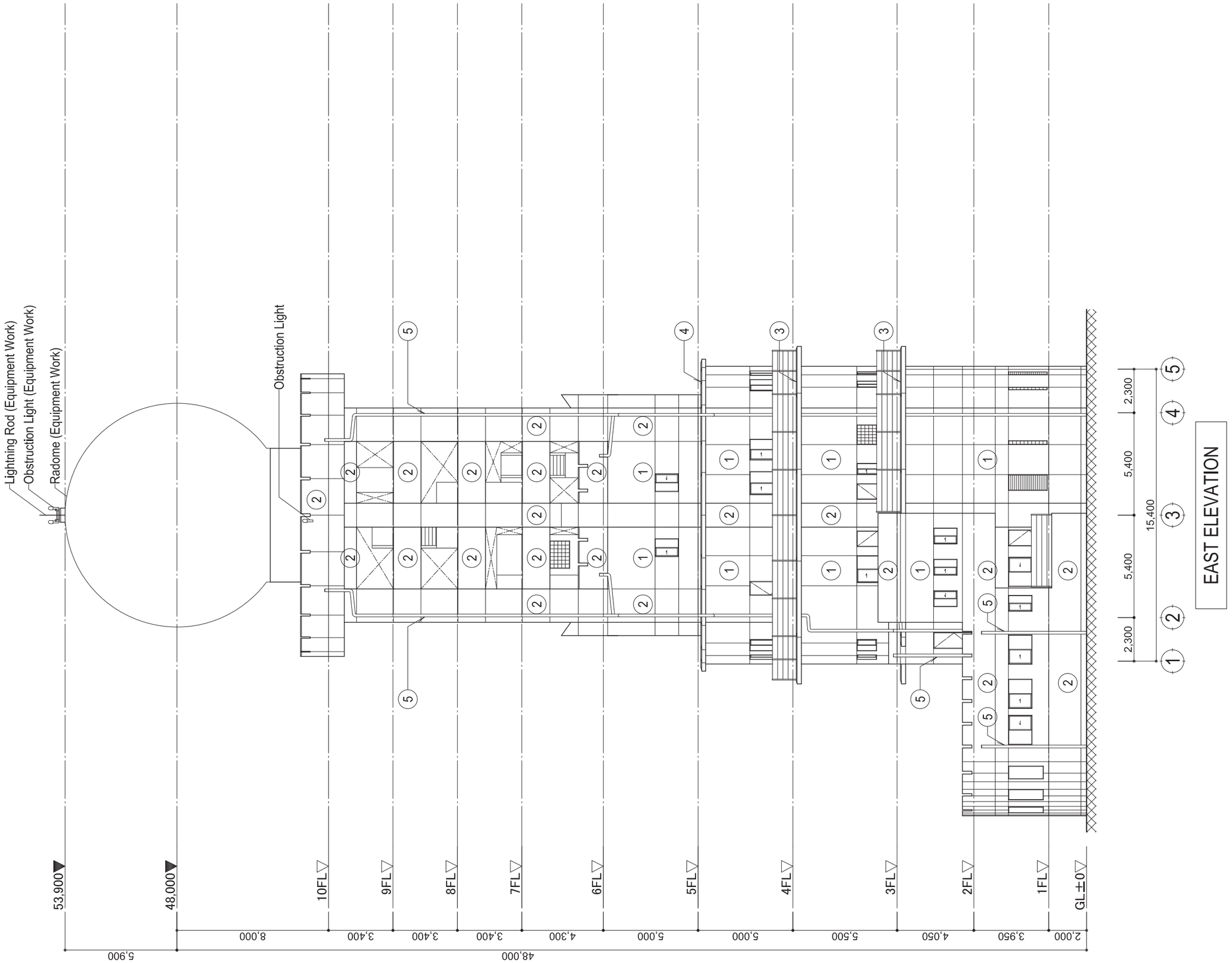
THE PROJECT FOR INSTALLATION OF
WEATHERE SURVEILLAMCE RADAR AT MULTAN
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 1

SCALE
1:200

DRAWING No.
A - 10



LEGEND

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

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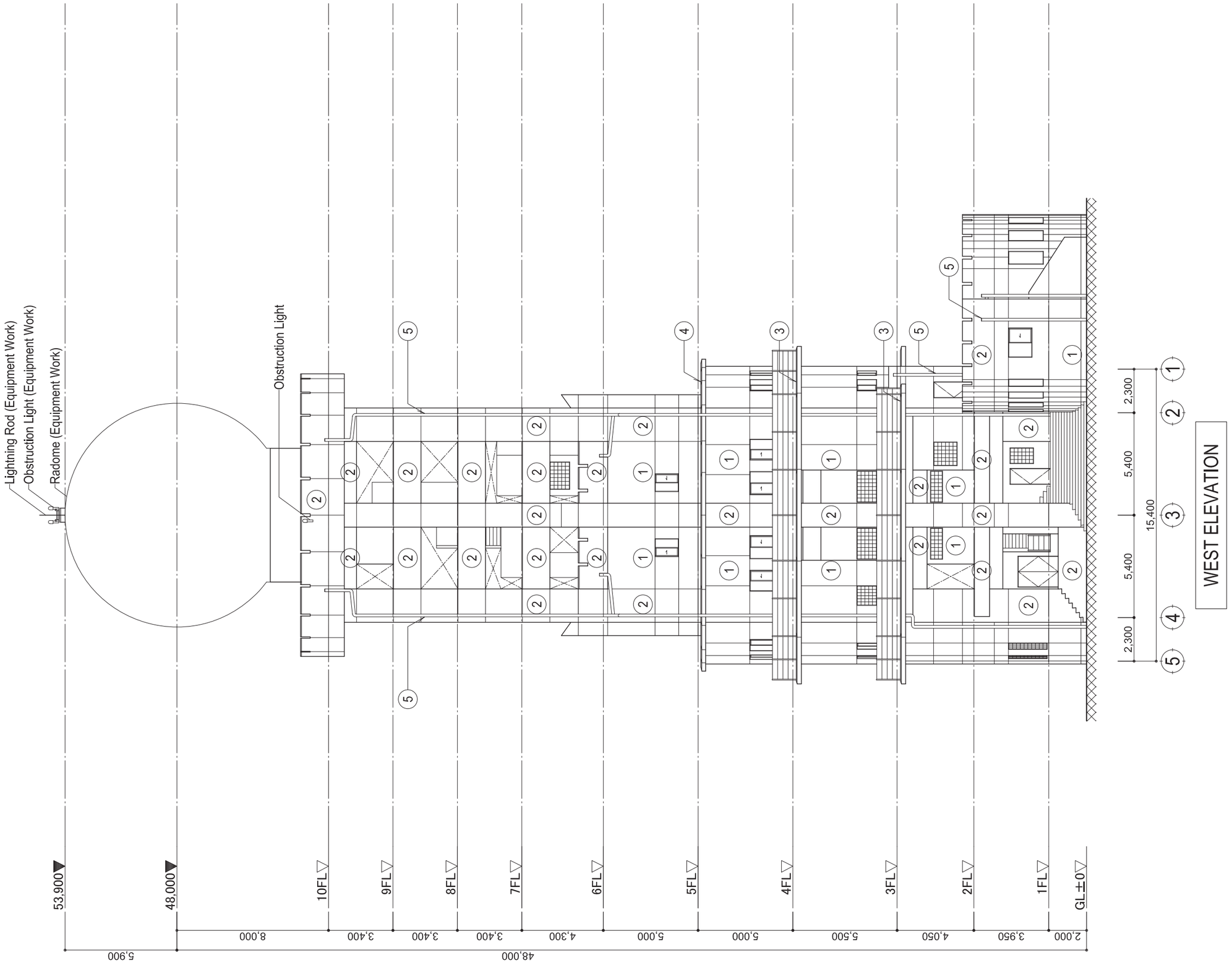
Tel. +81-3-6431-9559 Fax. +81-3-6431-9759

THE PROJECT FOR INSTALLATION OF
WEATHERE SURVEILLAMCE RADAR AT MULTAN
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 2

SCALE
1:200

DRAWING No.
A - 11



LEGEND

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

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THE PROJECT FOR INSTALLATION OF
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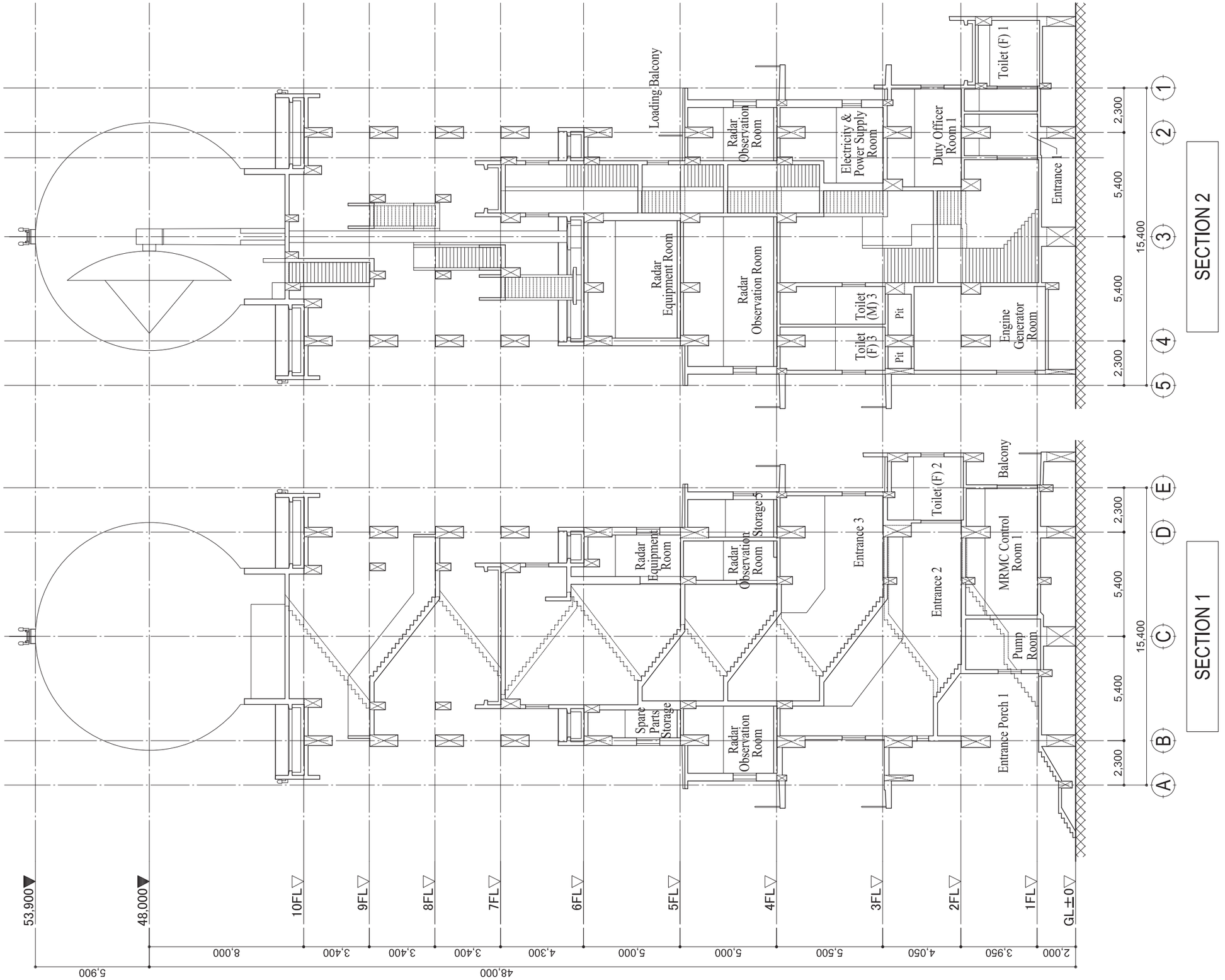
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 3

SCALE
1:200

DRAWING No.
A - 12



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THE PROJECT FOR INSTALLATION OF
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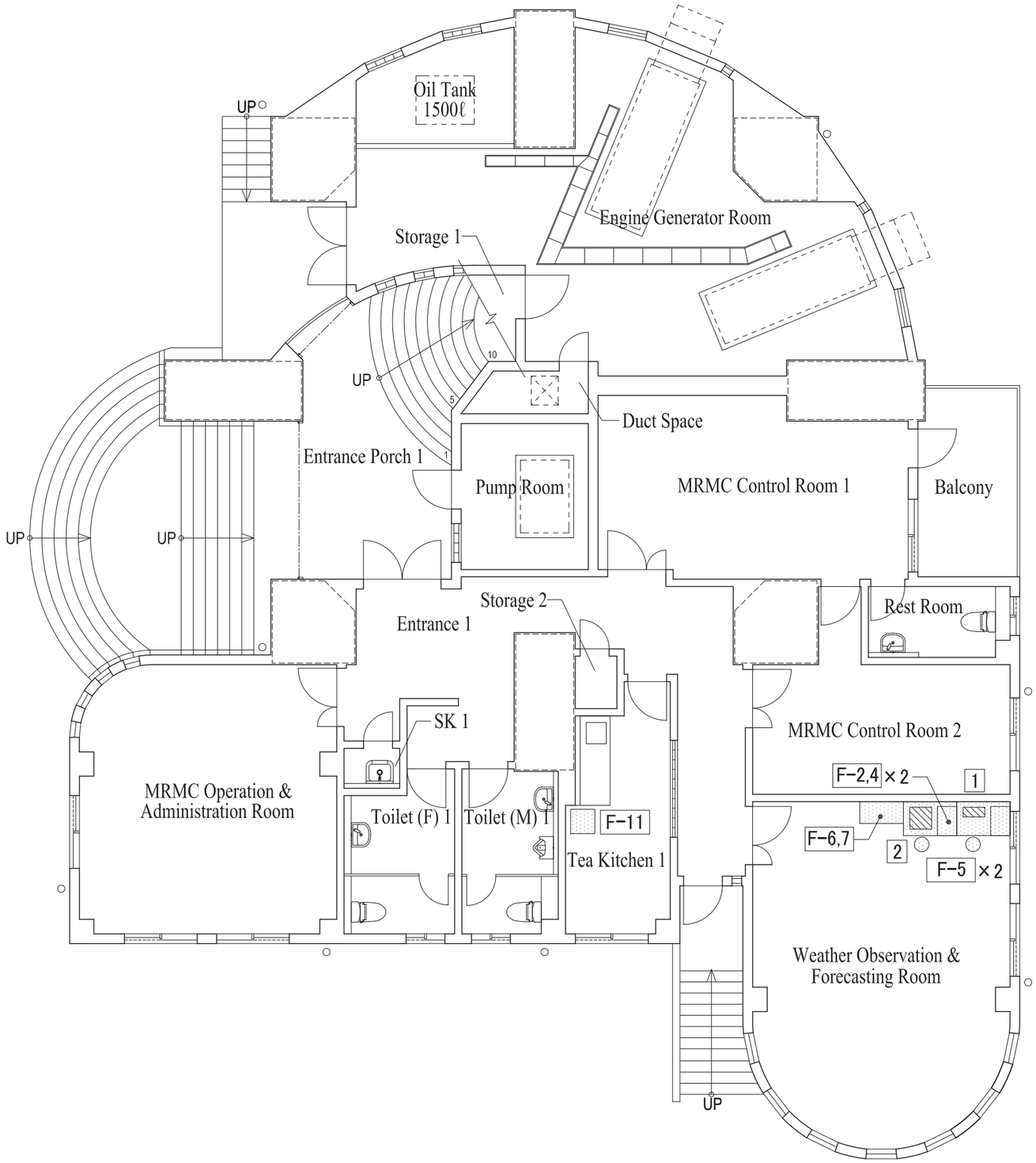
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
SECTION

SCALE
1:200

DRAWING No.
A - 13



FURNITURE (CONSTRUCTION WORK)

F-2	Pedestal-free Desk (W1,100 × D700)
F-4	Drawer Unit with Casters
F-5	Chair
F-6	Lateral Filling Cabinet H1,100
F-7	Cabinet (Double Hinged Doors) H1,000
F-11	Water Dispenser

EQUIPMENT (EQUIPMENT WORK)

1	Meteorological Product Display
2	Colour Printer

1FL PLAN

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THE PROJECT FOR INSTALLATION OF
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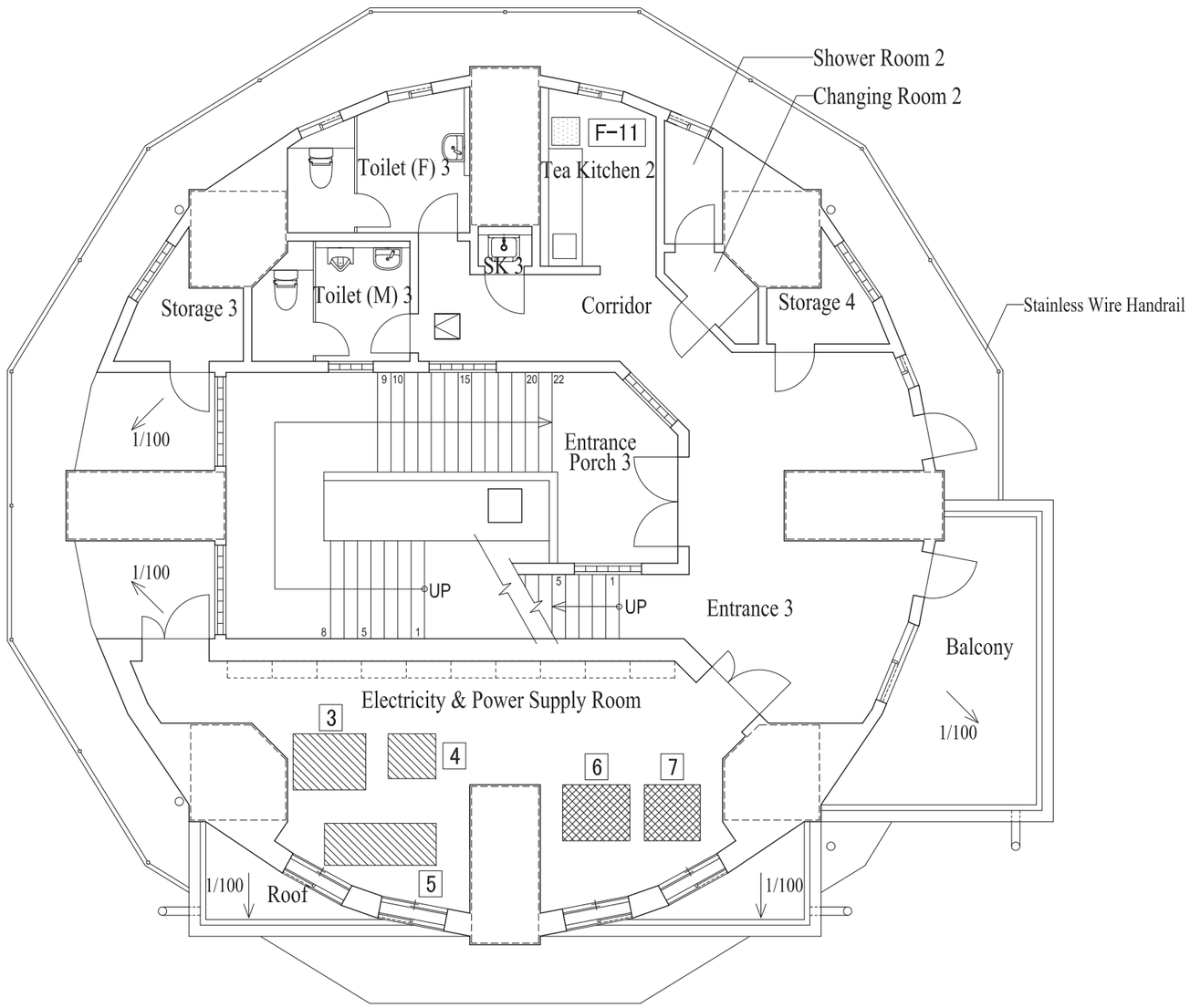
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
EQUIPMENT LAYOUT PLAN 1

SCALE
1:100

DRAWING No.
EQ - 01



EQUIPMENT (EQUIPMENT WORK)

3	Radar AVR
4	Radar IT
5	Power Backup System

EQUIPMENT (CONSTRUCTION WORK)

6	AVR
7	Isolation Transformer

FURNITURE (CONSTRUCTION WORK)

F-11	Water Dispenser

3FL PLAN

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THE PROJECT FOR INSTALLATION OF
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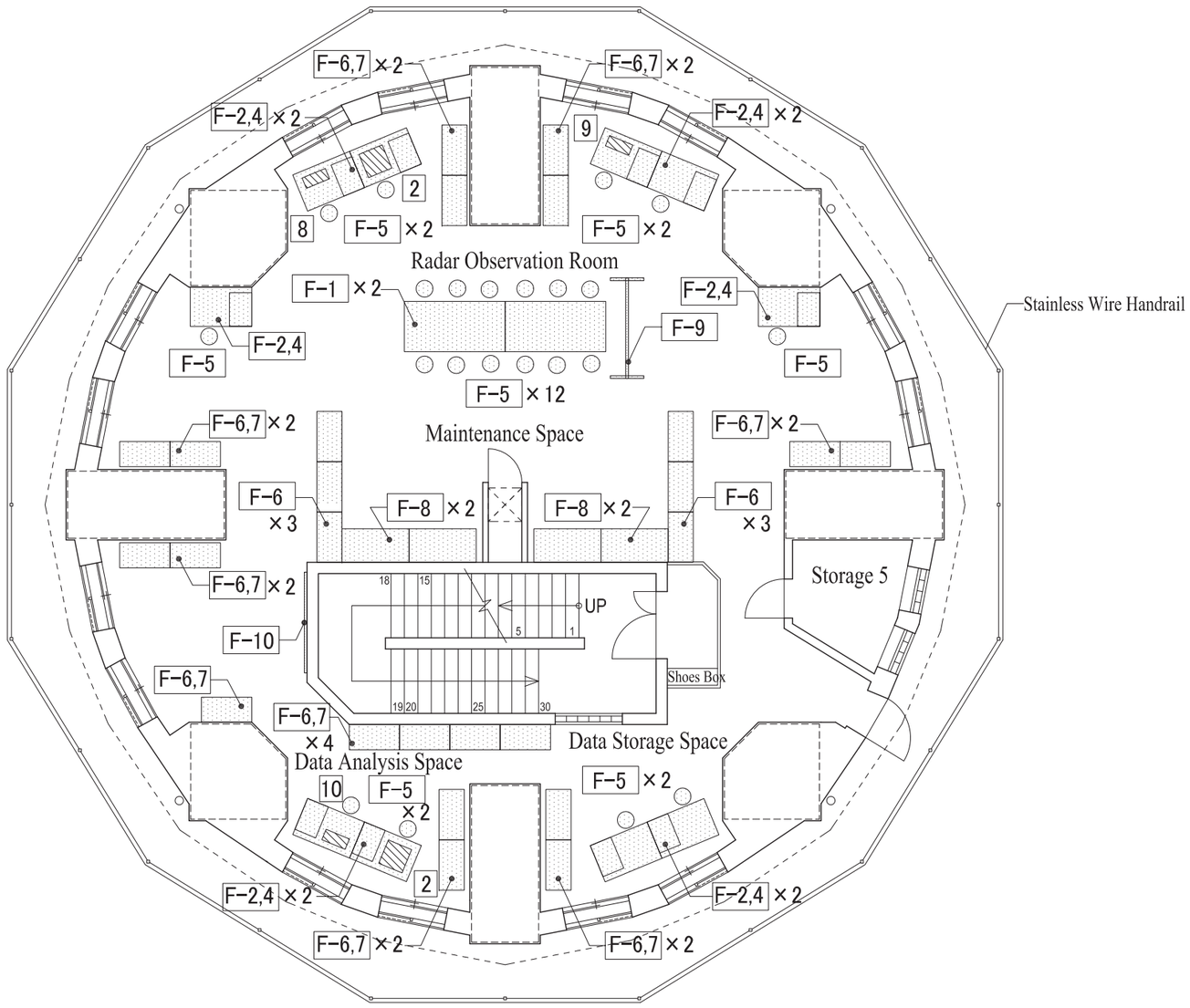
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
EQUIPMENT LAYOUT PLAN 2

SCALE
1:100

DRAWING No.
EQ - 02



4FL PLAN

EQUIPMENT (EQUIPMENT WORK)

2	Colour Printer
8	Rainfall Intensity Indicator
9	Doppler Velocity Indicator
10	Data Analyzing Unit

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

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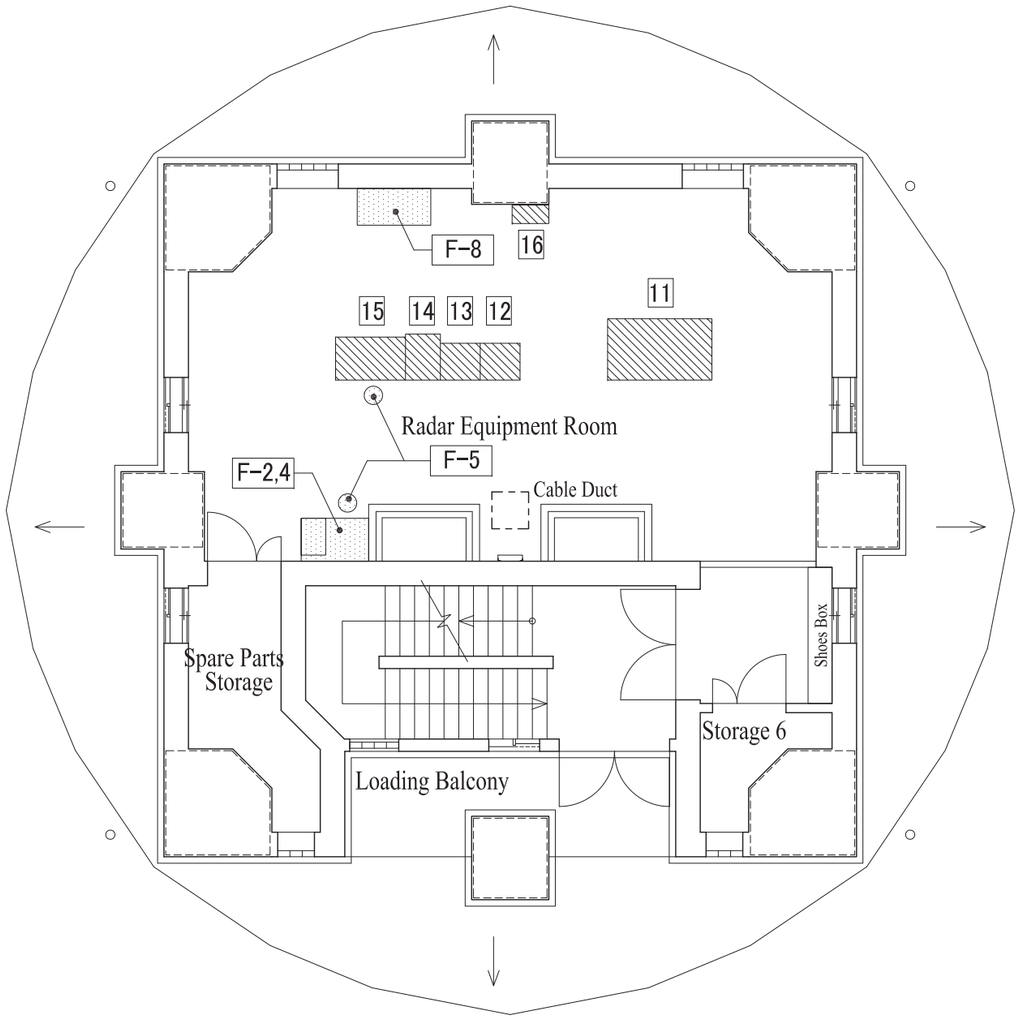
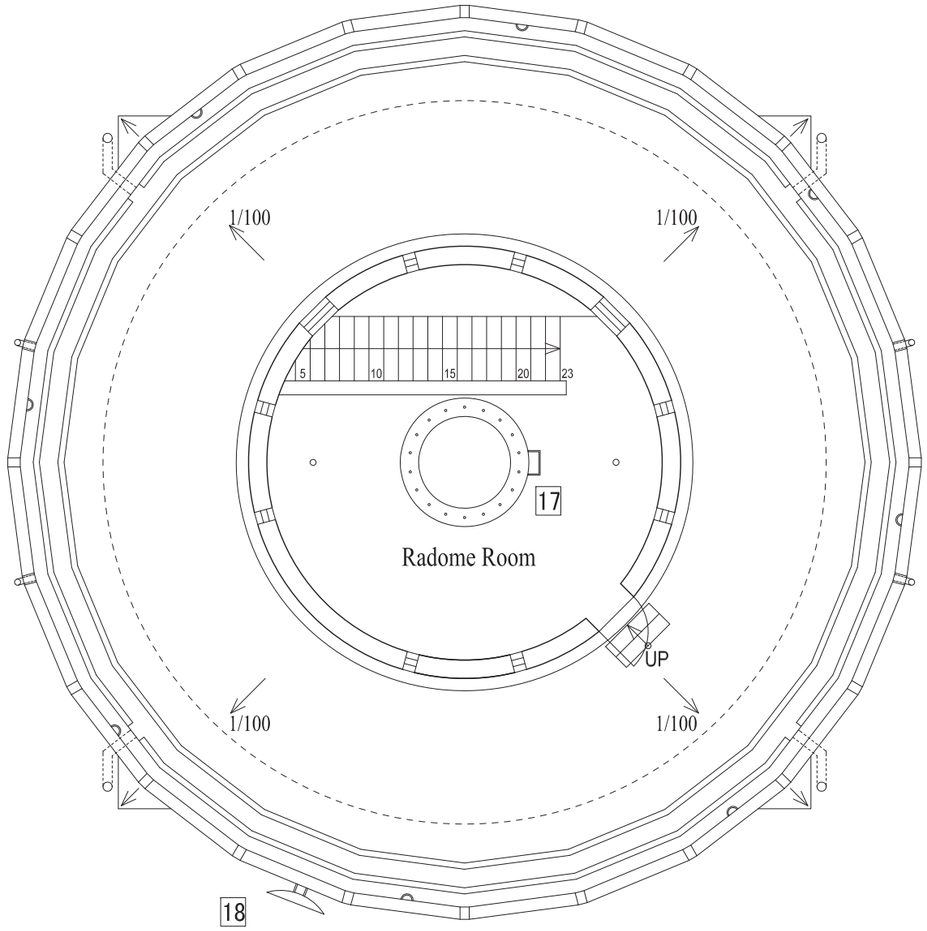
DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
EQUIPMENT LAYOUT PLAN 3

SCALE
1:100

DRAWING No.
EQ - 03



5FL PLAN



6FL PLAN

EQUIPMENT (EQUIPMENT WORK)

11	Transmitter	15	Radar TASK Controller
12	Antenna Controller & Dehydrator	16	Radar Power Maintenance Panel
13	DRSP	17	Antenna
14	Data & Protocol Converter	18	Wireless Transceiver Antenna

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

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Tel. +81-3-6431-9559 Fax. +81-3-6431-9759

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DRAWING TITLE
MULTAN METEOROLOGICAL RADAR TOWER BUILDING
EQUIPMENT LAYOUT PLAN 4

SCALE
1:100

DRAWING No.
EQ - 04

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 Islamic Republic of Pakistan and the Government of Japan and the Grant Agreement (G/A) between the Islamic Republic 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 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,

power supply capacitor, etc.). During the construction period, it is important that there should be a 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 trainees to ensure that the PMD can operate and maintain the equipment efficiently after 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.

Table 37: Major Undertakings to Be Done by the Islamic Republic of Pakistan/PMD during and after the 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 Initial Environmental Examination (IEE) procedures in Pakistan, if required so.		●
3	To handle duty (tax) exemption procedures and to take necessary measures as well as provide requisite legal and/or administrative documentations for import permit and customs clearance to the customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project as well as sending back of any defective equipment and/or spare parts to the manufacturer for repair at the factory or replacement and re-importation thereof into Pakistan during the implementation and warranty periods of the Project.		●
4	To provide necessary working spaces with Internet Connection at the PMD Islamabad Head Office and the Meteorological Office in the Multan International Airport, PMD Multan for the Consultant and the Contractor during the implementation of the Project.		●
5	To facilitate and provide marine (or air) transportation of the materials and equipment imported from overseas (Japan).	●	
6	To facilitate and provide 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 goods of Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed by the Government of Pakistan with respect to their supply (products) and services under the signed contracts.		●
9	To open Bank Account (Banking Arrangement (B/A)).		●

10	To pay bank charge (commission) for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.		●
11	To bear all the expenses, other than those to be borne by the Japanese Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment.		●
	Items for Safety Measures		
12	To take responsibility of arranging the maximum countermeasures and ensure the appropriate 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 implementation of the Project.		●
13	To arrange security around the proposed Project Site in Multan with the police.		●
14	To arrange security around the accommodation(s) of the Consultant & the Contractor with the police.		●
15	To arrange escort guard with the police during movements between the accommodation(s) of the Consultant & the Contractor and the proposed Project Site in Multan.		●
16	To construct security concrete boundary wall(s) with a height of 3 m & 6 m + a barbed wire, to enclose the spaces for the proposed Project Site in Multan and gates (boom gates, a sliding main gate: 4 m width and a back gate: 4 m width).	●	
17	To install security cameras and night time monitoring lights to be used during the implementation of the Project.	●	
18	To arrange guards (24 hours, 3 shifts) in the proposed Project Site in Multan.	●	
19	To procure security equipment (vehicle under-verification mirror, gate type walk-through metal detector and handy type metal detector) during implementation of the Project.	●	
20	To procure satellite mobile phone and Wi-Fi pocket router for the Consultant & the Contractor to ensure emergency contact during implementation of the Project.	●	
	For the Construction of the Radar Tower Building		
21	To fill soil to the proposed Project Site, compact and level prior to the commencement of construction work.	●	
22	To secure sufficient spaces at the proposed Project Site in Multan for temporary facilities such as a consultant's site office, contractor's office, workshop, building materials storage, etc. needed for the construction work.		●
23	To obtain all prior regulatory compliance and necessary permissions from the relevant agencies/authorities for the construction of the Radar Tower Building in the proposed Project Site in Multan.		●
24	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: no less than 150kVA) along with electric poles/wires, etc. from the main supply line to the proposed Project Site in Multan for the Radar Tower Building and other facilities to be constructed by the PMD prior to the commencement of construction work.		●
25	To install the required step-down transformer (capacity: no less than 150kVA) as well as service entrance connections for the commercial power supply at the proposed Project Site in Multan for the Radar Tower Building (400V, 3-phase, 4-wire, 50Hz) prior to the commencement of construction work.		●
26	To relocate the existing high voltage power cable in the proposed Project Site in Multan.		●
27	To provide as telephone lines for the Radar Tower Building in the proposed Project Site in Multan.		●
28	To provide temporary facilities for the availability or accessibility of electricity for the construction work.		●
29	To construct the Radar Tower Building, including: a) Architectural and civil works; b) Electrical works including a lightning protection system; c) Air-conditioning and Ventilation works; and, d) Plumbing works.	●	
30	To procure and install standard furniture for the Radar Tower Building.	●	
31	To undertake incidental outdoor works such as gardening/landscaping and exterior		●

	lighting in and around the proposed Project Site in Multan, if necessary.		
32	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.	●	
33	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.		●
34	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		
35	To provide free of charge and allocate secure temporary storage area/room for the materials, tools and equipment needed during the installation process.		●
36	To obtain the required frequencies for the Multan Meteorological Radar System, Polarimetric Test Horn Devices and Meteorological Data Communication System (between Multan Meteorological Radar Observation Station and the Meteorological Office in Multan International Airport, PMD Multan).		●
37	To promptly provide reliable and high-speed Internet environment at the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office (Forecasting Room) in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore (with each corresponding global/fix IP) for establishment of a Virtual Private Network (IP-VPN).		●
38	To set up the required and new assigned IP addresses in the computing equipment supplied under the Project and facilitate any required configuration i.e. firewall settings, etc. of the existing PMD equipment which may be made part of the Project Network Communication System, if any.		●
39	To secure ample and strategically located space/s at the existing facilities (the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office (Forecasting Room) in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore) for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project.		●
40	To install 1 additional air-conditioning system at the PMD Multan Meteorological Office (Forecasting Room).		●
41	To procure, install and adjust the required Equipment (including the lightning protection system) for the Project implementation.	●	
42	To procure and install furniture for the Equipment to be procured under the Project.	●	
43	To conduct the reliability & final tests and commissioning for the total system.	●	
44	To provide On-the-job Trainings (Initial Trainings) by the contractor on the operation and maintenance of the Equipment as well as the radar data/products display software training for the PMD.	●	
45	To support the Contractor to procure/obtain relevant and vital information or data i.e. shape file map of Pakistan containing the administrative boundaries (regions, provinces, cities, districts, wards, etc.) as well as the rivers, lakes, and dams in Pakistan to be incorporated into the radar data/products display software.		●
46	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.		●
47	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		
48	To assign the required staff including a responsible personnel of the PMD who has reliable technical skill and ample experience for the smooth operation and maintenance of the Equipment.		●
49	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment, and enter into a Preventive Maintenance Service Agreement with the equipment supplier if so desired.		●
50	To ensure adequate maintenance of the Radar Tower Building constructed under the Project so that they may function effectively for a long time.		●

51	To properly operate and maintain, and also effectively utilize the facilities constructed and the Equipment procured/installed under the Project.		●
52	To allocate the necessary budget and personnel for the smooth conduct of meteorological radar observation and forecasting works.		●
53	To periodically update all the operation/antivirus/application software(s).		●
54	To procure the appropriate number and capacity of disk media, hard disks, solid state disks, etc., and dutifully conduct the required schedule archiving of radar observation raw data and products.		●

Since the following two (2) works indicated below, which are large scale and require special technical knowledge and experience concerning civil engineering construction, are difficult to be implemented and supervised by the PMD (a meteorological agency) and in order to prevent any delays of the Project implementation, it has been decided that the said works are to be implemented by a contractor (a building construction company) of this Project as part of construction of the Multan Meteorological Radar Tower Building. In order to properly and effectively implement the soil filling work to the proposed Project Site, special technical knowledge related to civil engineering listed below with abundant experience are required.

- Selection of filling soil materials: to confirm less compressibility soil material and less settlement & deformation after soil filling and secure the required trafficability and bearing resistance
- Filling soil material adjustment: to implement water content ratio adjustment or particle size adjustment by expert engineers
- Soil grading: to plan for transport of filling soil materials, selection of grading machineries, management of each grading thickness
- Compacting: to select compacting machineries and compaction method through soil filling test
- Quality control: to implement density & intensity measurement and quality control of soil compaction

■ Filling soil to the proposed Project Site prior to the commencement of construction work (No. 21 in the table above)

Since the proposed Project Site for the Multan Meteorological Radar observation Station is lower than the road by 3.5 m or more (in depth), it is necessary to fill about 15,900 cubic meters of soil to the site. Filling soil to the proposed Project Site will be implemented after completion of the construction of security concrete boundary wall(s).

3,180 m^2 × 3.5 m (depth) × 1.2 (Premium rate in cost estimate) = 13,356 m^3
840 m^2 × 2.5m (depth) × 1.2 (Premium rate in cost estimate) = 2,520 m^3
Required Soil Volume: 15,876 m^3
Required Implementation Period: 1.5 months

- Construction of security concrete boundary wall(s) + a barbed wire (No. 16 in the table above)

As a result of consultation with the Multan police and the security officer of JICA Pakistan office including the PMD, in order to ensure safety during the Project implementation period, it is necessary to enclose the construction site of concrete security boundary wall(s) with height 3 m & 6 m+ barbed wire (boom gates, a sliding main gate: 4 m width and a back gate: 4 m width) are indispensable.

Concrete security boundary wall (height 3 m): about 109 m
Concrete security boundary wall (height 6 m): about 113 m
Required Implementation Period: 3.5 months

2-2-4-4 Consultant Supervision

1) Principal Guidelines

a) To ensure the appropriate security of the Japanese and other foreign nationals assigned to the Project prior to the commencement of and during implementation of the Project as the top priority.
b) 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.
c) 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.
d) To provide appropriate advice to the personnel of the PMD and the contractor.
e) 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 Islamic Republic 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 frequently 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 and concrete pouring work at nighttime when the outside air temperature goes down is required. The quality control plan for the main work is described in the table below.

Table 38: Quality Control Plan

Work	Work Type	Control Item	Method	Remarks
Structural Work	Concrete work	Fresh concrete Concrete strength	Slump, air volume, temperature Comprehensive strength test Chloride Quantity Test Alkali Aggregate Reactivity Test	Concrete strength test will be conducted at a public test institution. Chloride quantity test and alkali aggregate reactivity test will be conducted by a private laboratory.
	Reinforcing work	Reinforcing bar Arrangement	Tensile test, mill sheet check Bar arrangement check 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, Installation accuracy	Factory inspection sheet check Visual inspection, dimension check	
	Painting work	Workmanship	Visual inspection	
	Interior work	Products, workmanship	Visual inspection	
Electrical Work	Power Receiving &	Performance, operation	Factory inspection sheet check;	

	Transformer	installation check	withstand voltage, megar, operation, visual inspection	
	Conduit work	Bending, support check	Visual inspection, dimension check	
	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 check	
	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 Dual Polarization (Polarimetric) Meteorological Doppler Radar System which has already been put into practical use for meteorological observation and has confirmed its reliability, durability, accuracy and performance is made in Japan. The designed mean time between failure (MTBF) of the transmitter for this system is more than 50,000 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, 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 Material

[1] Structural Work

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

Concrete coarse aggregate and fine arrogate can be obtained in the Multan. The main materials for the structural works, such as fresh concrete, reinforcing bar and form (plywood), can be obtained 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.

[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.

Table 39: 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	○		✓		
Access floor panel (heavy duty type)	△		✓		
Paint	○		✓		
Gypsum board	○		✓		

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

Table 40: 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	○		✓		
	Lightening 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 ports in Japan to the Karachi Port are indicated in the following table.

Table 41: Scheduled Vessels to Karachi Port from Japan

Country	Name of Port	Schedule	Number of Days
Japan	Yokohama, Tokyo, Nagoya, Kobe	6 ships/week	Approx. 30-40 days

＜Import and Duty Exemption Procedures＞

For the import of the equipment from overseas, the 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.

Table 42: 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 · Shipping Invoice: 1 original · Bill of Lading: 1 original · Packing List: 1 original · 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 1,800 km 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.

Figure 20: Inland Transport Route

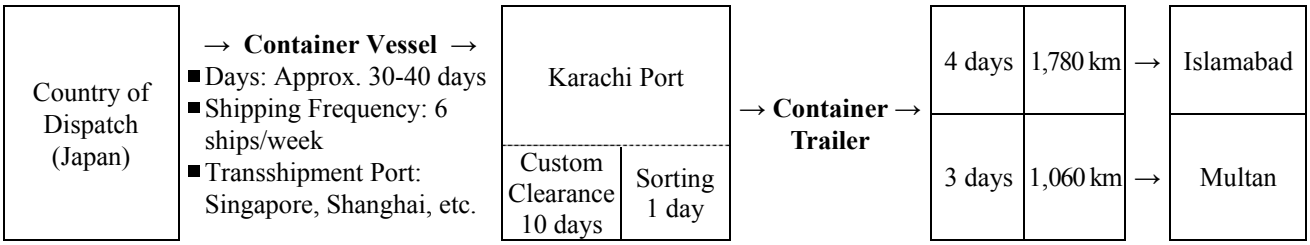


Figure 21: Transportation Period to Project Site

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.

Table 43: Operation and Maintenance Training (OJT)

Component	Multan Meteorological Radar Observation Station	National Weather Forecasting Centre, PMD Islamabad Head Office	Meteorological Office in the Multan International Airport, PMD Multan	Flood Forecasting Division (FFD), PMD Lahore
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System • Power Unit • Antenna • Radar Unit • Meteorological Radar Transmission Unit • Computer Network Unit • Power Back-up Unit • Application Software	○	-	-	-
Meteorological Radar Central Processing System • Power Unit • Computer Network Unit • Application Software	-	○	-	-
Meteorological Radar Data Display System • Power Unit • Computer Network Unit • Application Software	○	○	○	○

Meteorological Data Communication System • Power Unit • Communication Unit • Computer Network Unit • Application 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 Soft Component Plan

<Soft Component>

Majority of the PMD's technical staff is proficient in the use of computers and computerized meteorological observation equipment. Unfortunately, no engineer or technical officer of the PMD has practical experience to operate an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Doppler Meteorological Radar System planned to be procured under the Project since the system utilizes the latest technology of the world at present and is going to be established for the first time in Pakistan. For the smooth operation and maintenance of the digital S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar Systems and for the assurance of the required sustainability of the project outcomes, the implementation of technology transfers in the soft component mentioned below (with the Implementation Schedule attached hereunder) is required.

<Soft Component Target>

The target of the Soft Component is to enable the PMD to independently and appropriately operate the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System.

<Soft Component Indicators>

Soft Component Indicators are as follows.

Table 44: Soft Component Indicators

No.	Item	Output	Objectively Verifiable Indicators	Means of Verification
1	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery and Major Fault Countermeasures	Acquisition of technical know-how on appropriate inspection, adjustment, minor fault finding, remedy and recovery.	Inspection, adjustment, minor fault finding, remedy and recovery, and major fault countermeasures (a. routine maintenance using measuring instruments and tools, b. practice of replacing spare parts into the actual system and the subsequent confirmation of system operation, c. practice of remedy, recovery and major fault countermeasures: distributing information to the Consultant and the manufacturer and receiving technical advice) are carried out appropriately by the 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. · Visual check and technical interviews
2	Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing the Meteorological Radar System Summary & Maintenance Manual and the Meteorological Radar System Maintenance & Management Record Book including acquisition procedures and data table reading of Observation Raw Data	Technical knowledge on the acquisition of prompt and appropriate S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System operation and maintenance	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System operation and maintenance utilizing the meteorological radar system summary & maintenance manual and the meteorological radar system maintenance & management record book are implemented promptly and appropriately. Acquisition procedures and data table reading of raw observation data.	· Evaluation of the frequency of usage of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual. · Confirmation of entries (daily, weekly, monthly) in the meteorological radar system maintenance & management record book and thorough technical interviews
3	Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode Sequence & Schedule	Appropriate meteorological radar operation.	Meteorological radar observation is implemented according to the radar observation sequence & schedule for Intensity Mode and Doppler Mode.	Confirmation of meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecast operation.

<Means of Verification for the Achievement of Outputs>

The means of verification for the achievement of outputs of the Soft Component are also indicated in the Table attached above.

<Scheduled Activities of Soft Component>

Scheduled Activities of the Soft Component are as follows.

Table 45: Scheduled Activities of Soft Component

Output	Required Technique and Field	Current Technique Level and Required Technique Level	Target Group	Means of Implementation	Source of Implementation	Product
1. S-Band Pulse Compression Solid State Dual	An engineer capable of meteorological radar	Since engineers in the PMD have practical experience of adjusting and fault finding in an	Indicated in the table below	Routine maintenance using measuring instruments and tools. Practice of replacing	Expert Consultant on meteorological radar adjustment and fault finding:	Manual on routine maintenance using measuring instruments and tools.

Polarization (Polarimetric) Meteorological Doppler Radar System Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery, and Major Fault Countermeasures	adjustment and minor fault finding.	analog meteorological radar system, it is imperative that the PMD engineers should also acquire the capability of adjusting and fault finding in a digital meteorological radar system.		spare parts into the actual system and the subsequent confirmation of system operation. Practice of countermeasure, minor fault finding, remedy and recovery. Practice of major fault countermeasures. Production of operation and maintenance manual.	1.07 man-months. (Period of Technology Transfer in Pakistan: 32days) Direct Support	Manual on replacing spare parts into the actual system and the subsequent confirmation of system operation. Manual on fault finding, remedy and recovery. Manual on major fault countermeasures.
2. Preparation of S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual and Meteorological Radar System Maintenance & Management Record Book including acquisition procedures and data table reading of Observation Raw Data	An engineer capable of meteorological radar operation and maintenance.	Since engineers in the PMD have practical experience of operating and maintaining an analog meteorological radar system, it is imperative that the PMD engineers should also obtain the capability of operating and maintaining a digital meteorological radar system according to the manual summary and the meteorological radar system maintenance & management record book including acquisition procedures and data table reading of Observation Raw Data	Indicated in the table below	Discussion with the PMD engineers. Selection of the most important points from the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual. Production of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual. Production of the meteorological radar system maintenance & management record book. Utilization of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual and the maintenance & management record book by the PMD engineers. Acquisition procedures and data table reading of raw observation data.	Expert Consultant on meteorological radar operation and maintenance: 1.17 man-months (Period of Technology Transfer in Pakistan: 35days) Direct Support	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual Meteorological radar system maintenance & management record book • Date and time of occurrence of system failure/trouble • Cause/s of system failure/trouble (abnormal noise, part degradation, etc.) • Repair procedures implemented • Name and quantity of replaced parts • Name of engineer/s who perform/s the repair /troubleshooting • Acquisition procedures and data table reading of Observation Raw Data
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	Since engineers in the PMD have no practical experience in the use of CAPPI (Constant Altitude PPI (Plan Position Indicator)) observation due to the absence of a CAPPI function in the existing analog	Indicated in the table below	Discussion with the PMD engineers and lecture. Identification of Clutter of meteorological radar system and Blind Area at antenna elevation angle. Preparation of Blind Area at antenna elevation angle.	Expert Consultant on meteorological radar observation: 1.17 man-months (Period of Technology Transfer in Pakistan: 35days) Direct Support	Sequence & Schedule for Intensity Mode and Doppler Mode

	radar observation which is suited to the weather phenomena in Pakistan	meteorological radar system, it is imperative that the PMD engineers should obtain the capability of preparation of sequences & schedules for meteorological radar observation.		Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode. Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.		

Table 46: Target Personnel in the PMD for the Technology Transfer in the Soft Component

Technology Transfer of No. 1, 2 & 3				Technology Transfer of No. 3	
Islamabad	Number	Multan	Number	Islamabad	Number
Senior Electronic Engineer	1	Senior Electronic Engineer	0	Meteorologist in the National Weather Forecasting Center	15
Electronic Engineer	1	Electronic Engineer	2		
Assistant Electronic Engineer	1	Assistant Electronic Engineer	1	Multan	Number
Sub Engineer	4	Sub Engineer	2	Meteorologist including Meteorological Assistant	6
Mechanic Grade	6	Mechanic Grade	0		

<Soft Component Product>

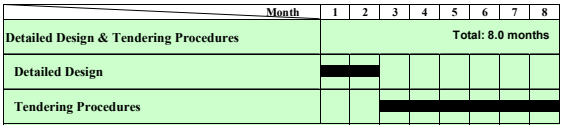
Soft Component Products are as follows.

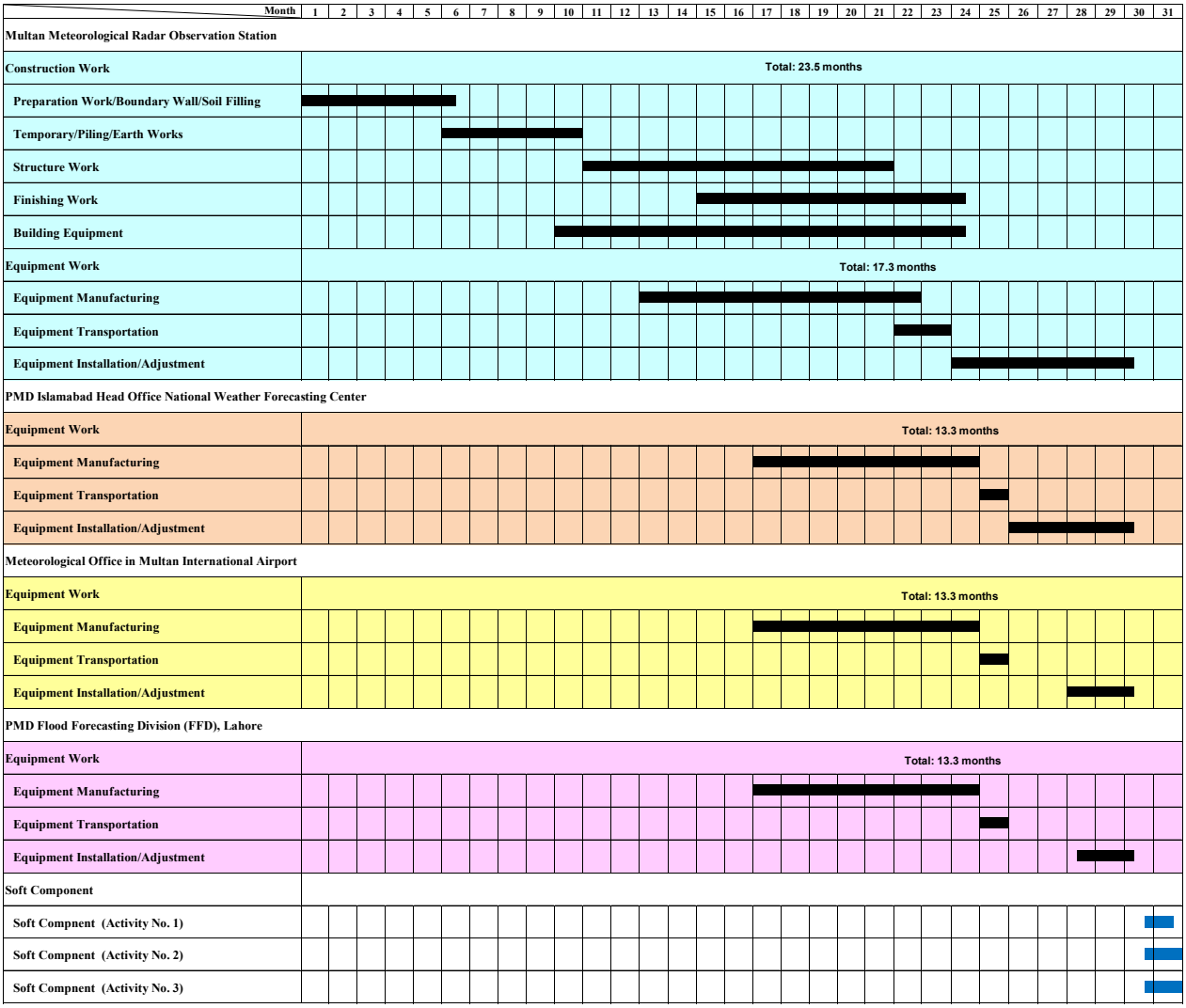
Table 47: Soft Component Products in Technology Transfer

Product Name		Submission Time	No. of Pages
Procedures paper on 1) routine maintenance using measuring instruments and tools; 2) practice of replacing spare parts into the actual system and the subsequent confirmation of system operation; 3) practice of minor fault finding, remedy and recovery; and, 4) major fault countermeasure for S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System.		After Technology Transfer	20
C-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual			30
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System maintenance and management record book			10
Radar observation sequence & schedule for Intensity Mode and Doppler Mode			15
Output Name	Content	Submission Time	No. of Pages
Soft Component Completion Report	• Scheduled Activities and Actual Achievement • Scheduled Outputs and Achievement • Factors which influence Achievement of Outputs • Recommendation • Outputs	Completion of Soft Component	50

2-2-4-9 Implementation Schedule

Table 48: Implementation Schedule





2-3 Obligations of Recipient Country

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

Table 49: Major Undertakings to be done by the Islamic Republic of Pakistan/PMD during and after the Implementation of the Project

No	Items
	General Items
1	To undertake all necessary institutional and juridical procedures in Pakistan.
2	To undertake the Initial Environmental Examination (IEE) procedures in Pakistan, if required so.
3	To handle duty (tax) exemption procedures and to take necessary measures as well as provide requisite legal and/or administrative documentations for import permit and customs clearance to the customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project as well as sending back of any defective equipment and/or spare parts to the manufacturer for repair at the factory or replacement and re-importation thereof into Pakistan during the implementation and warranty periods of the Project.
4	To provide necessary working spaces with Internet Connection at the PMD Islamabad Head Office and the Meteorological Office in the Multan International Airport, PMD Multan for the Consultant and the Contractor during 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 goods of Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed by the Government of Pakistan with respect to their supply (products) and services under the signed contracts.
7	To open Bank Account (Banking Arrangement (B/A)).
8	To pay bank charge (commission) for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.
9	To bear all the expenses, other than those to be borne by the Japanese Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment.
	Items for Safety Measures
10	To take responsibility of arranging the maximum countermeasures and ensure the appropriate 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 implementation of the Project.
11	To arrange security around the proposed Project Site in Multan with the police.
12	To arrange security around the accommodation(s) of the Consultant & the Contractor with the police.
13	To arrange escort guard with the police during movements between the accommodation(s) of the Consultant & the Contractor and the proposed Project Site in Multan.
	For the Construction of the Radar Tower Building
14	To secure sufficient spaces at the proposed Project Site in Multan for temporary facilities such as a consultant's site office, contractor's office, workshop, building materials storage, etc. needed for the construction work.
15	To obtain all prior regulatory compliance and necessary permissions from the relevant agencies/authorities for the construction of the Radar Tower Building in the proposed Project Site in Multan.
16	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: no less than 150kVA) along with electric poles/wires, etc. from the main supply line to the proposed Project Site in Multan for the Radar Tower Building and other facilities to be constructed by the PMD prior to the commencement of construction work.
17	To install the required step-down transformer (capacity: no less than 150kVA) as well as service entrance connections for the commercial power supply at the proposed Project Site in Multan for the Radar Tower Building (400V, 3-phase, 4-wire, 50Hz) prior to the commencement of construction work.
18	To relocate the existing high voltage power cable in the proposed Project Site in Multan.
19	To provide as telephone lines for the Radar Tower Building in the proposed Project Site in Multan.
20	To provide temporary facilities for the availability or accessibility of electricity for the construction work.

21	To undertake incidental outdoor works such as gardening/landscaping and exterior lighting in and around the proposed Project Site in Multan, if necessary.
22	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.
For Installation Work of the Equipment	
23	To provide free of charge and allocate secure temporary storage area/room for the materials, tools and equipment needed during the installation process.
24	To obtain the required frequencies for the Multan Meteorological Radar System, Polarimetric Test Horn Devices and Meteorological Data Communication System (between Multan Meteorological Radar Observation Station and Meteorological Office in Multan International Airport, PMD Multan).
25	To promptly provide reliable and high-speed Internet environment at the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office (Forecasting Room) in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore (with each corresponding global/fix IP) for establishment of a Virtual Private Network (IP-VPN).
26	To set up the required and new assigned IP addresses in the computing equipment supplied under the Project and facilitate any required configuration i.e. firewall settings, etc. of the existing PMD equipment which may be made part of the Project Network Communication System, if any.
27	To secure ample and strategically located space/s at the existing facilities (the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office (Forecasting Room) in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore) for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project.
28	To install 1 additional air-conditioning system at the PMD Multan Meteorological Office (Forecasting Room).
29	To support the Contractor to procure/obtain relevant and vital information or data i.e. shape file map of Pakistan containing the administrative boundaries (regions, provinces, cities, districts, wards, etc.) as well as the rivers, lakes, and dams in Pakistan to be incorporated into the radar data/products display software.
30	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.
After the completion of the Project	
31	To assign the required staff including a responsible personnel of the PMD who has reliable technical skill and ample experience for the smooth operation and maintenance of the Equipment.
32	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment, and enter into a Preventive Maintenance Service Agreement with the equipment supplier if so desired.
33	To ensure adequate maintenance of the Radar Tower Building constructed under the Project so that they may function effectively for a long time.
34	To properly operate and maintain, and also effectively utilize the facilities constructed and the Equipment procured/installed under the Project.
35	To allocate the necessary budget and personnel for the smooth conduct of meteorological radar observation and forecasting works.
36	To periodically update all the operation/antivirus/application software(s).
37	To procure the appropriate number and capacity of disk media, hard disks, solid state disks, etc., and dutifully conduct the required schedule archiving of radar observation raw data and products.

2-4 Project Operation Plan

(1) Operational and Maintenance Plan for the Equipment

1) Operational Plan of the Meteorological Radar System

The PMD should operate the meteorological radar system after completion of this project at least for 24 hours of non-stop operation during the monsoon season.

2) Staff Allocation at Multan Meteorological Radar Observation Station

Currently, 50 personnel are working on the 4 shift system at the Meteorological Office in the Multan International Airport, PMD Multan. The PMD has a plan to upgrade the Multan Meteorological Observation Station as a Regional Centre after completion of the Project. Eventually 31 personnel shown in the following table in addition to the current 50 personnel will be alocated in the Multan.

Table 50: Staff Allocation Plan for the Multan Meteorological Radar Observation Station

No.	Name of Post	Number
1	Principal Meteorologist	1
2	Senior Meteorologist	1
3	Meteorologist	1
4	Electronic Engineer	2
5	Assistant Meteorologist	2
6	Assistant Electronic Engineer	1
7	Sub-Engineer Electrical	3
8	Sub-Engineer Mechanical	1
9	Meteorological Assistant	2
10	Computer Data Entry Operator	1
11	Senior Observer	4
12	Driver	1
13	Peon	2
14	Security Guard	5
15	Gardener	2
16	Sweeper	2
	Total	31

Data Source: PMD

Table 51: Proposed Work Schedule of the Multan Meteorological Radar Observation Station

		Morning	Afternoon	Night	Number of Personnel/day
Ordinary	Working Hours	08:00-14:00	14:30-20:00	20:00-08:00	13
	Number of Personnel on Duty	7	3	3	
Monsoon Season (July-September)	Working Hours	08:00-14:00	14:30-20:00	20:00-08:00	13
	Number of Personnel on Duty	7	3	3	
Emergency(*)		It depends on the intensity of weather phenomenon			

(*) In case of occurrence of severe weather

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.

Table 52: Outline of Regular Inspection for the Building

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

Table 53: Life Expectancy of Building Equipment

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

2-5 Project Cost Estimation

2-5-1 Estimate of the Project Capital Cost

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

Estimated Total Project Capital Cost: 19,300,000 PKR (approx. 23 Million JP Yen)

Table 54: Estimated Project Capital Cost to Be Borne by the Government of Pakistan/PMD

No.	Items	Capital Cost (PKR)
1	To pay bank charge (commission) for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.	7,000,000
2	To undertake incidental outdoor works such as gardening/landscaping and exterior lighting in and around the proposed Project Site in Multan.	1,000,000
3	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: no less than 150kVA) along with electric poles/wires, etc. from the main supply line to the proposed Project Site in Multan for the Radar Tower Building and other facilities to be constructed by the PMD prior to the commencement of construction work.	2,500,000
4	To install the required step-down transformer (capacity: no less than 150kVA) as well as service entrance connections for the commercial power supply at the proposed Project Site in Multan for the Radar Tower Building (400V, 3-phase, 4-wire, 50Hz) prior to the commencement of construction work.	4,000,000
5	To promptly provide reliable and high-speed Internet environment at the National Weather Forecasting Centre, PMD Islamabad Head Office, the Meteorological Office (Forecasting Room) in the Multan International Airport, PMD Multan and the Flood Forecasting Division (FFD), PMD Lahore (with each corresponding global/fix IP) for establishment of a Virtual Private Network (IP-VPN).	1,000,000
6	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.	1,000,000
7	To shoulder the miscellaneous expenditures such as library books, petrol, telephone, application fee (obtaining the required frequencies for the meteorological radar system and the construction permissions of a new Radar Tower Building).	1,500,000
8	To relocate the existing high voltage power cable in the proposed Project Site in Multan.	1,000,000
9	To install 1 additional air-conditioning system at the Meteorological Office (Forecasting Room) in the Multan International Airport, PMD Multan.	300,000
	Total	19,300,000

Applied Exchange Rate: US$ 1 = 112.83 JP Yen, 1 PKR= 1.221 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 for all the systems procured under the Project to be borne by the PMD 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

Estimated Project Annual Recurrent Cost: 18,050,000 PKR (approx. 22 Million JP Yen)

Table 55: Estimated Project Annual Recurrent Cost to Be Borne by the Government of Pakistan (PMD) after Completion of the Project

No.	Description	Recurrent Cost (PKR)
1	Electricity Charges	3,000,000
2	Salary of 31 personnel	8,000,000
3	Telephone, Fax, Leased Lines, Internet Connections	2,000,000
4	Spare Parts, Consumables and Special Maintenance of the Systems	2,500,000
5	Consumables, Stationary, etc.	300,000
6	Books & Journals	50,000
7	Contingencies	200,000
8	P.O.L. Charges (for engine generators, vehicles, etc.)	2,000,000
	Total	18,050,000

As a general guidance, the renewal or expected upgrade/modernization of the meteorological radar system installed under the Project is projected to be from 15 to 20 years (estimated life-span of the equipment) after completion of the Project if adequate and proper operation and maintenance is implemented by the PMD.

(2) Annual Budget Trends

In order to secure the estimated recurrent cost of the Project, the PC-I Form (Detail of the Project) must be approved by the Executive Committee of the National Economic Council (ECNEC). If the PC-IV 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-I 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-I Form is required. The Pakistan side has a plan to obtain the approval of the PC-I 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.

Table 56: Movement of the PMD Annual Budget

Fiscal Year	Budget (In Thousand PKR)	Comparison with the previous year (%)
2008-09	394,991	-
2009-10	417,880	105.8
2010-11	451,327	108.0
2011-12	578,825	128.2
2012-13	680,347	117.5
2013-14	797,220	117.2
2014-15	874,369	109.7
2015-16	969,000	110.8
2016-17	1,027,937	106.1
2017-18	1,079,287	105.7

Budget for Public Sector Development Programme is not included

Chapter 3
Project Evaluation

Chapter 3 Project Evaluation

3-1 Preconditions

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

Table 57: Details of the Procedures required for the Project Implementation

Required Procedures	Office Concerned	Approximate Period Required	Required Documents to be submitted to the Aviation Division, Cabinet Secretariat by the Pakistan Meteorological Department (PMD)	Applicant
Application for Commercial Power Supply and Step-down Transformer Installation for the Radar Tower Building to be constructed	Multan Electric Power Company (MEPCO)	1 month	• Application Form: 1 set • Site Location Map: 1 set • Allotment Letter: 1 set	PMD
Frequency Permit for the Meteorological Radar System	Frequency Allocation Board (FAB)	2 months	• Application Form: 14 sets • Letter of Intent: 14 sets • Detailed Technical Literature of the Equipment: 14 sets • Antenna Pattern: 14 sets • Spectrum Chart for Transmitter: 14 sets • Network Diagram/Site Plan: 14 sets	
Building Construction Permit	City District Government, Multan	1 month	Application Form with the following drawings and documents • Architectural Drawings: 20 sets • Structural Drawings: 20 sets • Electrical Drawings: 20 sets • Air-conditioning & Ventilation Drawings: 20 sets • Plumbing Drawings: 20 sets • Structural Calculation Sheet: 20 sets • Copy of Non Objection Certificate (NOC) to be issued by the CAA: 20 sets	
Building Height Clearance	Civil Aviation Authority (CAA) Karachi Headquarters	1 month	• Application Form: 1 set • Site Location Map: 1 set • WGS84 Coordinate Map to be issued by the Geological Survey of Pakistan: 1 set	

<General Sales Tax (GST)>

The General Sales Tax (GST) imposed on the materials and equipment to be purchased locally by the main contractor under this Project will be exempted in accordance with the GST exemption procedures as presented in the following figure and as advised by the Economic Affairs Division (EAD) of the Ministry of Economic Affairs and Statistics. The required period for the GST exemption procedures is about one month. In addition, it is essential that the destination of all the receipts is the name of the main contractor as a condition to be tax exempted. It has to be noted that the GST imposed on materials and equipment to be purchased by subcontractor(s) shall not be exempted.

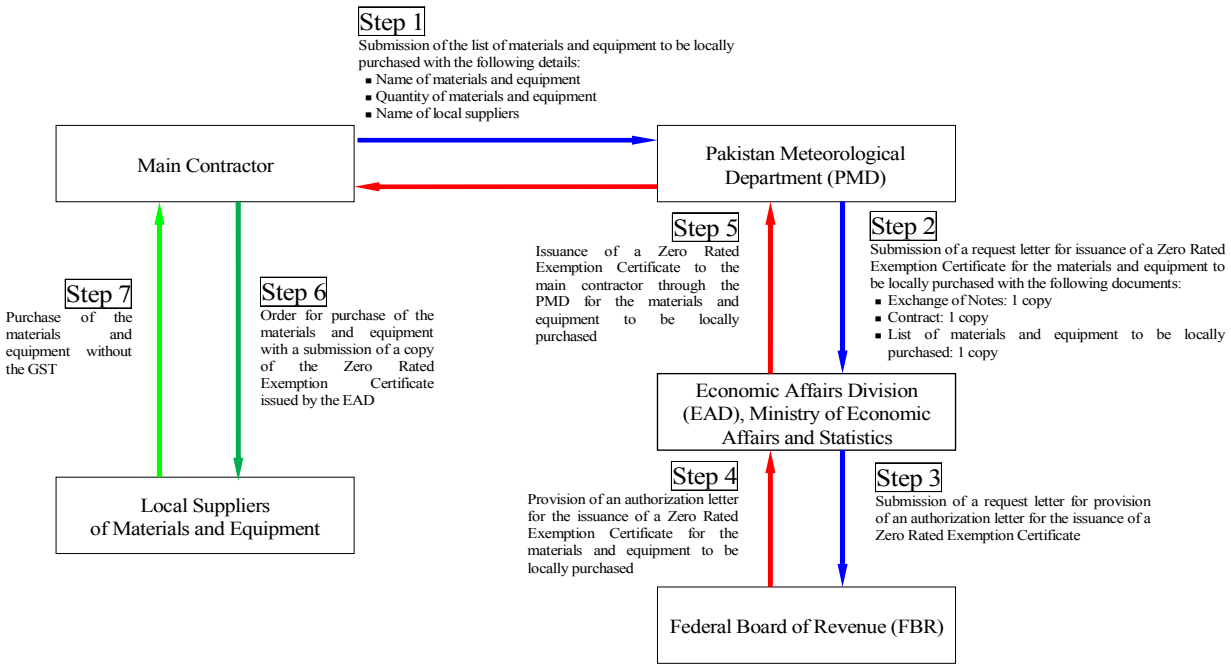


Figure 22: GST Exemption Procedures for Materials and Equipment to Be Purchased Locally

3-2 Necessary Inputs from the Recipient Country

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

1) Manpower Development

   a) Continuous recruitment of human resources for the next generation; and,

   b) Development of more qualified technical personnel through training and other related manpower development programs.

2) Natural Disaster Prevention and Management

   a) Setting up of redundancies in the announcement of warnings and other information dissemination methods through multi-channels to ensure reaching out to the general populace; and,

   b) Continuing educational activities for the general public in coordination with various related disaster management agencies and the mass media for a more effective natural disaster prevention and management strategy.

3) Longer Life Span of the Equipment procured and the Radar Tower Buildings constructed under the Project

   a) Regularly secure the necessary budget for the efficient operation and maintenance of the systems and building equipment, and the procurement of requisite spare parts and consumables for all the equipment to be supplied under the Project;

b) Ensure the protection of the buildings, equipment and facilities against theft and vandalism; and,

c) Regularly paint and caulk the caulking grooves of the Radar Tower Buildings.

3-3 Important Assumptions

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

3-4 Project Evaluation

3-4-1 Relevance

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

The overall objective of the Project is to reduce the devastation arising from meteorological disasters. This could be achieved by improving the PMD's capabilities of meteorological observation and forecast/warning in preparation for heavy rain. Floods caused by heavy rain are extreme manifestations of nature that may lead to immeasurable loss and distress for quite a number of people and have also become determining factors for the significant set-back of the national economy. To accurately observe weather phenomena causing heavy rain, the establishment of a meteorological radar system in Multan located in the central part of Punjab, where approximately 53% of the population of Pakistan is concentrated, makes it possible to improve the accuracy of the PMD's forecasts and warnings. Needless to say, it will enable the PMD to make further contributions in mitigating the damages due to natural disasters (mainly floods). Therefore, the population to be benefited both directly and indirectly by the Project will be the whole

nation of Pakistan (approx. 207 million based on the Pakistan Bureau of Statistics, 2017 Census). 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 2.4% and will be the 4th largest country in the world after India, China and the United States in 2050. The table below indicates the population of the respective administrative districts.

Table 58: Administrative District and Population of Pakistan

No.	Administrative District	Capital	Population (2017)
1	Balochistan	Quetta	12,344,408
2	Khyber Pakhtunkhwa	Peshawar	30,523,371
3	Punjab	Lahore	110,012,442
4	Sindh	Karachi	47,886,051
5	Islamabad Capital Territory	Islamabad	2,006,572
6	Federally Administered Tribal Areas	Peshawar	5,001,676
7	Azad Jammu and Kashmir	Muzaffarabad	-
8	Gilgit-Baltistan	Gilgit	-
		Total	207,774,520

Source (Population (2017)): Pakistan Bureau of Statistics

2) Objectives of the Project

The key objective of the Project is the effective mitigation and reduction of the devastation caused by disasters brought about by hazardous meteorological phenomena such as heavy rain through the improvement of the weather & flood information and forecasts & warnings released by the PMD by strengthening their monitoring capability of hazardous weather phenomena through the provision of technical support and the establishment of an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Doppler Meteorological Radar System at Multan in the Punjab Province including the associated Meteorological Radar Central Processing System, Meteorological Radar Data Display Systems and Meteorological Data Communication Systems under the Project. Moreover, the Project would substantially contribute to the mitigation of the adverse effects of natural disasters and effectively safeguard the basic human needs of the Pakistani people.

3) Development Plan of Pakistan

The enhancement and modernization of the meteorological services in Pakistan are urgent issues to alleviate the negative impact of severe weather and to ensure the people's safety as well as to significantly contribute to the sustainable development of the country. From the viewpoint of the PMD, in order to contribute to the achievement of the government goals indicated in "Vision 2025", which is the long-term national development policy of Pakistan, and the National Disaster Management Plan (NDMP), the Ten Year Development Plan of the PMD (a step towards modernization) has been formulated in 2016 by the PMD.

“Vision 2025” is a national development policy for the whole country published in August 2014 by the Ministry of Planning, Development & Reform. “Vision 2025” declares that Pakistan will enter the upper middle income country group by 2025 and sets numerical targets of 25. The numerical targets include increasing the per capita national income from US$1,299 to US$ 4,200 and reducing the population's poverty ratio from the current 49% to 20%. In addition, the declaration statement in “Vision 2025” that it will become one of the world’s top ten economic nations by total GDP by 2047, which celebrates the 100th anniversary of independence of the country, is included as a long-term goal.

The National Disaster Management Plan (NDMP) is a guideline for strengthening and modernizing the disaster-prevention sector in Pakistan and is one of the major achievements in support of disaster management measures of Pakistan by the Government of Japan. The NDMP is also a pillar of support by donor organizations in the area of disaster prevention.

In the document, "Reducing Vulnerability and Exposure to Disasters," published by the United Nations ESCAP/UNISDR, the disasters that occurred every year between 2004 and 2010 have pushed down Pakistan’s GDP by US$ 20 billion compared with no disasters in 2011. In view of such reports, the significance of promoting disaster reduction is considered to be very high for the sustainable development of the country.

Since the modernization of a meteorological radar observation network in Pakistan is mentioned in the first chapter (Chapter 1) of the Ten Year Development Plan of the PMD as one of the top priority implementation items, this Project agrees with the national development plan and disaster prevention plan, and in the first five years of the National Flood Protection Plan IV (Ten Year Plan) approved by the Government of Pakistan in May 2017, the upgrade and expansion of the PMD’s existing meteorological radar observation network and the flood forecasting & warnings are indicated. Based on the above, this project is consistent with the national development plan and disaster prevention plan of the country.

4) Aid Policy of Japan

Japan and Pakistan have developed congenial bilateral relations and have commemorated the sixtieth anniversary of the establishment of diplomatic ties between the two countries in 2012. Japan’s major aid policy in Pakistan is the “establishment of a stable and sustainable society through economic growth.” Pakistan is expected to have the fourth largest population in the world after India, China and the United States by 2050. In order to fully realize its potential, it is imperative to build up a stable and sustainable society through private-sector-led economic growth while ensuring a stable economy. The Government of Japan focuses on the following three priority areas for the realization of the aid policy indicated above.

1. Development of an economic foundation
2. Ensuring human security and improvement of social foundation

3. Stability and balanced development in the border area

Under the second priority area, the provision of aid for the "strengthening of disaster prevention capability against frequent natural disasters" is stated as one of Japan's important roles. Specifically, the establishment of an early warning system, the strengthening of disaster preparedness on a community level and the human resource development plan of disaster management organizations are included. It is truly significant to strengthen the meteorological monitoring system and improve disaster prevention capabilities in the whole of Pakistan through the Grant Aid from Japan as it is in congruence with Japanese priorities in terms of international cooperation.

3-4-2 Effectiveness

1) Quantitative indicators

Table 59: Achievement Indicators

Indicators	Present (Baseline in 2017)	Target (2025)
Enhancement of Severe Weather Monitoring Capability	Spatial resolution and observation intervals of the existing 143 surface observation stations in Pakistan: 74.6 km mesh on average at 60 minute observation intervals.	・ Spatial resolution and observation intervals of precipitation data in the radar detection range between 300-400 km: 1 km mesh at 10 minute observation intervals. ・ Spatial resolution and observation intervals of wind speed & direction data in the radar detection range within 200 km: 1 km mesh at 10 minute observation intervals.
	Observation of thunderstorm accompanying the development of cumulonimbus and rain cloud of severe weather using the meteorological satellite: 30 minute intervals.	Observation intervals of rainfall intensity, location, track, wind velocity of thunderstorm accompanied by cumulonimbus and rain cloud of severe weather caused by monsoon in the radar detection range: 10 minute observation intervals.
Enhancement of Heavy Rain Monitoring Capability	Observation only by using the existing surface observation stations (automatic observation systems: 60 minute intervals.	Observation intervals of rainfall intensity, location, development of rain distribution, and movement in the radar detection range: 10 minute observation intervals.

2) Qualitative indicators

a) Enable the provision of additional Information (in addition to the manual aeronautical observation) to the airport operators on weather conditions such as cumulonimbus, etc. detected by the radar systems to aircraft operations in the area surrounding the Multan International Airport.

b) Enable the provision of heavy rain information/advisory/warning indicating the area(s) identified and the area(s) located in the direction of rain cloud movement by the radar observation data which has/have received rainfall of over 50 mm within the last 1 hour, and 75 mm within the last 3 hours and based on synoptic trends to the government agencies concerned with disaster management and mass media.

c) Enable the disaster management authorities (NDMA and its allied disaster management authorities in provinces and districts) to issue prompt evacuation orders and commence necessary countermeasures against disasters and evacuation activity and support for disaster victims in a timely manner.

d) Enable the PMD to operate radar observation for prevention of secondary disasters and securing safety during rescue activities.

e) Enable the provision of accurate weather information to users engaged in industries such as transportation, tourism and agriculture by the PMD to promote the implementation of disaster mitigation measures and reducing economic losses.

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 natural disasters. The Project would substantially contribute to the mitigation of the adverse effects of the natural disasters and effectively safeguard the basic human needs of the Pakistan people.

Moreover, in order to reduce the PMD's operational and maintenance costs, the equipment was designed to minimize the need for 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 Pakistan portion of the capital and recurrent costs of the Project. In conclusion, the implementation of the Project is considered to be an appropriate, suitable, viable and worthwhile endeavor.

Appendices

Appendix 1. Member List of the Study Team

(1) Preparatory Survey (1) Team

Mr. Masahiro UEKI	Team Leader	Director, Disaster Risk Reduction Team 1, Disaster Risk Reduction Group, Global Environment Department, Japan International Cooperation Agency (JICA)
Mr. Kunio AKATSU	Technical Advisor (International Meteorology)	Senior Advisor (Meteorology), Japan International Cooperation Agency (JICA)
Ms. Miki INAOKA	Project Planning	Disaster Management Team 1, Disaster Management Group, Global Environment Department, Japan International Cooperation Agency (JICA)
Mr. Yoshihisa UCHIDA	Chief Consultant/Meteorological Radar Planning/Operation & Maintenance	International Meteorological Consultant Inc. (IMC)
Mr. Toshihide ENDO	Data Communication/Equipment Planning	International Meteorological Consultant Inc. (IMC)
Mr. Hiroyuki INOMATA	Meteorological Radar Facility Planning	International Meteorological Consultant Inc. (IMC)
Mr. Kenji MORI	Project Implementation Planning/Natural Conditions Survey	International Meteorological Consultant Inc. (IMC)
Mr. Felipe Asane Sarigumba	Procurement Planning/Cost Estimation	International Meteorological Consultant Inc. (IMC)

(2) Preparatory Survey (2) Team

Ms. Miki INAOKA	Project Planning	Disaster Management Team 1, Disaster Management Group, Global Environment Department, Japan International Cooperation Agency (JICA)
Mr. Yoshihisa UCHIDA	Chief Consultant/Meteorological Radar Planning/Operation & Maintenance	International Meteorological Consultant Inc. (IMC)
Mr. Kenji MORI	Project Implementation Planning/Natural Conditions Survey	International Meteorological Consultant Inc. (IMC)

Appendix 2. Study Schedule

Preparatory Survey 1

Schedule			Governmental Member			Consultant Member				
			Mr. Masahiro UEKI	Mr. Kunio AKATSU	Ms. Miki INAOKA	Mr. Yoshihisa UCHIDA	Mr. Toshihide ENDO	Mr. Hiroyuki INOMATA	Mr. Kenji MORI	Mr. Felipe Asane SARIGUMBA
2017			Team Leader	Technical Advisor (International Meteorology)	Project Planning	Chief Consultant/Meteorological Radar Equipment Planning/Operation & Maintenance Planning	Data Communication Equipment Planning	Meteorological Radar Facility Planning	Construction Planning/Natural Conditions Survey	Procurement Planning/Cost Estimation
1	8 Jul	Sat							Tokyo → Islamabad	
2	9 Jul	Sun							Data Collection, Preparation Work	
3	10 Jul	Mon							Discussion with PMD Islamabad, Procurement of the required equipment for the Study, Discussion with the Local Contractor for Topographic and Geotechnical Survey	
4	11 Jul	Tue							Discussion with the Local Contractor for Topographic and Geotechnical Survey	
5	12 Jul	Wed							Discussion with PMD Islamabad, Procurement of the required equipment for the Study	
6	13 Jul	Thu							Discussion with PMD Islamabad, Arrangement of Inland Transport for the procured equipment	
7	14 Jul	Fri							Discussion with PMD Islamabad, Study for Unit Price of Construction Materials, Data Collection	
8	15 Jul	Sat				Tokyo → Islamabad			Data Collection, Internal Meeting	
9	16 Jul	Sun				Data Collection, Internal Meeting			Data Collection, Internal Meeting	
10	17 Jul	Mon				Discussion with PMD Islamabad			Discussion with PMD Islamabad, Study for Unit Price of Construction Materials, Data Collection	
11	18 Jul	Tue				Discussion with PMD Islamabad Signing with Local Contractor for Topographic and Geotechnical Survey			Discussion with PMD Islamabad, Study for Unit Price of Construction Materials, Data Collection	
12	19 Jul	Wed				Discussion with PMD Islamabad and JICA Security Officer Islamabad → Colombo			Discussion with PMD Islamabad and JICA Security Officer	
13	20 Jul	Thu							Discussion with PMD Islamabad Discussion with National Bank of Pakistan	
14	21 Jul	Fri							Islamabad → Lahore Discussion with Lahore Flood Forecasting Division and City District Government, Multan	
15	22 Jul	Sat							Lahore → Multan Site Survey at Multan International Airport, PMD Multan Office andProposed Multan Meteorological Radar Station, Survey of Electric Power Quality	
16	23 Jul	Sun							Site Survey at Proposed Multan Meteorological Radar Station, Survey of Electric Power Quality, Discussion with the Local Contractor for Topographic and Geotechnical Survey Multan → Islamabad	
17	24 Jul	Mon							Discussion with PMD Islamabad	
18	25 Jul	Tue							Islamabad → Karachi Discussion with Karachi Civil Aviation Authority, Karachi → Islamabad	
19	26 Jul	Wed	Tokyo → Islamabad	Colombo → Dubai	Tokyo → Islamabad	Colombo → Dubai			Discussion with PMD Islamabad	
20	27 Jul	Thu	Discussion with JICA Pakistan Office, Courtesy call on PMD Islamabad, Aviation Disision, National Disaster Management Authority (NDMA), Economic Affairs Division (EAD) , Emabassy of Japan (EOJ)	Dubai → Islamabad Courtesy call on Economic Affairs Division (EAD) , Emabassy of Japan (EOJ)	Discussion with JICA Pakistan Office, Courtesy call on PMD Islamabad, Aviation Disision, National Disaster Management Authority (NDMA), Economic Affairs Division (EAD) , Emabassy of Japan (EOJ)	Dubai → Islamabad Discussion with JICA Pakistan Office, Courtesy call on PMD Islamabad, Aviation Disision, National Disaster Management Authority (NDMA), Economic Affairs Division (EAD) , Emabassy of Japan (EOJ)			Discussion with JICA Pakistan Office, Courtesy call on PMD Islamabad, Economic Affairs Division (EAD) , Emabassy of Japan (EOJ)	
21	28 Jul	Fri	Courtesy call on Federal Flood Comission (FFC), Discussion with PMD Islamabad Islamabad → Multan						Discussion with PMD Islamabad Islamabad → Multan	
22	29 Jul	Sat	Site Survey at Proposed Multan Meteorological Radar Station, Multan International Airport, PMD Multan Office Discussion with Regional Police Office, Multan Multan → Islamabad						Site Survey at Proposed Multan Meteorological Radar Station, Multan International Airport, PMD Multan Office, Discussion with Regional Police Office, Multan Multan → Islamabad	
23	30 Jul	Sun	Data Collection, Internal Meeting						Data Collection, Internal Meeting	

Appendix 2. Study Schedule

24	31 Jul	Mon	Discussion with PMD, Confirmation of Minutes of Discussions, Internal Meeting		Tokyo → Islamabad	Discussion with PMD, Confirmation of Minutes of Discussions, Internal Meeting	
25	1 Aug	Tue	Discussion with PMD, Confirmation of Minutes of Discussions, Internal Meeting		Discussion with PMD Islamabad, Data Collection from Internet Service Provider / Data Collection, Internal Meeting	Discussion with PMD, Confirmation of Minutes of Discussions, Internal Meeting	
26	2 Aug	Wed	Report to JICA Pakistan Office, Signing on Minutes of Discussions, Report to Embassy of Japan		Discussion with PMD Islamabad, Data Collection from Internet Service Provider	Discussion with PMD Islamabad, Islamabad → Multan	
27	3 Aug	Thu		Discussion with PMD Islamabad Islamabad → Multan		Discussion with City District Government, Multan, Site Survey at Proposed Multan Meteorological Radar Station, Data Collection, Topographic and Geotechnical Survey Follow-up	
28	4 Aug	Fri		Site Survey at Multan International Airport, PMD Multan Office and Proposed Multan Meteorological Radar Station, Data Collection,		Discussion with Multan Development Authority, Site Survey at Proposed Multan Meteorological Radar Station, Data Collection, Topographic and Geotechnical Survey Follow-up	
29	5 Aug	Sat		Site Survey at Multan International Airport and PMD Multan Office Multan → Islamabad			
30	6 Aug	Sun		Data Collection, Internal Meeting			Manila → Islamabad
31	7 Aug	Mon		Discussion with PMD Islamabad, Data Collection		Data Collection, Study for Unit Price of Construction Materials	Discussion with PMD Islamabad, Data Collection
32	8 Aug	Tue		Discussion with PMD Islamabad Discussion with Frequency Allocation Board		Data Collection, Study for Unit Price of Construction Materials	Discussion with PMD Islamabad Data Collection / Data Collection, Study for Unit Price of Construction Materials
33	9 Aug	Wed		Islamabad → Lahore, Discussion with Punjab Environment Protection Department and Flood Forecasting Division	Discussion with PMD Islamabad Data Collection		Islamabad → Lahore, Discussion with Punjab Environment Protection Department and Flood Forecasting Division / Discussion with PMD Islamabad, Data Collection
34	10 Aug	Thu		Lahore → Sialkot, Site Survey at the existing Sialkot Radar Observation Station, Sialkot → Mangla, Site Survey at the existing Mangla Radar Observation Station, Mangla → Islamabad	Discussion with PMD Islamabad Data Collection		Lahore → Sialkot, Site Survey at the existing Sialkot Radar Observation Station, Sialkot → Mangla, Site Survey at the existing Mangla Radar Observation Station, Mangla → Islamabad / Discussion with PMD Islamabad, Data Collection
35	11 Aug	Fri		Discussion with PMD Islamabad, Data Collection	Data Collection	Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad, Data Collection / Study for Unit Price of Construction Materials, Data Collection
36	12 Aug	Sat		Data Collection, Internal Meeting			
37	13 Aug	Sun		Data Collection, Internal Meeting			
38	14 Aug	Mon		Data Collection, Internal Meeting			
39	15 Aug	Tue		Discussion with PMD Islamabad, Study for Security Measurement for the Multan Project Site	Discussion with PMD Islamabad Data Collection	Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad, Study for Security Measurement for the Multan Project Site / Study for Unit Price of Construction Materials, Data Collection
40	16 Aug	Wed		Discussion with PMD Islamabad Data Collection		Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad Data Collection / Study for Unit Price of Construction Materials, Data Collection
41	17 Aug	Thu		Discussion with PMD Islamabad, Site Survey at PMD Islamabad, Data Collection		Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad, Site Survey at PMD Islamabad, Data Collection / Study for Unit Price of Construction Materials, Data Collection
42	18 Aug	Fri		Discussion with PMD Islamabad, Site Survey at PMD Islamabad, Data Collection		Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad, Site Survey at PMD Islamabad, Data Collection / Study for Unit Price of Construction Materials, Data Collection
43	19 Aug	Sat		Data Collection, Internal Meeting			
44	20 Aug	Sun		Data Collection, Internal Meeting			
45	21 Aug	Mon		Discussion with PMD Islamabad, Data Collection		Discussion with PMD Islamabad, Data Collection Islamabad → Multan	Discussion with PMD Islamabad, Data Collection
46	22 Aug	Tue		Discussion with PMD Islamabad, Data Collection		Site Survey at Proposed Multan Meteorological Radar Station, Data Collection, Topographic and Geotechnical Survey Follow-up Multan → Islamabad	Discussion with PMD Islamabad, Data Collection
47	23 Aug	Wed		Discussion with PMD Islamabad, Data Collection		Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad, Data Collection / Study for Unit Price of Construction Materials, Data Collection
48	24 Aug	Thu		Discussion with PMD Islamabad, Data Collection		Study for Unit Price of Construction Materials, Data Collection	Discussion with PMD Islamabad, Data Collection / Study for Unit Price of Construction Materials, Data Collection
49	25 Aug	Fri		Discussion with PMD Islamabad Islamabad →			
50	26 Aug	Sat		→ Tokyo			→ Manila

PMD: Pakistan Meteorological Department

Appendix 2. Study Schedule

Preparatory Survey 2

Schedule			Governmental Member	Consultant Member	
			Ms. Miki INAOKA	Mr. Yoshihisa UCHIDA	Mr. Kenji MORI
2018			Project Planning	Chief Consultant/Meteorological Radar Equipment Planning/Operation & Maintenance Planning	Construction Planning/Natural Conditions Survey
1	7 Feb	Wed		Tokyo → Islamabad	
2	8 Feb	Thu		Discussion with PMD Islamabad, Explanation of Draft Final Report, Data Collection	
3	9 Feb	Fri		Discussion with PMD Islamabad, Explanation of Draft Final Report	
4	10 Feb	Sat	Tokyo → Islamabad	Discussion with PMD Islamabad, Explanation of Draft Final Report	
5	11 Feb	Sun	Discussion with JICA Pakistan Office, Discussion with PMD Islamabad, Explanation of Draft Final Report	Discussion with JICA Pakistan Office, Discussion with PMD Islamabad, Explanation of Draft Final Report	
6	12 Feb	Mon	Discussion with PMD Islamabad, Explanation of Draft Final Report, Confirmation of Minutes of Discussions	Discussion with PMD Islamabad, Explanation of Draft Final Report, Confirmation of Minutes of Discussions	
7	13 Feb	Tue	Discussion with PMD Islamabad, Explanation of Draft Final Report, Confirmation of Minutes of Discussions	Discussion with PMD Islamabad, Explanation of Draft Final Report, Confirmation of Minutes of Discussions	
8	14 Feb	Wed	Discussion with PMD Islamabad, Explanation of Draft Final Report, Confirmation of Minutes of Discussions	Discussion with PMD Islamabad, Explanation of Draft Final Report, Confirmation of Minutes of Discussions	
9	15 Feb	Thu	Discussion with PMD Islamabad, Signing of Minutes of Discussions	Discussion with PMD Islamabad, Signing of Minutes of Discussions	
10	16 Feb	Fri	Seminar for Meteorology, Report to JICA Pakistan Office, Report to Embassy of Japan Islamabad →	Seminar for Meteorology, Report to JICA Pakistan Office, Report to Embassy of Japan	
11	17 Feb	Sat	→ Tokyo	Discussion with PMD Islamabad, Data Collection Islamabad →	
12	18 Feb	Sun		→ Tokyo	

Appendix 3. List of Parties Concerned in the Recipient Country

- **Economic Affairs Division, Ministry of Economic Affairs and Statistics**

Mr. Syed Mujtaba Hussain	Joint Secretary
Mr. Asghar Ali	Deputy Secretary, ADB Wing
Ms. Muneeza Hamid	Section Officer (Japan)

- **Aviation Division, Cabinet Secretariat**

Mr. Owais Nauman Kundi	Senior Joint Secretary

- **Pakistan Meteorological Department：PMD**

Head Quarter Office, Islamabad

Dr. Ghulam Rasul	Director General
Mr. Hazrat Mir	Chief Meteorologist
Mr. Muhammad Riaz	Chief Meteorologist
Mr. Muhammad Akram Anjum	Chief Meteorologist
Dr. Muhammad Hanif	Director (National Weather Forecasting Centre)
Dr. Azmat Hayat Khan	Director (National Drought Monitoring Centre)
Mr. Jan Muhammad Khan	Director (Planning)
Mr. Zahir Rafi	Director (National Seismic Monitoring Centre)
Dr. Khalid M. Malik	Director (National Agromet Centre)
Dr. Muhammad Afzaal	Director (Research and Development)
Mr. Mazahir Hussain	Senior Electronic Engineer

Regional Meteorological Centre, Lahore

Mr. Mahr Sahibzad Khan	Director

Flood Forecasting Division, Lahore

Mr. Mohammad Riaz	Chief Meteorologist
Mr. Muhammad Aslam	Director
Mr. Muhammad Ajmal Shad	Director

Meteorological Office, Multan

Mr. Muhammad Zawar	Deputy Director
Mr. Nisar Bhatti	Sub-Engineer
Mr. Naveed	Assistant Electrical Engineer

Meteorological Complex, Camp Office, Karachi

Mr. Abdul Rashid	Chief Meteorologist
Mr. Ghulam Rasool Mangi	Director (Maintenance)
Mr. Jan Muhammad	Meteorologist

- **Japan International Cooperation Agency, Pakistan Office**

Mr. Lt Col (R) Yawar Aftab	Security Adviser

- **National Bank of Pakistan: NBP**

Mr. Muhammad Tufail	Operation Manager, Main Branch
Mr. Safeer Ullah	Manager, Foreign Exchange Department, Main Branch

- **City District Government, Multan**

Mr. Shafqat Raza	Additional Deputy Commissioner (General)
Mr. Muhammad Arif Butt	Municipal Officer (Infrastructure), Multan Municipal Corporation
Mr. Muhammad Rashid	Commercial Clerk, Multan Municipal Corporation

- **Civil Aviation Authority, Karachi: CAA**

Mr. Muhammad Salman Athar	Director Airport Services
Mr. L. A. Shahzad	Director Operation
Mr. Iftikhar Ahmad	Additional ATS
Mr. Javed Anwar	Additional Radar CNS
Mr. Muhammad Amir Ashraf	Senior Joint Director
Mr. Hassan Mujahid	Joint ATS Coordinator

- **National Disaster Management Authority: NDMA**

Mr. Waqar Uddin Siddiqui	Member of Disaster Risk Reduction (DPR)
Mr. Lt. Col. R. Raza Iqbal	Director (LMP)
Mr. Abdul Latif	Assistant Director

- **Federal Flood Commission: FFC**

Mr. Ahmed Kamal	Chairman
Mr. Alamgir Khan	Office of the Chief Engineering Adviser
Mr. Ashhok Kumar	Senior Engineer
Mr. Hussain Shigri	Senior Engineer

- **Multan Regional Police Office: RPO**

Mr. Sultan Azam Temuri	Regional Police Officer
Ms. Talat Habib	Deputy Superintendent of Police
Ms. Saadia Saeed	Inspector
Mr. Imran Jalil	HC/IT Section (Police Communication)

- **Multan Development Authority: MDA**

Mr. Rana Rigawan Qadeer	Additional Director General
Mr. Khalid Javed	District Town Planning
Mr. Khawaja Waqas Ahmend	Deputy Director Town Planning
Mr. Usame Nawaz	Architect Director
Mr. Ramsha Rehman	Deputy Director Architec

- **Bahauddin Zikriya University**

Mr. Shamsul Wahab	Laboratory Incharge, Civil Engineering Department

- **Environment Protection Department, Government of Punjab**

Mr. Ijaz Ahmed	Additional Secretary
Mr. Mohammed Tahir	Director (EIA)

- **Frequency Allocation Board: FAB**

Mr. Imran Zahoor	Deputy Director

Appendix4-1. Minutes of Discussions

Minutes of Discussions
on
the Preparatory Survey
for
the Project for the Installation of Weather Surveillance Radar at Multan
in
the Islamic Republic of Pakistan

In response to the request from the Government of the Islamic Republic of Pakistan (hereinafter referred to as "Pakistan"), the Government of Japan decided to conduct a Preparatory Survey for the Project for the Installation of Weather Surveillance Radar at Multan (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to Pakistan, headed by Mr.Masahiro Ueki, Director of Disaster Risk Reduction Team 1, Global Environment Department, and is scheduled to stay in Pakistan from 8 July to 25 August, 2017.

The Team held a series of discussions with the officials concerned of the Government of Pakistan and conducted a field survey in the Project area. In the course of the discussions, both sides have confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Preparatory Survey Report.

Islamabad, 2nd August 2017

Mr. Masahiro Ueki
Team Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Dr. Ghulam Rasul
Director General
Pakistan Meteorological Department
Aviation Division
Government of Pakistan

Ms.Sajeela Naveed
Deputy Secretary
Aviation Division
Government of Pakistan

Mr.Waqar Uddin Siddiqui
Member, Disaster Risk Reduction
National Disaster Management Authority
Government of Pakistan

Mr.Syed Mujtaba Hussain
Joint Secretary (ADB/Japan)
Economic Affairs Division
Government of Pakistan

Mr. Ahmed Kamal
Chief Engineering Advisor/ Chairman
Federal Flood Commission
Ministry of Water and Power
Government of Pakistan

ATTACHMENT

1. Objective of the Project
   The objective of the Project is to improve the PMD's capabilities in meteorological observation, weather forecasting and dissemination of forecast/warnings through the installation of a meteorological radar system in Multan. This will largely contribute to the mitigation of damages caused by natural disasters in Pakistan which are predicted to increase due to climate change.

2. Title of the Preparatory Survey
   Both sides confirmed the title of the Preparatory Survey as "the Preparatory Survey for the Project for the Installation of Weather Surveillance Radar at Multan".

3. Project Site
   Both sides confirmed that the site of the Project is Multan which is shown in Annex 1.

4. Responsible/ Sponsoring Agency and Implementing Agency
   Both sides confirmed the responsible/ sponsoring agency and implementing agency as follows:
   4-1. The Responsible/ Sponsoring Agency: Aviation Division, Cabinet Secretariat.
   4-2. The Implementing Agency: Pakistan Meteorological Department (hereinafter referred to as "PMD").
   4-3. The Coordinating Agencies: Economic Affairs Division (EAD), National Disaster Management Authority (NDMA), and Federal Flood Commission (FFC).
   The organization chart of PMD is shown in Annex 2.

5. Items requested by the Government of Pakistan
   5-1. As a result of discussions, both sides confirmed that the items requested by the Government of Pakistan are as shown in Table below.

Table: Main Components to be required for the Project

Component	Proposed Multan Meteorological Radar Observation Station	PMD Islamabad Head Office National Weather Forecasting Center	PMD Meteorological Office in Multan International Airport	PMD Flood Forecasting Division, Lahore
Procurement and Installation of Equipment				
Meteorological Radar System including Power Back-up System, Lightning System, Measuring Equipment and Spare Parts	1			
Central Processing System		1		
Meteorological Radar Data Display System	1	1 (including Radar Picture Composite Processor and Radar Web Server)	1	1
Meteorological Data Communication System (between Multan Meteorological Radar Observation Station and Meteorological Office in Multan International Airport)	1		1	
Construction of Radar Tower Building				
Radar Tower Building	1			

Initial Technical Training of the equipment	Initial operation guidance in the contract of manufacturer
Soft Component	Guidance for operation and maintenance of the equipment and machineries

5-2. JICA will assess the appropriateness of the above requested items through the survey and will report findings to the Government of Japan. The final components of the Project would be decided by the Government of Japan.

6. Japanese Grant Aid Scheme

6-1. The Pakistan side understands the Japanese Grant Scheme and its procedures as described in Annex 3, Annex 4 and Annex 5, and necessary measures to be taken by the Government of Pakistan.

6-2. The Pakistan side understands to take the necessary measures, as described in Annex 6, for smooth implementation of the Project, as a condition for the Japanese Grant to be implemented. The detailed contents of the Annex 6 will be worked out during the survey and shall be agreed no later than the Explanation of the Draft Preparatory Survey Report.
The contents of Annex 6 will be used to determine the following:
(1) The scope of the Project.
(2) The timing of the Project implementation.
(3) Timing and possibility of budget allocation.
Contents of Annex 6 will be updated as the Preparatory Survey progresses, and will finally be the Attachment to the Grant Agreement.

7. Schedule of the Survey

7-1. The Team will proceed with further survey in Pakistan until 25 August 2017.

7-2. JICA will prepare a draft Preparatory Survey Report in English and dispatch a mission to Pakistan in order to explain its contents around the end of January 2018.

7-3. If the contents of the draft Preparatory Survey Report is accepted in principle and the undertakings are fully agreed by the Pakistan side, JICA will complete the final report in English and send it to the Government of Pakistan around March 2018.

7-4. The above schedule is tentative and subject to change.

8. Other Relevant Issues

8-1. Security Arrangement

The Government of Pakistan shall take all possible and necessary measures to ensure the safety of the concerned Japanese and other foreign persons during the implementation of the Project at the Project site and movement to the Project site from their accommodations, whenever Japanese side requests in advance.

8-2. Specifications Summary

Both sides confirmed basic specifications as follows:

1) Specifications of the requested Radar System:
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System

2) Specifications of the data communication to be arranged by Pakistan side: IP/VPN with the required transmission speed (more than 2 Mbps continuous).

3) Specifications of the radar tower (steel or reinforced concrete tower building) will be further examined by the Team to consider necessary functions, cost and construction period.

The Team will make necessary survey further and make analysis in Japan. Detailed specifications will be explained in next Mission to be scheduled around the end of January 2018.

8-3. Soft component

Both sides confirmed that guidance for operation and maintenance of the equipment and machinery will be included in the Project to support smooth operation. Components will be studied further.

8-4. Necessary Clearance/ Permit for the Project and Approval of PC-I

Both sides confirmed the time table of the following key actions for the Project:

1) In order to implement the Project smoothly, the PMD shall confirm with the Environmental Protection Agency (EPA), Punjab Province that an Environmental Impact Assessment (EIA) permit is not required for the Project. Initial Environmental Examination (IEE) on the Project shall be completed by the PMD for the approval of PC-I. Necessary information will be provided by the Team.
2) The height clearance (No Objection Certificate) from the relevant authorities such as the Civil Aviation Authority, Pakistan Air Force, and etc., for construction of a new meteorological radar tower shall be obtained for the approval of PC-I.
3) The Building Construction Permit of the Multan City Government or any other relevant agencies for the construction of a new meteorological radar tower building shall be obtained for the approval of PC-I.
4) The frequencies of the proposed S-Band radar system in Multan and radio communication link between Multan Meteorological Radar Observation Station and Meteorological Office in Multan International Airport shall be allocated and allowed by the Pakistan Telecommunication Authority (PTA)/ Frequency Allocation Board (FAB) to the PMD for the approval of PC-I.
5) PMD agreed to make arrangements to provide commercial power supply from the main supply line to the proposed project site in Multan for the radar tower building for the approval of PC-I.
6) In order to obtain the required approval from the Japanese Cabinet for the Grant Aid for the implementation of the Project, the PC-I shall be approved by the Central Development Working Party (CDWP), and Executive Committee of the National Economic Council (ECNEC) (if required), Government of Pakistan by the end of March 2018. The Team will provide necessary information for preparation of the PC-I by the end of January 2018.
7) PC-IV shall be submitted immediately after the completion of the Project.

8-5. Land acquisition

PMD explained the land of Multan Meteorological Radar Observation Station is available for the Project. PMD shall be responsible for the acquisition of land from Irrigation Department, Government of Punjab by September 2017, based on the recommendation from the Team.

8-6. Reclaiming of the Site and Construction of Security Wall

The Team explained that levelling and reclaiming the Multan meteorological radar site, as well as construction of security walls are

generally the responsibilities of the Pakistan side. However the Pakistan side expressed concerns on their technical capacity and experience to complete the above mentioned works on schedule, and requested the works to be included in the Project. The Team will convey this genuine request to JICA HQ.

8-7. Dissemination of radar data

Both sides confirmed 1) near real-time radar data/products will be provided to the public through PMD web site and also provided to other related organizations through data servers in PMD, and 2) radar data will be archived and be available to other disaster management related organizations for disaster survey.

8-8. Necessary budget and number of staff for Operation and Maintenance

PMD agreed to allocate necessary budget and staff required for proper operation and maintenance.

8-8. Tax Exemption

The tax exemption including the General Sales Tax (GST), custom duty, and any other taxes and fiscal levies in Pakistan which are to arise from the Project activities shall be ensured by the Government of Pakistan. The Government of Pakistan shall take necessary procedures for tax exemption.

8-9. Height Restriction

The Team recommended PMD that the Government of Pakistan shall establish Height Restriction avoiding construction of any other higher building/facility within 5 km radius from the new radar tower building to be constructed under the Project for ensuring appropriate radar observation.

PMD agreed to request the relevant authorities to restrict the height limitations set by the Multan City Government (35 m) within 5 km radius accordingly.

8-10. Visibility of the Project

The Pakistan side affirmed the following measures to be taken in order to enhance publicity of the Project:

(a) Mass media sources
(b) Brochures
(c) Commemoration panels

8-11. Adaptation to climate change

In Pakistan, the adverse impacts of climate change induced by global warming have been notable as evidenced by the increase in meteorological disasters such as floods, etc. The possible causes are the increases in the frequency of heavy rain and the intensity of tropical cyclones generated in the Arabian Sea which are closely associated with the increase in sea surface temperature of the Arabian Sea. In recent years, the number of tropical cyclones approaching/ landing in Pakistan has increased. To mitigate the impacts of climate change, it is absolutely necessary to monitor tropical cyclones through the Multan meteorological radar system. Therefore, the Project is expected to contribute to climate change adaptation.

8-12. Contribution for Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030:

In March 2015, the Third UN World Conference on Disaster Risk Reduction was held in Sendai, Japan and the Sendai Framework for Disaster Risk Reduction 2015-2030 (hereinafter referred to as "SFDRR 2015-2030") was adopted. The concept of the Project is in line with SFDRR 2015-2030 and priorities for action. Particularly, the Project contributes to implement "Priority 1: Understanding disaster risk" through an improved meteorological observation capability, and "Priority 4: Enhancing disaster preparedness for effective response" through an improved accuracy of forecasts and warnings.

8-13. Contribution to the National Disaster Management Plan (NDMP)

Both sides confirmed that the Project is in line with the priority areas identified in the National Disaster Management Plan (NDMP) which has been approved by the National Disaster Management Commission, Government of Pakistan.

8-14. Contribution to the National Flood Protection Plan-IV (NFPP-IV) of Federal Flood Commission (FFC) which has been approved by the Council of Common Interests (CCI)-The highest national interprovincial coordination forum.

Being the main coordinating agency of the Government of Pakistan for integrated flood management, FFC will coordinate with other stakeholders to harness the benefits of this Project.

8-15. Monitoring during the implementation

PMD agreed to monitor the Project every three (3) months during the implementation by using the Project Monitoring Report form as attached in Annex-7.

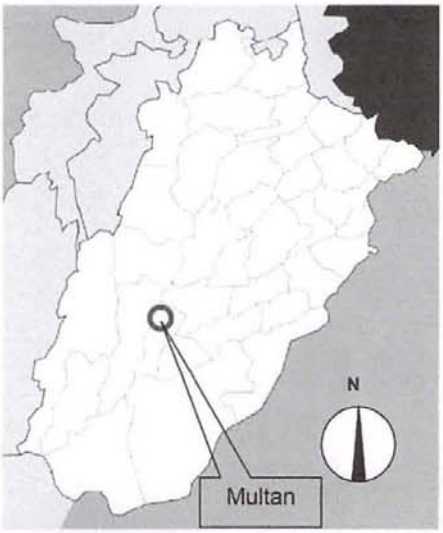
8-16. Confidentiality of the Project

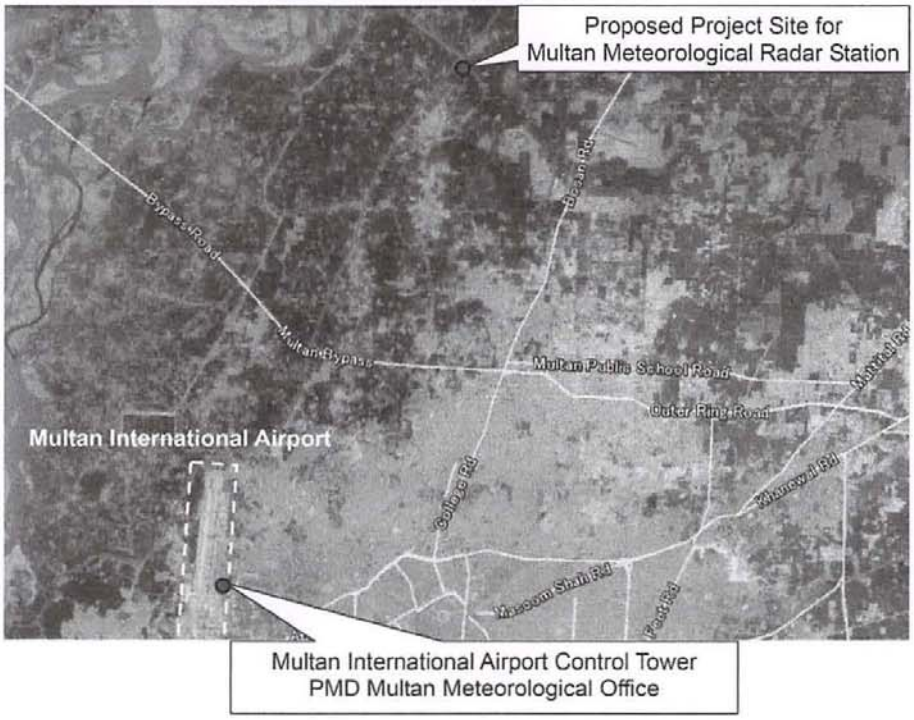
The Team explained that the preparatory survey report to be prepared at the end of the survey would be disclosed to the public in Japan. However, the Team also explained that a confidential part which might affect bidding process such as cost estimation should be kept undisclosed until the bidding has completed.

Annex 1 Project Site
Annex 2 Organization Chart
Annex 3 Japanese Grant
Annex 4Flow Chart of Japanese Grant Procedures
Annex 5 Financial Flow of Japanese Grant
Annex 6 Major Undertakings to be taken by Recipient Government
Annex 7 Project Monitoring Report (template)

Annex 1

Project Sites

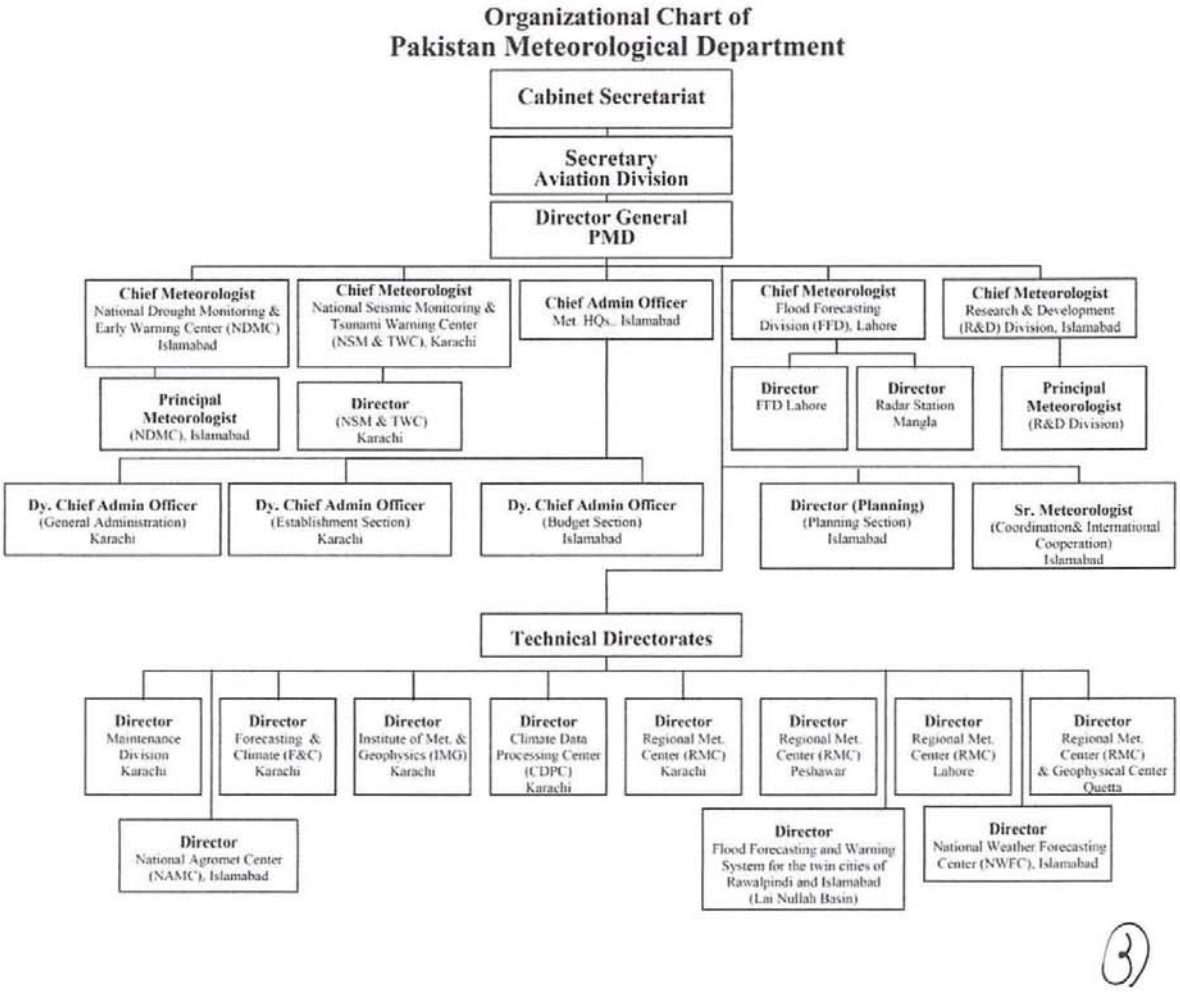




The depiction and use of boundaries, geographic names and related data shown on themap do not necessarily imply official endorsement or acceptance by JICA.

Annex 2

Organization Chart of Pakistan Meteorological Department(PMD)



Annex-3

JAPANESE GRANT

The Japanese Grant (hereinafter referred to as the "Grant") is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant is not supplied through the donation of materials as such.

Based on a JICA law which was entered into effect on October 1, 2008 and the decision of the GOJ, JICA has become the executing agency of the Japanese Grant for Projects for construction of facilities, purchase of equipment, etc.

1. Grant Procedures

The Grant is supplied through following procedures:

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the Preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.

- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant project. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japanese Grant Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be signed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles, in accordance with the E/N, to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. The Grant may be used for the purchase of the products or services of a third country, if necessary, taking into account the quality, competitiveness and economic rationality of products and services necessary for achieving the objective of the Project.

However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals", in principle.

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals, in principle. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Project, the recipient country is required to undertake such necessary measures as Annex. The Japanese Government requests the Government of the recipient country to exempt all customs duties, internal taxes and other fiscal levies such as VAT, commercial tax, income tax, corporate tax, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract, since the Grant fund comes from the Japanese taxpayers.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant.

(7) "Export and Re-export"

The products purchased under the Grant should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"), in principle. JICA will execute the Grant by making payments in Japanese yen, in principle, to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Environmental and Social Considerations

The Government of the recipient country must carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the recipient country and JICA Guidelines for Environmental and Social Consideration (April, 2010) .

(11) Monitoring

The Government of the recipient country must take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and must regularly report to JICA about its status by using the Project Monitoring Report (PMR).

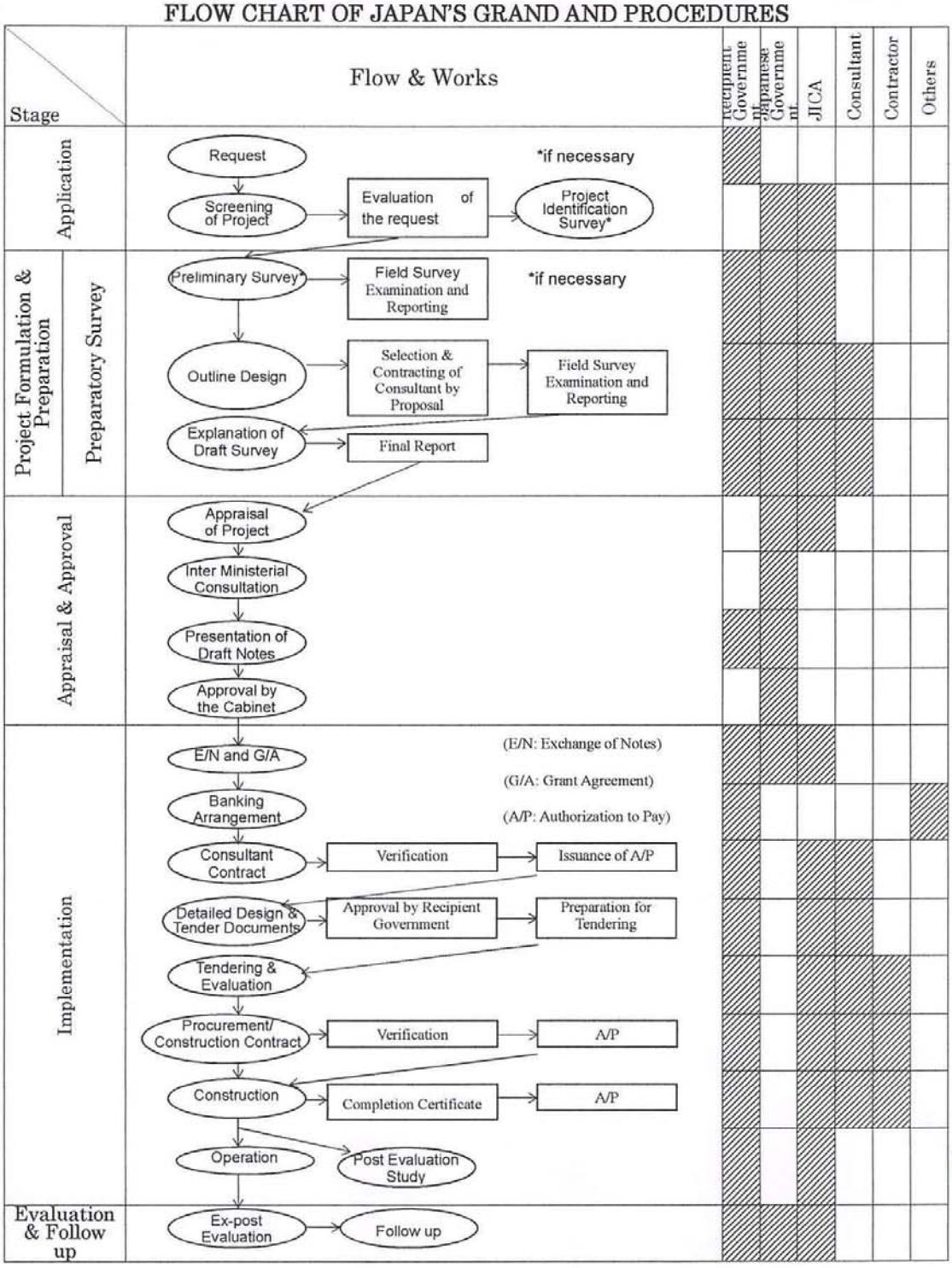
(12) Safety Measures

The Government of the recipient country must ensure that the safety is highly observed during the implementation of the Project.

3

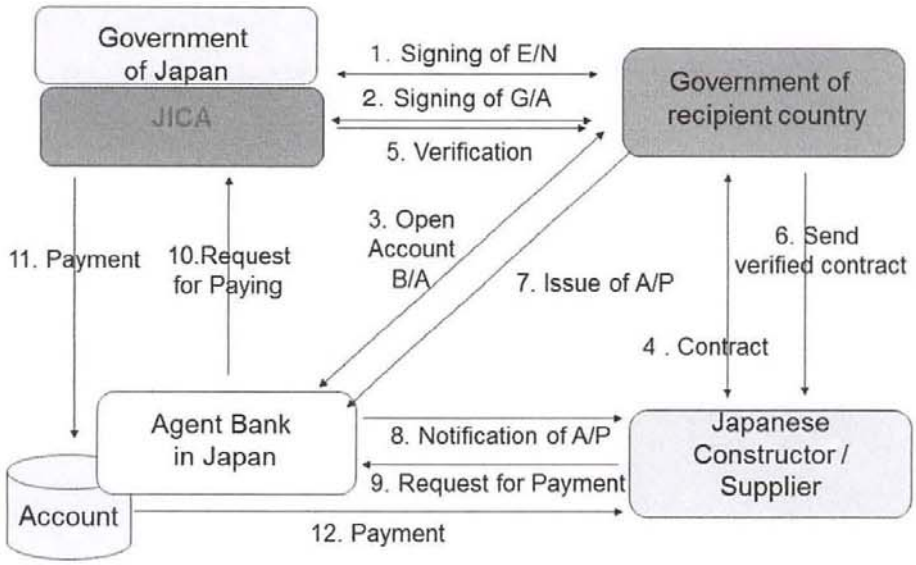
Annex-4

FLOW CHART OF JAPAN'S GRAND AND PROCEDURES



Annex-5

Financial Flow of Grant Aid



Annex 6

Major Undertakings to be taken by Recipient Government

1) Before the Tender

NO	Items	Deadline	In charge	Cost	Ref.
1	To open Bank Account (Banking Arrangement (B/A))	within 3 months after G/A	PMD		
2	To secure sufficient spaces at the proposed Project site in Multan for temporary facilities such as a consultant's site office, contractor's office, workshop, building materials storage, etc. needed for the construction work.	before notice of the Tender	PMD		
3	To obtain all prior regulatory compliance and necessary permissions (Building Construction Permit, Building Height Clearance) from the relevant agencies/authorities for the construction of the Radar Tower Building in the proposed project site in Multan.	before completion of PC-I	PMD		
4	To obtain the required frequencies for the Multan meteorological radar system, Polarimetric Test Horn Devices, and Meteorological Data Communication System (between Multan Meteorological Radar Observation Station and Meteorological Office in Multan International Airport).	before notice of the Tender	PMD		

2) During the Project

NO	Items	Deadline	In charge	Cost	Ref.
1	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.	every payment	PMD		
2	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 the customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project as well as sending back of any defective equipment and/or spare parts to the manufacturer for repair at the factory or replacement and re-importation thereof into Pakistan during the implementation and warranty periods of the Project.	during the Project	EAD PMD		
	1) Marine (air) transportation of the Products from Japan to Pakistan	during the Project	Contractor		
	2) Internal transportation from the port of disembarkation to the project sites	during the Project	Contractor		
3	1) To take full responsibility, arrange the maximum countermeasures and ensure the appropriate 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 implementation of the Project. 2) To arrange security around the proposed Project Site with the police. 3) To arrange security around the accommodation(s) of the Consultants & the Contractor with the police. 4) To arrange escort guard with the police during movements between the accommodation(s) of the Consultants & the Contractor and the proposed Project Site.	during the Project	PMD		
4	To provide necessary working spaces with Internet Connection at the PMD Islamabad Head Office and the PMD Multan Meteorological	during the Project	PMD		

	Office at the International Airport for the Consultant and the Contractor during 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).	during the Project	PMD		
6	To exempt goods of Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed by the Government of Pakistan with respect to their supply (products) and services under the signed contracts.	during the Project	EAD PMD		
7	To bear all the expenses, other than those to be borne by the Japanese Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment.	during the Project	PMD		
8	1) To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: no less than 150kVA) along with electric poles/wires, etc. from the main supply line to the proposed project site in Multan for the Radar Tower Building and other facilities to be constructed by the PMD for establishing an observatory. 2) To install the required step-down transformer as well as service entrance connections for the commercial power supply at the proposed project site in Multan for the Radar Tower Building (400V, 3-phase, 4-wire, 50Hz).	Before commencement of the radar tower building construction	PMD		
9	To provide facilities for distribution of electricity, water supply, drainage and other incidental facilities necessary for the implementation of the Project outside the site(s)				
	1) Electricity	before completion of the radar tower building construction			
	The Distribution line to the site		PMD		
	2) Water Supply Sufficient water will be available		PMD		
	3) Drainage		PMD		
	4) Furniture and equipment General Furniture		PMD		
10	To promptly provide reliable and high-speed Internet environment at the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Multan Meteorological Office (Forecasting Room) located in the Multan International Airport and the PMD Flood Forecasting Division (FFD), Lahore (with each corresponding global/fix IP) for establishment of a Virtual Private Network (IP-VPN).	during the Project	PMD		
11	To set up the required and new assigned IP addresses in the computing equipment supplied under the Project and facilitate any required configuration i.e. firewall settings, etc. of the existing PMD equipment which may be made part of the Project Network Communication System, if any.	during the Project	PMD		
12	To install 1 additional air-conditioning system at the PMD Multan Meteorological Office (Forecasting Room).	during the Project	PMD		
13	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.	during the Project	PMD		

3) After the Project

NO	Items	Deadline	In charge	Cost	Ref.
1.	To maintain and use properly and effectively the facilities constructed and equipment provided under the Japanese Grant	after completion of the Project	PMD		
	1) Allocation of maintenance cost		PMD		
	2) Operation and maintenance structure		PMD		
	3) Routine check/Periodic inspection		PMD		
	4) Other contingency expenditures if necessary		PMD		
2	To assign the required staff including a responsible personnel of the PMD who has reliable technical skill and ample experience for the smooth operation and maintenance of the Equipment.	after completion of the Project	PMD		
3	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment, and enter into a Preventive Maintenance Service Agreement with the equipment supplier if so desired.	after completion of the Project	PMD		
4	To procure the appropriate number and capacity of disk media, hard disks, solid state disks, etc., and dutifully conduct the required schedule archiving of radar observation raw data and products.	after completion of the Project	PMD		
5	To periodically update all the operation/antivirus/application software(s).	after completion of the Project	PMD		

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

(Note) Progress of the specific obligations of the Recipient may be confirmed and updated from time to time with written agreement between JICA and the Recipient in the form other than the amendment of the G/A.

(3)

Annex-7

Project Monitoring Report
on

Grant Agreement No. XXXXXXX
20XX, Month

Organization Information

Authority (Signer of the G/A)	_____ Person in Charge _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Executing Agency	_____ Person in Charge _____ Contacts Address: _____ Phone/FAX: _____ Email:
Line Agency	_____ Person in Charge _____ Contacts Address: _____ Phone/FAX: _____ Email: _____

Outline of Grant Agreement:

Source of Finance	Government of Japan: Not exceeding JPY. Government of Pakistan:
Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:

17

1: Project Description

1-1 Project Objective

1-2 Necessity and Priority of the Project

- Consistency with development policy, sector plan, national/regional development plans and demand of target group and the recipient country.

1-3 Effectiveness and the indicators

- Effectiveness by the project

Quantitative Effect (Operation and Effect indicators)		
Indicators	Original (Yr 2017)	Target (Yr 2021)
Qualitative Effect		

2: Project Implementation

2-1 Project Scope

Table 2-1-1a: Comparison of Original and Actual Location

Location	Original: *(M/D)* Attachment(s):Map	Actual: *(PMR)* Attachment(s):Map

Table 2-1-1b: Comparison of Original and Actual Scope

Items	Original	Actual

2-1-2 Reason(s) for the modification if there have been any.

A2
③

2-2 Implementation Schedule

2-2-1 Implementation Schedule

Table 2-2-1: Comparison of Original and Actual Schedule

Items	Original		Actual
	DOD	G/A	
Cabinet Approval		-	-
E/N			
G/A			
Approval of consultant contract			
Early Mobilization of consultant			
Detailed Design			
Budget Request for FY2016			
Tender Process of contractor and supplier			
Approval of contractor and supplier contract			
Budget Appropriation and Issuance of A/P			
Construction Period			
Shipment			
Custom Clearance			
Installation and acceptance Check			
Soft component			
Project Completion Date			
Defect Liability Period			

*Project Completion was defined as Completion of Soft component at the time of G/A.

2-2-2 Reasons for any changes of the schedule, and their effects on the project.

2-3 Undertakings by each Government

2-3-1 Major Undertakings

See Attachment 2.

2-3-2 Activities

See Attachment 3.

2-3-3 Report on RD

See Attachment 4.

2-4 Project Cost

2-4-1 Project Cost

Table 2-4-1a Comparison of Original and Actual Cost by the Government of Japan
(Confidential until the Tender)

Items			Cost (Million Yen)	
	Original	Actual	Original	Actual
Construction of Facilities				
Equipment				
Soft Component				
Consulting Services				
Contingency				
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =**Yen

Table 2-4-1b Comparison of Original and Actual Cost by the Government of **

Items			Cost (Thousand MMK)	
	Original	Actual	Original	Actual
				Please state not only the most updated schedule

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =(local currency)

2-4-2 Reason(s) for the wide gap between the original and actual, if there have been any, the remedies you have taken, and their results.

2-5 Organizations for Implementation

2-5-1 Executing Agency:

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original: *(M/D)*
Actual, if changed: *(PMR)*

2-6 Environmental and Social Impacts

- The environmental monitoring is not required in the Project as this project was categorized as category C in accordance with the GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS of JICA as of April 2010.

3: Operation and Maintenance (O&M)

3-1 O&M and Management

- Organization chart of O&M
- Operational and maintenance system (structure and the number ,qualification and skill of staff or other conditions necessary to maintain the outputs and benefits of the project soundly, such as manuals, facilities and equipment for maintenance, and spare part stocks etc)

Original: *(M/D)*
Actual: (*PMR)*

3-2 O&M Cost and Budget

- The actual annual O&M cost for the duration of the project up to today, as well as the annual O&M budget.

Original: *(M/D)*

Actual: *(PMR)*

4: Precautions (Risk Management)

- Risks and issues, if any, which may affect the project implementation, outcome, sustainability and planned countermeasures to be adapted are below.

Original Issues and Countermeasure(s)*: (M/D)*	
Potential Project Risks	Assessment
1. Delay of budget appropriation	Probability: H/M/L
	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
2.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
3.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
Actual issues and Countermeasure(s)	

(PMR)

5: Evaluation at Project Completion and Monitoring Plan

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan for the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Undertakings to be taken by each Government
3. Monthly Report
4. Report on RD
5. Yearly disbursement plan
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Final Report Only)

Minutes of Discussions
on the Preparatory Survey for the Project for
the Installation of Weather Surveillance Radar at Multan
in the Islamic Republic of Pakistan
(Explanation on Draft Preparatory Survey Report)

With reference to the minutes of discussions signed between Pakistan Meteorological Department (hereinafter referred to as "PMD") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on 2nd August 2017 and in response to the request from the Government of the Islamic Republic of Pakistan(hereinafter referred to as "Pakistan") dated 13th July 2015, JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Team") for the explanation of Draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") for the Project for the Installation of Weather Surveillance Radar at Multan (hereinafter referred to as "the Project").

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Islamabad, 15th February, 2018

Ms Michino Yamaguchi
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Dr. Ghulam Rasul
Director General
Pakistan Meteorological Department
Aviation Division
Government of Pakistan

Mr.Owais Nauman Kundi
Senior Joint Secretary
Aviation Division
Government of Pakistan

Mr. Idrees Mahsud
Member, Disaster Risk Reduction
National Disaster Management Authority
Government of Pakistan

Mr. Jahanzeb Khan
Deputy Secretary (Japan)
Economic Affairs Division
Government of Pakistan

Mr. Ahmed Kamal
Chief Engineering Advisor/ Chairman
Federal Flood Commission
Ministry of Water Resources
Government of Pakistan

ATTACHMENT

1. Objective of the Project
The objective of the Project is to improve the PMD's capabilities in meteorological observation, weather forecasting and dissemination of forecast/warnings through the installation of a meteorological radar system in Multan, thereby contributing to mitigate damages caused by natural disasters in Pakistan.

2. Title of the Preparatory Survey
Both sides confirmed the title of the Preparatory Survey as "the Preparatory Survey for the Project for the Installation of Weather Surveillance Radar at Multan in the Islamic Republic of Pakistan".

3. Project site
Both sides confirmed that the sites of the Project are in Multan, Lahore and Islambad, which are shown in Annex 1.

4. Responsible authority for the Project
Both sides confirmed the authorities responsible for the Project are as follows:

4-1. The PMD will be the executing agency for the Project (hereinafter referred to as "the Executing Agency"). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be taken care by relevant authorities properly and on time. The organization charts are shown in Annex 2.

4-2. The line ministry of the Executing Agency is the Aviation Division, Cabinet Secretariat. The Aviation Division, Cabinet Secretariat shall be responsible for supervising the Executing Agency on behalf of the Government of Pakistan.

5. Contents of the Draft Report
After the explanation of the contents of the Draft Report by the Team, the Pakistan side agreed to its contents.

6. Cost estimate
Both sides confirmed that the cost estimate including the contingency explained by the Team is provisional and will be examined further by the Government of Japan for its approval. The contingency would cover the additional cost against natural disaster, unexpected natural conditions, etc.

7. Confidentiality of the cost estimate and technical specifications
Both sides confirmed that the cost estimate and technical specifications of the Project should never be disclosed to any third parties until all the contracts under the Project are concluded.

8. Procedures and Basic Principles of Japanese Grant
The Pakistan side agreed that the procedures and basic principles of Japanese Grant as described in Annex 3 shall be applied to the Project. In addition, the Pakistan side agreed to take necessary measures according to the procedures.

9. Timeline for the project implementation
The Team explained to the Pakistan side that the expected timeline for the project implementation is as attached in Annex 4.

10. Expected outcomes and indicators
Both sides agreed that key indicators for expected outcomes are as follows. The Pakistan

side will be responsible for the achievement of agreed key indicators targeted in year 2025 and shall monitor the progress based on those indicators.

[Quantitative indicators]

Indicator	Present (Baseline in 2017)	Target (2025)
Enhancement of Severe Weather Monitoring Capability	Spatial resolution and observation intervals of the existing 143 surface observation stations in Pakistan: 74.6 km mesh on average at 60 minute observation intervals.	- Spatial resolution and observation intervals of precipitation data in the radar detection range between 300-400 km: 1 km mesh at 10 minute observation intervals. - Spatial resolution and observation intervals of wind speed & direction data in the radar detection range within 200 km: 1 km mesh at 10 minute observation intervals.
	Observation of thunderstorm accompanying the development of cumulonimbus and rain cloud of severe weather using meteorological satellite (qualitative data being received at 30 minute intervals).	Observation intervals of rainfall intensity, location, track, wind velocity of thunderstorm accompanied by cumulonimbus and rain cloud of severe weather caused by monsoon in the radar detection range: 10 minute observation intervals.
Enhancement of Heavy Rain Monitoring Capability	Observation only by using the existing surface observation stations (synoptic observation stations and automatic observation systems).	Observation intervals of rainfall intensity, location, development of rain distribution, and movement in the radar detection range: 10 minute observation intervals.

[Qualitative indicators]

① Additional Information provision (in addition to the manual aeronautical observation) to the airport operators on weather conditions such as cumulonimbus, etc. detected by the radar systems to aircraft operations in the area surrounding the Multan International Airport.

② Provision of heavy rain information/advisory/warning indicating the area(s) identified and the area(s) located in the direction of rain cloud moving by the radar observation data which has/have received rainfall of over 50mm within the last 1 hour and 75 mm within the last 3 hours and based on synoptic trends to the government agencies concerned with disaster management and mass media.

③ Enable the disaster management authorities (NDMA, PDMA and concerned district authorities) to issue prompt evacuation orders and commence necessary countermeasures against disasters and evacuation activity and support for disaster victims in a timely manner.

④ Enable the PMD to operate radar observation for prevention of secondary disasters and securing safety during rescue activities.

⑤ Enable the provision of accurate weather information to users engaged in industries such as transportation, tourism and agriculture by the PMD to promote the implementation of disaster mitigation measures and reducing economic losses.

11. Technical assistance ("Soft Component" of the Project)
Considering the sustainable operation and maintenance of the products and services granted through the Project, following technical assistance is planned under the Project. The Pakistan side confirmed to deploy necessary number of counterparts who are appropriate and competent in terms of its purpose of the technical assistance as described in the Draft Report.

12. Undertakings of the Project
Both sides confirmed the undertakings of the Project as described in Annex 5. With regard to exemption of customs duties, internal taxes and other fiscal levies as stipulated in No.2 of "2)During the Project"of Annex 5, both sides confirmed that such customs duties, internal taxes and other fiscal levies, which shall be clarified in the bid documents by Pakistan Metreorological Department during the implementation stage of the Project.
The Pakistan side assured to take the necessary measures and coordination including allocation of the necessary budget which are preconditions of implementation of the Project. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage.
Both sides also confirmed that the Annex 5 will be used as an attachment of G/A.

12.1 Necessary Clearance/ Permit for the Project and Approval of PC-I
Both sides confirmed the timetable of the following key actions for the Project;

1) In order to submit the Project to the Japanese Cabinet, PMD shall make effort for seeking approval of PC-I by Central Development Working Party (CDWP) by the end of May, 2018. The Team will provide necessary information for preparation of the PC-I by end of February 2018.
2) Initial Environmental Examination (IEE) on the Project shall be completed for the approval of PC-I (by the end of February 2018).
3) The height clearance (No Objection Certificate) from the relevant authorities such as the Civil Aviation Authority and Pakistan Air Force for construction of a new Meteorological Radar Tower shall be obtained for the approval of PC-I (by mid May 2018).
4) The required procedures to obtain regulatory compliance and necessary permissions from the relevant agencies/authorities for the construction of the Radar Tower Building in the project site in Multan shall be commenced immediately after signing of the Exchange of Notes and Grant Agreement of the Project and shall be completed before the commencement of the tendering procedures (within one month).
5) The frequencies of the proposed S-Band radar system in Multan and radio communication link between Multan Meteorological Radar Observation Station and Meteorological Office in Multan International Airport shall be allocated and allowed by the Pakistan Telecommunication Authority (PTA)/ Frequency Allocation Board (FAB) to the PMD before the manufacturing of the equipment.
6) The Team strongly recommended PMD that the Government of Pakistan shall establish Height Restriction to avoid construction of any building/facility higher than the new Radar Tower Building within 5 km radius from the Multan Radar site to ensure appropriate Radar observation. PMD understood the recommendation made by the Team to take appropriate action in this regard for up to 20 years.
7) PMD agreed to make arrangements to provide commercial power supply from the main supply line to the proposed project site in Multan for the radar tower building.
8) PC-IV shall be submitted right after the completion of the Project.

12.2 Land acquisition
PMD acquired the land of Multan Meteorological Radar Observation Station from

Irrigation Department, Government of Punjab.

12.3 Stable communication between Radar tower and Airport Control Tower

The Team strongly requested PMD that the Government of Pakistan will assure stable communication between Multan Meteorological Radar Tower Building and the Multan International Airport Control Tower. In case any obstacles such as tropical trees may touch the Fresnel Zone of the radio waves, PMD will negotiate with the owner of the tree to trim the obstracted part of the tree.

13. Monitoring during the implementation

The Project will be monitored by the Executing Agency and reported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 6. The timing of submission of the PMR is described in Annex 5.

14. Project completion

Both sides confirmed that the project completes when all the facilities constructed and equipment procured by the grant are in operation. The completion of the Project will be reported to JICA promptly, but in any event not later than six months after completion of the Project.

15. Ex-Post Evaluation

JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability). The result of the evaluation will be publicized. The Pakistan side is required to provide necessary support for the data collection.

16. Schedule of the Study

JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the Pakistan side around March 2018.

17. Environmental and Social Considerations

17-1 General Issues

17-1-1 Environmental Guidelines and Environmental Category

The Team explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as C because the Project is likely to have minimal adverse impact on the environment under the Guidelines.

17-2 Environmental Issues

17-2-1 Environmental Impact Assessment (EIA)

Both sides confirmed the EIA report is not required for the Project in the country's legal system.

18. Other Relevant Issues

18-1. Disclosure of Information

Both sides confirmed that the Preparatory Survey Report from which project cost is excluded will be disclosed to the public after completion of the Preparatory Survey. The comprehensive report including the project cost will be disclosed to the public after all the contracts under the Project are concluded.

18-2. Security Arrangement

The Government of Pakistan shall take all possible and necessary measures to ensure the safety of the concerned Japanese and other foreign persons during the implementation of the Project at the Project site and movement to the Project site from their accommodations, whenever Japanese side requests in advance.

18-3 Visibility of the Project

The Pakistan side affirmed the following measures to be taken after the completion of the Project in order to enhance publicity of the Project:

(a) Mass media sources
(b) Brochures
(c) Commemoration panels

18-4 Adaptation to climate change

In Pakistan, the adverse impacts of climate change induced by global warming have been notable as evidenced by the increase in meteorological disasters such as floods, etc. To mitigate the impacts of climate change, it is absolutely necessary to monitor severe weather events through the Multan meteorological radar system. Therefore, the Project is expected to contribute to climate change adaptation.

18-5 Contribution for Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030:

In March 2015, the Third UN World Conference on Disaster Risk Reduction was held in Sendai, Japan and the Sendai Framework for Disaster Risk Reduction 2015-2030 (hereinafter referred to as "SFDRR 2015-2030") was adopted. The concept of the Project is in line with SFDRR 2015-2030 and priorities for action. Particularly, the Project contributes to implement "Priority 1: Understanding disaster risk" through an improved meteorological observation capability, and "Priority 4: Enhancing disaster preparedness for effective response" through an improved accuracy of forecasts and warnings.

18-6 Contribution to the National Disaster Management Plan (NDMP)

Both sides confirmed that the Project is in line with the priority areas identified in the National Disaster Management Plan (NDMP) which has been approved by the National Disaster Management Commission.

18-7 Contribution to the Fourth National Flood Protection Plan (NFPP-IV) of Federal Flood Commission (FFC)

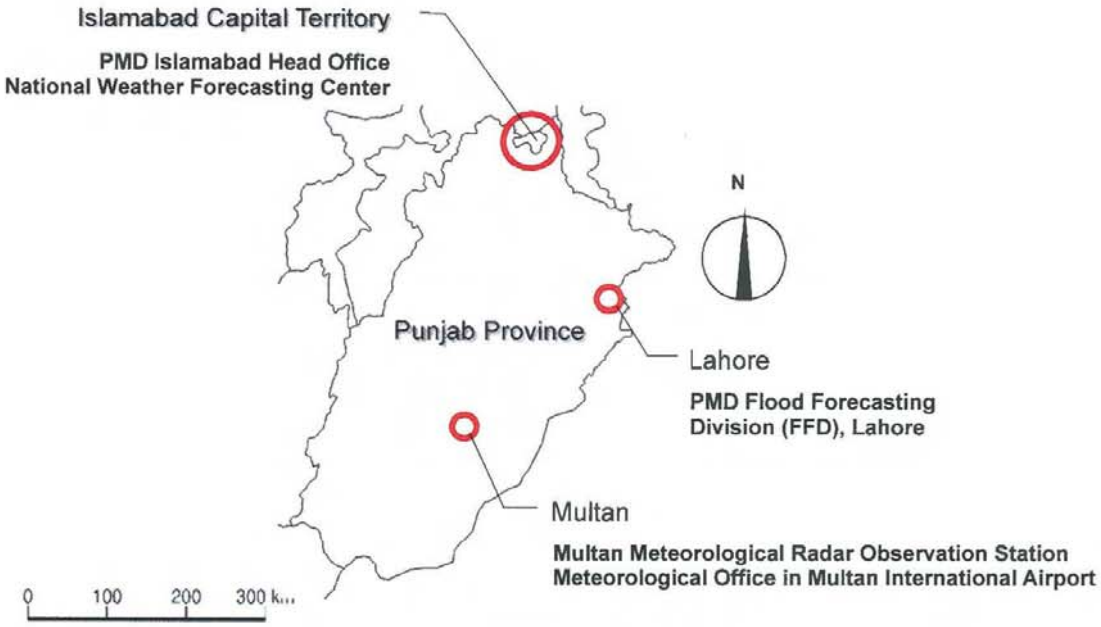
Both sides confirmed that the Project is in line with the priority areas identified in the Contribution to the Fourth National Flood Protection Plan (NFPP-IV) of Federal Flood Commission (FFC) approved the Council of Common Interests(CCI), and it will contribute in the realization of benefits expected due to its implementation.

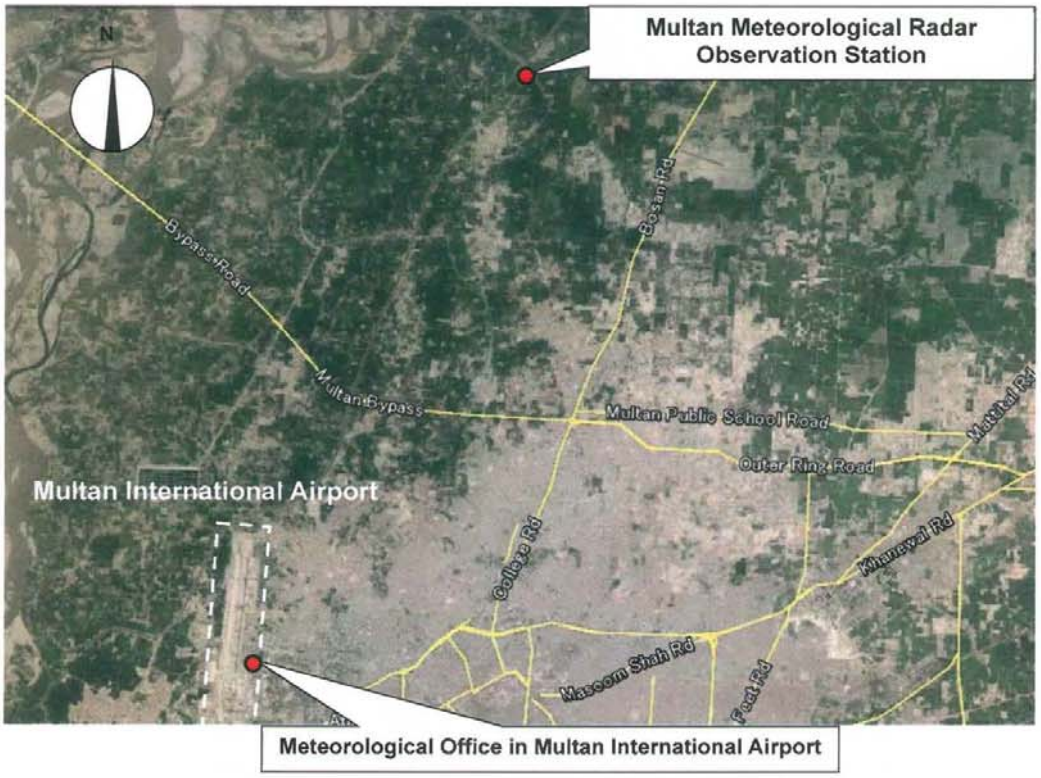
Being the main coordinating agency of the Government of Pakistan for integrated flood management, FFC will coordinate with other stakeholders to harness the benefits of this Project.

Annex 1

Project Sites

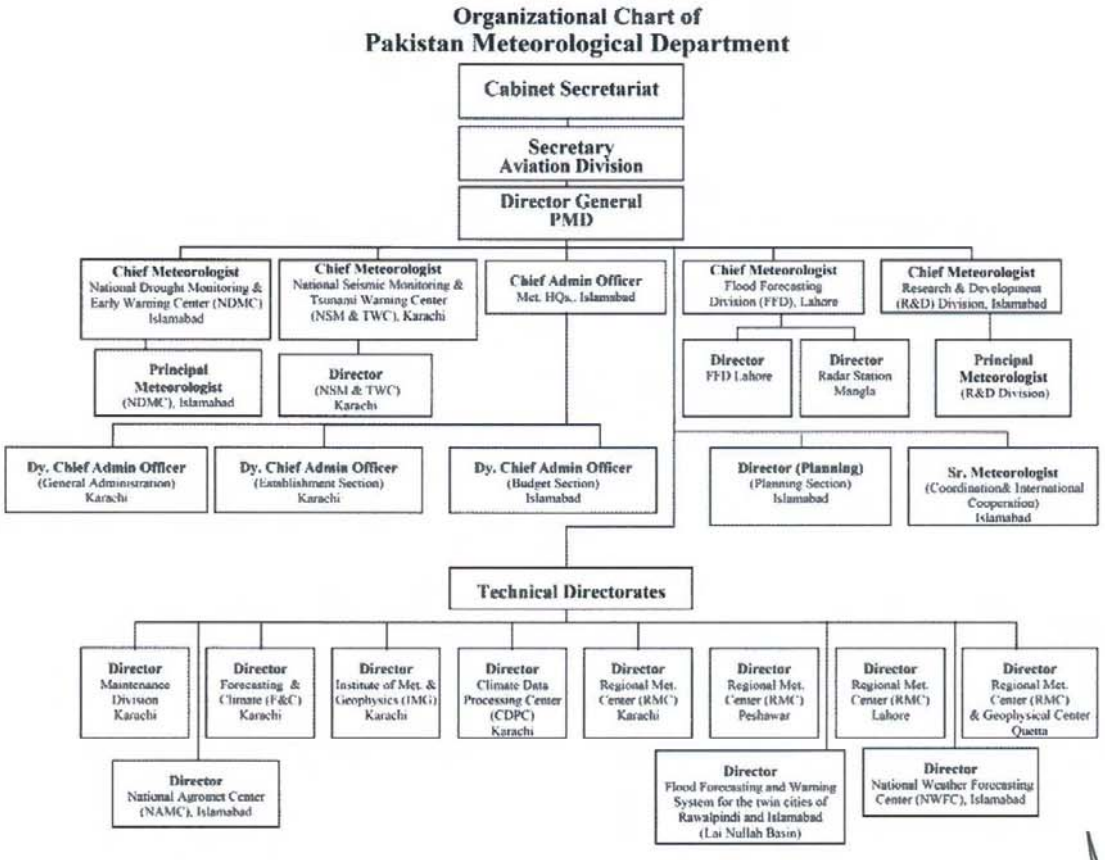
■ **Islamic Republic of Pakistan**





Annex 2

Organization Chart of Pakistan Meteorological Department (PMD)



Annex-3

JAPANESE GRANT

The Japanese Grant (hereinafter referred to as the "Grant") is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant is not supplied through the donation of materials as such.

Based on a JICA law which was entered into effect on October 1, 2008 and the decision of the GOJ, JICA has become the executing agency of the Japanese Grant for Projects for construction of facilities, purchase of equipment, etc.

1. Grant Procedures

The Grant is supplied through following procedures:

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the Preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Scheme from a technical, financial, social and economic point of view.

- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant project. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japanese Grant Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be signed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles, in accordance with the E/N, to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. The Grant may be used for the purchase of the products or services of a third country, if necessary, taking into account the quality, competitiveness and economic rationality of products and services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals", in principle.

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals, in principle. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Project, the recipient country is required to undertake such necessary measures as Annex. The Japanese Government requests the Government of the recipient country to exempt all customs duties, internal taxes and other fiscal levies such as VAT, commercial tax, income tax, corporate tax, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract, since the Grant fund comes from the Japanese taxpayers.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant.

(7) "Export and Re-export"

The products purchased under the Grant should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"), in principle. JICA will execute the Grant by making payments in Japanese yen, in principle, to cover the obligations incurred by the Government of the recipient country or

its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Environmental and Social Considerations

The Government of the recipient country must carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the recipient country and JICA Guidelines for Environmental and Social Consideration (April, 2010) .

(11) Monitoring

The Government of the recipient country must take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and must regularly report to JICA about its status by using the Project Monitoring Report (PMR).

(12) Safety Measures

The Government of the recipient country must ensure that the safety is highly observed during the implementation of the Project.

Annex-3 Attachment 1

PROCEDURES OF JAPANESE GRANT

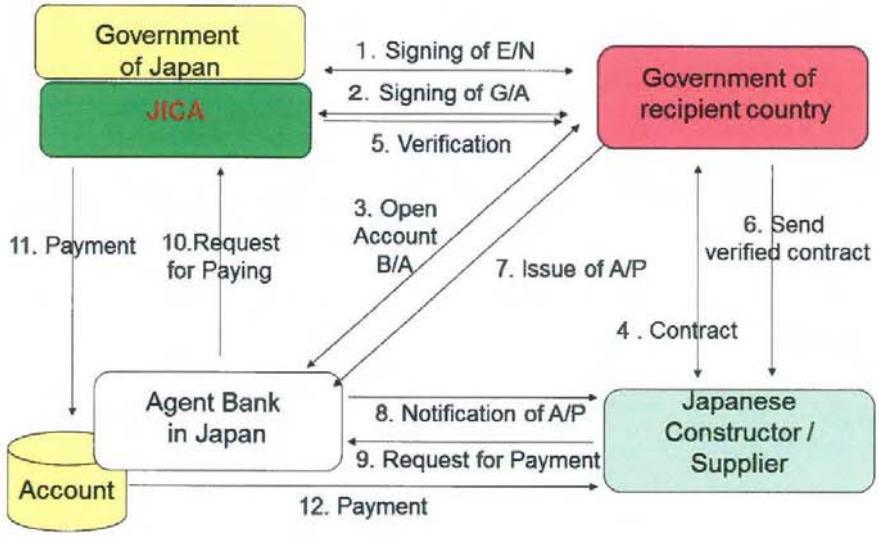
Stage	Procedures	Remarks	Recipient Government	Japanese Government	JICA	Consultants	Contractors	Agent Bank
Official Request	Request for grants through diplomatic channel	Request shall be submitted before appraisal stage.	x	x				
1. Preparation	(1) Preparatory Survey Preparation of outline design and cost estimate	—	x		x	x		
2. Appraisal	(2)Preparatory Survey Explanation of draft outline design, including cost estimate, undertakings, etc.		x		x	x		
	(3)Agreement on conditions for implementation	Conditions will be explained with the draft notes (E/N) and Grant Agreement (G/A) which will be signed before approval by Japanese government.	x	x (E/N)	x (G/A)			
	(4) Approval by the Japanese cabinet	—		x				
3. Implementation	(5) Exchange of Notes (E/N)		x	x				
	(6) Signing of Grant Agreement (G/A)		x		x			
	(7) Banking Arrangement (B/A)	Need to be informed to JICA	x					x
	(8) Contracting with consultant and issuance of Authorization to Pay (A/P)	Concurrence by JICA is required	x			x		x
	(9) Detail design (D/D)	—	x			x		
	(10) Preparation of bidding documents	Concurrence by JICA is required	x			x		
	(11) Bidding	Concurrence by JICA is required	x		—	x	x	
	(12) Contracting with contractor/supplier and issuance of A/P	Concurrence by JICA is required	x				x	x
	(13) Construction works/procurement	Concurrence by JICA is required for major modification of design and amendment of contracts.	x			x	x	
	(14) Completion certificate	—	x			x	x	
4. Ex-post monitoring & evaluation	(15) Ex-post monitoring	To be implemented generally after 1, 3, 10 years of completion, subject to change	x		x			
	(16) Ex-post evaluation	To be implemented basically after 3 years of completion	x		x			

notes:

1. Project Monitoring Report and Report for Project Completion shall be submitted to JICA as agreed in the G/A.
2. Concurrence by JICA is required for allocation of grant for remaining amount and/or contingencies as agreed in the G/A.

Annex-3 Attachment 2

Financial Flow of Grant Aid



Annex-4

Project Implementation Schedule

Month	1	2	3	4	5	6	7	8
Detailed Design & Tendering Procedures								Total: 8.0 months
Detailed Design								
Tendering Procedures								

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Multan Meteorological Radar Observation Station																															
Construction Work																					Total: 23.6 months										
Preparation Work/Boundary Wall/Soil Filling																															
Temporary/Filling/Earth Works																															
Structure Work																															
Finishing Work																															
Building Equipment																															
Equipment Work																					Total: 17.3 months										
Equipment Manufacturing																															
Equipment Transportation																															
Equipment Installation/Adjustment																															
PMD Islamabad Head Office National Weather Forecasting Center																															
Equipment Work																								Total: 13.3 months							
Equipment Manufacturing																															
Equipment Transportation																															
Equipment Installation/Adjustment																															
Meteorological Office in Multan International Airport																															
Equipment Work																								Total: 13.3 months							
Equipment Manufacturing																															
Equipment Transportation																															
Equipment Installation/Adjustment																															
PMD Flood Forecasting Division (FFD), Lahore																															
Equipment Work																								Total: 13.3 months							
Equipment Manufacturing																															
Equipment Transportation																															
Equipment Installation/Adjustment																															
Soft Component																															
Soft Component (Activity No. 1)																															
Soft Component (Activity No. 2)																															
Soft Component (Activity No. 3)																															

Annex 5

Major Undertakings to be taken by Recipient Government

1) Before the Tender

NO	Items	Deadline	In charge	Cost (PKR)	Ref.
1	To open Bank Account (Banking Arrangement (B/A))	within 3 months after G/A	PMD	-	
2	To secure sufficient spaces at the proposed Project site in Multan for temporary facilities such as a consultant's site office, contractor's office, workshop, building materials storage, etc. needed for the construction work.	before notice of of the Tender	PMD	-	
3	To obtain all prior regulatory compliance and necessary permissions (Building Construction Permit, Building Height Clearance) from the relevant agencies/authorities for the construction of the Radar Tower Building in the proposed project site in Multan.	before completion of PC-I	PMD	-	
4	To relocate the existing high voltage power cable in the proposed Project Site in Multan.	before notice of the Tender	PMD	1,000,000	

2) During the Project

NO	Items	Deadline	In charge	Cost (PKR)	Ref.
1	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.	every payment	PMD	7,000,000	
2	To obtain the required frequencies for the Multan meteorological radar system, Polarimetric Test Horn Devices, and Meteorological Data Communication System (between Multan Meteorological Radar Observation Station and Meteorological Office in Multan International Airport).	before manufacturing of the equipment	PMD	1,500,000	
3	To shoulder the miscellaneous expenditures such as library books, petrol, telephone, application fee, etc.	before notice of the Tender	PMD	0	
4	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 the customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project as well as sending back of any defective equipment and/or spare parts to the manufacturer for repair at the factory or replacement and re-importation thereof into Pakistan during the implementation and warranty periods of the Project.	during the Project	EAD PMD	-	
	1) Marine (air) transportation of the Products from Japan to Pakistan	during the Project	Contractor	-	
	2) Internal transportation from the port of disembarkation to the project sites	during the Project	Contractor	-	
5	1) To take full responsibility, arrange the maximum countermeasures and ensure the appropriate 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 implementation of the Project. 2) To arrange security around the proposed Project Site with the police. 3) To arrange security around the accommodation(s) of the Consultants & the Contractor with the police. 4) To arrange escort guard with the police during movements between the accommodation(s) of the Consultants & the Contractor and the proposed Project Site.	during the Project	PMD	-	

6	To provide necessary working spaces with Internet Connection at the PMD Islamabad Head Office and the PMD Multan Meteorological Office at the International Airport for the Consultant and the Contractor during the implementation of the Project.	during the Project	PMD	-	
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).	during the Project	PMD	-	
8	To exempt goods of Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed by the Government of Pakistan with respect to their supply (products) and services under the signed contracts	during the Project	PMD	-	
9	1) To bear all the expenses, other than those to be borne by the Japanese Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment	during the Project	PMD	-	
	2) To undertake incidental outdoor works such as gardening/landscaping and exterior lighting in and around the proposed Project Site in Multan.	during the Project	PMD	1,000,000	
10	1) To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: no less than 150kVA) along with electric poles/wires, etc. from the main supply line to the proposed project site in Multan for the Radar Tower Building and other facilities to be constructed by the PMD for establishing an observatory. 2) To install the required step-down transformer as well as service entrance connections for the commercial power supply at the proposed project site in Multan for the Radar Tower Building (400V, 3-phase, 4-wire, 50Hz).	Before commencement of the radar tower building construction	PMD	2,500,000 4,000,000	
11	To provide facilities for distribution of electricity, water supply, drainage and other incidental facilities necessary for the implementation of the Project outside the site(s)				
	1) Electricity	before completion of the radar tower building construction			
	The Distribution line to the site		PMD	Indicated in above 8, 2)	
	2) Furniture and equipment General Furniture		PMD	-	
12	To promptly provide reliable and high-speed Internet environment at the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Multan Meteorological Office (Forecasting Room) located in the Multan International Airport and the PMD Flood Forecasting Division (FFD), Lahore (with each corresponding global/fix IP) for establishment of a Virtual Private Network (IP-VPN).	during the Project	PMD	1,000,000	
13	To set up the required and new assigned IP addresses in the computing equipment supplied under the Project and facilitate any required configuration i.e. firewall settings, etc. of the existing PMD equipment which may be made part of the Project Network Communication System, if any.	during the Project	PMD	-	
14	To install 1 additional air-conditioning system at the PMD Multan Meteorological Office (Forecasting Room).	during the Project	PMD	300,000	
15	To assign appropriate number of trainees and shoulder their dispatching cost to the training sites, such as daily allowance, transportation fee, accommodation, if any.	during the Project	PMD	1,000,000	
16	To submit the Project Monitoring Report (PMR) as per Annex 6.	every month during the Project	PMD	-	

3) After the Project

NO	Items	Deadline	In charge	Cost (PKR)	Ref.
1.	To maintain and use properly and effectively the facilities constructed and equipment provided under the Japanese Grant	after completion of the Project	PMD	7,250,000	
	1) Allocation of maintenance cost				
	2) Operation and maintenance structure				
	3) Routine check/Periodic inspection				
	4) Other contingency expenditures if necessary				
2	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 the customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project as well as sending back of any defective equipment and/or spare parts to the manufacturer for repair at the factory or replacement and re-importation thereof into Pakistan during the implementation and warranty periods of the Project.	after completion of the Project	EAD PMD		
3	To assign the required staff including a responsible personnel of the PMD who has reliable technical skill and ample experience for the smooth operation and maintenance of the Equipment.	after completion of the Project	PMD	8,000,000	
4	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment, and enter into a Preventive Maintenance Service Agreement with the equipment supplier if so desired.	after completion of the warranty period	PMD	2,500,000	
5	To procure the appropriate number and capacity of disk media, hard disks, solid state disks, etc., and dutifully conduct the required schedule archiving of radar observation raw data and products.	after completion of the Project	PMD	300,000	
6	To periodically update all the operation/antivirus/application software(s).	after completion of the Project	PMD	Included in above 1	

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable)

(Note) Progress of the specific obligations of the Recipient may be confirmed and updated from time to time with written agreement between JICA and the Recipient in the form other than the amendment of the G/A.

Annex-6

Project Monitoring Report
on

Grant Agreement No. XXXXXXX
20XX, Month

Organization Information

Authority (Signer of the G/A)	Person in Charge Contacts Address: Phone/FAX: Email:
Executing Agency	Person in Charge Contacts Address: Phone/FAX: Email:
Line Agency	Person in Charge Contacts Address: Phone/FAX: Email:

Outline of Grant Agreement:

Source of Finance	Government of Japan: Not exceeding JPY . Government of Pakistan:
Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:

1: Project Description

1-1 Project Objective

1-2 Necessity and Priority of the Project

- Consistency with development policy, sector plan, national/regional development plans and demand of target group and the recipient country.

1-3 Effectiveness and the indicators

- Effectiveness by the project

Quantitative Effect (Operation and Effect indicators)		
Indicators	Original (Yr 2017)	Target (Yr 2021)
Qualitative Effect		

2: Project Implementation

2-1 Project Scope

Table 2-1-1a: Comparison of Original and Actual Location

	Original: *(M/D)*	Actual: *(PMR)*
Location	Attachment(s):Map	Attachment(s):Map

Table 2-1-1b: Comparison of Original and Actual Scope

Items	Original	Actual

2-1-2 Reason(s) for the modification if there have been any.

2-2 Implementation Schedule

2-2-1 Implementation Schedule

Table 2-2-1: Comparison of Original and Actual Schedule

Items	Original		Actual
	DOD	G/A	
Cabinet Approval		-	-
E/N			
G/A			
Approval of consultant contract			
Early Mobilization of consultant			
Detailed Design			
Budget Request for FY2016			
Tender Process of contractor and supplier			
Approval of contractor and supplier contract			
Budget Appropriation and Issuance of A/P			
Construction Period			
Shipment			
Custom Clearance			
Installation and acceptance Check			
Soft component			
Project Completion Date			
Defect Liability Period			

*Project Completion was defined as Completion of Soft component at the time of G/A.

2-2-2 Reasons for any changes of the schedule, and their effects on the project.

2-3 **Undertakings by each Government**

2-3-1 **Major Undertakings**

See Attachment 2.

2-3-2 **Activities**

See Attachment 3.

2-3-3 Report on RD

See Attachment 4.

2-4 Project Cost

2-4-1 Project Cost

Table 2-4-1a Comparison of Original and Actual Cost by the Government of Japan
(Confidential until the Tender)

Items			Cost (Million Yen)	
	Original	Actual	Original	Actual
Construction of Facilities				
Equipment				
Soft Component				
Consulting Services				
Contingency				
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =**Yen

Table 2-4-1b Comparison of Original and Actual Cost by the Government of **

Items			Cost (Thousand MMK)	
	Original	Actual	Original	Actual
				Please state not only the most updated schedule

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =(local currency)

2-4-2 Reason(s) for the wide gap between the original and actual, if there have been any, the remedies you have taken, and their results.

2-5 Organizations for Implementation

2-5-1 Executing Agency:

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original: *(M/D)*
Actual, if changed: *(PMR)*

2-6 Environmental and Social Impacts

- The environmental monitoring is not required in the Project as this project was categorized as category C in accordance with the GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS of JICA as of April 2010.

3: Operation and Maintenance (O&M)

3-1 O&M and Management

- Organization chart of O&M
- Operational and maintenance system (structure and the number ,qualification and skill of staff or other conditions necessary to maintain the outputs and benefits of the project soundly, such as manuals, facilities and equipment for maintenance, and spare part stocks etc)

Original: *(M/D)*
Actual: (*PMR)*

3-2 O&M Cost and Budget

- The actual annual O&M cost for the duration of the project up to today, as well as the annual O&M budget.

Original: *(M/D)*

Actual: *(PMR)*

4: Precautions (Risk Management)

- Risks and issues, if any, which may affect the project implementation, outcome, sustainability and planned countermeasures to be adapted are below.

Original Issues and Countermeasure(s): *(M/D)*	
Potential Project Risks	Assessment
1. Delay of budget appropriation	Probability: H/M/L
	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
2.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
3.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
Actual issues and Countermeasure(s)	
(PMR)	

5: Evaluation at Project Completion and Monitoring Plan

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan for the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Undertakings to be taken by each Government
3. Monthly Report
4. Report on RD
5. Yearly disbursement plan
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)

(Final Report Only)

Appendix 5. Soft Component Plan

Soft Component Plan

<Background of the Soft Component Plan>

Pakistan is one of the most disaster-prone countries in the world due to its topographic feature with mountains as high as 8,000 meters and the Indus River running through the country longitudinally. Once heavy rain falls, floods, flash floods and landslides occur everywhere.

In recent years, large-scale flooding has occurred consecutively in 2010, 2011, 2012, the recent most devastating catastrophes that occurred in the country was the Indus River Flood in 2010 (killed or missing: over 2,000; affected people: over 20 million; total damage: approx. US$9,500 million) and the flood which occurred mainly in Sindh province in 2011 (killed or missing: over 500; affected people: over 5 million). The Indus River Flood in 2010 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. 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.

Most of the rain clouds that bring about torrential rain in the monsoon season invade Pakistan from India, about 80% of which rise northward, bringing heavy rains to the north causing floods. 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. In addition to this, rainwater from heavy rainfall due to thunderstorm accompanied by cumulonimbus in the heavy rain area around the Sulaiman Range flows into the rivers further increasing the scale of floods in the central and southern areas of Pakistan.

Currently, the Pakistan Meteorological Department (PMD) is unable to accurately observe the rain clouds that cause concentrated torrential rain in the wide area of Punjab Province and the thunderstorm accompanied by cumulonimbus and heavy rain around the Sulaiman Range during the Monsoon season invading Pakistan from India. As a result, it is actually difficult for the PMD to appropriately reflect heavy rain information in its flood forecasting and warnings. Since Multan is located in the best position to observe the approach of the rain cloud of severe weather caused by Monsoon, thunderstorm accompanied by cumulonimbus and the heavy rain around the Sulaiman Range, the PMD will be capable to provide highly accurate meteorological observations on the wide area of the Punjab Province and from India side and to ensure the stable and sustained supply of weather and flood forecast/warnings to the general public

through the establishment of a new meteorological radar system in Multan. Therefore, it will enable the PMD to greatly contribute to the mitigation of damage caused by natural disasters in Pakistan.

Given the circumstances indicated above, the key objective of the Project is the effective mitigation of the devastation generated by disasters caused by hazardous meteorological phenomena such as heavy rain, through the improvement of the weather & flood information and forecasts & warnings released by the PMD by means of strengthening their monitoring capability of hazardous weather phenomena through the provision of technical support and the establishment of an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Doppler Meteorological Radar System in Multan in the Punjab Province, Meteorological Radar Central Processing System, Meteorological Radar Data Display Systems and Meteorological Data Communication Systems under the Project.

Majority of the PMD's technical staff is proficient in the use of computers and computerized meteorological observation equipment. Unfortunately, no engineer or technical officer of the PMD has practical experience to operate an S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Doppler Meteorological Radar System planned to be procured under the Project since the system utilizes the latest technology of the world at present and is going to be established for the first time in Pakistan. For the smooth operation and maintenance of the digital S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar Systems and for the assurance of the required sustainability of the project outcomes, the implementation of technology transfers in the soft component mentioned below (with the Implementation Schedule attached hereunder) is required.

Although the replacement of the existing C-band ordinary meteorological radar systems of Islamabad and Karachi is being implemented under Japan's Grant Aid, the Meteorological Radar System in Multan is different from the new meteorological radar systems (S-Band Pulse Compression Solid State Meteorological Doppler Radar Systems) of Islamabad and Karachi. This is also the first time to establish such systems in Pakistan. Given these circumstances, the Soft Component contents to be implemented in this Project do not overlap with the contents scheduled to be implemented in Islamabad and Karachi. In addition, the required PMD technical personnel is exclusively assigned to each meteorological radar observation station, therefore, there is also no overlap among the target personnel for the technology transfer in the Soft component.

<Soft Component Target>

The target of the Soft Component is to enable the PMD to independently and appropriately operate the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System.

<Soft Component Indicators>

Soft Component Indicators are as follows.

Table 1: Soft Component Indicators

No.	Item	Output	Objectively Verifiable Indicators	Means of Verification
1	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery and Major Fault Countermeasures	Acquisition of technical know-how on appropriate inspection, adjustment, minor fault finding, remedy and recovery.	Inspection, adjustment, minor fault finding, remedy and recovery, and major fault countermeasures (a. routine maintenance using measuring instruments and tools, b. practice of replacing spare parts into the actual system and the subsequent confirmation of system operation, c. practice of remedy, recovery and major fault countermeasures: distributing information to the Consultant and the manufacturer and receiving technical advice) are carried out appropriately by the 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. · Visual check and technical interviews
2	Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing the Meteorological Radar System Summary & Maintenance Manual and the Meteorological Radar System Maintenance & Management Record Book including acquisition procedures and data table reading of Observation Raw Data	Technical knowledge on the acquisition of prompt and appropriate S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System operation and maintenance	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System operation and maintenance utilizing the meteorological radar system summary & maintenance manual and the meteorological radar system maintenance & management record book are implemented promptly and appropriately. Acquisition procedures and data table reading of raw observation data.	· Evaluation of the frequency of usage of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual. · Confirmation of entries (daily, weekly, monthly) in the meteorological radar system maintenance & management record book and thorough technical interviews
3	Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode Sequence & Schedule	Appropriate meteorological radar operation.	Meteorological radar observation is implemented according to the radar observation sequence & schedule for Intensity Mode and Doppler Mode.	Confirmation of meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecast operation.

<Means of Verification for the Achievement of Outputs >

The means of verification for the achievement of outputs of the Soft Component are also indicated in the Table attached above.

<Scheduled Activities of the Soft Component>

Scheduled Activities of the Soft Component are as follows.

Table 2: Scheduled Activities of Soft Component

Output	Required Technique and Field	Current Technique Level and Required Technique Level	Target Group	Means of Implementation	Source of Implementation	Product
1. S-Band Pulse Compression	An engineer capable of meteorological	Since engineers in the PMD have practical experience of adjusting	Indicated in the table below	Routine maintenance using measuring instruments and tools.	Expert Consultant on meteorological radar adjustment	Manual on routine maintenance using measuring

Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery, and Major Fault Countermeasures	radar adjustment and minor fault finding.	and fault finding in an analog meteorological radar system, it is imperative that the PMD engineers should also acquire the capability of adjusting and fault finding in a digital meteorological radar system.		Practice of replacing spare parts into the actual system and the subsequent confirmation of system operation. Practice of countermeasure, minor fault finding, remedy and recovery. Practice of major fault countermeasures. Production of operation and maintenance manual.	and fault finding: 1.07 man-months. (Period of Technology Transfer in Pakistan: 32days) Direct Support	instruments and tools. Manual on replacing spare parts into the actual system and the subsequent confirmation of system operation. Manual on fault finding, remedy and recovery. Manual on major fault countermeasures.
2. Preparation of S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual and Meteorological Radar System Maintenance & Management Record Book including acquisition procedures and data table reading of Observation Raw Data	An engineer capable of meteorological radar operation and maintenance.	Since engineers in the PMD have practical experience of operating and maintaining an analog meteorological radar system, it is imperative that the PMD engineers should also obtain the capability of operating and maintaining a digital meteorological radar system according to the manual summary and the meteorological radar system maintenance & management record book including acquisition procedures and data table reading of Observation Raw Data	Indicated in the table below	Discussion with the PMD engineers. Selection of the most important points from the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual. Production of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual. Production of the meteorological radar system maintenance & management record book. Utilization of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual and the maintenance & management record book by the PMD engineers. Acquisition procedures and data table reading of raw observation data.	Expert Consultant on meteorological radar operation and maintenance: 1.17 man-months (Period of Technology Transfer in Pakistan: 35days) Direct Support	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual Meteorological radar system maintenance & management record book • Date and time of occurrence of system failure/trouble • Cause/s of system failure/trouble (abnormal noise, part degradation, etc.) • Repair procedures implemented • Name and quantity of replaced parts • Name of engineer/s who perform/s the repair /troubleshooting • Acquisition procedures and data table reading of Observation Raw Data
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	Since engineers in the PMD have no practical experience in the use of CAPPI (Constant Altitude PPI (Plan Position Indicator)) observation due to the absence of a CAPPI function in the existing analog	Indicated in the table below	Discussion with the PMD engineers and lecture. Identification of Clutter of meteorological radar system and Blind Area at antenna elevation angle. Preparation of Blind Area at antenna elevation angle.	Expert Consultant on meteorological radar observation: 1.17 man-months (Period of Technology Transfer in Pakistan: 35days) Direct Support	Sequence & Schedule for Intensity Mode and Doppler Mode

	radar observation which is suited to the weather phenomena in Pakistan	meteorological radar system, it is imperative that the PMD engineers should obtain the capability of preparation of sequences & schedules for meteorological radar observation.		Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode. Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.		

Table 3: Target Personnel in the PMD for the Technology Transfer in the Soft Component

Technology Transfer of No. 1, 2 & 3				Technology Transfer of No. 3	
Islamabad	Number	Multan	Number	Islamabad	Number
Senior Electronic Engineer	1	Senior Electronic Engineer	0	Meteorologist in the National Weather Forecasting Center	15
Electronic Engineer	1	Electronic Engineer	2		
Assistant Electronic Engineer	1	Assistant Electronic Engineer	1	Multan	Number
Sub Engineer	4	Sub Engineer	2	Meteorologist including Meteorological Assistant	6
Mechanic Grade	6	Mechanic Grade	0		

Details of each activity schedule are as follows.

Table 4: No. 1, No. 2 and No. 3 Activities Details of the Schedule of the Soft Component

	Activity No. 1	Activity No. 2	Activity No. 3
Date	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery, and Major Fault Countermeasure	S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual and Meteorological Radar System Maintenance & Management Record Book	Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode
1	Departure from Japan Arrival in Islamabad	Departure from Japan Arrival in Islamabad	Departure from Japan Arrival in Islamabad
2	Technical Discussion with the PMD personnel in Islamabad. Islamabad→Multan	Technical Discussion with the PMD personnel in Islamabad Islamabad→Multan	Technical Discussion with the PMD personnel in Islamabad Islamabad→Multan
3	Preparatory Work at Multan Meteorological Radar Tower Building Technical Discussion with the PMD engineers in Multan Practice of routine maintenance using measuring instruments and tools.	Preparatory Work at Multan Meteorological Radar Tower Building Technical Discussion with the PMD engineers in Multan	Technical Discussion with the PMD meteorological and engineering personnel in Multan and basic radar meteorology & summary of data quality control
4	Practice of routine maintenance using measuring instruments and tools.	Selection of the most important points from S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual.	Identification of Clutter of meteorological radar system and Blind Area at each antenna elevation angle.
5	Production of operation and maintenance manual.		
6	Sat. (Holiday)	Sat. (Holiday)	Sat. (Holiday)
7	Sun. (Holiday)	Sun. (Holiday)	Sun. (Holiday)
8	Production of operation and maintenance manual.	Production of S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual (Draft). Production of meteorological radar	Preparation of Blind Area at each antenna elevation angle.
9	Practice of replacement of spare parts to actual system and confirmation of system operation.		
10	Production of operation and maintenance		Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode (Draft).

11	manual.	system maintenance & management record book (Draft).	Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.
12			
13	Sat. (Holiday)	Sat. (Holiday)	Sat. (Holiday)
14	Sun. (Holiday)	Sun. (Holiday)	Sun. (Holiday)
15	Production of operation and maintenance manual.	Production of S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual (Draft).	Review of Sequence & Schedule for Intensity Mode and Doppler Mode (Draft).
16	Practice of minor fault finding, remedy and recovery. Production of operation and maintenance manual.		Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.
17		Utilization of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual (Draft) and the meteorological radar system maintenance & management record book (Draft) by the PMD engineers.	
18			
19			
20	Sat. (Holiday)	Sat. (Holiday)	Sat. (Holiday)
22	Sun. (Holiday)	Sun. (Holiday)	Sun. (Holiday)
22	Production of operation and maintenance manual.	Review of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual (Draft) and the Meteorological radar system maintenance & management record book (Draft).	Completion of Radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.
23	Practice of major fault countermeasure Review of training by the PMD. Production of operation and maintenance manual.		
24		Utilization of the S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System manual and the meteorological radar system maintenance & management record book by the PMD engineers.	Production of Soft Component Completion Report.
25			
26			Technical discussion with the PMD.
27	Multan→Islamabad Sat. (Holiday)	Multan→Islamabad Sat. (Holiday)	Departure from Islamabad and arrival in Japan
28	Sun. (Holiday)	Sun. (Holiday)	Sun. (Holiday)
29	Production of Soft Component Completion Report.	Preparation of acquisition procedures and data table reading paper of Observation Raw Data Review and utilization of acquisition procedures and data table reading paper of Observation Raw Data	Technical Discussion with the PMD meteorological and engineering personnel in Islamabad and basic radar meteorology & summary of data quality control
30			Explanation on identified Clutter of meteorological radar system and Blind Area at each antenna elevation angle. Explanation of the finalized Sequence & Schedule for Intensity Mode and Doppler Mode. Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode (remote control from Islamabad)
31	Technical Discussion with the PMD personnel in Islamabad. Departure from Islamabad		
32	Arrival in Japan		
33		Production of Soft Component Completion Report. Technical Discussion with the PMD personnel in Islamabad.	Production of Soft Component Completion Report. Technical Discussion with the PMD personnel in Islamabad.
34		Production of Soft Component Completion Report. Departure from Islamabad Sat. (Holiday)	Production of Soft Component Completion Report. Departure from Islamabad Sat. (Holiday)
35		Arrival in Japan Sun. (Holiday)	Arrival in Japan Sun. (Holiday)

<Procurement Method for Soft Component Implementation Resources>

Implementation Resources are procured based on the direct support of the Japanese consultants who are in

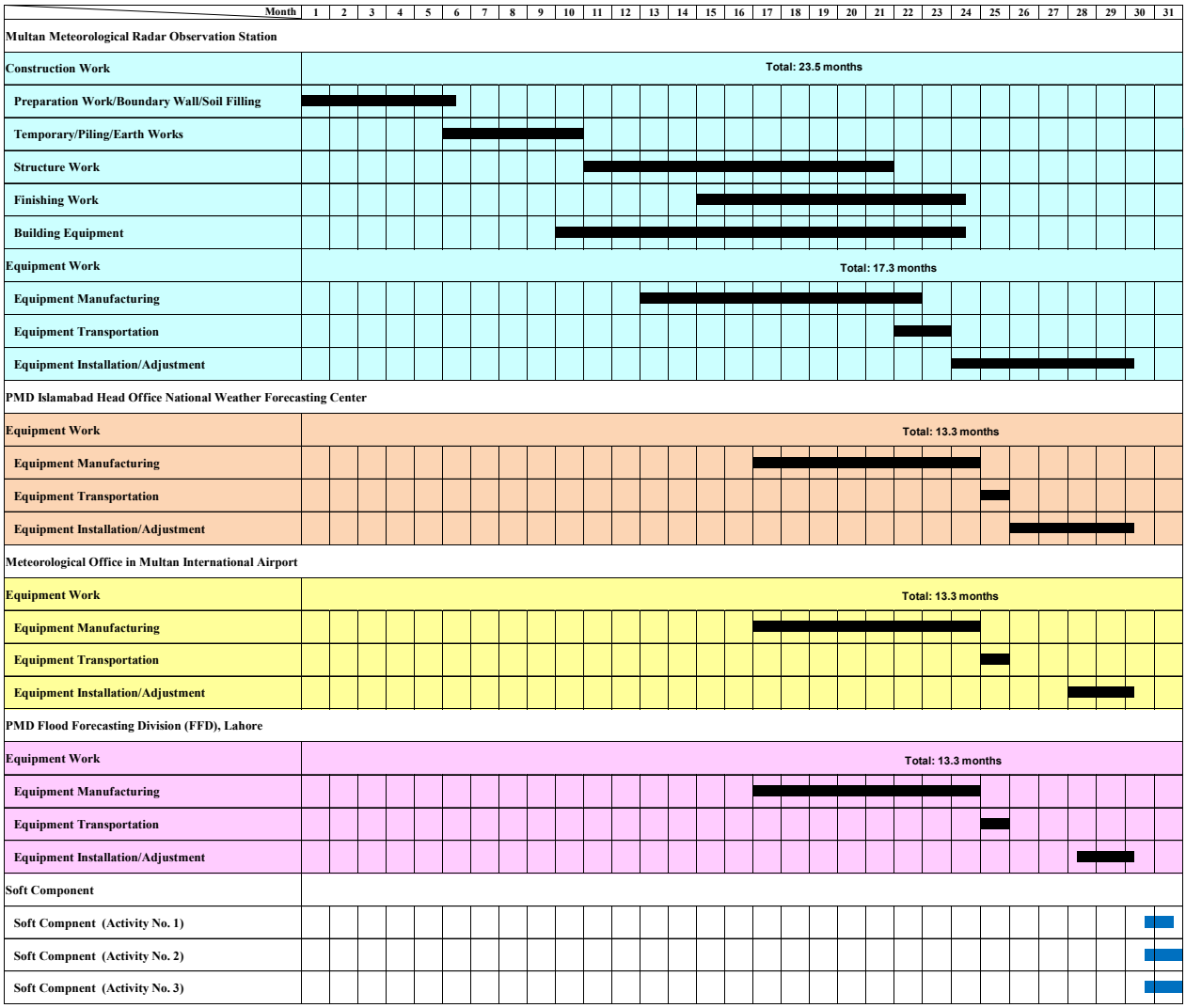
charge of equipment procurement for the Project. The rationales for which are presented below.

- Personnel with advanced technique and knowledge of weather services and meteorological radar system is necessary.
- Personnel as indicated above usually belongs to weather organizations which actually conduct weather services.
- Personnel who has similar experience to the proposed technology transfer is required.

<Implementation Schedule>

The implementation schedule of the whole Project and soft component is indicated in the following table. The soft component is planned to be implemented during the adjustment stage after the installation of the meteorological radar system and before the completion of the Project.

Table 5: Implementation Schedule



<Soft Component Product>

Soft Component Products are as follows.

Table 6: Soft Component Products in Technology Transfer

Product Name		Submission Time	No. of Pages
Procedures paper on 1) routine maintenance using measuring instruments and tools; 2) practice of replacing spare parts into the actual system and the subsequent confirmation of system operation; 3) practice of minor fault finding, remedy and recovery; and, 4) major fault countermeasure for S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System.		After Technology Transfer	20
C-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System Summary & Maintenance Manual			30
S-Band Pulse Compression Solid State Dual Polarization (Polarimetric) Meteorological Doppler Radar System maintenance and management record book			10
Radar observation sequence & schedule for Intensity Mode and Doppler Mode			15
Output Name	Content	Submission Time	No. of Pages
Soft Component Completion Report	• Scheduled Activities and Actual Achievement • Scheduled Outputs and Achievement • Factors which influence Achievement of Outputs • Recommendation • Outputs	Completion of Soft Component	50

<Obligations of the Recipient Country>

Obligations of the PMD for the implementation of Soft Component are as follows.

1) Manpower Development
   a) Continuous recruitment of human resources for the next generation.
   b) Development of more qualified technical personnel through training and other related manpower development programs.
2) Longer Life Span of the Equipment procured under the Project
   a) Regularly secure the necessary budget for the efficient operation and maintenance of the systems and the procurement of requisite spare parts and consumables for all the equipment to be supplied under the Project.
   b) Ensure protection of the equipment against theft and vandalism.

The PMD will be able to implement the above obligations through its organizational and personnel capabilities. Most especially, the “continuous recruitment of human resources for the next generation” is of vital concern. It is imperative for the PMD to become self-reliant in technical areas such as the operation and maintenance of radar systems. Hence, it is essential that it puts forth continued efforts to recruit and fill vacancies, thereby, promoting technology transfer across all staff levels from the assistant personnel to the engineer(s).

Appendix 6. References

No	Name of References	Original/Copy/ Digital File	Publisher	Data of Publication
1	Annual Flood Report 2010	Digital File	Government of Pakistan Ministry of Water and Power	2011
2	Annual Flood Report 2011	Digital File	Government of Pakistan Ministry of Water and Power	2012
3	Annual Flood Report 2012	Digital File	Government of Pakistan Ministry of Water and Power	2013
4	Annual Flood Report 2013	Digital File	Government of Pakistan Ministry of Water and Power	2014
5	Annual Flood Report 2014	Digital File	Government of Pakistan Ministry of Water and Power	2015
6	Annual Flood Report 2015	Digital File	Government of Pakistan Ministry of Water and Power	2016
7	Annual Flood Report 2016	Digital File	Government of Pakistan Ministry of Water and Power	2017