Pakistan Meteorological Department
The Islamic Republic of Pakistan

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

February 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN WEATHER ASSOCIATION
INTERNATIONAL METEOROLOGICAL CONSULTANT INC.

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PREFACE

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

The survey team held a series of discussions with the officials concerned of the Government of the Islamic Republic of Pakistan, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the survey team.

February, 2015

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

Summary

Summary

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. The southern area also suffers from damages caused by a tropical cyclone which attacks the country once in a few years. These meteorological disasters lead to the loss of human lives and properties, thereby, contributing to the significant set-back of socio-economic activities. The Indus River Flood in 2010 (Killed or Missing: 1,985; Affected people: over 20 million) and the Sindh Flood in 2011 (Killed or Missing: over 500; Affected people: approx. 5 million) were the most extraordinary catastrophes in recent years. Significantly, the damages in the southern area worsened and prolonged as the agricultural & livestock industries were devastated during the flood in 2011 when the people were in the middle of recovering from the Indus River Flood in 2010.

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.

At present, in Pakistan, there are four meteorological radar systems (Islamabad, Karachi, Dera Ismail Khan and Rahimyar Khan) established under the grant aid of Japan. These networked meteorological radar systems make it possible to observe the precipitation of about 80% areas of the whole country where more than 90% of the overall population live. Among them, the existing Karachi meteorological radar system established in 1991 has played an important role in monitoring meteorological phenomena in the southern area or tropical cyclones which are generated in the Arabian Sea and the Bay of Bengal. However, its function deteriorates day by day and could completely stop in a few years despite the appropriate maintenance done by the radar engineers of the Pakistan Meteorological Department (hereinafter referred to as the "PMD"). In addition, since many parts transit from analog to digital and the supply of spare parts and consumables from the manufacturer has become limited, it would be extremely difficult to restore the radar system once a serious failure occurs. Thus, it is strongly required, as a permanent measure, to replace the existing Karachi meteorological radar system. Due to a lack of financial and technical capabilities, the Government of Pakistan, in 2012, has requested the Government of Japan to

procure and install the required equipment as well as to provide the relevant systems and facilities under Japan's Grant Aid Assistance scheme.

In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Installation of a Weather Surveillance Radar at Karachi (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 January 18 to February 14, 2014. 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, 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.

In particular, in order to assess the viability of the re-utilization of the existing Karachi Meteorological Radar Tower Building for the Project (renovation/re-construction), a comprehensive structural evaluation for re-utilization of the existing Karachi Meteorological Radar Tower Building such as the confirmation of the current state of the main structures, structural calculation, schmidt hammer test for concrete compressive strength (concrete deterioration diagnosis) and analysis of horizontal distortion angle due to wind pressure were conducted. As a result of the comprehensive structural evaluation, it was confirmed that the re-utilization of the existing Meteorological Radar Tower Building for the Project is quite dangerous and is not a viable option.

JICA sent the Preparatory Survey Team again to Pakistan from May 24 to June 12, 2014 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	PMD Islamabad Head Office National Weather Forecasting Center	PMD Karachi	Meteorological Office Karachi International Airport	Meteorological Office New Benazir Bhutto International Airport Islamabad	PMD Flood Forecasting Division (FFD), Lahore
Procurement and Installation of Equipment					
S-Band Doppler Pulse Compression Solid State Radar System including	-	1	-	-	-

Power Back-up System, Lightning System Measuring Equipment and Spare Parts					
Meteorological Radar Data Display System	1	2 (PMD Karachi Radar Tower Building & Tropical Cyclone Warning Center)	1 (To display Islamabad and Karachi radar products)	1 (To display Karachi radar products)	1
Construction of Radar Tower Building					
Radar Tower Building	-	1	-	-	-
Technical Training	Initial operation guidance including the contract of manufacturer				
Soft Component	Initial guidance for operation and maintenance of the equipment and machineries				

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. Global climate change has a potential to increase the frequency and scale of these natural disasters in the medium-to-long-term run and creates risks of adverse impacts on Pakistan, one of the natural disaster-prone countries. Thus, the establishment of a disaster management system including an early warning system is an urgent task in Pakistan. Therefore, as a permanent measure, the purpose of the project is to improve the PMD's capabilities in meteorological observation, weather forecasting and dissemination of forecasts/warnings through the replacement of the existing Karachi C-band ordinary meteorological radar system to state-of-the-art S-band Doppler pulse compression solid state radar system.

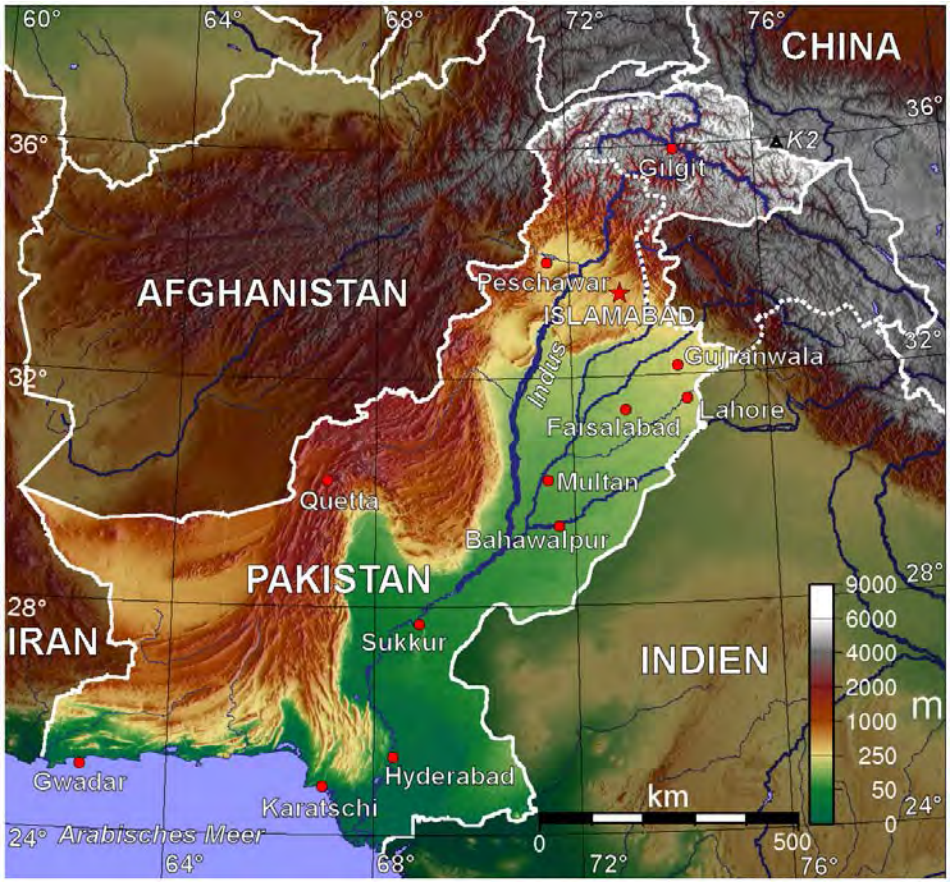
As adequately pointed out in the careful and comprehensive evaluation of the effects of the Project, considerable and enhanced benefits can be achieved vis-à-vis the improvement of the PMD's capabilities in reducing human loss and the recurrent economic set-back brought about by meteorological disasters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

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

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

Contents

■ Islamic Republic of Pakistan



Karachi Meteorological Radar Tower Building

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ABBREVIATIONS

AWS : Automatic Weather Observation System
EAD : Economic Affairs Division
FAB : Frequency Allocation Board
GMDSS : Global Maritime Distress and Safety System
INMARSAT : International Maritime Satellite
ITCZ : Inter Tropical Convergence Zone
JICA : Japan International Cooperation Agency
NDMA : National Disaster Management Authority
NWFC : National Weather Forecasting Center
PMD : Pakistan Meteorological Department
TCWC : Tropical Cyclone Warning Center
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 disaster-prone country which is largely affected by natural disasters such as floods, landslides, cyclones, droughts, earthquake and etc. Floods, in particular, occur most frequently and sometimes affect most of the country since the Indus River runs through the country longitudinally. Recently, the frequency of floods has increased and, in fact, massive floods have happened in three consecutive years: 2010, 2011 and 2012. Especially, the Indus River Flood in 2010 was the most devastating catastrophe in Pakistani history which caused unimaginable damages to almost the entire nation (killed or missing: 1,985, affected people: over 20 million, total estimated damage: 9.5 billion US dollars). The southern area is also damaged by rain storm or storm surge caused by tropical cyclones which approach/land on the coast of Pakistan facing the Arabian Sea once in every two or three years. These natural disasters have led to the loss of human lives and properties and the stagnation of socio-economic activities in Pakistan.

Pakistan receives most of 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. 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. On the other hand, the tropical cyclone season in Pakistan is during May to June and October to November as tropical cyclones are generated in the ITCZ located at low latitudes. In order to mitigate natural disasters, it is necessary to detect these meteorological phenomena through an effective meteorological radar system and improve the accuracy of forecasts issued by the PMD.

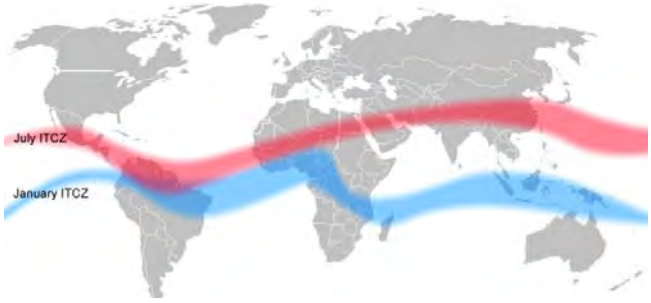


Figure1: Seasonal Position of Inter Tropical Convergence Zone (ITCZ)

The existing Karachi meteorological radar system has played a pivotal role in the early detection of and preparation for meteorological disasters happening in the southern area of Pakistan like tropical cyclones. If it became inoperative, there would be no means to monitor disaster-causing meteorological phenomena. There is, however, a high possibility that it could stop operation completely in a few years since it is in a critical condition wherein its function deteriorates because of aging. Therefore, the replacement of the existing Karachi meteorological radar system under the Project is an urgent task.

1-2 Meteorological disasters in Southern Pakistan

The main meteorological disasters in the southern area of Pakistan are "monsoon floods" and "tropical cyclones." "Monsoon floods" can be divided into two patterns: (A) floods occurring when heavy rain falling in the northern area flows into the Indus River and (B) floods caused by heavy rain directly falling in the southern area. The figure on the right shows the death toll in each state due to the floods which occurred in 2010, 2011 and 2012. Since the flood in 2010 followed Pattern (A) as indicated above, the damages were spread across the country. However, both floods in 2011 and 2012 followed Pattern (B) and the damages were mostly focused in the Sindh and Balochistan states in the southern area of Pakistan. Monsoon depressions approaching and crossing India from the Bay of Bengal indicated in the following figure brought heavy rains which caused the floods in 2011 and 2012. In general, monsoon depressions initially gain strength, which would have weaken during its journey through India, but it ended up regaining back its strength due to the abundant supply of moist south wind from the Arabian Sea.

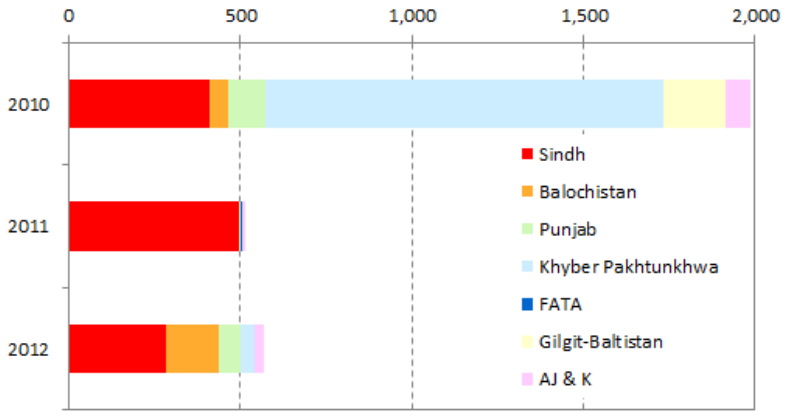


Figure2: Number of Death of Each State due to Floods (2010, 2011, 2012)

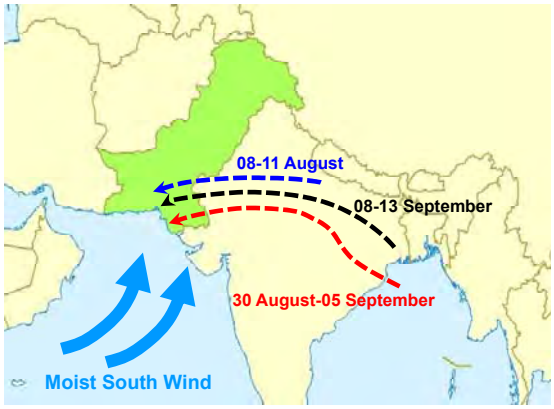


Figure3: Tracks of Monsoon Depressions in 2011

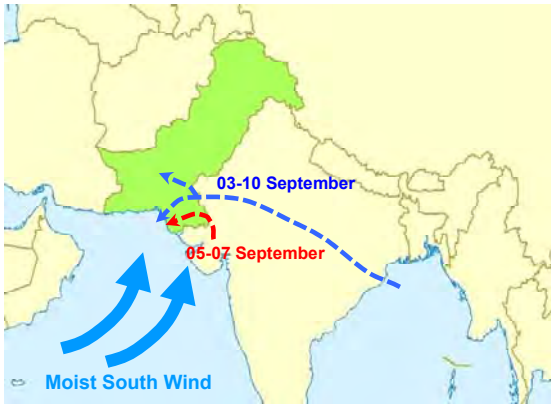


Figure4: Tracks of Monsoon Depressions in 2012

For the mitigation of flood damages, it is absolutely essential to continuously monitor the wide range of movement or development of rain clouds through a meteorological radar system. There are four meteorological radar systems which had been installed under the Grant Aid of Japan in Pakistan: the Islamabad and Dera Ismail Khan meteorological radar systems in the northern area and the Rahimyar Khan and Karachi meteorological radar systems in the southern area.

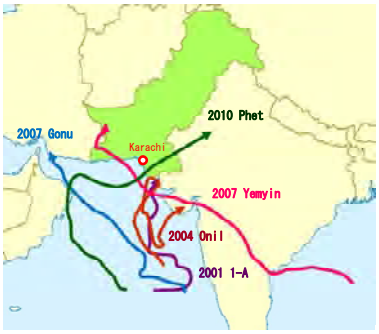
As can be seen in the table below, tropical cyclones approach or land in Pakistan once in two or three years since 2000 and brought about damages to the Sindh and Balochistan states. The damages incurred

by Cyclone “Yemyin ” in 2007 were tremendous (Death/missing: 242, Affected people: 1,650,000, Total estimated damage: more than 1.6 billion US dollars). During the onslaught of Cyclone “Gonu,” more than 200 vessels anchored inshore sustained significant damages from storm surges though, fortunately, there was no loss of human lives.

Table2: Damages of Cyclones in Pakistan since 2001

Month/Year	Name of Cyclone	Death/ Missing	Affected People	Estimated damages (US$ Million)	Damaged Area	
					Sindh	Balochistan
06/2010	Phet	23	4,000	80	○	○
06/2007	Yemyin	242	1,650,000	1,620	○	○
06/2007	Gonu	-	-	-	○	○
10/2004	Onil	9	-	-	○	
05/2001	1-A	-	-	-	○	

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



Most of the tropical cyclones affecting Pakistan are generated in the Arabian Sea. As shown by the dotted-line circle in the figure below, the generation area is near the southeastern part of India where the sea surface temperature is the highest in the Arabian Sea. Then, the tropical cyclones either move northwest-northward and land in Pakistan (Course A) or move westward for the Arabian Peninsula or the Somali peninsula carried by the easterlies (Course B). Since a tropical cyclone moves relatively slowly, it takes about five days on average from its generation to its landfall in Pakistan (i.e. the center of cyclone reaches Pakistan). The S band radar system requested by Pakistan can detect cyclones within a 450km radius, thereby, being able to detect a cyclone about 60 hours (2.5 days) ahead of the time when a cyclone starts having direct influence on Pakistan. In addition, compared to the existing C band radar system, an S band radar system is able to obtain quantitative rain data on a widespread basis with little attenuation of air and precipitation that is suitable for monitoring tropical cyclones.

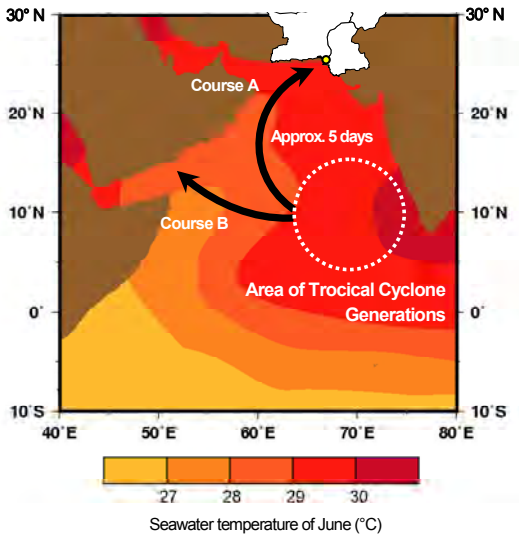


Figure5: Generation Area & Course of Tropical Cyclone in the Arabian Sea

Some tropical cyclones are generated in the Bay of Bengal and move across India to Pakistan as was the case of Cyclone “Yemyin” in 2007 though it occurs less frequently. The Karachi meteorological radar system located in the middle of the southern coast of Pakistan can detect tropical cyclone approaching from the east, west and south.

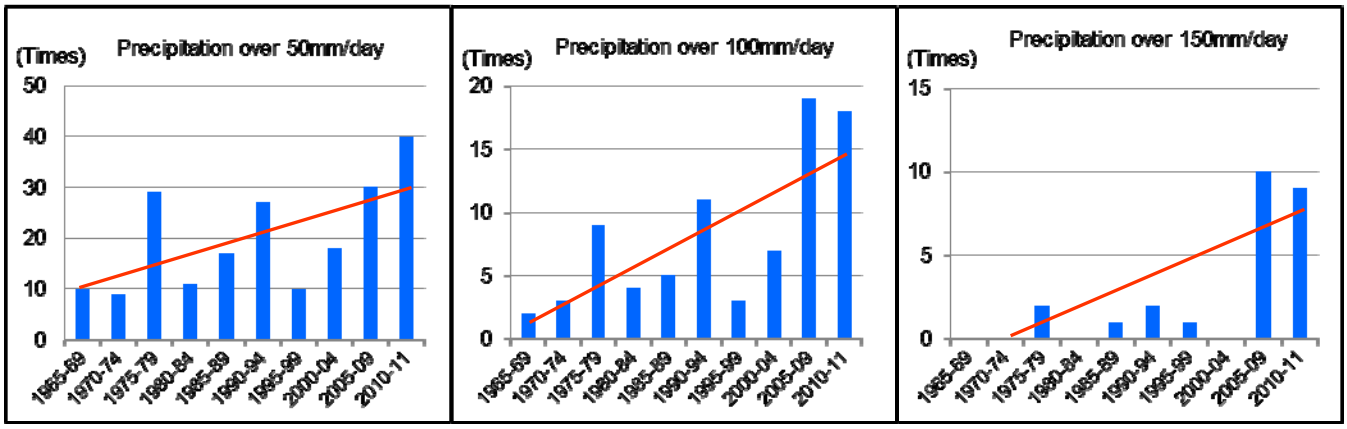
1-3 Influence of Climate Change induced by Global Warming in Pakistan

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.

1) Increase in the Frequency of Heavy Rain

When the sea surface temperature of the Arabian Sea becomes higher than usual, the monsoon convective activity becomes more active, forming well-developed cumulonimbus, thus, dumping heavy rain into Pakistan. In 2010, when the Indus River Flood happened, the sea temperature of the Arabian Sea was quite high as the influence of La Nina was factored in. As a result, the activated monsoon brought about the one of the highest recorded amounts of rainfall in Pakistan.

The figures below show the frequency of precipitation over 50mm/day, 100mm/day and 150mm/day observed at twelve meteorological observatories in the Sindh state for every 5 years since 1965 (exception: 2 years during 2010-2011). As can surmised from the figures below, there is an increasing trend in the frequency of precipitation through the years. In particular, the frequency of rainfall over 150mm/day which has the potential to induce flood just in one event has risen sharply. Moreover, the precipitation frequency of 2010-2011 was comparable to that of 2005-2009 despite being only a brief period of 2 years. It can, thus, be said that the frequency of heavy rain has become prominent and significant recently.



Source: Climate Change in Pakistan, Focused on Sindh Province by the PMD

Figure6: Tendency of Precipitation Frequency over 50mm/day, 100mm/day and 150mm/day in Sindh State (Statistics every 5 years since 1965, except 2010-2011: 2 years)

2) Increase in the Intensity of Tropical Cyclone

A tropical cyclone generated in the south-southeastern area of the Arabian Sea usually loses its strength while moving northward. However, it may keep developing and strengthening if the sea temperature is high.

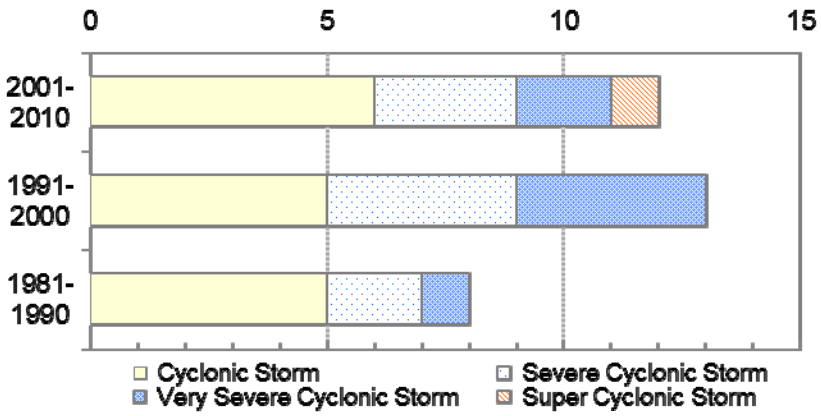


Figure7: Number of Tropical Cyclones in the Arabian Sea ranked by Strength (1981-2010)

The figure on the right shows the number of tropical cyclones in the Arabian Sea ranked by strength and by decade since 1981. The number of "Severe Cyclonic Storm" and "Very Severe Cyclonic Storm" increased to 8 (1990-2000) from 3 (1981-1990). In 2001-2010, a "Super Cyclonic Storm" was generated for the first time in the Arabian Sea (Cyclone "Gonu" in 2007).

In recent years, the number of tropical cyclones approaching/landing in Pakistan has increased. If global warming does not stop, it is undeniable that more "Super Cyclonic Storm" may attack Pakistan in the future. As a form of countermeasure of climate change, it is absolutely necessary to monitor tropical cyclones through the Karachi meteorological radar system.

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

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

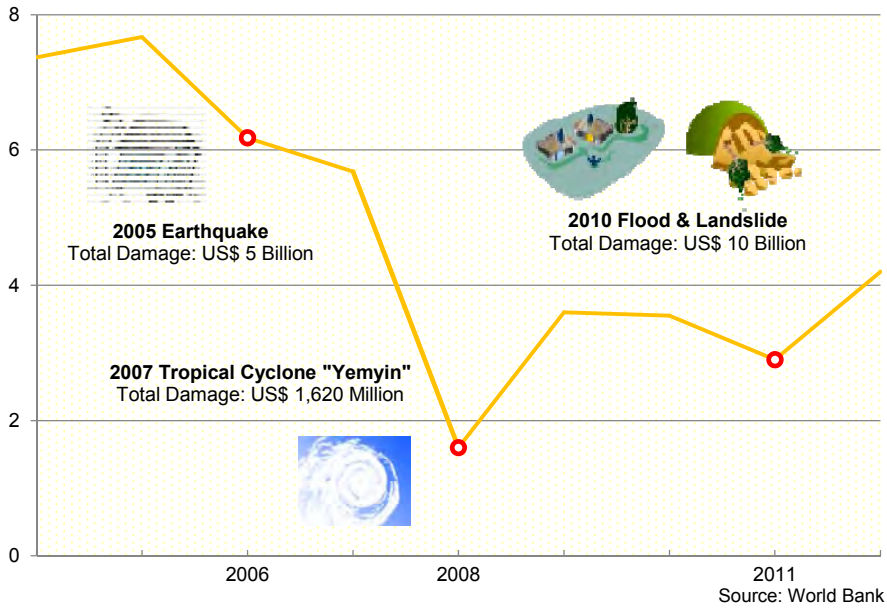


Figure8: GDP Growth Rate of Pakistan and Meteorological Disaster

1-5 Brief Summary on the Request for the Project by Pakistan

As indicated above, the Karachi meteorological radar system plays an important role in monitoring tropical cyclones and other meteorological phenomena which might cause serious disasters in Pakistan. However, more than 20 years have already passed since it was established under the grant aid of Japan. Despite the follow-up maintenance work done, its function deteriorates day by day and could completely stop once a serious malfunction occurs. Thus, it is strongly required, as a permanent measure, to replace the existing Karachi meteorological radar system. Due to a lack of financial and technical capabilities, the Government of Pakistan, in 2012, has requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities under Japan's Grant Aid Assistance scheme.

In response to this request, the Government of Japan decided to conduct a Preparatory Survey for the Installation of a Weather Surveillance Radar at Karachi (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 January 18 to February 14, 2014. 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 Pakistan Meteorological Department (hereinafter referred to as the "PMD"), best equipment arrangement plan, etc.

In particular, in order to assess the viability of the re-utilization of the existing Karachi Meteorological Radar Tower Building for the Project (renovation/re-construction), a comprehensive structural evaluation

for re-utilization of the existing Karachi Meteorological Radar Tower Building such as the confirmation of the current state of the main structures, structural calculation, schmidt hammer test for concrete compressive strength (concrete deterioration diagnosis) and analysis of horizontal distortion angle due to wind pressure were conducted. As a result of the comprehensive structural evaluation, it was confirmed that the re-utilization of the existing Meteorological Radar Tower Building for the Project is quite dangerous and is not a viable option.

JICA sent the Preparatory Survey Team again to Pakistan from May 24 to June 12, 2014 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.

Table3: Object Items of the Preparatory Survey

Component	PMD Islamabad Head Office National Weather Forecasting Center	PMD Karachi	Meteorological Office Karachi International Airport	Meteorological Office New Benazir Bhutto International Airport Islamabad	PMD Flood Forecasting Division (FFD), Lahore
Procurement and Installation of Equipment					
S-Band Doppler Pulse Compression Solid State Radar System including Power Back-up System, Lightning System Measuring Equipment and Spare Parts	-	1	-	-	-
Meteorological Radar Data Display System	1	2 (PMD Karachi Radar Tower Building & Tropical Cyclone Warning Center)	1 (To display Islamabad and Karachi radar products)	1 (To display Karachi radar products)	1
Construction of Radar Tower Building					
Radar Tower Building	-	1	-	-	-
Technical Training	Initial operation guidance including the contract of manufacturer				
Soft Component	Initial guidance for operation and maintenance of the equipment and machineries				

1-6 Project Site Location Information

Table4: Project Site Location Information

Name of Site	PMD Islamabad Head Office National Weather Forecasting Center	PMD Karachi Tropical Cyclone Warning Center	Meteorological Office Karachi International Airport	PMD Flood Forecasting Division (FFD), Lahore
Latitude	N 33º 41'02.1"	N 24º 55'58.9"	N 24º 54'1.7"	N 31º 32'33.1"
Longitude	E 73º 03'50.3"	E 67º 08'32.8"	E 67º 10'5.6"	E 74º 19'29.5"
Altitude	525m	39m	37m	163m

1-7 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.

Tabl5: Stability of Commercial Power (Measured by a Power Quality Analyzer)

Name of Site		PMD Islamabad Head Office	PMD Karachi Cyclone Warning Center
Commercial Power (Voltage: Nominal)		400V, 50Hz, 3-phase 4-wire	400V, 50Hz, 3-phase 4-wire
Voltage (Nominal: 230V)*	Max.	250.4	254.0
	Min.	215.0	185.1
Frequency (Hz)	Max.	50.43	51.34
	Min.	48.60	48.60
Frequency of Electric Outage	Winter	Three times/day (Approx. for 1 hour/1 power stoppage)	Three times/day (Approx. for 2 hours/1 power stoppage)
	Summer	Seven times/day (Approx. for 1 hour/1 power stoppage)	Seven times/day (Approx. for 1-2 hours/1 power stoppage)

*Result of measuring that nominal 440V 3-phase power divided into 3 lines × 220V Single-phase

1-8 Existing Internet Connection

Table6: Existing Internet Connection

Name of Site		PMD Islamabad Head Office			
Internet Service Provider		NAYATEL	World Call		
Connection Type		Optical Fiber Link (Shared Line)	Optical Fiber Link (Dedicated Line)		
Static IP Address		○		○	
Contracted Line Capacity (bps)		1 M	3 M (R&D)	3 M (Forecasting & Seismic)	3M (Others)
Speed Test Result (bps)*	Download	0.98 M	2.97 M	3.67 M	0.28 M
	Upload	5.46 M	17.71 M	5.31 M	0.18 M

Name of Site		PMD Karachi Tropical Cyclone Warning Center	Meteorological Office in Karachi International Airport	PMD Flood Forecasting Division (FFD), Lahore	
Internet Service Provider		PTCL	NTC	PTCL	NTC
Connection Type		Radio Link (Dedicated Line)	DSL (Dedicated Line)	DSL Link Shared Line	DSL Link Dedicated Line
Static IP Address		○	○	×	○
Contracted Line Capacity (bps)		2 M	512K	Max. 2 M	1 M
Speed Test Result (bps)*	Download	1.64 M	0.31 M	0.90 M	0.94 M
	Upload	1.62 M	0.20 M	0.39 M	0.43 M

*Speed Test at Internet speed test site www.speedtest.com.pk
Since the airport is under construction, the test was not conducted at the Meteorological Office in New Benazir Bhutto International Airport (NBBIA)

1-9 Natural Conditions of Southern Pakistan

Precipitation events in Southern Pakistan are caused by the southwest monsoon and tropical cyclones/tropical depressions from the Arabian Sea and the monsoon depressions coming across India during the summer season. As shown in the figure on the right, Karachi receives much rain in July and August compared to the other months. Moreover, during the winter season from December to March, an upper trough/depression from the west brings precipitation mainly to the Balochistan state.

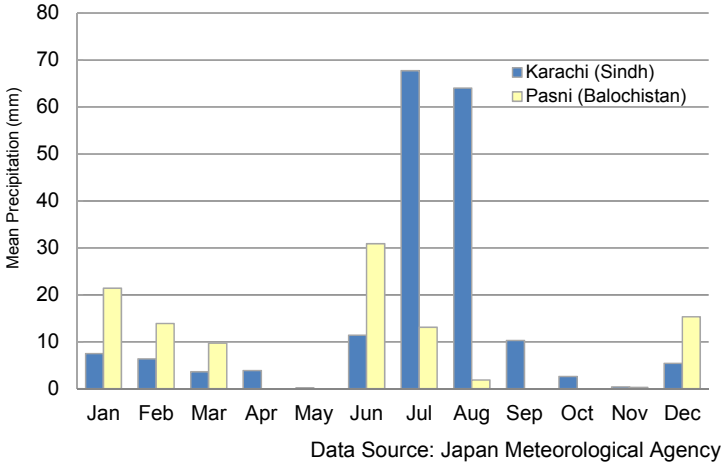


Figure9: Karachi and Pasni Monthly Mean Rainfall (1981-2010)

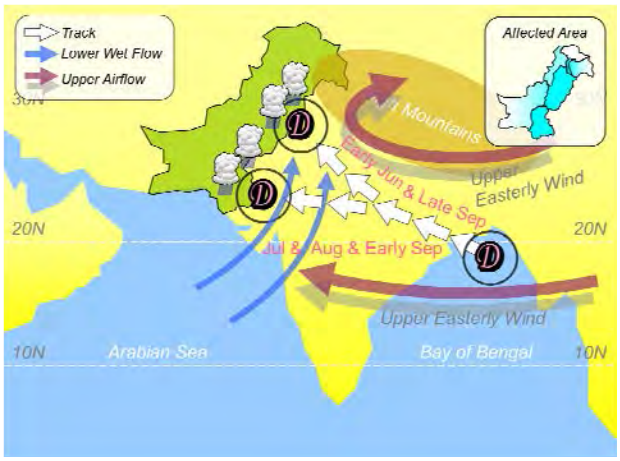
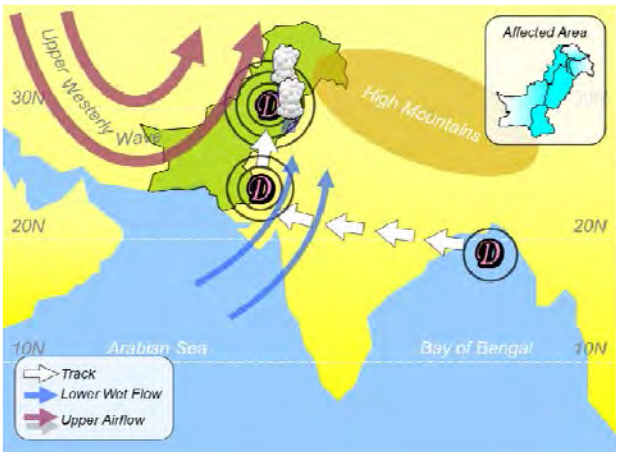
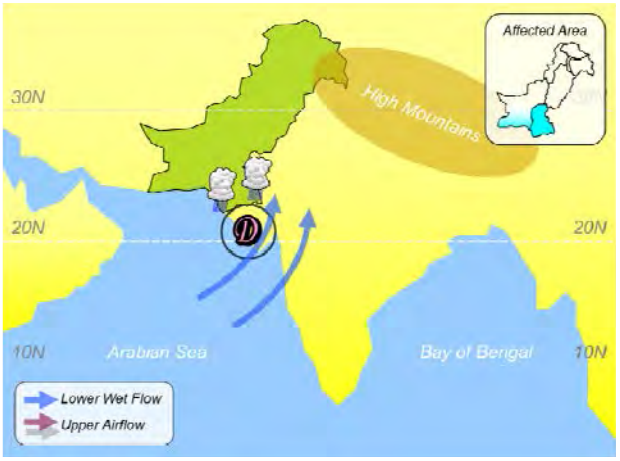
The following tables show the period of typical precipitation events and their details including its mechanism and influence in Southern Pakistan.

Table7: Calendar of Typical Precipitation Events in Southern Pakistan

Season of each Event
Peak Season of Each Event

Monsoon Depression

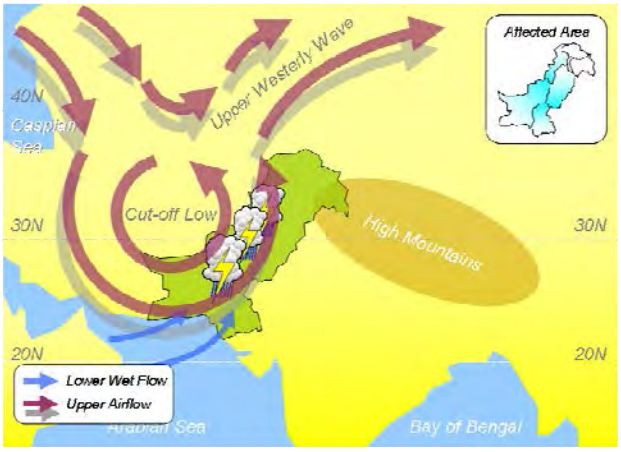
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					←	═	═	═ →			

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 through the seasonal upper easterly wind blowing from the Tibetan High. These depressions generally weaken after crossing India due to a cut-off in moisture supply. However, when moisture is supplied from the Arabian Sea, they can keep their intensity and adopt a westerly course to reach Pakistan. Observed Rainfall in the Event: 291mm/24h (Mithi (Sindh), 11-Aug-2011) 538mm/4 days (Mithi (Sindh), 7 to 10-Sep-2011) 124mm/24h (Karachi, 10-Aug-2007)
Normal Pattern + Upper Westerly Wave  	Mechanism: In addition to the Normal Pattern indicated above, 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. Observed Rainfall in the Event: 80mm/48h (Ormara (Balochistan), 28 to 29-Jul-2010) 66mm/48h (Karachi, 27 to 28-Jul-2010) Expected Rainfall (in Islamabad): 100-120 mm/24h or 150 mm/event
Mid-Tropospheric Cyclone: MTC  	Mechanism: Although most of the Monsoon Depressions are formed over the Bay of Bengal, some Monsoon Depressions, called Mid-Tropospheric Cyclones (MTCs), are formed over the northwestern part of India (around Saurashtra-Kutch) or the Northeastern Arabian Sea. At the beginning of the formation of an MTC, circular vortices are visible at the middle troposphere but are not visible on the surface. An MTC, however, becomes visible on the surface as well over time and receives more moisture from the Arabian Sea. Since an MTC tends to stay for a couple of days, the southern part of Pakistan, particularly the Sindh Province, is affected. Observed Rainfall in the Event: 143mm/24h (Karachi, 19-Jul-2009) 86mm/24h (Hyderabad (Sindh), 18-Jul-2009)

Western Disturbance

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

Cut-off Low + Moist Flux from the Arabian Sea



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

Observed Rainfall in the Event:
225mm/48h (Ormara (Balochistan), 03 to 04-Dec-2006)
53mm/24h (Kalat (Balochistan), 13-Feb-2011)

Tropical Cyclone

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

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

Recent Damaging Cyclones:
- Cyclone Phet (June, 2010)

194mm/48h (Jiwani (Balochistan), 5 to 6-June-2010)
97mm/48h (Karachi, 6 to 7-June-2010)
- Cyclone Yemyin (June, 2007)

276mm/48h (Ormara (Balochistan), 26 to 27-June-2007)

1-10 Topographic and Geotechnical Surveys

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

Table8: 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 (0.5m contour line) - Position of the existing facilities (electrical lines, water lines, telephone lines, sewage, public roads, fences, vegetation, trees: more than 4m height, streetlights, manholes and other features)
	• Longitudinal profile and cross section - Indication of ground level at intervals of 10m - 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

Table9: Geotechnical Survey

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

Table 10: Geotechnical Survey Result of Karachi Meteorological Radar Observation Station

Boring No.	Depth (m)	Soil Type	N-value	R.Q.D (%)
BH-1	0.00-0.75	Silty sand	-	-
	0.75-4.50	Conglomerate	>50	-
	4.50-7.50	Silty clay	>50	38
	7.50-21.00	Limestone	>50	86
	21.00-22.50	Sandy shale	>50	62
	22.50-24.00	Limestone	>50	40
	24.00-33.00	Sandy shale	>50	48
	33.00-40.00	Siltstone	>50	-
BH-2	0.00-0.75	Silty sand	-	-
	0.75-6.00	Conglomerate	>50	-
	6.00-9.00	Silty clay	>50	35
	9.00-13.50	Limestone	>50	41
	13.50-14.50	Sandy shale	>50	8
	14.50-18.00	Limestone	>50	29
	18.00-19.50	Sandy shale	>50	16
	19.50-25.50	Limestone	>50	40
	25.50-35.00	Sandy shale	>50	26
	35.00-40.00	Siltstone	>50	-
BH-3	0.00-0.75	Silty sand	-	-
	0.75-4.50	Conglomerate	>50	-
	4.50-8.25	Silty clay	>50	30

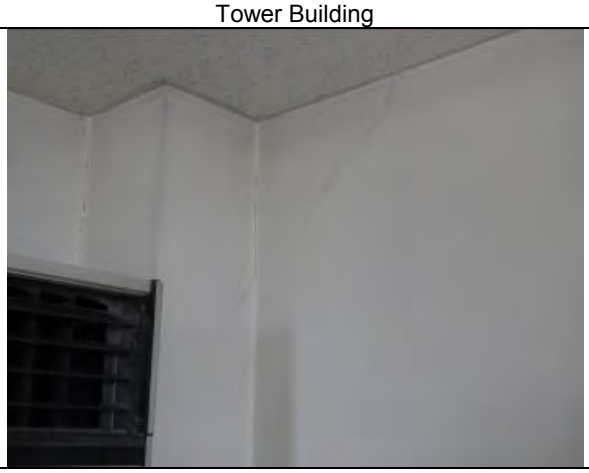
	8.25-13.50	Limestone	>50	21
	13.50-16.50	Silty clay	>50	18
	16.50-24.00	Limestone	>50	53
	24.00-35.00	Sandy shale	>50	27
	35.00-40.00	Siltstone	>50	-

1-11 Existing Facility and Equipment

<Existing Karachi Radar Tower Building>

Since the periodic painting of the external wall of the existing Karachi Radar Tower Building has been consistently done by the PMD, the existing damage cannot be easily identified. However, the gradual and overall deterioration of the existing building has been progressing due to the passage of more than 20 years. Pictures of the existing Karachi Radar Tower Building are attached hereunder.

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

	
Overview of the Existing Karachi Meteorological Radar Tower Building	Observation Room Water Leakage from a damaged drainage pipe
	
Observation Room Concrete Brick Crack	Roof Top Gaps between the Radome Foundation and the Steel Basering

	
Radom Room Water Leakage from Gaps between the Radome Foundation and the Steel Basering	Roof Top Concrete Crack on the Parapet

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

Table11: Result of Schmidt Hammer Test for Concrete Compressive Strength of Existing Karachi Meteorological Radar Tower Building

Location	Schmidt Hammer Test No.	No.	No.	Rejection/Acceptance Region		Average of Acceptance Value (R)	Concrete Compressive Strength (F) of Islamabad Existing Meteorological Radar Tower Building	
Girder	1	36	31. 7	Rejection Region: ≥+20% of Average =31.7×1.2=38.04 Acceptance Region Rejection Region: ≤ -20% of Average =31.7×0.8=25.36	36	32. 8	coefficient angle of inclination -90°→32.8+3.1=35.9 F=α×(13R-184)/9.8 α=coefficient of concrete age concrete age ≤ 1,000 days: α=0.6.6	17.3 N/mm^2
	2	26			26			
	3	30			30			
	4	37			37			
	5	36			36			
	6	21			21			
	7	23			23			
	8	37			37			
	9	34			34			
	10	28			28			
	11	36			36			
	12	28			28			
	13	38			38			
	14	35			35			
	15	36			36			
	16	36			36			
	17	30			30			
	18	28			28			
	19	33			33			
	20	26			26			

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

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

Table12: Comprehensive Structural Evaluation for the Existing Karachi Meteorological Radar Tower Building

Current Situation on the Main Structures		
Column	Not found concrete cracks	
Girder	Not found concrete cracks	
Floor	Not found concrete cracks	
Wall	Concrete brick crack	
Roof Slab	Not found concrete cracks and water leakage	
Re-bar	Not found exposed re-bar.	
Result of structural calculation (Replace radar equipment)		
Additional load of 11tons on the existing radar tower building (11tons is the equivalent weight of a new meteorological radar system including a new power back-up system and a new radar data display system) was considered		
Allowable load capacity was calculated after removal of the existing radar system due to 3-dimensional modeling of the existing Karachi Radar Tower Building		
Condition for structural calculation	Live load (during radar operation): 3.0kN/m^2 (300kg/m^2)	
	Wind speed：36m/s (during storm)	
	Seismic coefficient：C0=0.1　C0 '= 0.125 (1.25 importance factor to consider)	
	Concrete compression strength: Fc=21N/mm^2　Re-bar：SD295	
Main Structure	Analysis result	Pass-Fail
Column: 500mm×500mm	Out of range for allowable stress (during seismic)	Fail (Danger)
Girder: 400mm×800mm	Out of range for allowable stress (during seismic)	Fail (Danger)
Grade Beam: 400mmx1840mm	Within the allowable stress	Pass
Slab: 130mm	Out of range for allowable stress	Fail (Danger)
Foundation slab	Out of range for allowable stress	Fail (Danger)
The result of Schmidt Hammer Test for Concrete Compressive Strength		
Slab	Current concrete compression strength: 17.3N/mm^2 (Design concrete compression strength：21N/mm^2)	
Synthetic judgment	As a consequence of the Comprehensive Structural Evaluation, it was confirmed that an additional load of 11tons on the roof top poses a distinct danger (destruction) to the existing radar tower building. For the installation of these new systems, a new radar tower building is required.	

1-12 Consideration for Environmental Conservation

In order to implement the Project, it was confirmed by the PMD with the Environmental Protection Agency (EPA) in the Sindh Province that an Environmental Impact Assessment (EIA) permit is not required.

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

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. The southern area also suffers from damages caused by a tropical cyclone which attacks the country once in a few years. These meteorological disasters lead to the loss of human lives and properties, thereby, contributing to the significant set-back of socio-economic activities. The Indus River Flood in 2010 (Killed or Missing: 1,985; Affected people: over 20 million) and the Sindh Flood in 2011 (Killed or Missing: over 500; Affected people: approx. 5 million) were the most disastrous catastrophes in recent years. Significantly, the damages in the southern area worsened and prolonged as the agricultural & livestock industries were devastated during the flood in 2011 when the people were in the middle of recovering from the Indus River Flood in 2010.

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.

At present, in Pakistan, there are four meteorological radar systems (Islamabad, Karachi, Dera Ismail Khan and Rahimyar Khan) established under the grant aid of Japan. These networked meteorological radar systems make it possible to observe the precipitation of about 80% of the areas in the whole country where more than 90% of the overall population live. Among them, the existing Karachi meteorological radar system established in 1991 has played an important role in monitoring meteorological phenomena in the southern area or tropical cyclones which are generated in the Arabian Sea and the Bay of Bengal. However, its function deteriorates day by day and could completely stop in a few years despite the appropriate maintenance done by the radar engineers of the PMD. In addition, since many parts transit from analog to digital and the supply of spare parts and consumables from the manufacturer has become limited, it would be extremely difficult to restore the radar system once a serious failure occurs. Therefore, as a permanent measure, the replacement of the existing Karachi meteorological radar system is an urgent task in Pakistan.

Given the situation indicated above, the key objectives of the Project are to improve the PMD's capabilities in meteorological observation, weather forecasting and dissemination of forecasts/warnings through the replacement of the existing Karachi C-band ordinary meteorological radar system with an S-band Doppler pulse compression solid state radar system. This will largely contribute to the mitigation of damages caused by natural disasters in Pakistan which are predicted to increase due to the climate change.

2-2 Outline Design of Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Policy of the Project

a) To design a meteorological observation system to contribute to disaster prevention in the Sothern part of 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 tropical cyclones through the upgrading of the PMD's monitoring capabilities of meteorological phenomena including tropical cyclones.
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 Tropical Cyclone 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 Karachi 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 Karachi 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 Karachi Meteorological Radar System are delivered to the PMD Islamabad National Weather Forecasting Center (NWFC) and PMD Karachi Tropical Cyclone Warning Center every 15 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/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 is not more than 0.075 degree (approx. 5% of beam angle of an antenna to be manufactured).
c) To adopt the design wind pressure: 7kN/m^2 and the seismic zone factor: Z=0.20 of the Building Code of Pakistan-Seismic Provisions-2007.
d) To ensure that the working environment for the PMD's 24-hour/day work schedule of observations is conducive to ensuring effective and efficient performance.

e) To be sufficiently robust enough to withstand extreme weather and ensure uninterrupted radar observation and continuous provision of weather forecasts & warnings to the public, even during the occurrence of a natural disaster.
f) To make use of local building materials for the easy maintenance of the radar tower building by the PMD.
g) To design the equipment so as to minimize lightning damage.

(2) Design Policy on Environmental Conditions

1) Temperature/Humidity

Air-conditioning systems are required for the rooms (radar equipment room, radar observation room, spare parts room, electricity room, etc.) where the equipment to be procured under the Project (radar transmitter, operation terminals, display monitors, spare parts, test instruments and power back-up system) are to be installed in for the smooth operation of the equipment under the appropriate environment at a controlled temperature/humidity.

2) Rainfall

Meteorological data should be transmitted and received even during the occurrence of very heavy rains. A maintenance staircase is located at the center of the building, covered by an upper concrete slab, to enable the PMD personnel to easily reach each room for the regular maintenance of the radar equipment without getting wet during the rainy season.

3) Lightning

Frequent lightning occurs especially during the rainy season. A lightning protection and grounding system (see Page 2-36, Lightning Protection & Grounding System) are, therefore, indispensable to prevent damage to the building and to the equipment.

4) Wind

For calculating the design wind pressure: 7kN/m^2 of the Building Code of Pakistan-Seismic Provisions-2007 will be utilized.

5) Earthquake

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

6) Load Bearing Layer

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

Table13: Foundation Type of the Proposed Karachi Meteorological Radar Tower Building

	Karachi Meteorological Radar Tower Building
Foundation type	Pile foundation (cast in site concrete)

(3) Design Policy for Construction Work

1) Environmental Regulation

Waste water discharged from the radar tower building must undergo initial treatment before filtering the treatment into the soil at the site.

2) Use of Locally Procurable Materials

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

3) Use of Local Construction Methods and Local Workers

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

(4) Policy for Use of Local Construction Companies

1) Construction Work of the Radar Tower Building

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

2) Equipment Installation Work

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

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

1) User-friendly equipment

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

2) Easy maintenance and affordable recurrent costs of the equipment

The equipment must be designed in such a way so as to minimize the spare parts and consumables required and to simplify regular maintenance. Replacement parts must be quickly and readily available. The biggest recurrent cost of the Project is expected to be electricity; therefore, the equipment and facility should be designed to minimize power consumption.

3) Consideration of minimizing operational & maintenance costs

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

- The ability to restrict the operation of the air-conditioning systems and the electricity supply in the operational rooms within the radar tower building only.
- The utilization of natural light to reduce energy requirements by minimizing the hours of artificial 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 only available and made in Japan.

2-2-2 Basic Plan

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

Table14: Object Items of the Preparatory Survey

Component	PMD Islamabad Head Office National Weather Forecasting Center	PMD Karachi	Meteorological Office Karachi International Airport	Meteorological Office New Benazir Bhutto International	PMD Flood Forecasting Division (FFD), Lahore

				Airport Islamabad	
Procurement and Installation of Equipment					
S-Band Doppler Pulse Compression Solid State Radar System including Power Back-up System, Lightning System Measuring Equipment and Spare Parts	-	1	-	-	-
Meteorological Rader Data Display System	1	2 (PMD Karachi Radar Tower Building & Tropical Cyclone Warning Center)	1 (To display Islamabad and Karachi radar products)	1 (To display Karachi radar products)	1
Construction of Radar Tower Building					
Radar Tower Building	-	1	-	-	-

(1) Equipment Plan

1) Meteorological Radar System

The meteorological radar system requested by the PMD is of the S band radar system type which is the same system which will be used to replace the existing Islamabad meteorological radar system. The S band radar system must be a pulse compression solid state Doppler radar system with a changeable function accurately having quantitative rainfall observation and air-turbulence observation capability for monitoring rapidly changing weather conditions in real time. The PMD Karachi Centre is approximately 4.5km from the Karachi International Airport which is the biggest airport in Pakistan. Since the Karachi meteorological radar system is designed to work in Doppler mode which detects the wind velocity distribution of tropical cyclones/depressions and cumulonimbus, it can monitor severe weather phenomena generated by wind with other observations such as surface observation, etc. within a 200km radius. The replacement of the existing Karachi radar system with a Doppler radar system is quite significant for the improvement of weather observation and forecasting in the aviation meteorological service and enables accurate and real-time detection of suddenly changing weather phenomena (localized wind turbulence such as windshear and downburst, storm wind of tropical cyclone, storm, tornado, etc.) which could potentially affect aircrafts which are landing and taking off at the Karachi International Airport and the prompt provision of the required information to aircraft pilots and air traffic controllers.

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. For these reasons, it has been selected as the most suitable system to monitor large-scale and distant phenomena such as tropical cyclones.

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

radar system are as follows.

Table15: Major Features of Meteorological Radar System

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

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

Table16: Comparison of Precipitation Detection Range between the Existing Radar System and the Proposed Radar System by Reception Power (dbm) Precipitation Intensity

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

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

Out of Range New Area of Detection Reliable Detection Range

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

[1] Doppler Mode

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

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

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

[3] Required Radar Display and Output Information Functions

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

Table17: Required Radar Display and Output Information Functions

	Radar Display and Output Information Functions	Purpose of Observation/Utilization
1	PPI Display (Intensity, Doppler Velocity, Velocity Width)	Rainfall
2	RHI Display (Intensity)	
3	Cyclone Eyes Location Manual Data Input and Cyclone Track Display	
4	Identified Heavy Rainfall Level Display	
5	Accumulated Rainfall (1H, 2H, 3H, 6H, 12H, 24H)	
6	Z-R Parameter Registration	
7	Dissemination of Accumulated Rainfall Data	
8	Specific District Rainfall Amount Display	
9	Surface Rain Display	
10	Range Time Indicator	
11	Composite Picture Display	
12	Wind Velocity and Direction	Wind Velocity and Direction
13	Wind Profile of Upper Layer	
14	Wind Shear Information Display	
15	Overlay Display of Plural Products	
16	Specific District Strong Wind Display	
17	CAPPI Display	3-dimensional
18	Echo Height Display	
19	Vertically Integrated Liquid	

20	Maximum Rainfall Display	
21	3-dimensional Data Display	
22	Cross Section	
23	Radar Control and Monitoring	Radar Control and Monitoring
24	Observation Scheduling	
25	Stored Data Listing on Each External Storages	Storing and Retrieving
26	Storing To External Storages	
27	Retrieved Data Listing From External Storages	
28	Various Weather Products Retrieving from External Storages	
29	Data Receiving	Display, Data Input and Output
30	JPG Image Output	
31	Multi-Window Display	
32	Map Overlay Feature	
33	Information of Pointed Locations (Location, Numerical Radar Echo Value, Distance of Specified Span)	
34	Zooming Display (2 Times or 4 Times Selectable)	
35	Animation	
36	Map Edit	
37	Product Output to Web (GIF Animation Format)	Web
38	Radar Images to Internet Server at HTTP Style	
39	Login From Internet Browser and Download	

The figure of the “Maximum Detection Area and Observed Data Processing Area of the Proposed Karachi Meteorological Radar System and the Existing Automatic Weather Observation System (AWS) Network of the PMD Karachi TCWC” is attached hereunder. In order to effectively monitor tropical cyclones, the simultaneous operation of the Proposed Karachi Meteorological Radar System within the Existing Automatic Weather Observation System (AWS) Network is quite significant.

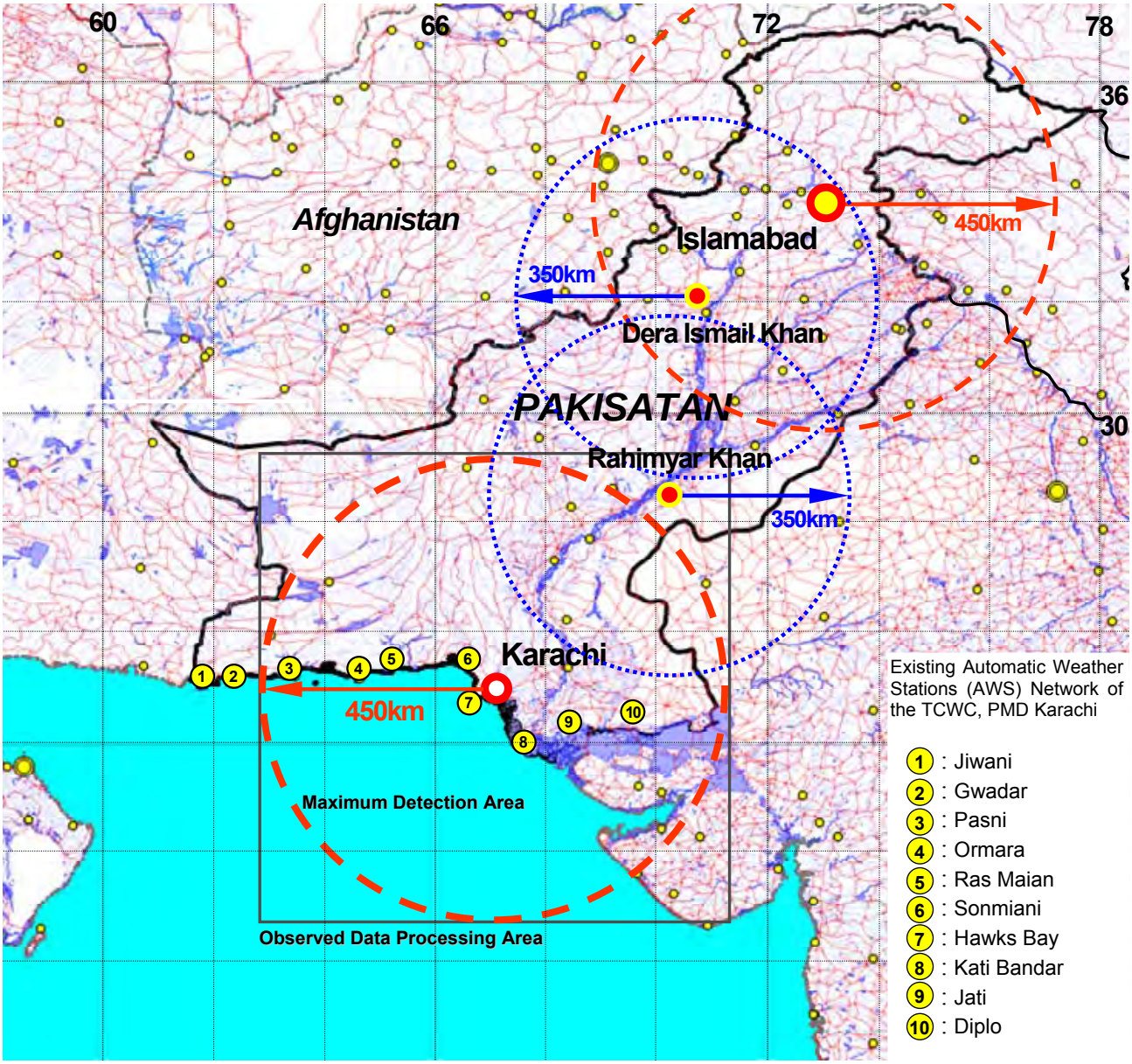


Figure10: Maximum Detection Area and Observed Data Processing Area of the Proposed Karachi Meteorological Radar System and the Existing AWS Network of the PMD Karachi TCWC

- Islamabad Meteorological Radar System: to be established by the Japan's Grant Aid (the Project for Establishment of Specialized Medium Range Weather Forecasting Center and Strengthening of Weather Forecasting System)
- Existing Dera Ismail Khan and Rahimyar Khan Meteorological Radar Systems: established by the Japan's Grant Aid (the Project for Improvement of the Meteorological Radar Network, Phase-II)

2) Meteorological Radar Data Display System

A meteorological radar data display system must have the ability to receive and display all meteorological products in real time 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 within a short period of time so the meteorological radar data display systems are to be installed in the proposed Karachi

Meteorological Radar Tower Building, the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Karachi TCWC, Meteorological Office Karachi International Airport, Meteorological Office New Benazir Bhutto International Airport Islamabad and the PMD Flood Forecasting Division (FFD), 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 long time operation. The meteorological radar data display system will be designed to store data files of the radar pictures as binary data of hourly accumulated precipitation data of 2.5 km mesh. The Karachi Meteorological Radar Tower Building and the PMD Karachi Tropical Cyclone Warning Center will be connected by an optical fiber line to make high-speed data transmission possible and prevent the intrusion of lightning surges.

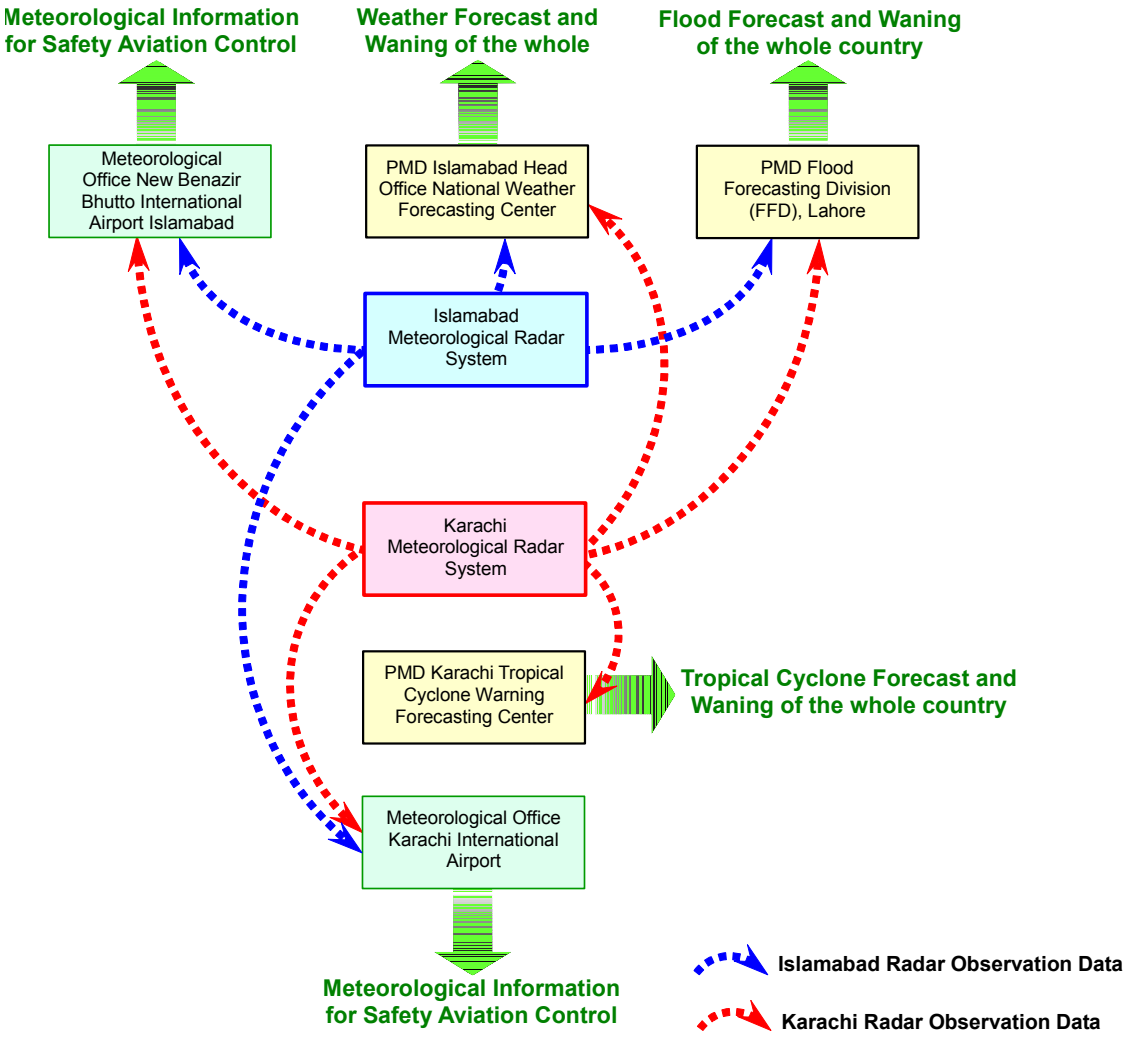


Figure11: Flow Chart of Radar Observation Data and PMD Meteorological Outputs

The "Schematic Diagram of the PMD Karachi Meteorological Observation & Data Communication Network System" is attached hereunder.

Schematic Diagram of PMD Karachi Meteorological Observation & Data Communication Network System

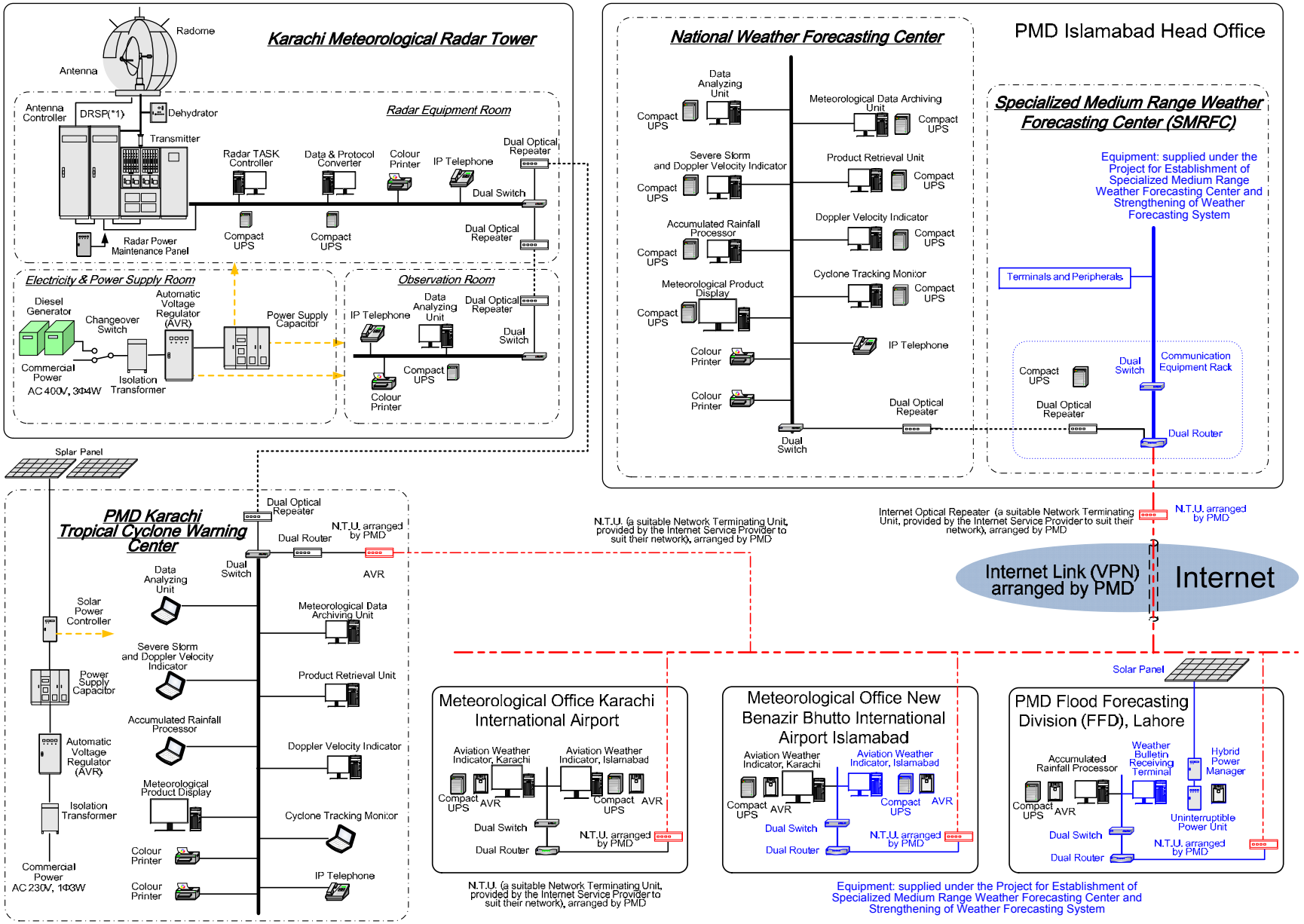


Figure12: Schematic Diagram of PMD Karachi Meteorological Observation & Data Communication Network System

(2) Major Equipment List

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

Table18: Main Equipment Components

Component	PMD Islamabad Head Office National Weather Forecasting Center	PMD Karachi	Meteorological Office Karachi International Airport	Meteorological Office New Benazir Bhutto International Airport Islamabad	PMD Flood Forecasting Division (FFD), Lahore
Procurement and Installation of Equipment					
S-Band Doppler Pulse Compression Solid State Radar System including Power Back-up System, Lightning System Measuring Equipment and Spare Parts	-	1	-	-	-
Meteorological Rader Data Display System	1	2 (PMD Karachi Radar Tower Building & Tropical Cyclone Warning Center)	1 (To display Islamabad and Karachi radar products)	1 (To display Karachi radar products)	1

Major Equipment List

S-Band Doppler Pulse Compression Solid State Radar System

Name of Site: Karachi Meteorological Radar Tower		
Equipment	Quantity	Purpose
Radome	1 set	For protecting the radar antenna assembly (a parabolic dish reflector) and the maintenance personnel from severe weather conditions and lightning attacks.
Antenna	1 set	For radiating radar beam into the atmosphere and receiving scatter waves while rotating the parabola antenna in azimuth and elevation direction.
Antenna Controller	1 set	For rotating the parabolic dish reflector and for controlling the antenna in azimuth and elevation by both horizontal and vertical drive motor units.
Transmitter	1 set	For amplifying pulse-modulated power with stable frequency and transmitting the power to the antenna.
Digital Receiver and Signal Processor (DRSP)	1 set	For receiving, pulse compression and processing echo signal from the Antenna. For suppressing unnecessary echo such as clutter signals reflected from the ground. For sending ingest data to the radar TASK controller.
Dehydrator	1 set	For supplying dried and pressurized air into the wave-guide to reduce wave propagation loss.
Wave-guide Configuration	1 set	For feeder line propagation of the wave traveling between the antenna and TX/RX.
Radar TASK Controller	1 set	For operating the radar system, monitoring the condition of the radar system and generating raw product data. Control and monitoring items: Radiate control/status, Azimuth/elevation position control/status, TX standby status, Pulse width control/status and Antenna local/maintenance mode status.
Data & Protocol Converter	1 set	For sending raw data to the central system according to specified intervals.
Radar Power Maintenance Panel	1 set	For distributing and supplying AC power to the radar system.
Compact UPS	2 sets	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.
Dual Switch	1 set	For connecting all the computer equipment to LAN.
Colour Printer	1 set	For printing radar image.

Dual Optical Repeater		2 sets	For converting electrical signal and optical signal on LAN for protection against surges.
IP Telephone		1 set	For voice communication through IP network.
Isolation Transformer		1 set	For protecting each equipment from surges in voltage in the main power.
Automatic Voltage Regulator (AVR)		1 set	For supplying constant or regulated voltage to the radar system.
Power Supply Capacitor		1 set	For supplying uninterrupted power by Electric Dual Layer Capacitor energy to the radar system when power failure occurs.
Spectrum Analyzer		1 set	For maintenance of the system.
Test signal Generator		1 set	
Power Meter		1 set	
Power Sensor		1 set	
Frequency Counter		1 set	
Detector		1 set	
Attenuator Set		1 set	
Terminator for Detector		1 set	
Oscilloscope		1 set	
Digital Multimeter		1 set	
CW Converter		1 set	
Network Camera		1 set	
Tool Kit		1 set	
Extension Cable		1 set	
Leveler		1 set	
Step Ladder		1 set	
Clump Current Meter		1 set	
Vacuum Cleaner		1 set	
Radar Antenna Maintenance Deck		1 set	
Spare Parts	Timing belt for antenna (for azimuth drive)	1 set	For maintenance of the system.
	Timing belt for antenna (for elevation drive)	1 set	
	Encoder for antenna (for azimuth angle signal)	1 set	
	Encoder for antenna (for elevation angle signal)	1 set	
	Motor for antenna (for azimuth drive)	1 set	
	Motor for antenna (for elevation drive)	1 set	
	Servo unit for antenna controller (for azimuth drive)	1 set	
	Servo unit for antenna controller (for elevation drive)	1 set	
	Power supply unit for antenna controller	1 set	
	Power supply unit for transmitter	1 set	
	Power supply unit for digital receiver and signal processor	1 set	
	Fan unit for radar equipment	2 sets	
	LAN Arrester	2 sets	
	Obstruction light	2 sets	
Consumables	Grease with pump and oil with jug for antenna	1 set	For maintenance of the system.
	Antenna carbon brush for power	1 set	
	Antenna carbon brush for signal	1 set	
Service Manuals		2 sets	For maintenance of the system.

Meteorological Radar Data Display System

Name of Site: Karachi Meteorological Radar Tower		
Equipment	Quantity	Purpose
Data Analyzing Unit	1 set	For analyzing weather phenomena by using observed radar data.
Compact UPS	1 set	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.

Colour Printer		1 set	For printing radar image.
IP Telephone		1 set	For voice communication through IP network.
Dual Switch		1 set	For connecting all the computer equipment to LAN.
Dual Optical Repeater		1 set	For converting electrical signal and optical signal on LAN for protection against surges.
Spare Parts	LAN Arrester	1 set	For maintenance of the system.
Service Manuals		2 sets	For maintenance of the system.

Meteorological Radar Data Display System

Name of Site: PMD Karachi Tropical Cyclone Warning Center			
Equipment		Quantity	Purpose
Data Analyzing Unit		1 set	For analyzing weather phenomena by using observed radar data.
Severe Storm and Doppler Velocity Indicator		1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Accumulated Rainfall Processor		1 set	For generating and sending accumulated rainfall data.
Meteorological Product Display		1 set	For displaying meteorological product
Meteorological Data Archiving Unit		1 set	For storing of radar and weather information to a selected media.
Product Retrieval Unit		1 set	For retrieving and displaying radar data.
Doppler Velocity Indicator		1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Cyclone Tracking Monitor		1 set	To track cyclone course and predicting cyclone course and time.
Colour Printer		2 sets	For printing radar image.
IP Telephone		1 set	For voice communication through IP network.
Dual Switch		1 set	For connecting all the computer equipment to LAN.
Dual Optical Repeater		1 set	For converting electrical signal and optical signal on LAN for protection against surges.
Dual Router		1 set	For forwarding data packets between computer networks.
LED Projector		1 set	For presentation of meteorological products
Portable Screen		1 set	For presentation of meteorological products
Isolation Transformer		1 set	For protecting each equipment from surges in voltage in main power.
Automatic Voltage Regulator (AVR)		1 set	For supplying constant or regulated voltage to the radar system.
Power Supply Capacitor		1 set	For supplying uninterrupted power by Electric Dual Layer Capacitor energy to the radar system when power failure occurs.
Solar Power controller		1 set	For controlling the electric power generated by solar panel
Solar Panel		1 set	For generating electric power and supplying it to the system.
LED Ceiling Light		6 sets	For providing necessary illuminance during the failure of the electric power supply
Spare Parts	LAN Arrester	8 sets	For maintenance of the system.
	Battery for Laptop or Portable Type Computer	4 sets	For maintenance of the system.
	Service Manuals	2 sets	For maintenance of the system.

Meteorological Radar Data Display System

Name of Site: PMD Islamabad Head Office		
Equipment	Quantity	Purpose
<National Weather Forecasting Center>		
Data Analyzing Unit	1 set	For analyzing weather phenomena by using observed radar data.
Severe Storm and Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Accumulated Rainfall Processor	1 set	For generating and sending accumulated rainfall data.
Meteorological Product Display	1 set	For displaying meteorological product
Meteorological Data Archiving Unit	1 set	For storing of radar and weather information to a selected media.
Product Retrieval Unit	1 set	For retrieving and displaying radar data.
Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various Doppler radar products.
Cyclone Tracking Monitor	1 set	To track cyclone course and predicting cyclone course and time.
Compact UPS	8 sets	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.
Colour Printer	2 sets	For printing radar image.
IP Telephone	1 set	For voice communication through IP network.
Dual Switch	1 set	For connecting all the computer equipment to LAN.

Dual Optical Repeater		1 set	For converting electrical signal and optical signal on LAN for protection against surges.
<Specialized Medium Range Weather Forecasting Center>			
Compact UPS		1 set	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.
Dual Optical Repeater		1 set	For converting electrical signal and optical signal on LAN for protection against surges.
Spare Parts	LAN Arrester	8 sets	For maintenance of the system.
	Service Manuals	2 sets	For maintenance of the system.

Meteorological Radar Data Display System

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

Meteorological Radar Data Display System

Name of Site: PMD Flood Forecasting Division (FFD), Lahore			
Equipment		Quantity	Purpose
Accumulated Rainfall Processor		1 set	For generating and sending accumulated rainfall data.
Compact UPS		1 set	For supplying back-up AC power to the computer equipment in order to enable the proper shutdown of the system in case of power failure.
Automatic Voltage Regulator (AVR)		1 set	For supplying constant or regulated voltage to the radar system.
Spare Parts	LAN Arrester	1 set	For maintenance of the system.
	Service Manuals	2 sets	For maintenance of the system.

(3) Basic Plan of the Facility

1) Proposed Building Construction Site

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

Table19: Construction Site for Proposed Meteorological Radar Tower Building

Study Items		Proposed Site for the Karachi Meteorological Radar Tower Building
Picture of Proposed Site		
Land Expropriation		PMD Karachi
Location		
	Latitude Longitude	N 24º 55'59" E 67º 08'34"
Altitude		34m
Enough Space for Radar Tower Construction		Enough space available
Access Road		Available
Description Outline of the Premises		The premises are located in the Karachi city, surrounded by public facilities (International Airport).
Infrastructure		
	Commercial Power Supply	Available
	Public Water Supply System	Available
	Public Sewerage System	Not available
	Telephone Line	Available
	Internet Access	Available
	Mobile Phone Service	Available
Staff House		Available
Staff Commuting		No Problem

2) Architectural Design

[1] Floor Plan

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

Table20: Calculation Base of Each Room in the Proposed Meteorological Radar Tower Building

Name of Room	Karachi Meteorological Radar Tower Building Floor Area (m^2)	Room Function	Calculation Base
Radome Room	30.18	Installation space for radar antenna apparatus.	Maintenance space for radar antenna apparatus. Room area depends upon radome base of 6.2m in diameter.

Radar Equipment Room	89.75	Installation space for antenna controller, transmitter, solid state power amplifier, digital receiver, signal processor, dehydrator, wave-guide configuration, radar task controller, power distribution box, optical repeater, compact link transmitter/receiver, maintenance box, maintenance cabinet, measuring instrument cabinet, air-conditioning units, etc.	Operation and maintenance space for all the apparatuses described in the left column. For installation of all the required equipment, at least 77m^2 is required.
Observation Room	154.05	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 • data storage cabinets for keeping observation records and observed data of the radar system for analysis • cabinets for maintenance instruments and operation & maintenance manuals Space for keeping spare parts & consumables.	Radar observation space and installation space for all the equipment described in the left column. A space for data analysis terminal, desk, data storage cabinets and also working space. Necessary space for keeping all data secured. Maintenance space for various type of the equipment and keeping space for maintenance instruments, measuring equipment.
Electricity & Power Supply Room	44.20	For isolation transformers, power distribution boards, cable rack, test terminals, AVR, etc. For radar power back-up system (capacitor) and control rack.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column. Installation, operation and maintenance space for all the apparatuses described in the left column.
Toilet	22.12	European Style Commode: M1+F1, Wash Basin: M1+F1, Urinal:1, Slop Sink: 1	—
Tea Kitchen	9.26	Kitchen: 1	—
Changing Room	1.72	Changing space for taking shower.	—
Shower Room	2.42	Space for taking shower.	—
Storage	2.38	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
Engine Generator Room	59.25	For 75kVA engine generators: 2, oil tank & oil pump: 1, automatic change-over switch, etc.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column.
Pump Room	14.40	Water reservoir tank: 1 Pump for water reservoir tank: 2	For maintenance space and installation space for Water reservoir tank: approx. 8 m^2 required.

[2] Sectional Plan

I. Height of the Radar Tower Building

The required radar antenna center height for the proposed radar system in the Karachi Meteorological Radar Observation Station is at least 68m as shown in the figure below. In case that the radar antenna center height is 68m and the radar antenna angle is 0 degree, approximately 6m clearance between the radar beam bottom and the roof top of the high-rise building adjacent to the PMD Karachi premises can be secured.

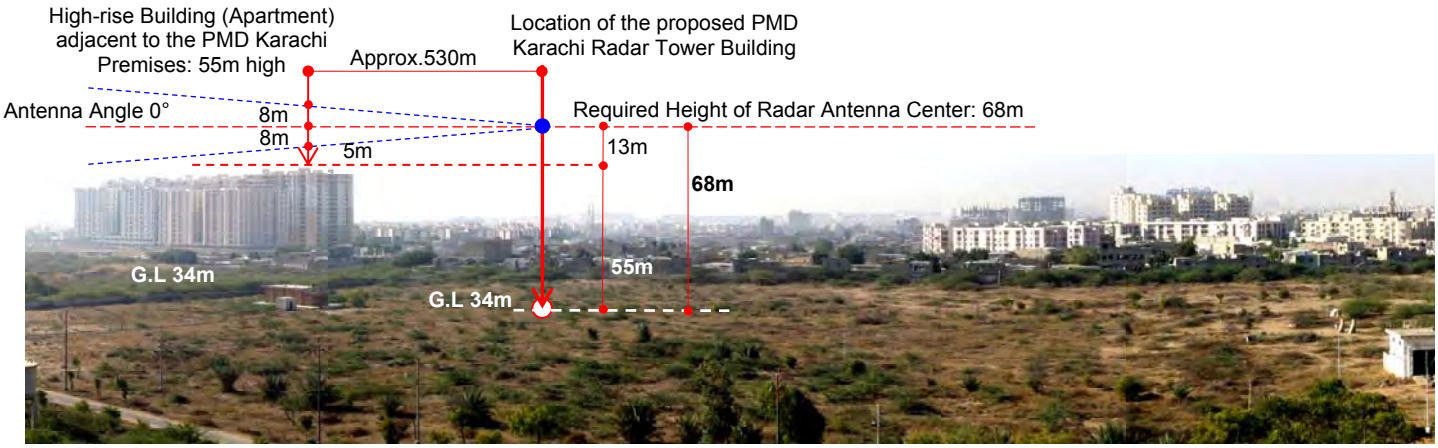


Figure13: Required Height of Radar Antenna Center for the proposed PMD Karachi Radar System

<Existing Obstructive Building/Facility>

It is being considered that urban development in Karachi be accelerated. The buildings which were already constructed are unavoidable. However, it is necessary to take appropriate measures in Karachi 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 design and establish a restrictive framework on the construction of high rise buildings, which are unsurpassable and unavoidable obstructions for radar observation, around the Karachi Meteorological Radar Observation Station (at least within a 5km radius from the Station) and the Pakistan side understood the necessity.

The existing obstructive buildings/facilities around the PMD Karachi are indicated in the following table.

Table21: Existing Obstructive Buildings/Facilities to the Radar Observation in Karachi (as of January, 2014)

Location Map No.	**1**	**2**	**3**
Name of Building	Space and Upper Atmosphere Research Commission: SUPARCO	Apartment Building	Apartment Building (under construction)
Picture			
Number of Stories	-	13	17
Height	68m	45m	52m
Latitude(N) Longitude(E)	N24º 56'47.64" E67º 08'10.29"	N21º 58'50.9" E96º 04'38.7"	N21º 57'45.5" E96º 04'33.8"
Altitude	48m	51m	50m
Distance from the PMD Karachi	approx. 2.3km	approx. 2.8km	approx. 3.3km
Direction from the PMD Karachi	340º	4º	9º
Approximate height difference	68m-68m+15m=14m Ground level is 15m higher than	45m-68m+17m=-6m Ground level is 17m higher than the	52m-68m+16m=0m Ground level is 16m higher than the

(Existing obstructive building height –planned height of radar antenna center: 68m + Ground level difference)	the PMD Karachi	PMD Karachi	PMD Karachi
Required radar antenna angle to eliminate the shadow area caused by the identified buildings	+1.2°	+0.7°	+0.8°

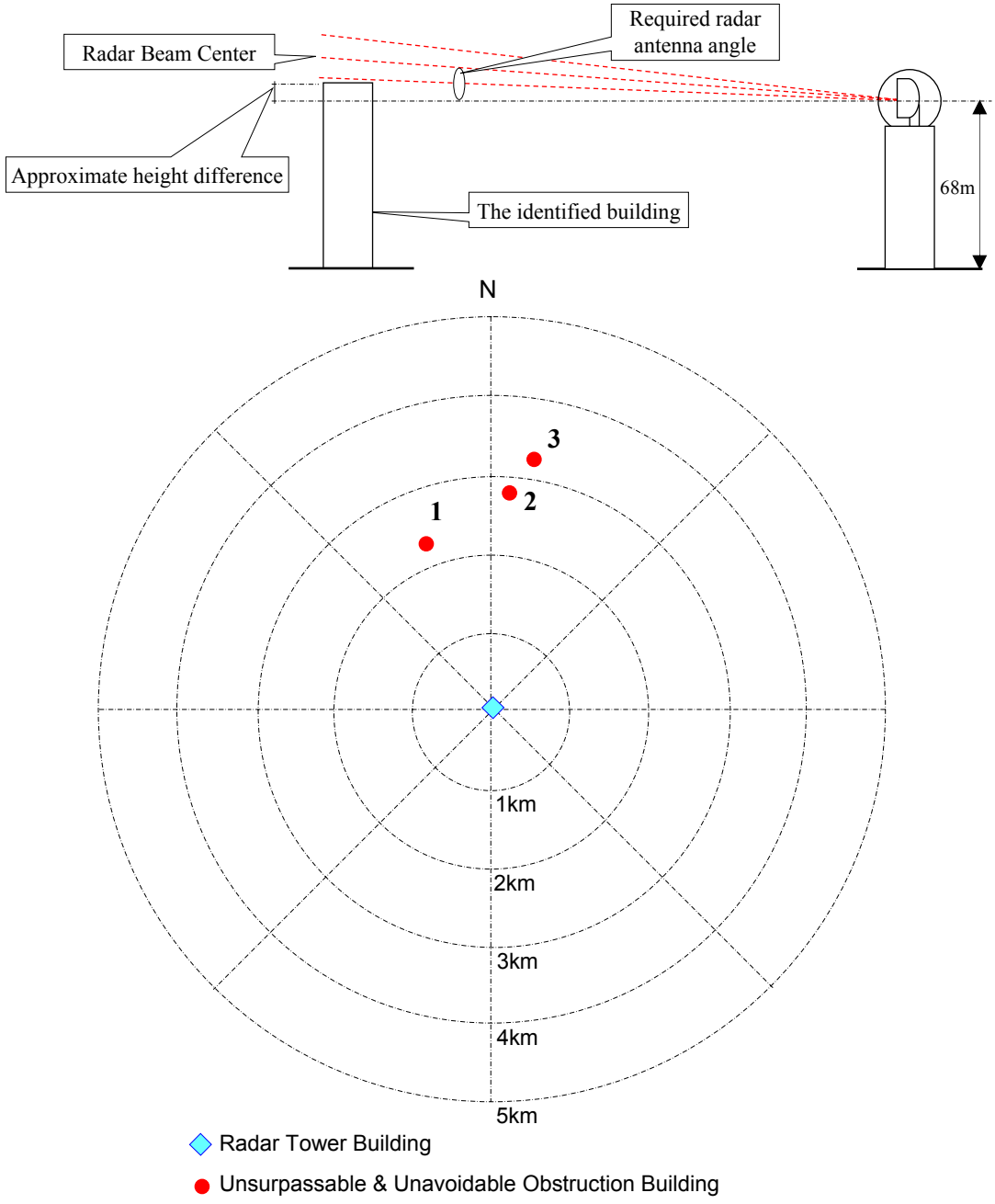


Figure14: Location Map of the Existing Obstructive Buildings around the PMD Karachi

It is technically possible to complement the shadow areas created by the existing obstructive buildings

indicated in the above table in the radar detection range with the CAPPI data.

II. Ground Level

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

III. Equipment Installation

In order to install all the equipment inside the radar equipment room, a large opening would be needed to allow equipment ingress. However, a large opening would be undesirable from the standpoint of air-tightness and dust proofing. The equipment will, therefore, be brought in via a loading balcony through the adjacent staircase room. For lifting the equipment, a lifting hook with a capacity of 2-tons will be installed on the upper part of this balcony.

[3] Elevation Plan

The structural columns and beams will extend outside the building, thereby, enhancing the building design. Given that the columns and beams will not intrude into the staircase, the staircase will be able to comfortably handle traffic in both directions.

[4] Internal and External Finishing Plan

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

a) Floor

The radar equipment room and the observation room will have an access floor with a clearance of 15cm for easy wiring of power and signal cables, trouble-free maintenance and simple future expansion. An 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 observation room and the radar equipment room, which are to be air-conditioned, are designed as cavity walls in which glass wool is sandwiched in between for heat insulation. Because of the thermal insulation provided by the building design, the recurrent electric power cost to the PMD for air-conditioning systems will be minimized.

c) Ceiling

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

d) Window

Since the sustained wind pressure to be used for the windows of the radar equipment room located at a height of 50m is expected to reach approximately 3,000 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.

Table22: Finishing Materials of the Proposed Meteorological Radar Tower Building

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

Table23: Bases for Adoption of Materials of the Proposed Meteorological Radar Tower Building

		Bases for adoption of materials	Procurement
Exterior Finishing	Roof Floor	Since external temperatures are high (reaching over 35 degrees), an insulation board t=30mm will be required. Asphalt waterproofing is the most reliable waterproofing material to be protected by protection concrete, cement sand mortal and cement tiles.	To be procured locally
	Walls	Reinforced concrete blocks will be applied. Concrete blocks are generally used locally and are considered highly reliable in terms of both ease and accuracy of construction.	
Interior Finishing	Floors	Materials will be selected on the basis of superior durability and ease of maintenance. Vinyl tiles around offices, corridors and staircases will be applied. In rooms where dust must be avoided, a dust-proof paint finish will be specified.	
		In the offices where computer systems will be installed, access floors shall be applied for cabling under the floor.	
	Walls	Cement sand mortal (trowel-coated) will be applied primarily for its durability, and vinyl paint will be applied to avoid dirt. Glazed ceramic tiles will be laid in the toilets and the slop sink booth.	
	Ceilings	In order to enhance the environment and efficiency of air-conditioning, non-asbestos acoustic mineral boards will be used. Other rooms which will not require any ceiling board will be directly applied with emulsion paint finish on the cement and sand mortal.	
Windows and Door	Exterior	Aluminum and steel will be chosen all throughout for reasons of durability, ease of handling and accuracy.	
	Interior	Wooden and steel with synthetic oil resin paint will be employed all throughout for its handling ease during construction and from a maintenance standpoint.	

[5] Structural Plan

I. Structural Design Standard

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

II. Soil Condition and Foundation Plan

To ensure radar observation accuracy, building robustness is important and the permissible horizontal deflection of the building must be not more than 0.075 degree. Due to this, the foundation structures must prevent the building differential settlement. The bearing layer, pile and foundation of the proposed radar tower building are indicated in the following table.

Table24: Bearing Layer, Pile and Foundation of the Proposed Meteorological Radar Tower Building

	Karachi Meteorological Radar Observation Station
Depth of Bearing Layer	33.63m
N value of Bearing Layer	Over 50
Piling	Required
Designed Pile Length	30.0m
Required Number of the Designed Pile	24
Diameter of the Designed Pile	1.2m
Foundation type	Pile foundation (cast in site concrete)

III. Structure Type

Reinforced concrete has been selected as the construction material for the proposed radar tower building. Floor slabs are to be 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.

Table25: Weight of Meteorological Radar System Unit

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

b) Live load

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

c) Wind load

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

Design wind pressure: $P=Ce\times Cq\times Iw\times Qs$ (kN/m^2)

Ce: Combined height, exposure and gust factor coefficient

Cp: Pressure coefficient for the structure

Iw: Importance Factor

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

- $P=2.16\times3.6\times1.15\times0.78=6.98kN/m^2 \approx 7kN/m^2$

  Ce=2.16 Cq=3.60 Iw=1.15 Qs=0.78

d) Seismic load

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

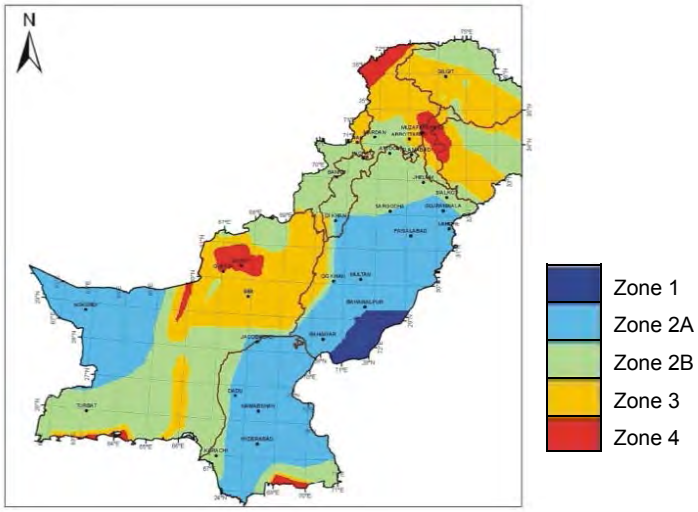


Figure15: Seismic Zoning Map of Pakistan

V. Structural Building Material

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

- Concrete (conventional concrete)
  : specified concrete strength Fc= 24N/mm^2 (Foundation to 8F slab)
  Fc= 21N/mm^2 (over 8F slab)
- Cement: American Society for Testing and Materials (ASTM) or equivalent
- Deformed reinforcing bars : ASTM A615 Grade 60 or equivalent

[6] Electrical Facility Design

I. Power intake facility

Table26: Power Intake Facility

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

II. Power generating facility

Table27: Power Generating Facility

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

III. Trunk line and power facility

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

Table28: Trunk Line and Power Facility

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

IV. Lighting and power outlet

The voltage required for lighting and the power sockets is a single-phase 230V and all the fixtures must be grounded. Steel pipes will be used for wiring conduits. Lighting fixtures will be mainly LED, primarily for their low power consumption, though incandescent fixtures will also be used to some extent, depending on the particular situation. Lighting levels in the various rooms will be approximately as shown below.

Table29: Approximate Lighting Levels in the Various Rooms

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

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

V. Telephone system

A service terminal box, 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 observation room) and outside of the building entrance.

VII. Alarm system

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

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

VIII. Grounding system

Grounding cables for the equipment installed on the 2nd 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 observation room.

[7] Water Supply, Drainage and Sanitary Fixture Design

I. Water supply system

Public water supply is available in the PMD Karachi Centre so a water supply gate valve will be installed for water inflow to the proposed radar tower building. To supply public water to the proposed radar tower building, a pump room with a water reservoir tank and feed pumps are required.

II. Drainage system

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

III. Sanitary fixtures

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

IV. Fire extinguisher

Fire extinguishers will be supplied in the following rooms.

Table30: Fire Extinguisher

	Karachi Meteorological Radar Tower Building
Radome Room	CO_2 type
Radar Equipment Room	CO_2 type
Observation Room	CO_2 type
Engine Generator Room	ABC type
Electricity & Power Supply Room	CO_2 type
Pump Room	CO_2 type
Tea Kitchen	ABC type

[8] Air-conditioning and Ventilation System Design

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

Table31: Air-conditioning and Ventilation System

	Karachi Meteorological Radar Tower Building
Radome Room	Fan forced ventilation
Radar Equipment Room	Air-conditioning system Heat exchange system
Observation Room	Air-conditioning system Fan forced ventilation

Engine Generator Room	Fan forced ventilation
Electricity & Power Supply Room	Air-conditioning system Fan forced ventilation
Pump Room	Fan forced ventilation
Shower Room	Fan forced ventilation
Toilet (M & F)	Fan forced ventilation
Tea Kitchen	Fan forced ventilation

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

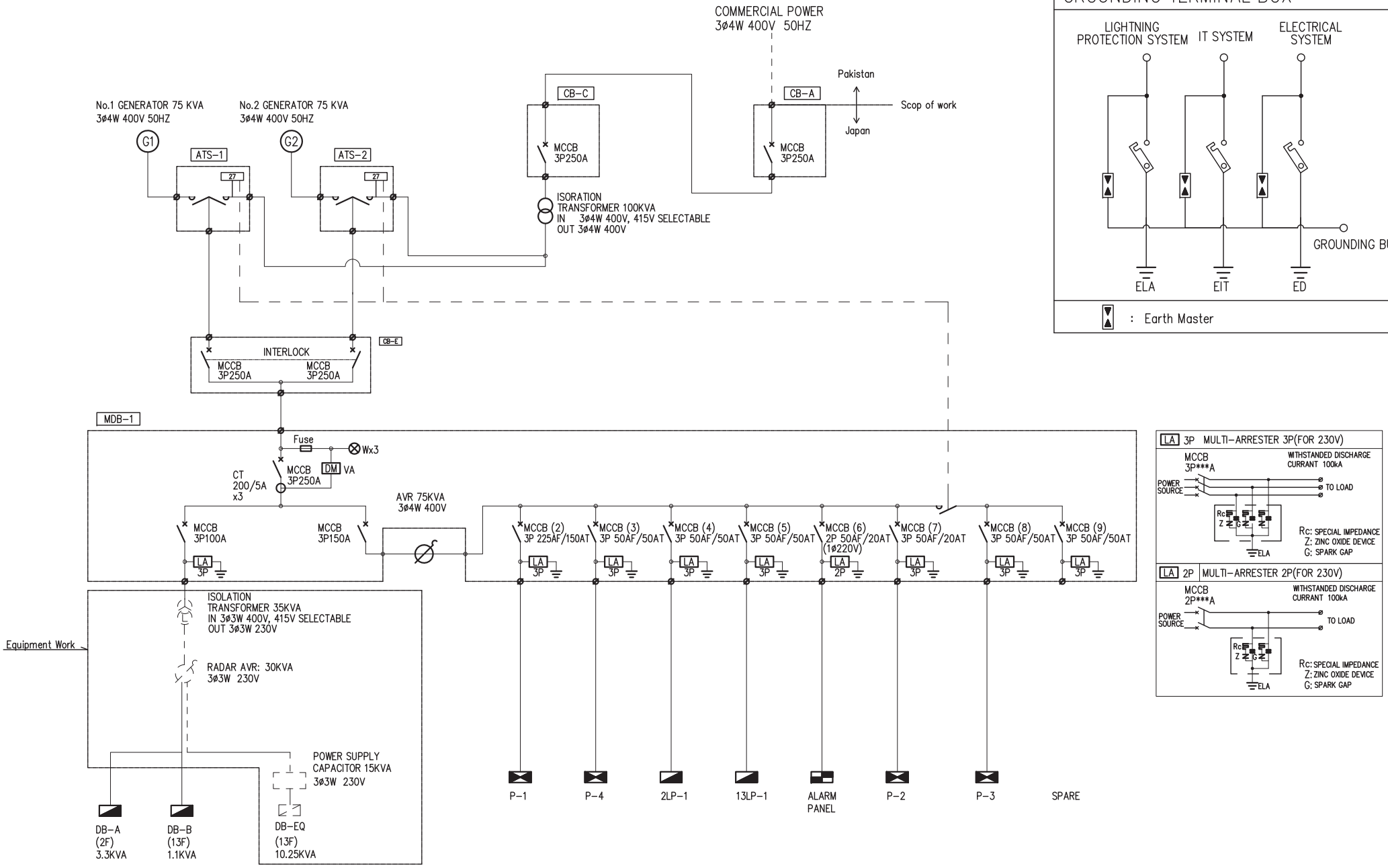
<Environmental conditions>

- Outside condition: 33°C (maximum temperature: 44°C)
- Indoor condition: temperature 26°C humidity 40-60%
  In the radar equipment room and the electricity & power supply room: temperature 25°C humidity 40-60%

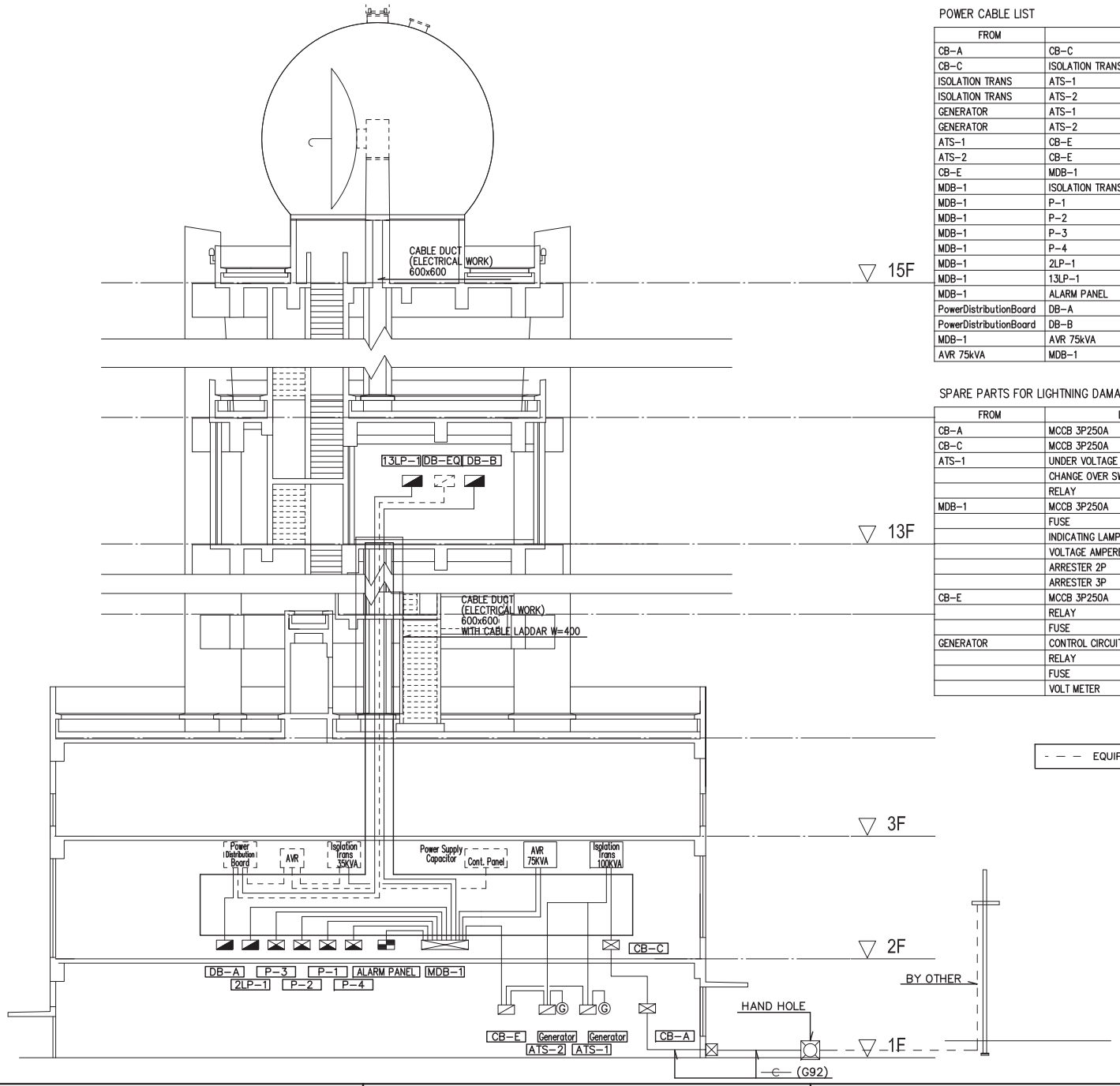
The following diagrams of the building equipment plan for the meteorological radar tower building can be found in the subsequent pages immediately hereafter.

<Karachi 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



Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI 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 100KVA	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ATS-1	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ATS-2	CB-E	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
CB-E	MDB-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
MDB-1	ISOLATION TRANS 35KVA(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	13LP-1	XLPE/PVC 4C-16sq +E16sq	(G40) / CABLE LADDAR
MDB-1	ALARM PANEL	XLPE/PVC 2C- 6sq +E 6sq	(G32) / CABLE LADDAR
PowerDistributionBoard	DB-A	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDAR
PowerDistributionBoard	DB-B	XLPE/PVC 2C-10sq +E10sq	(G40) / CABLE LADDAR
MDB-1	AVR 75kVA	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDAR
AVR 75kVA	MDB-1	XLPE/PVC 1C-4x95sq +E50sq	(G70) / CABLE LADDAR

SPARE PARTS FOR LIGHTNING DAMAGE LIST

FROM	DESCRIPTION	UNIT
CB-A	MCCB 3P250A	1
CB-C	MCCB 3P250A	1
ATS-1	UNDER VOLTAGE RELAY	1
	CHANGE OVER SWITCH	1
	RELAY	4
MDB-1	MCCB 3P250A	1
	FUSE	6
	INDICATING LAMP	3
	VOLTAGE AMPERE INDICATOR	1
	ARRESTER 2P	2
	ARRESTER 3P	7
CB-E	MCCB 3P250A	1
	RELAY	4
	FUSE	4
GENERATOR	CONTROL CIRCUIT BOARD	1
	RELAY	4
	FUSE	4
	VOLT METER	1

- - - EQUIPMENT WORK

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THE PROJECT FOR INSTALLATION OF
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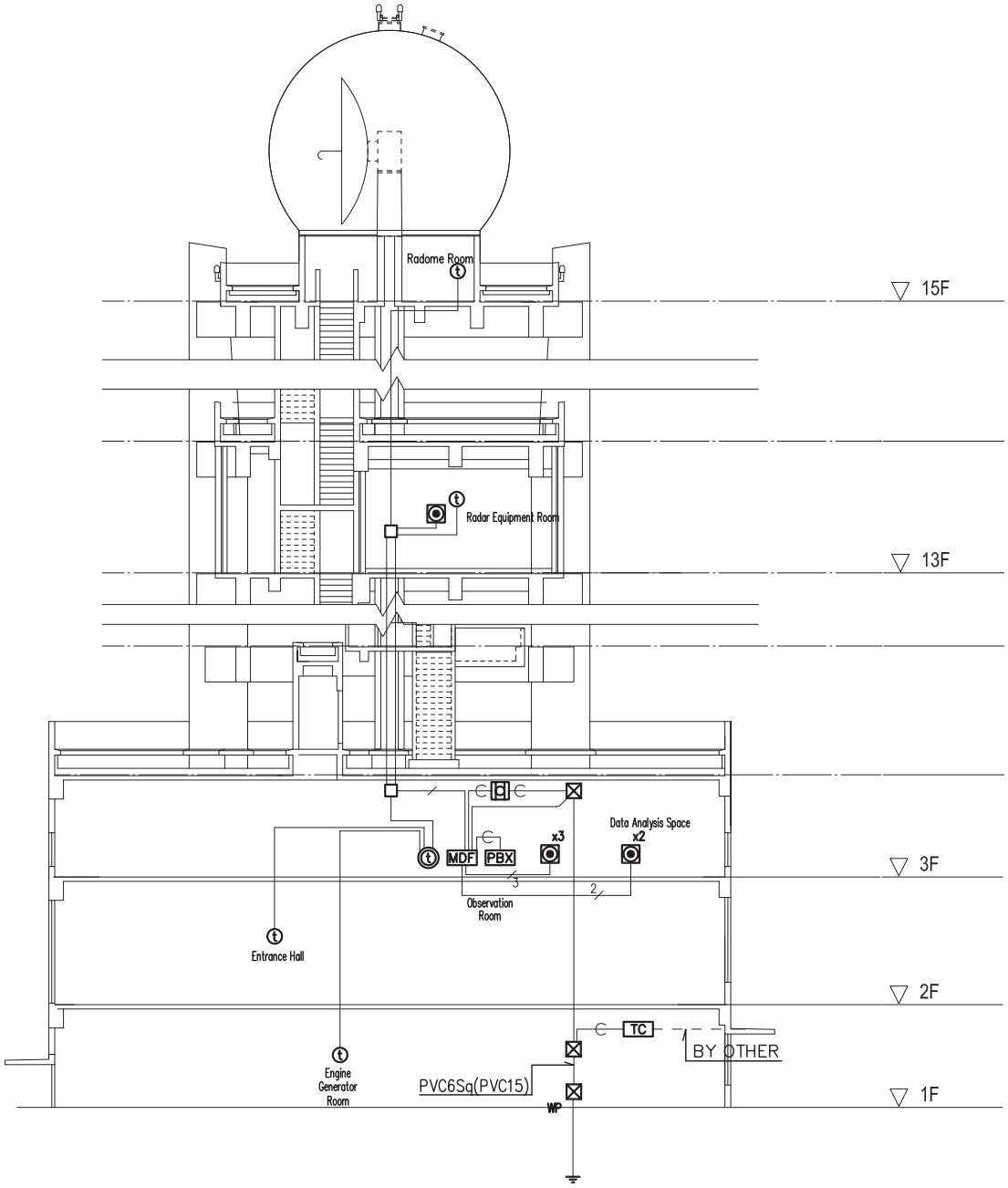
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
KARACHI 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

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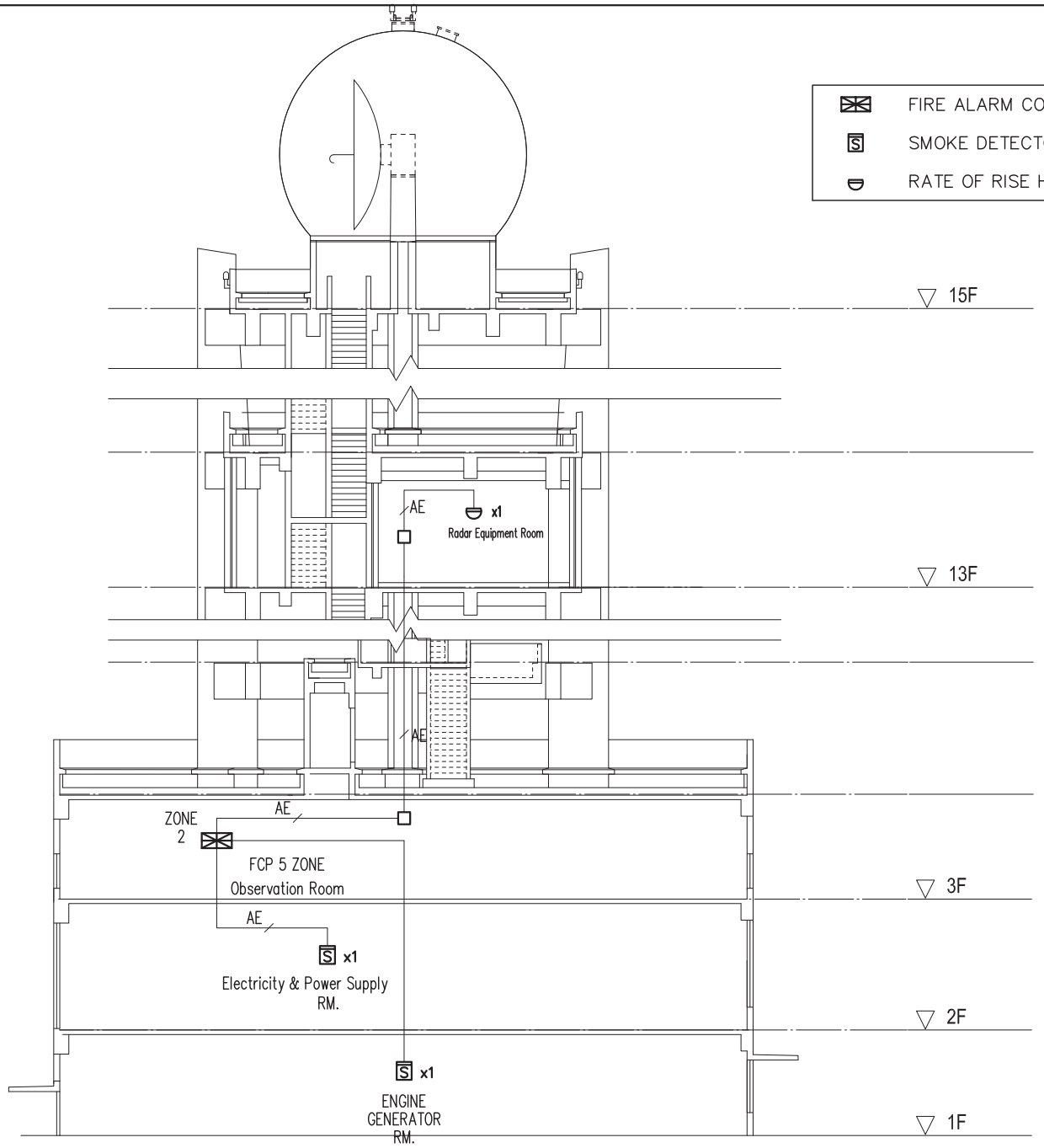
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
INTERPHONE & TEL SYSTEM

SCALE
NONE

DRAWING No.
SD - 03



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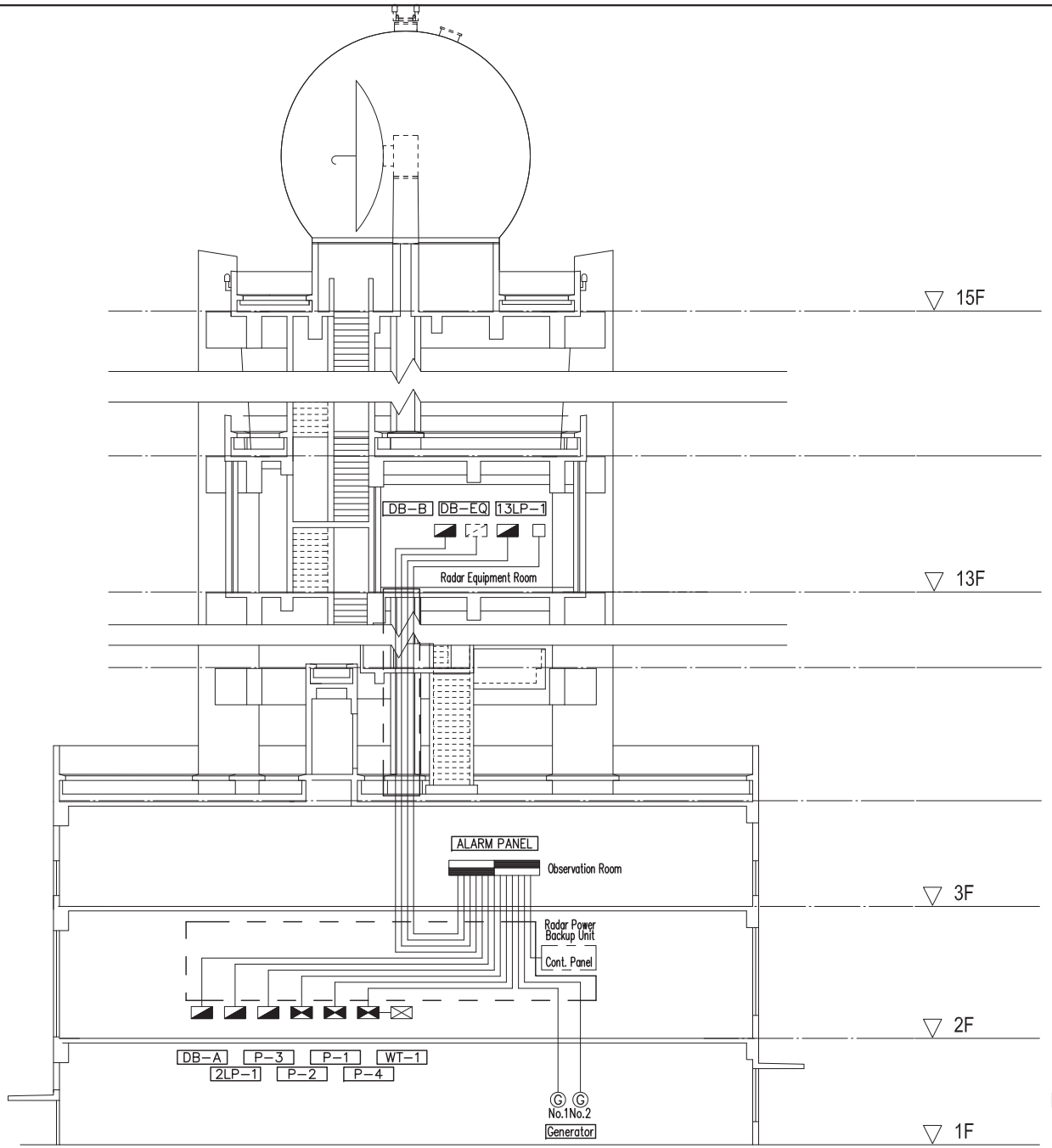
			DRAWING No. SD - 04



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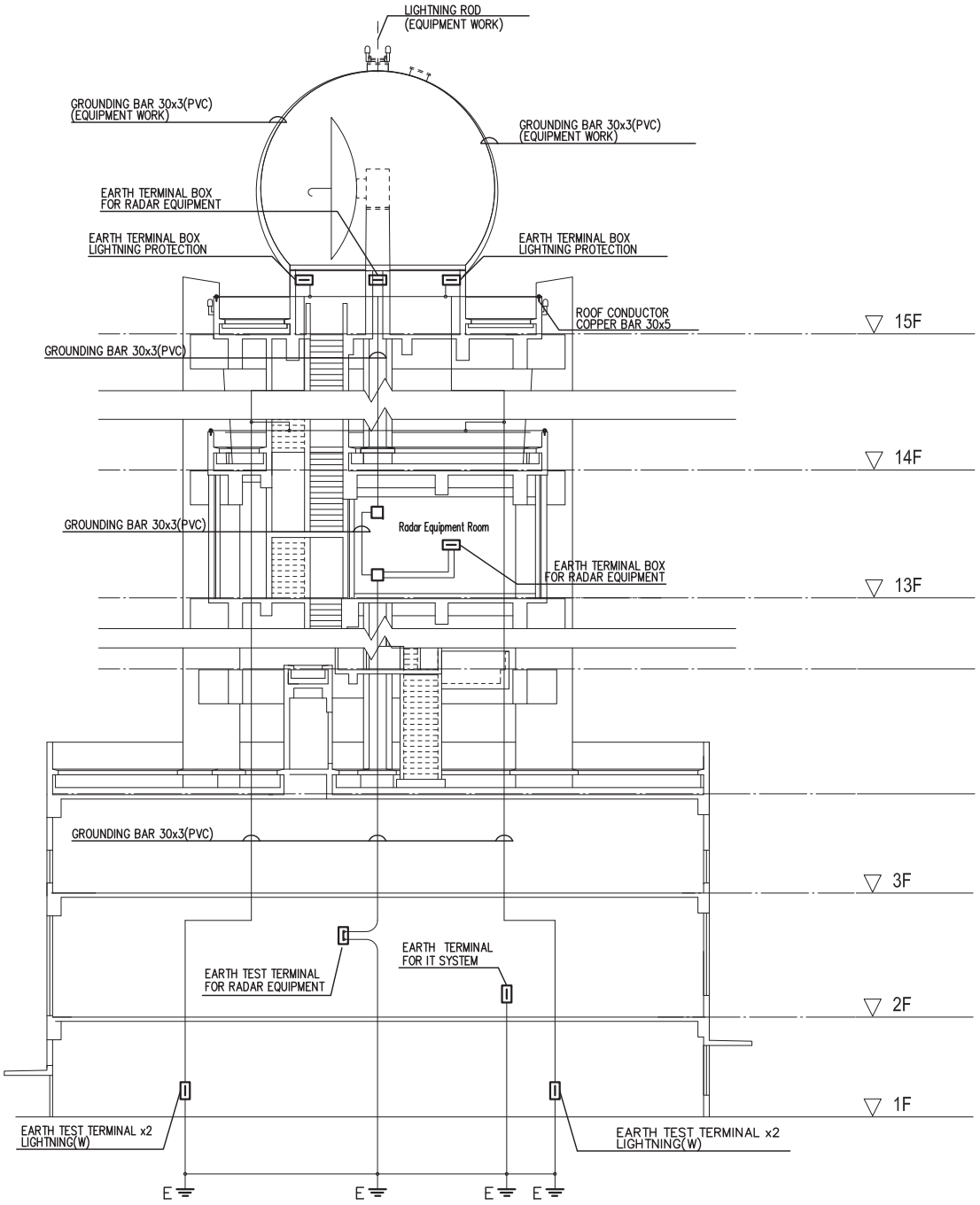

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THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
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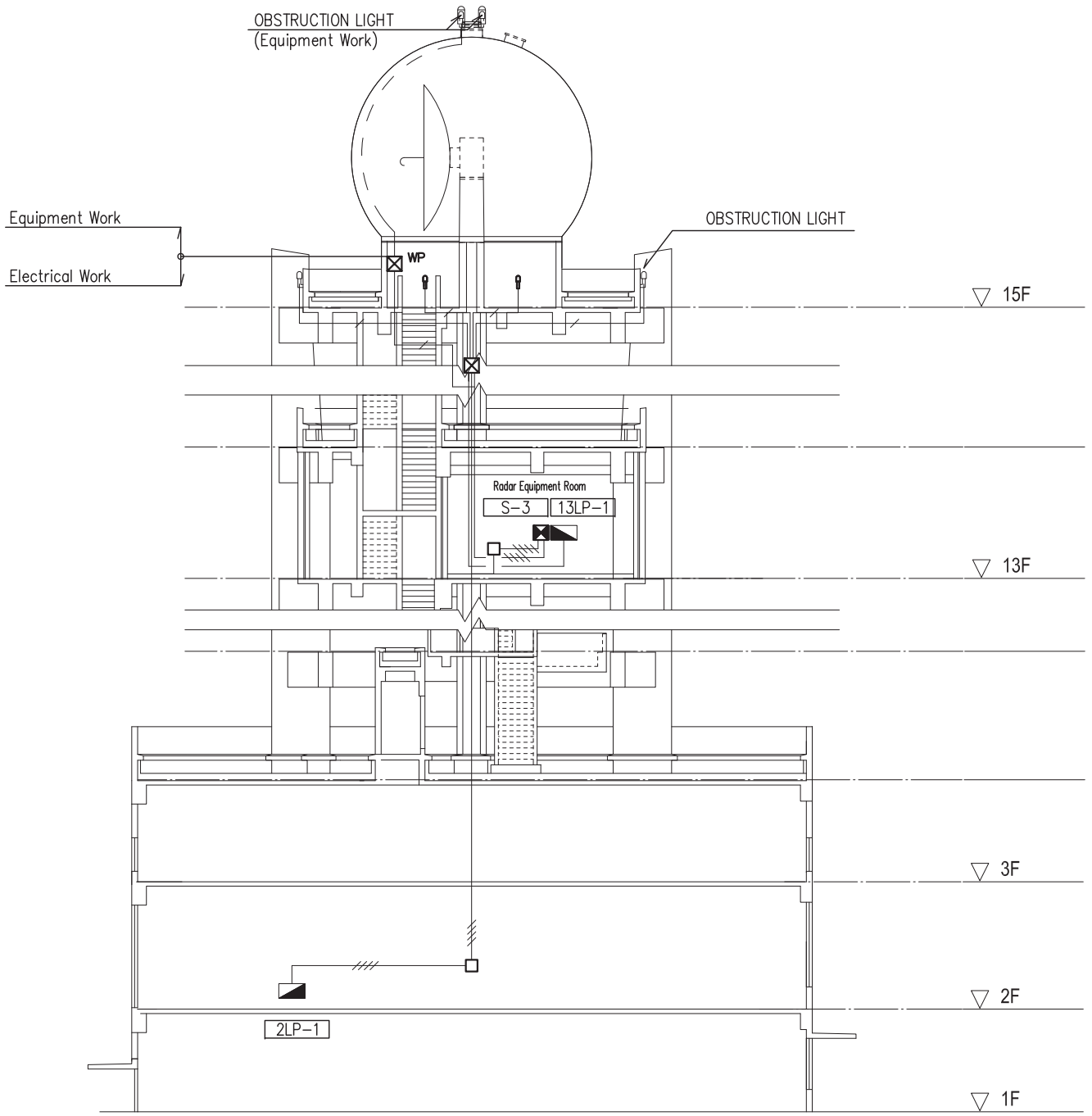
DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
LIGHTNING PROTECTION
& GROUNDING SYSTEM

SCALE
NONE

DRAWING No.
SD - 06



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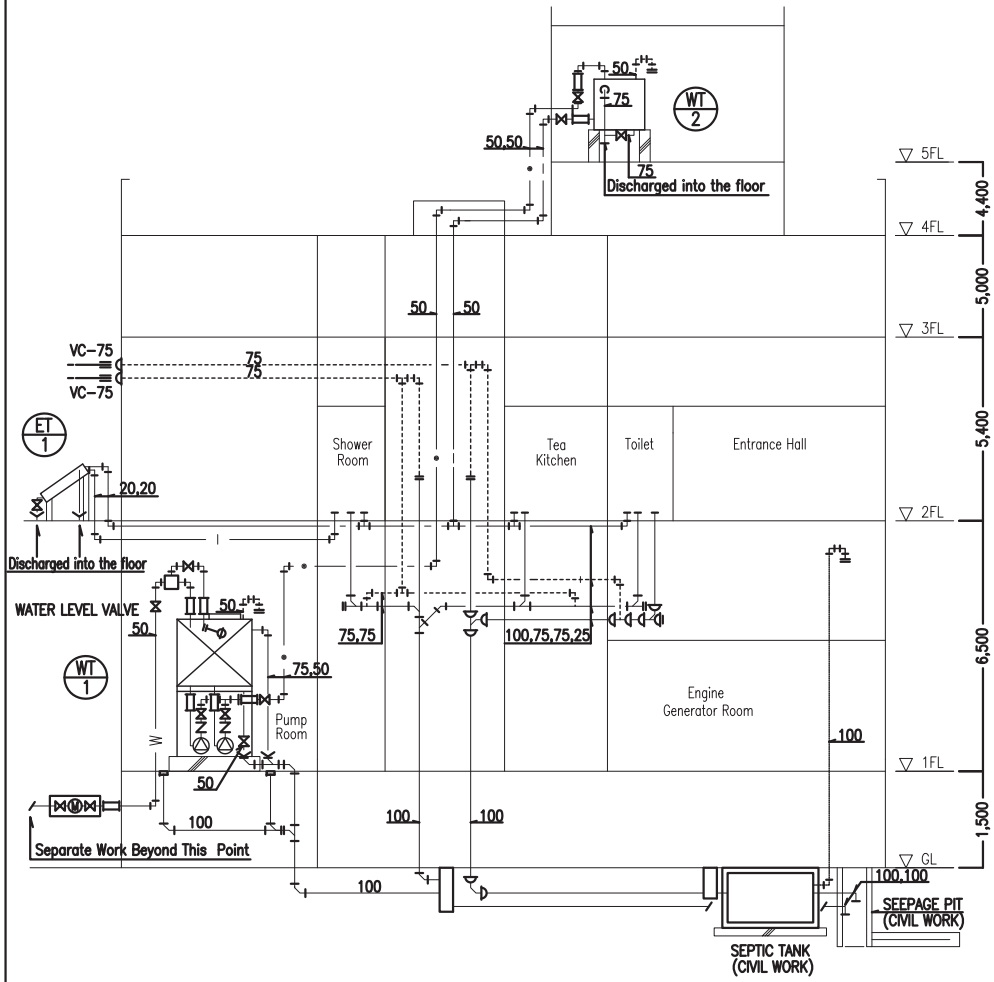

ITEM	1F	2F					TOTAL	REMARK
	PUMP ROOM	TOILET(M)	TOILET(F)	SHOWER ROOM	TEA KITCHEN	SERVICE		
WATER CLOSET		1	1				2	
LAVATORY		1	1				2	
PAPER HOLDER		1	1				2	
FAUCET	1	1	1		1	1	5	
MIRROR		1	1				2	
SHOWER HEAD				1			1	
KITCHEN SINK					1		1	
URINAL		1					1	
SERVICE SINK						1	1	

NO.	NAME	SPECIFICATION	Q'TY	POWER SUPPLY					LOCATION	REMARKS
				PHASE	VOLT (V)	FREQUENCY (Hz)	MOTOR (KW)	EMERGENCY POWER SUPPLY		
WT-1	POTABLE WATER	FPR Tank	1					O	Pump Room	RC FOUNDATION
	TANK / PUMP	Rated capacity 2.5 m^3								(CIVIL WORK)
		Dimension 1,000 x 1,500 x 2,000H								1.8x1.8x0.3mH
		Accessories Manhole 600ø Breather								
		Ball tap 25A , overflow and drain pipe 40A								
		Electrode 4P								
		Constant pressure type pump	2	3	230	50	1.5			
		40 ø x 100 l/min x 270 kpa x 2 pcs (1 spare)								
		Accessories Flexible connector for suction 40A								
WT-2	POTABLE WATER	FRP tank	1						5FL Roof	RC FOUNDATION
	GRAVITY TANK	Rated capacity 1.5 m^3								(CIVIL WORK)
		Dimension 1,000 x 1,500 x 1,500H								0.4x1.4x0.5mH
		Earth quake proof 2.0G(Wind –Proof type)								
		Accessories Flat frame 150H,manhole 600 ø								
		Electrode 4P								
ET-1	Solar powered water	Model: Natural circulation method type	1						2F Out door	
	heater	Dimension:Collector 1002x2002x60 (Two pieces)								
		Water storage tank 465x2008x505								
		Heat to collect Area: 4.02m^2								
		Water storage volume: 200 LIT								
ABC	FIRE EXTINGUISHER	ABC Dry chemical, wall hang	2						Each room	
		10 Lbs Discharge time 14 sec								
CO2	FIRE EXTINGUISHER	Carbon dioxicide, wall hang	9						Each room	
		10 Lbs Discharge time 14 sec								
	SEPTIC TANK	Septic tank & Seepage pit (RC type, Civil work)	1						Out door	
	(CIVIL WORK)	Blower pump (Civil work)								

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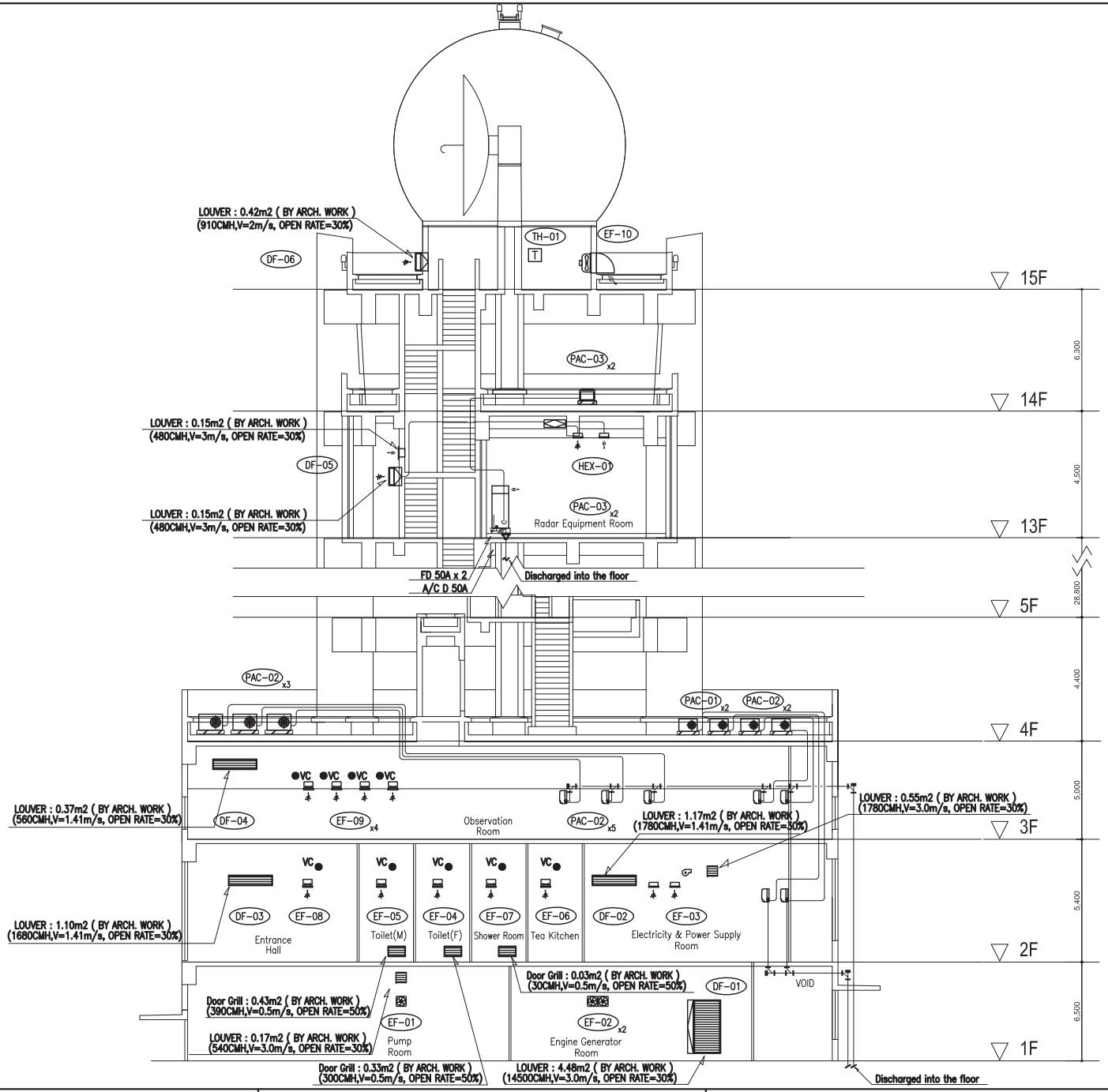
THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

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

SCALE
NONE

DRAWING No.
SD - 08



Consortium of
Japan Weather Association and
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THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
AIR-CONDITIONING & VENTILATION SYSTEM

SCALE
NONE

DRAWING No.
SD - 09

2-2-3 Outline Design Drawing

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

<PMD Karachi, Karachi Meteorological Radar Tower Building>

- Site Layout 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
- Floor Plan 9 : A-10
- Elevation 1 : A-11
- Elevation 2 : A-12
- Section : A-13

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

<PMD Islamabad Head Office, National Weather Forecasting Center>

- Equipment Layout Plan 4 : EQ-04

<PMD Karachi, Tropical Cyclone Warning Center>

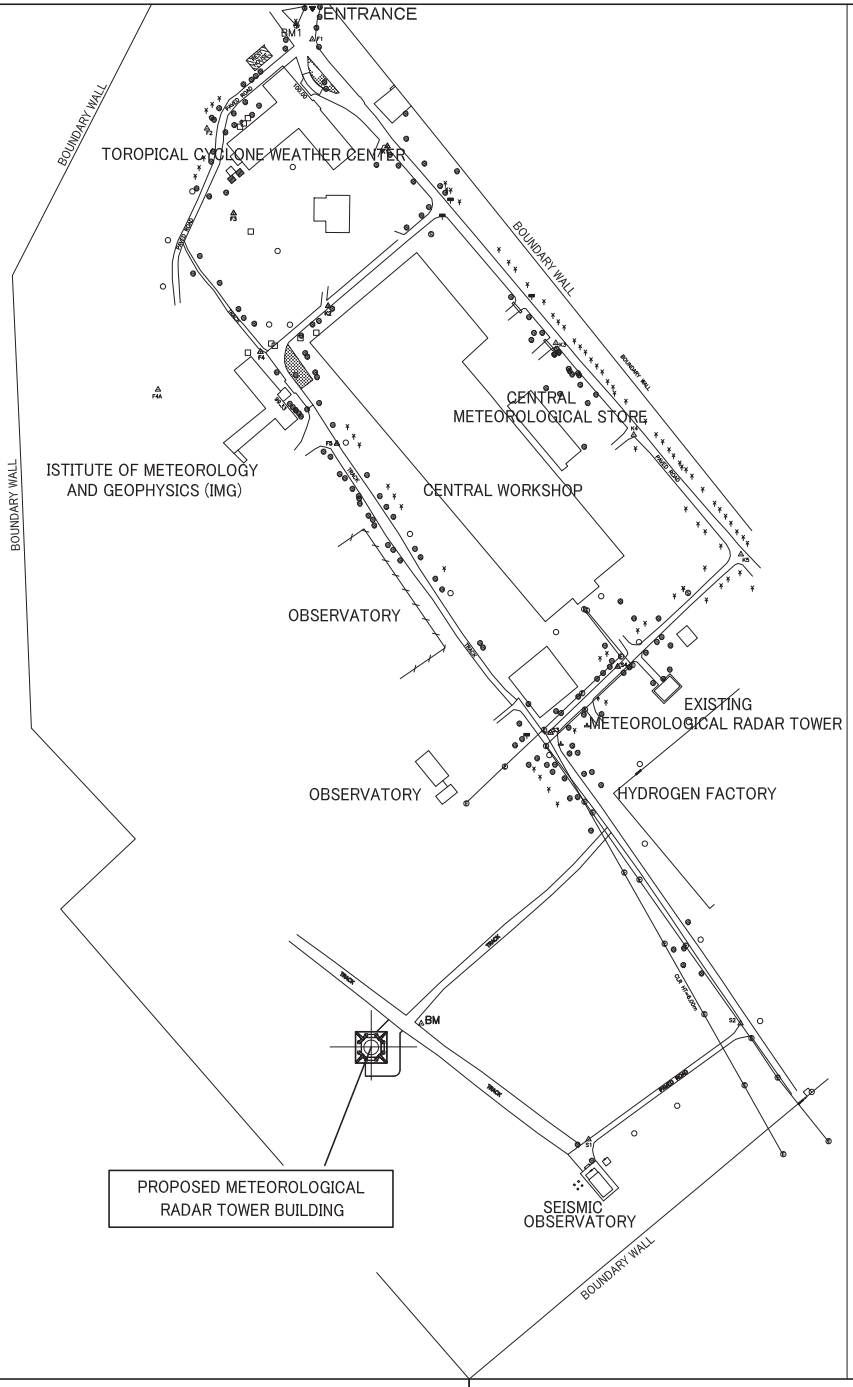
- Equipment Layout Plan 5 : EQ-05
- Equipment Layout Plan 6 : EQ-06

<Meteorological Office in Karachi International Airport>

- Equipment Layout Plan 7 : EQ-07

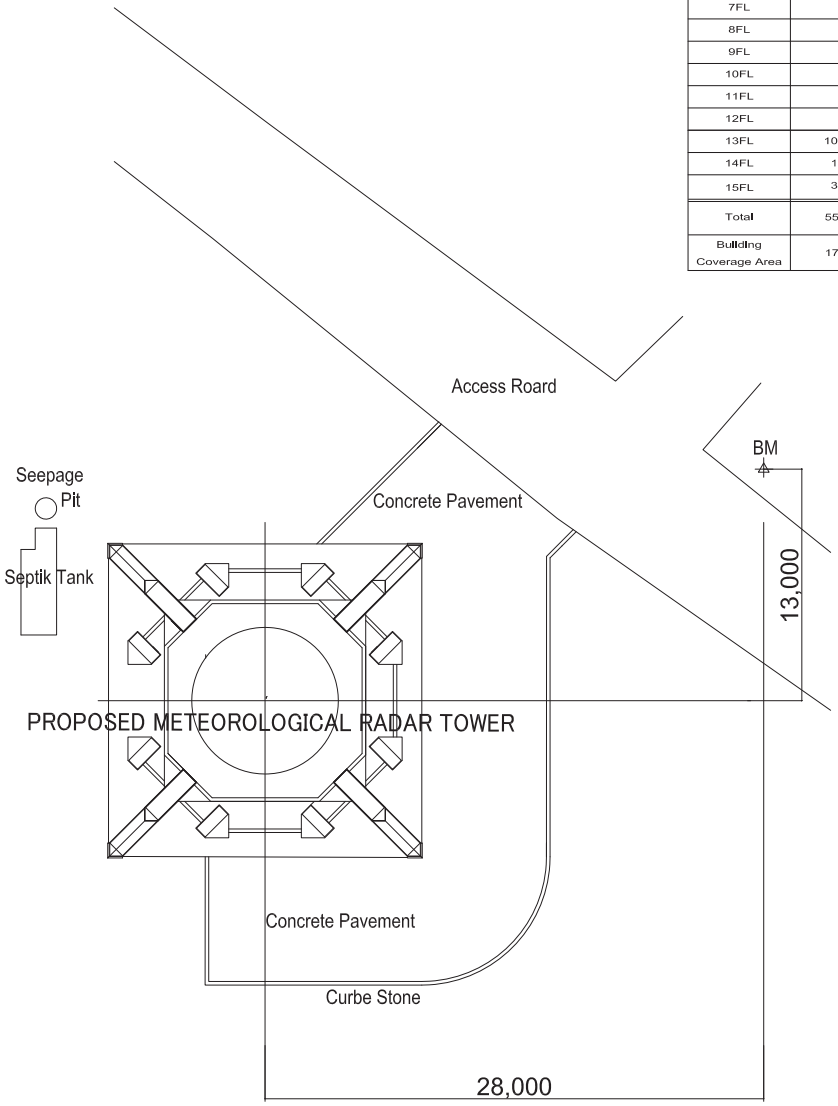
<PMD Lahore Flood Forecasting Division>

- Equipment Layout Plan 8 : EQ-08



Area Calculations

Floor	Floor Area (m2)	Construction Area (m2)
1FL	82.22	309.76
MPFL	-	69.00
2FL	125.00	309.76
3FL	176.18	309.76
4FL	16.59	309.76
5FL	-	169.00
6FL	-	169.00
7FL	-	169.00
8FL	-	169.00
9FL	-	116.64
10FL	-	116.64
11FL	-	116.64
12FL	-	116.64
13FL	107.22	116.64
14FL	17.35	116.64
15FL	30.17	116.64
Total	554.73 m2	2,800.52 m2
Building Coverage Area	176.18 m2	-



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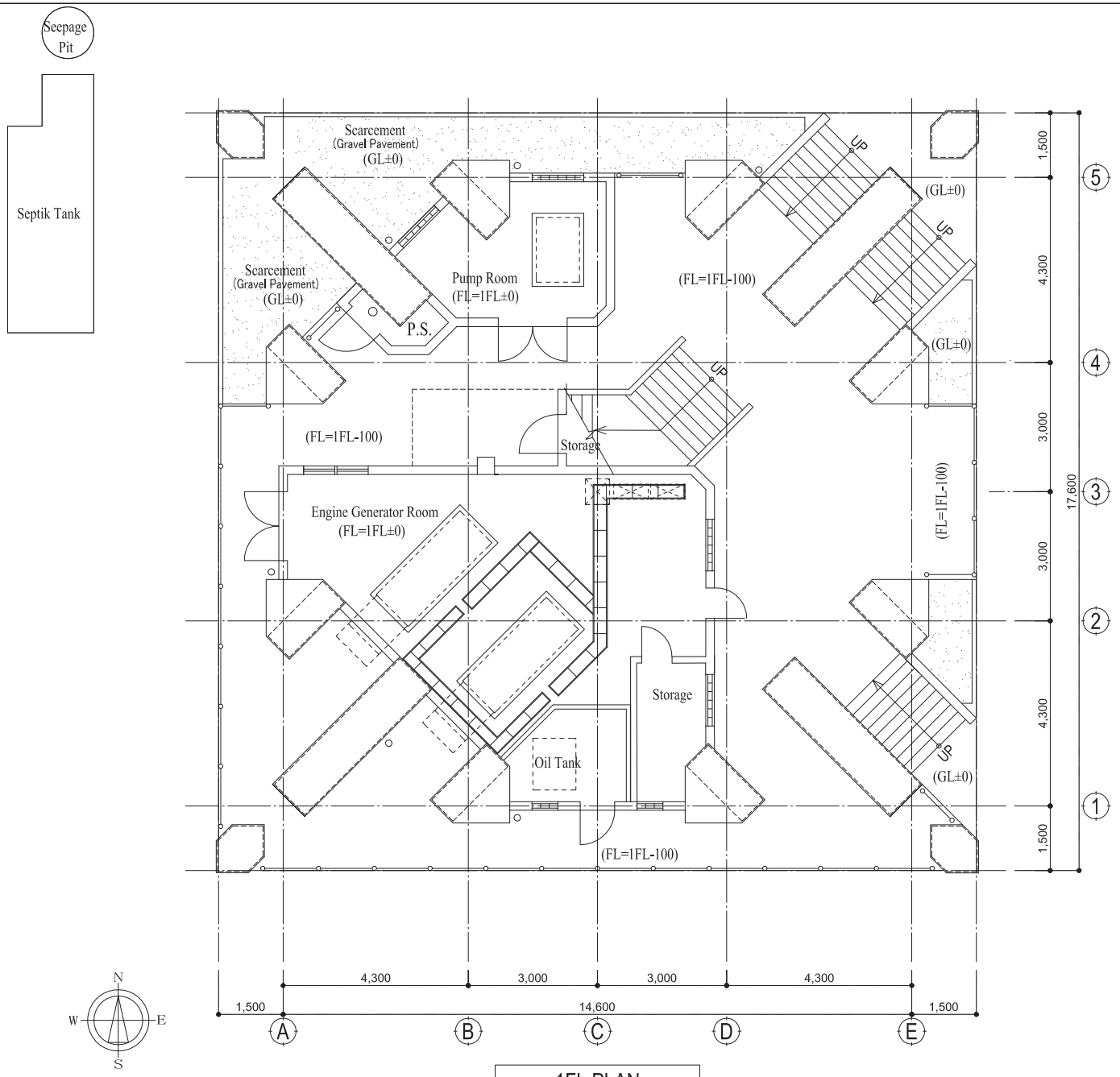
THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
SITE LAYOUT PLAN

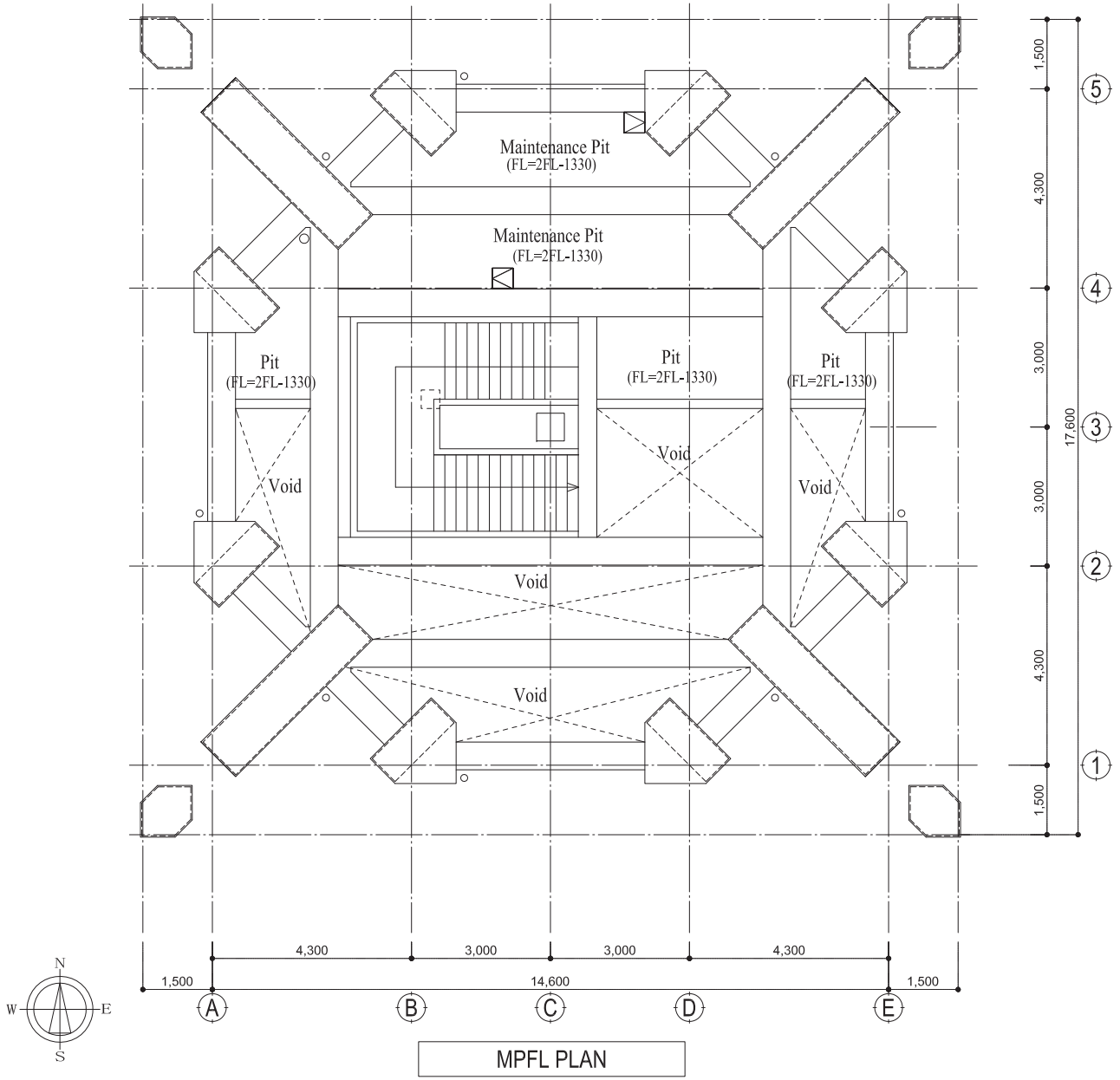
SCALE
1:3000
1:300

DRAWING No.
A - 01



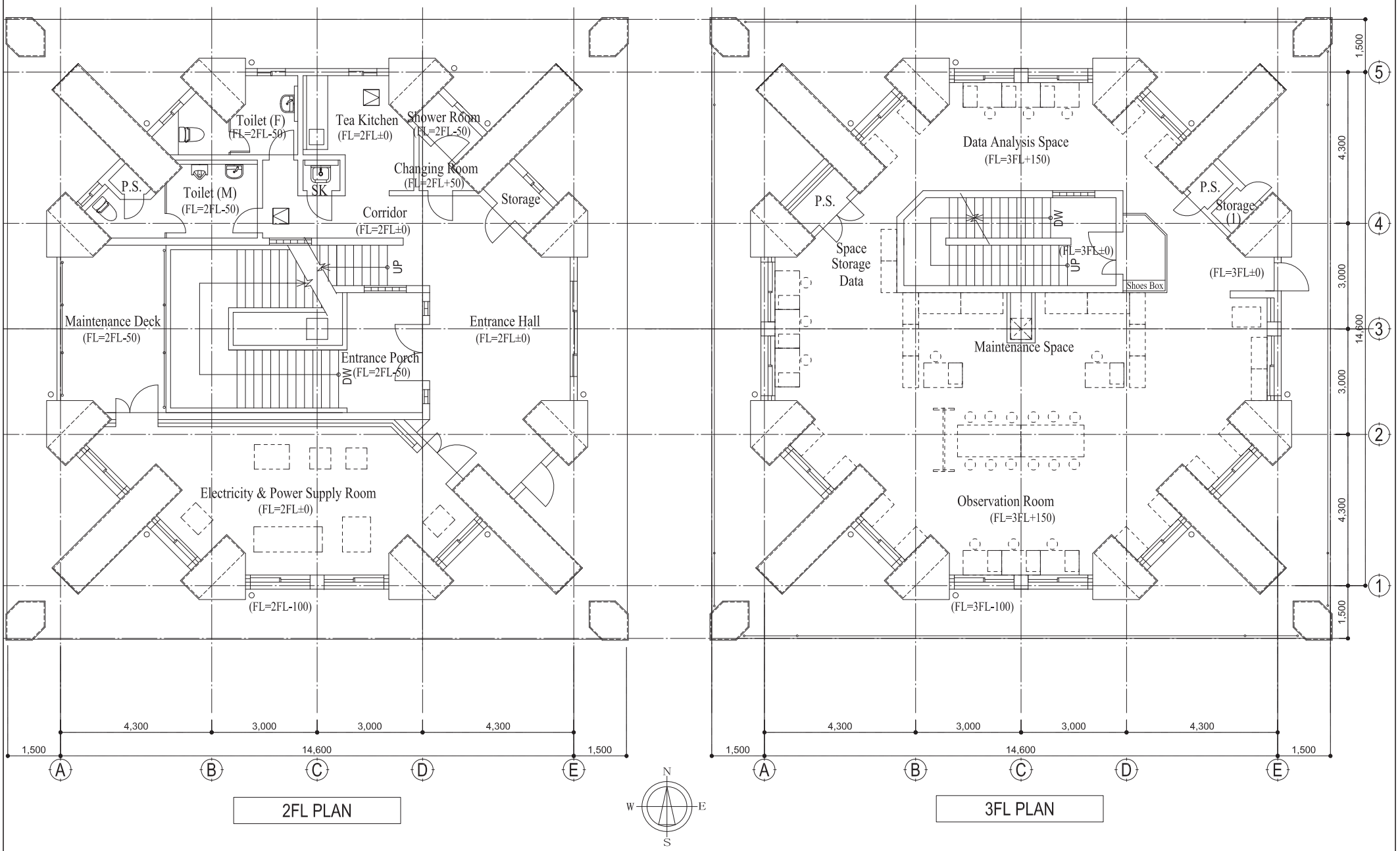
1FL PLAN

Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 1	SCALE 1:100	DRAWING No. A - 02

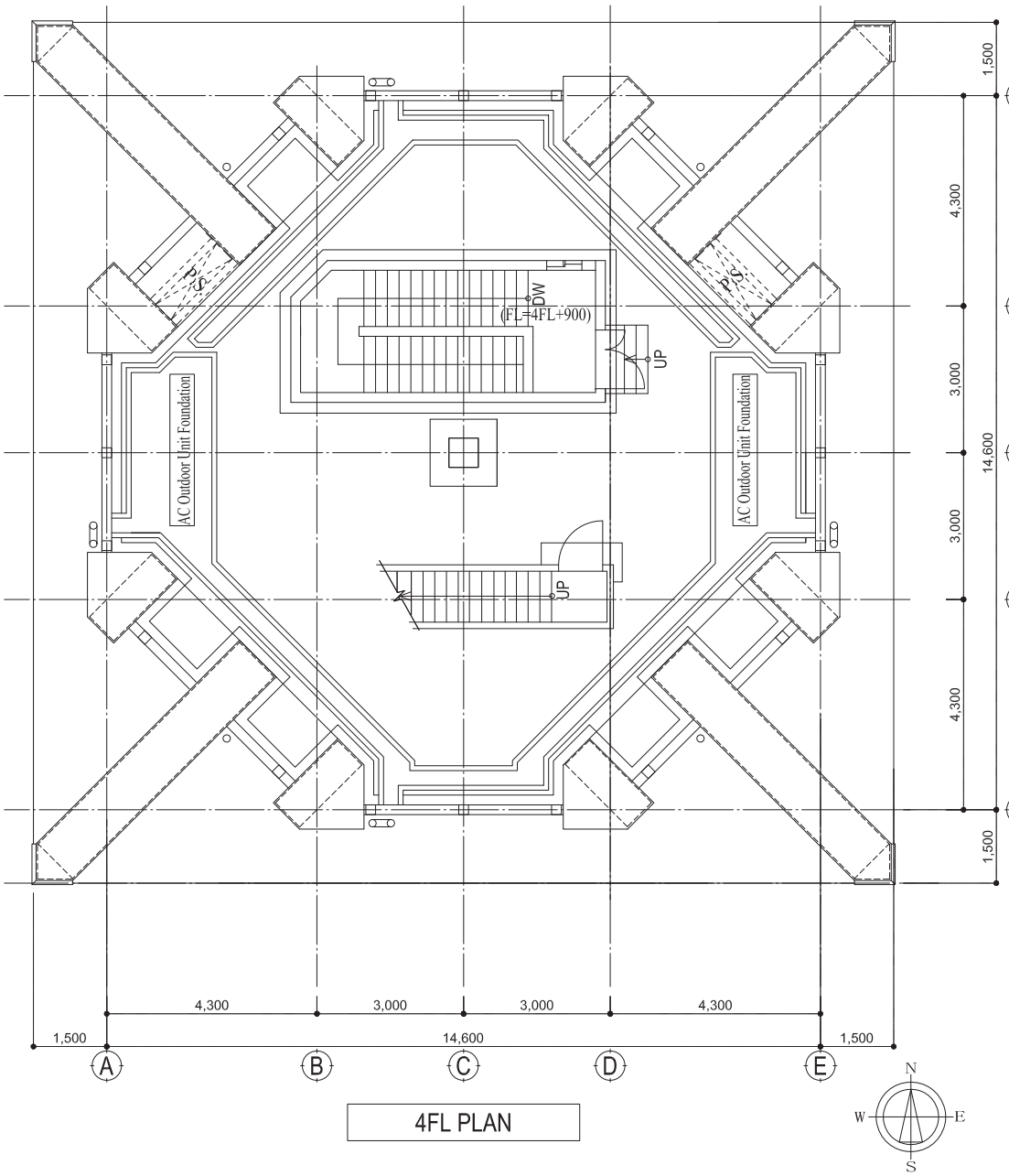


MPFL PLAN

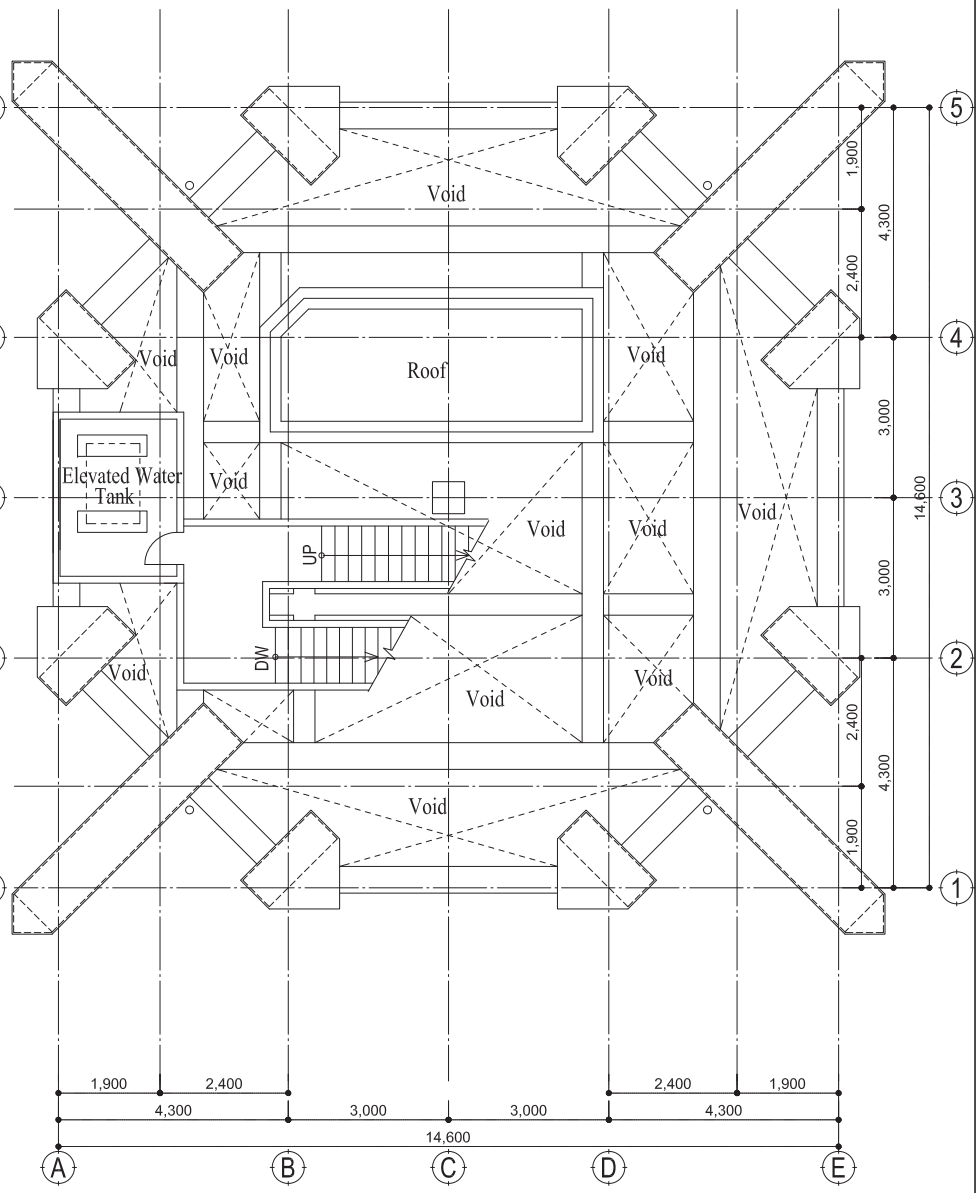
Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE: KARACHI METEOROLOGICAL RADAR TOWER BUILDING — FLOOR PLAN 2	SCALE: 1:100	DRAWING No.: A - 03



Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE: KARACHI METEOROLOGICAL RADAR TOWER BUILDING — FLOOR PLAN 3	SCALE: 1:100	DRAWING No.: A - 04

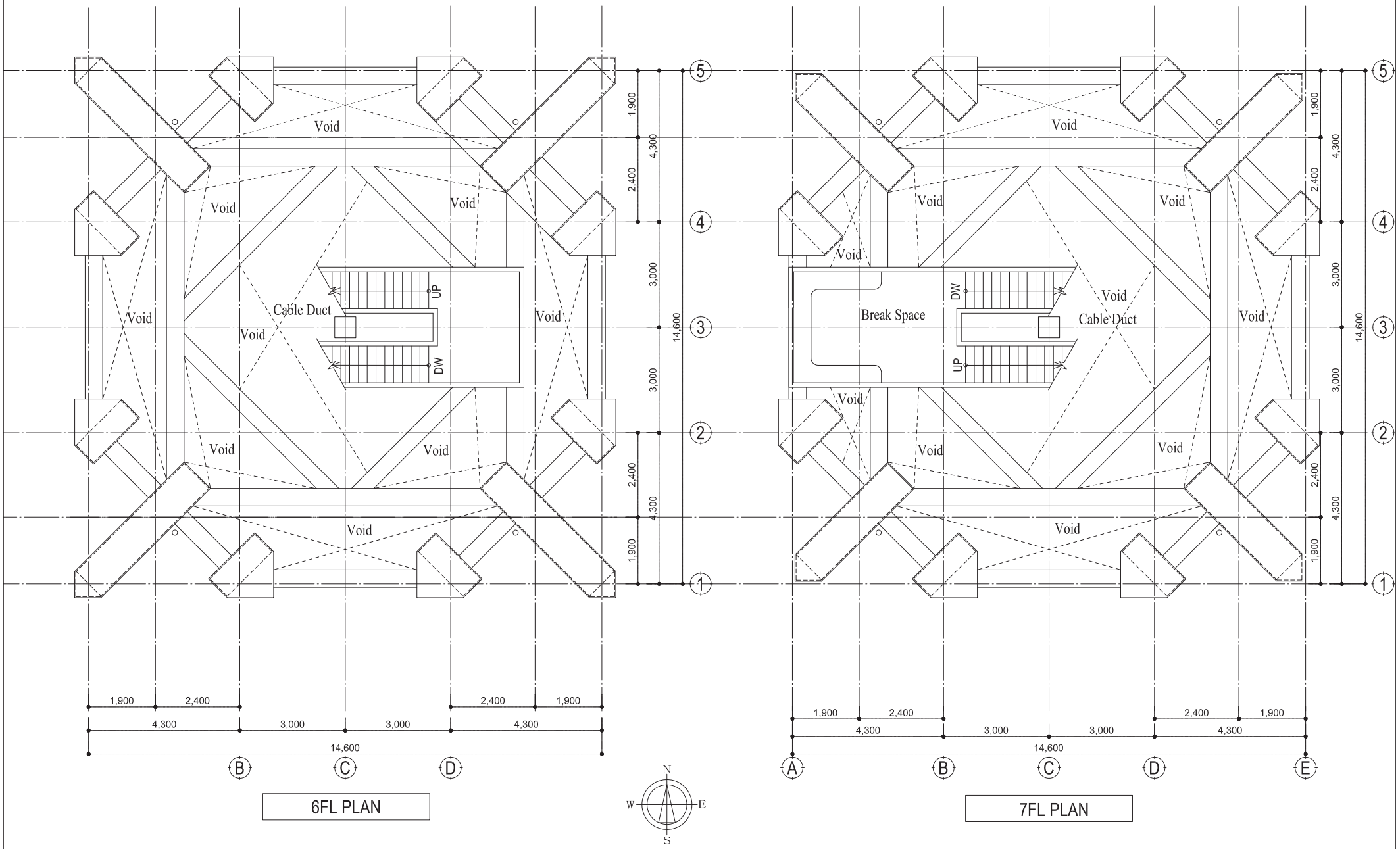


4FL PLAN



5FL PLAN

Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 4	SCALE 1:100	DRAWING No. A - 05



6FL PLAN

7FL PLAN

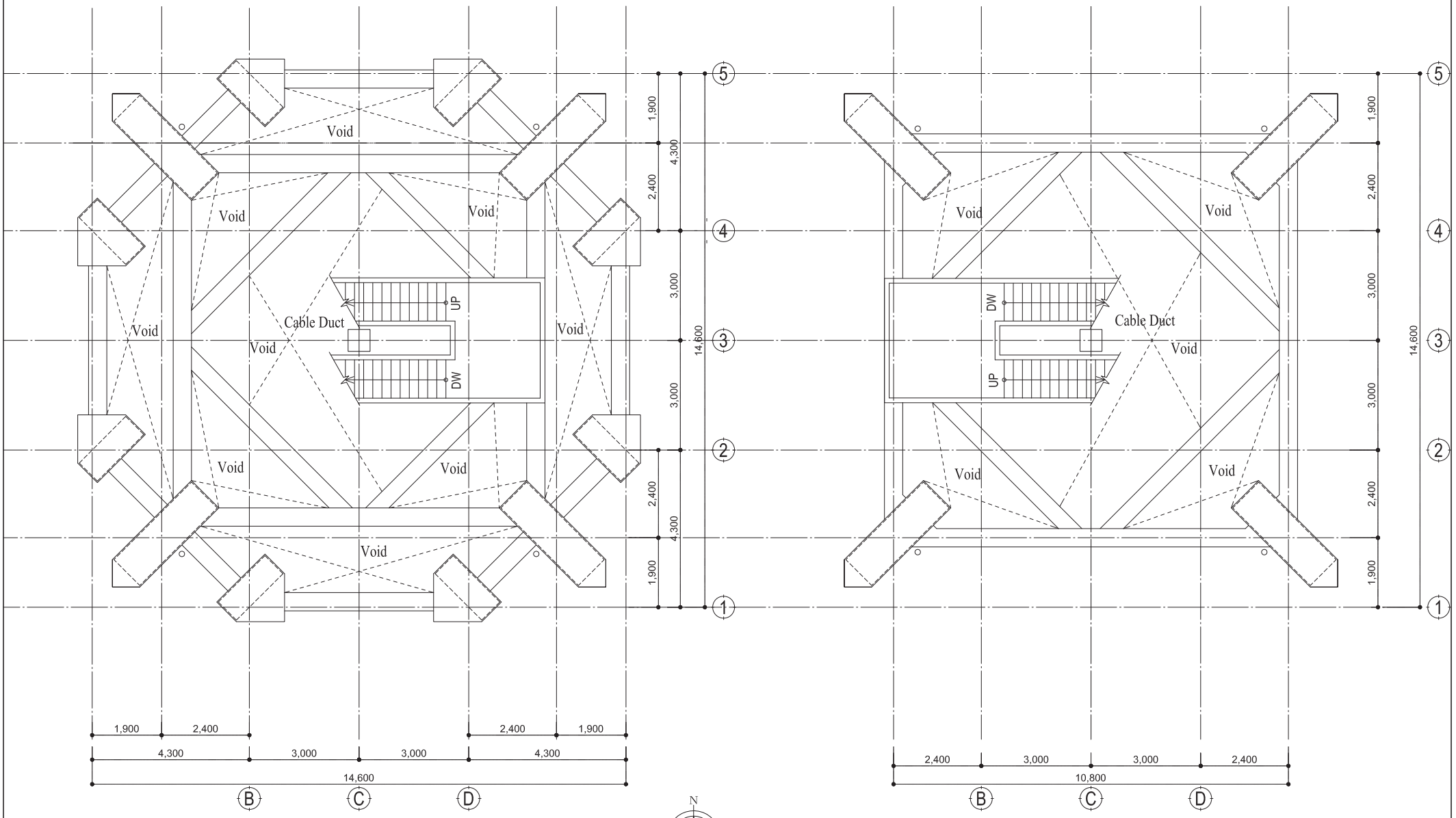
Consortium of
Japan Weather Association and
International Meteorological Consultant Inc.

THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

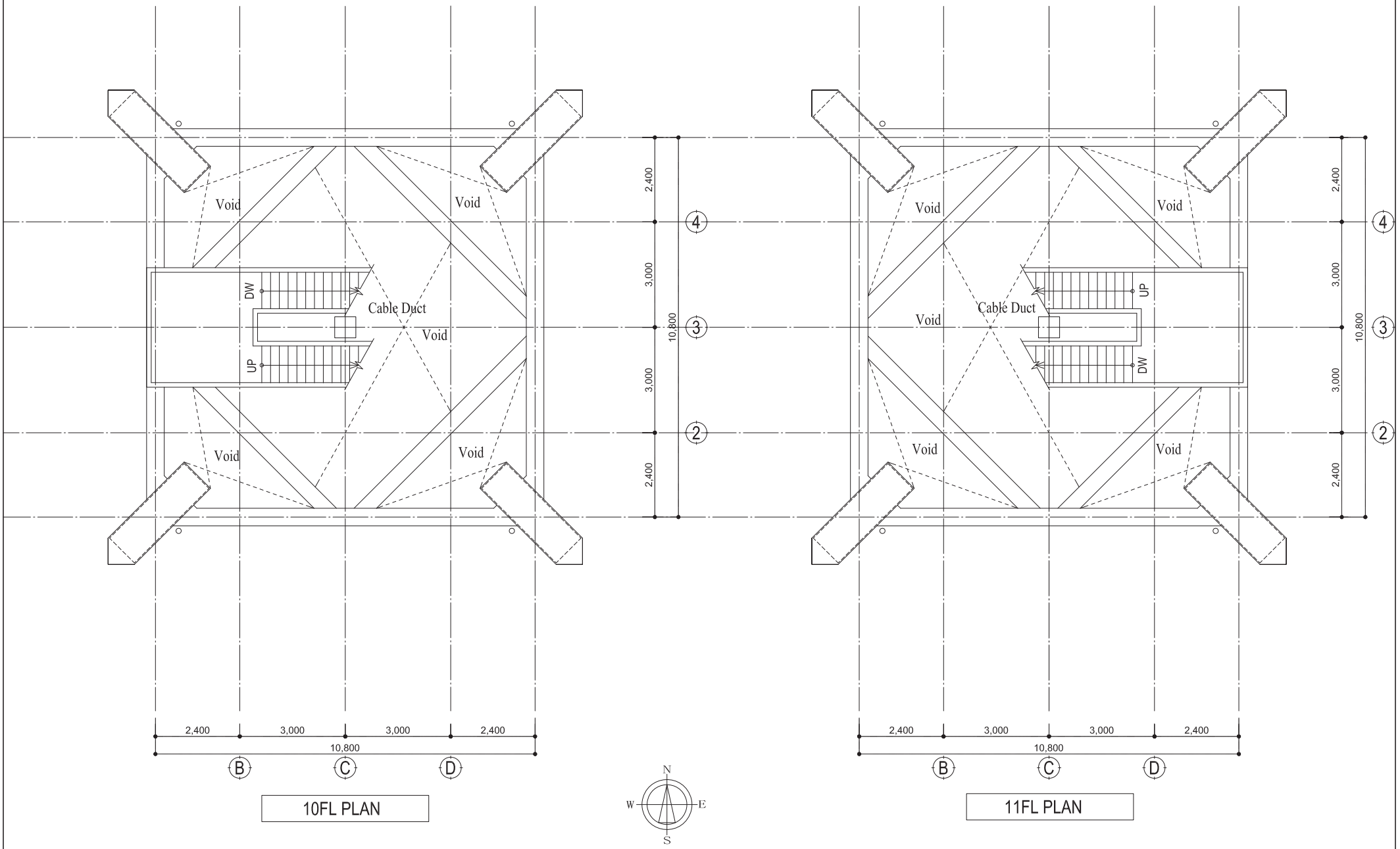
DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 5

SCALE
1:100

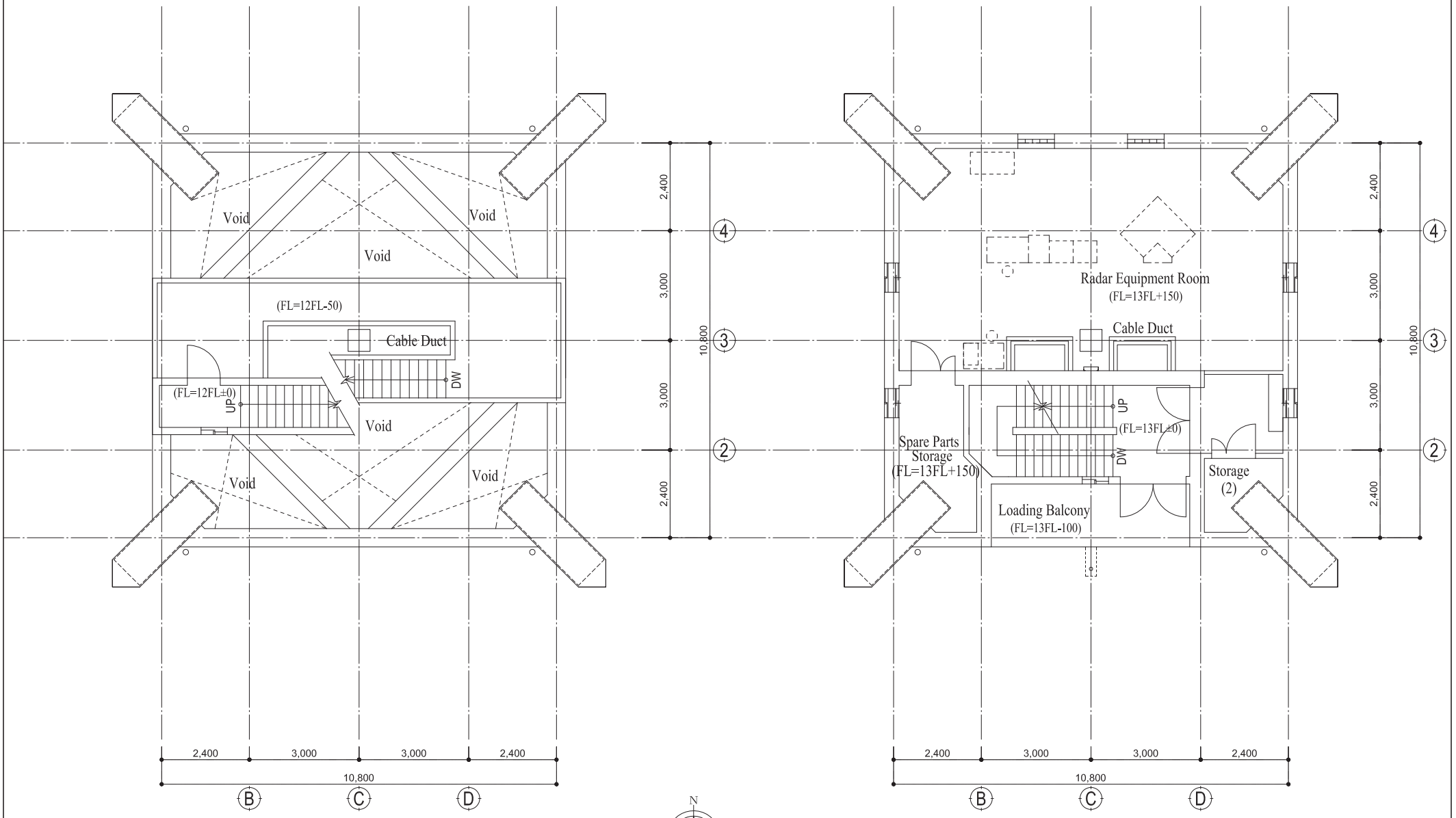
DRAWING No.
A - 06



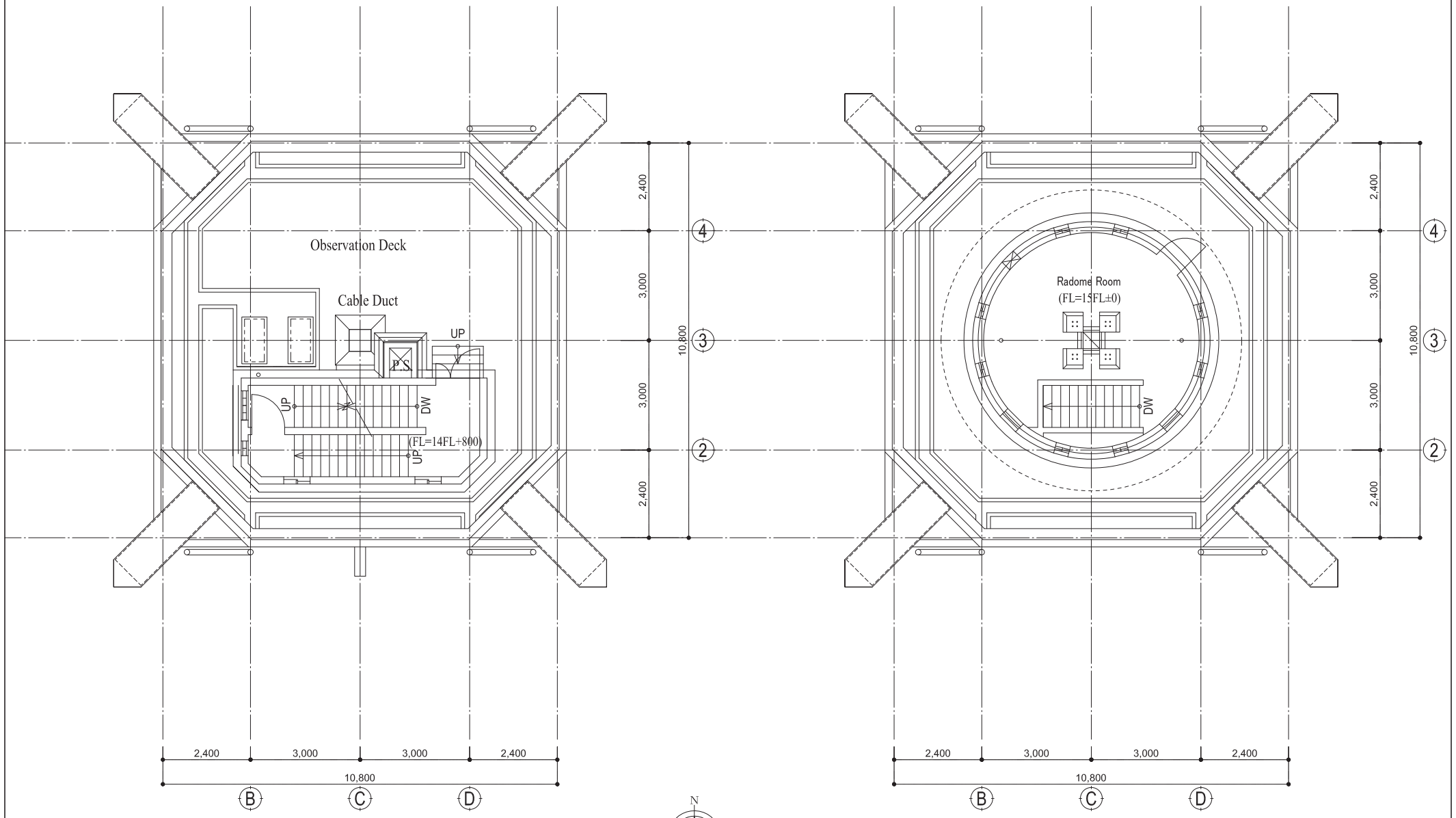
Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE: KARACHI METEOROLOGICAL RADAR TOWER BUILDING — FLOOR PLAN 6	SCALE: 1:100	DRAWING No.: A - 07



Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 7	SCALE 1:100	DRAWING No. A - 08



Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 8	SCALE 1:100	DRAWING No. A - 09



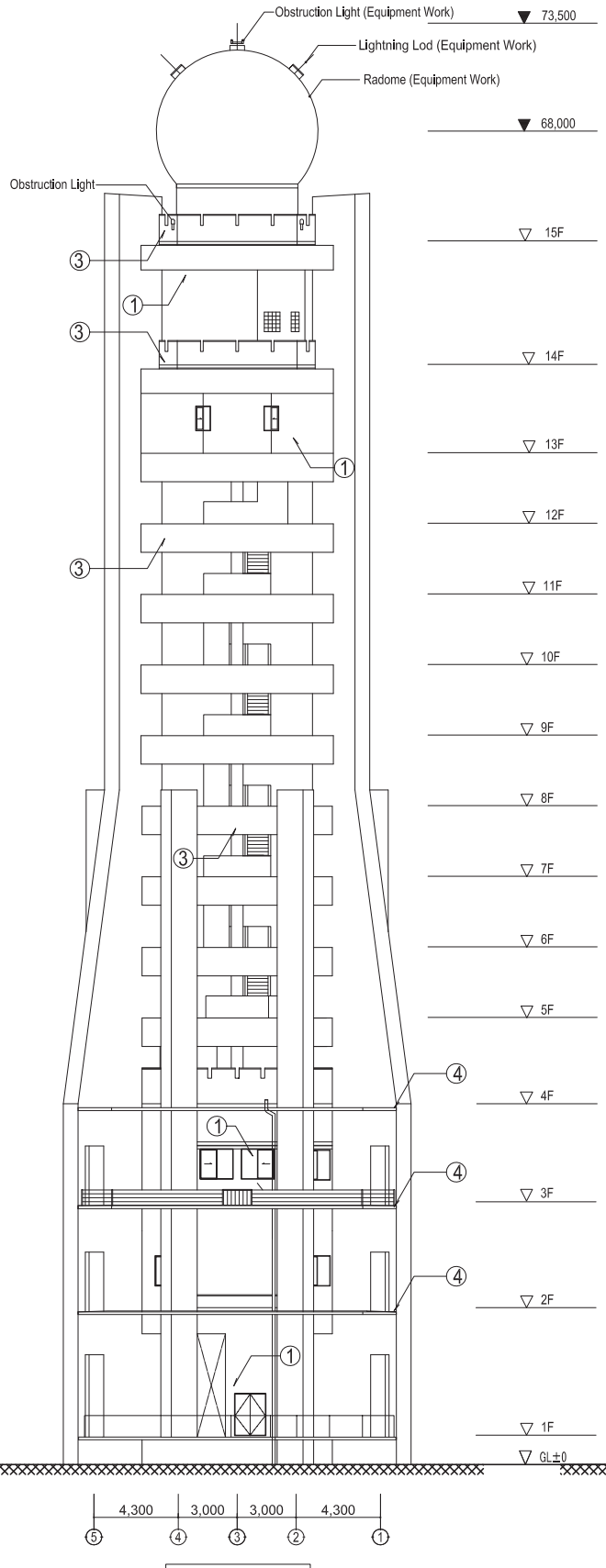
14FL PLAN

15FL PLAN

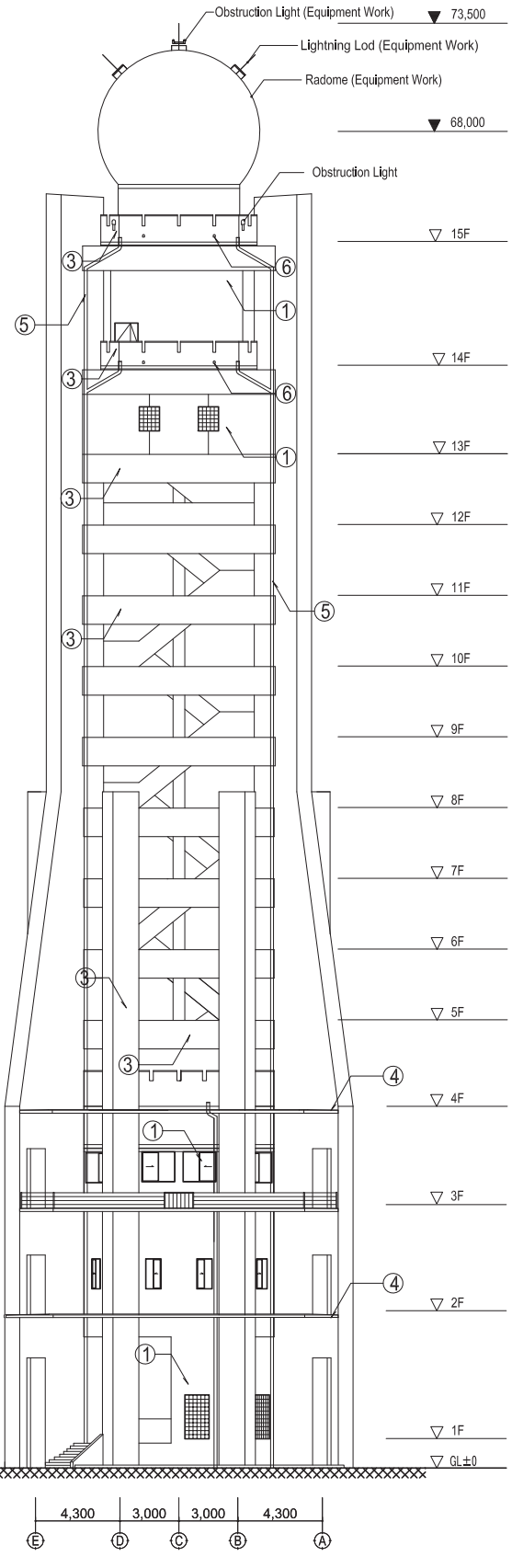
Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE: KARACHI METEOROLOGICAL RADAR TOWER BUILDING — FLOOR PLAN 9	SCALE: 1:100	DRAWING No.: A - 10

LEGEND

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



WEST ELEVATION



NORTH ELEVATION

JWA
Japan Weather Association and International Meteorological Consultant Inc.
Consortium of
IMC International Meteorological Consultant Inc.

THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 1

SCALE
1:250

DRAWING No.
A - 11

Consortium of
Japan Weather Association and
International Meteorological Consultant Inc.

THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

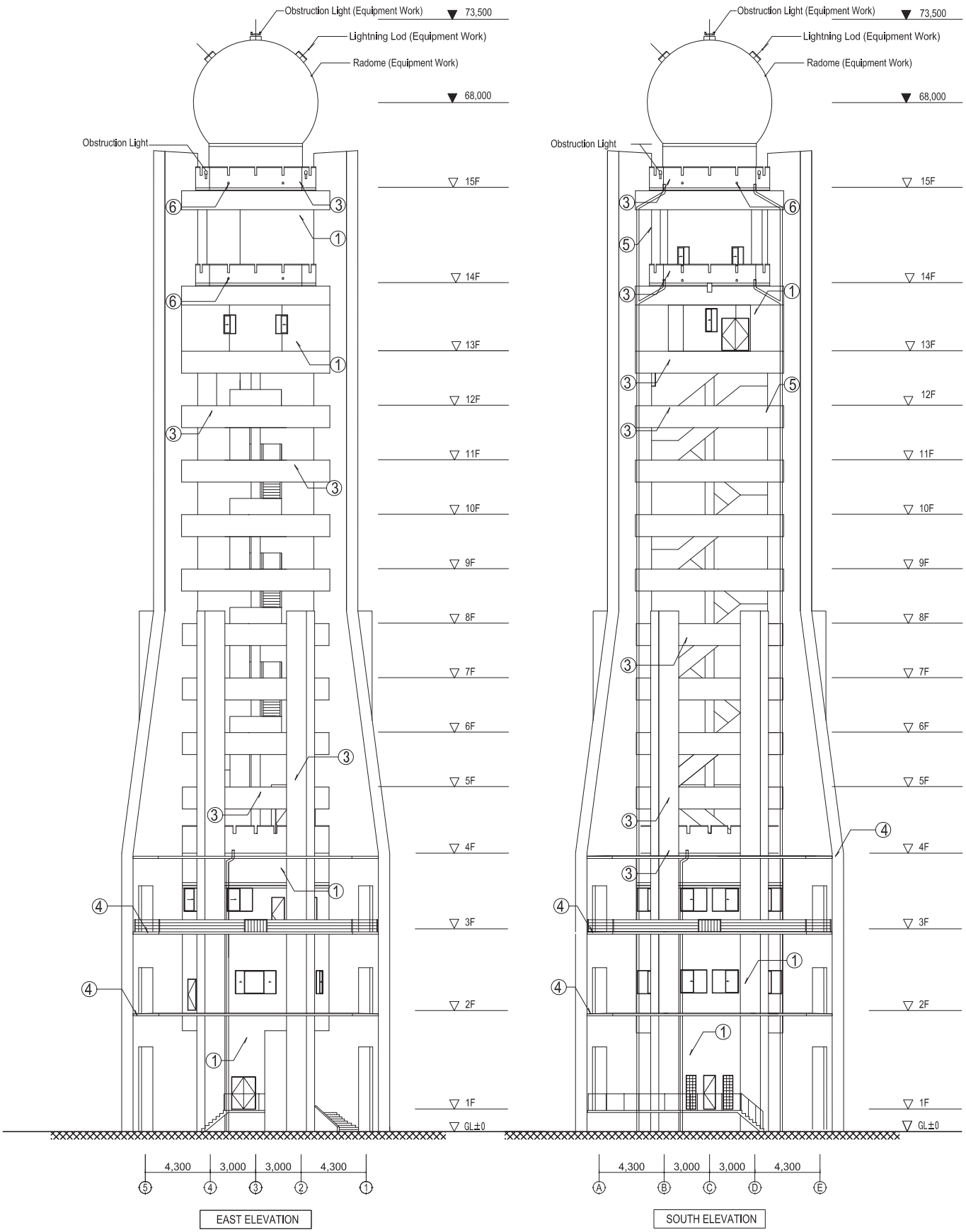
DRAWING TITLE
KARACHI METEOROLOGICAL RADAR TOWER BUILDING
ELEVATION 2

SCALE
1:250

DRAWING No.
A - 12

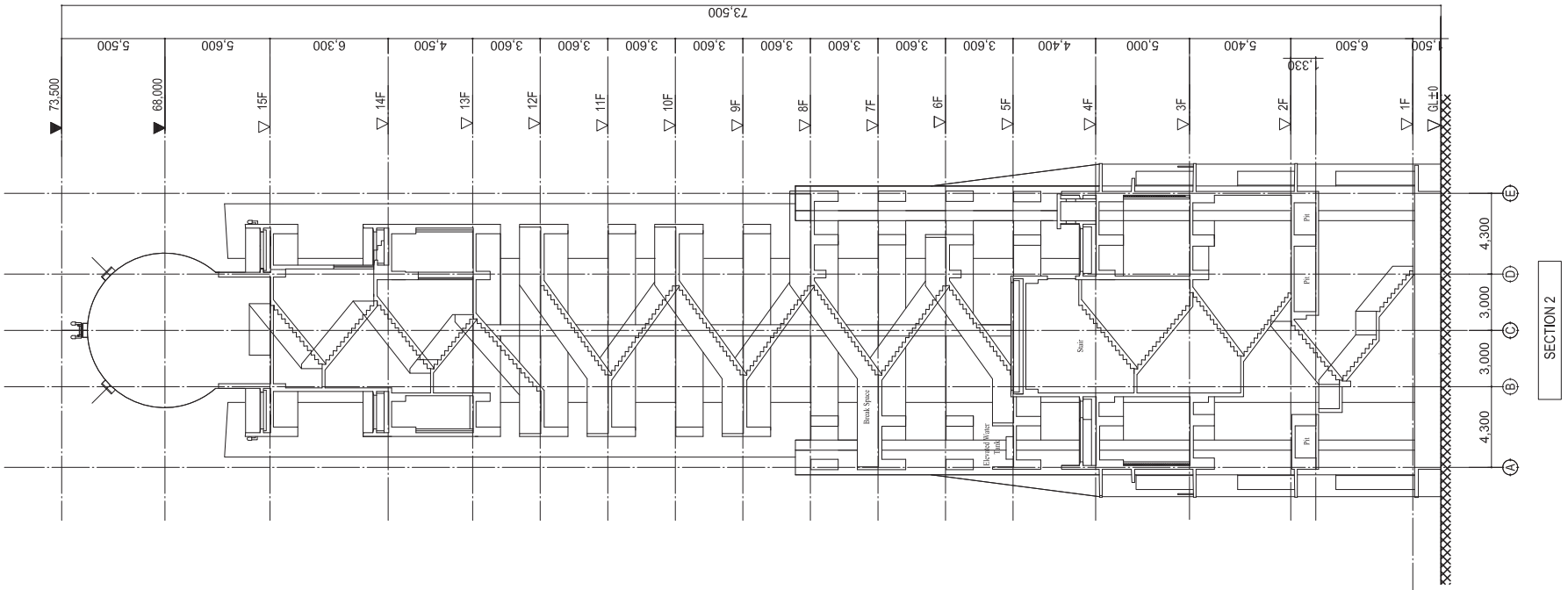
LEGEND

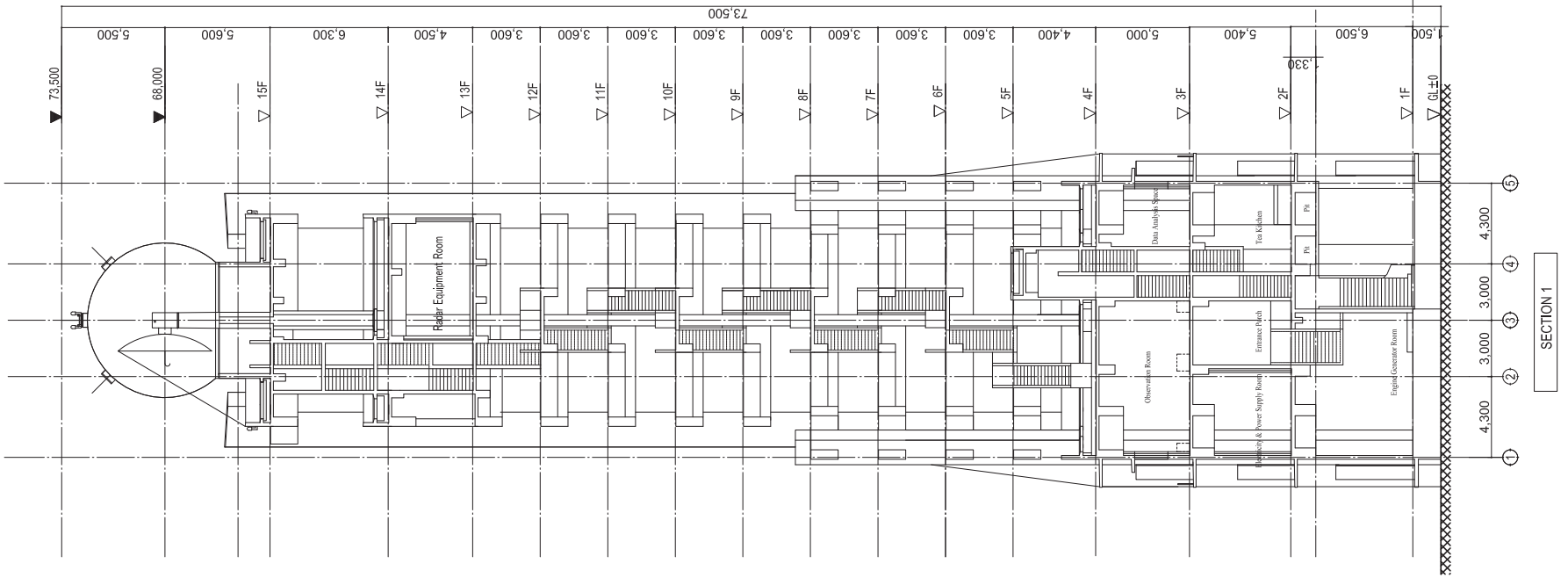
1	C.S. Mortar t=25 Spray Tile
2	C.S. Mortar t=25
3	Fair-faced Concrete, Mortar Mending, Spray Tile
4	Waterproof Mortar t=30, ERP
5	Rain Leader Pipe: Galvanized Steel Pipe 150A, Spray Tile
6	Overflow Pipe: Galvanized Steel Pipe 100A, Spray Tile



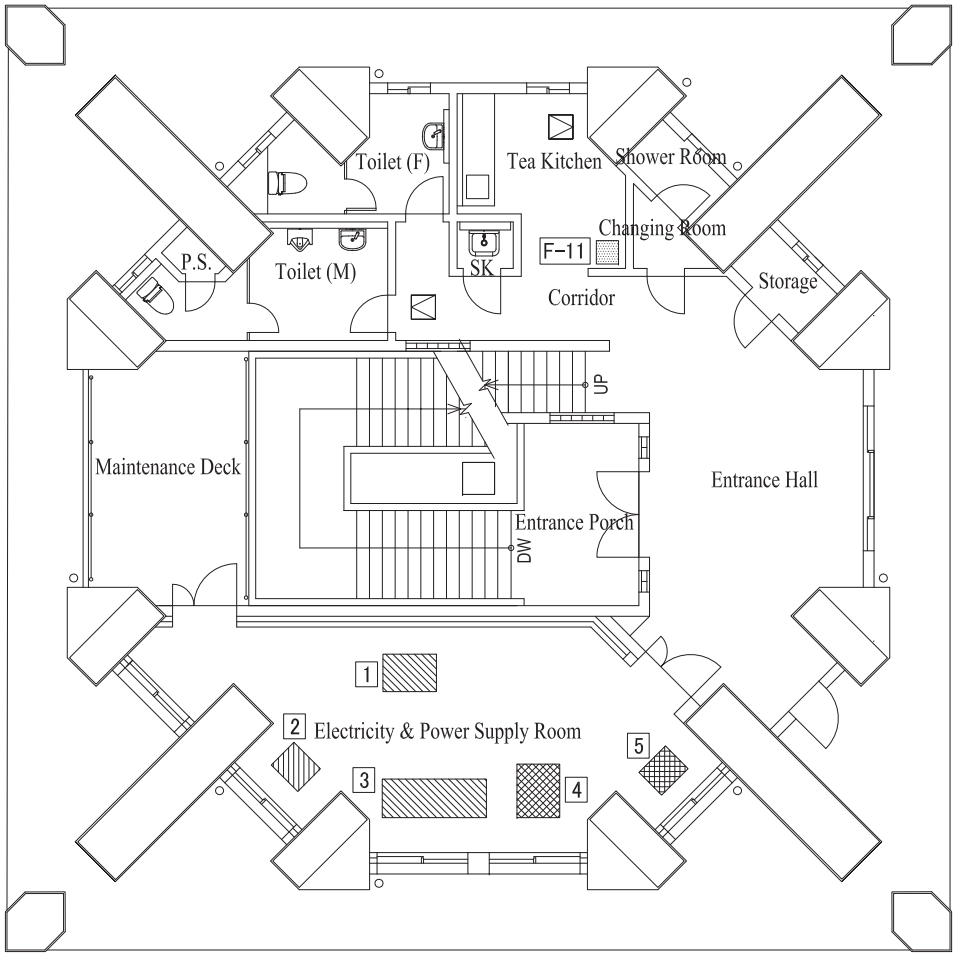
EAST ELEVATION

SOUTH ELEVATION





Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING SECTION	SCALE 1:250	DRAWING No. A - 13



2FL PLAN

EQUIPMENT (EQUIPMENT WORK)

1	Radar AVR
2	Isolation Transformer
3	Power Supply Capacitor

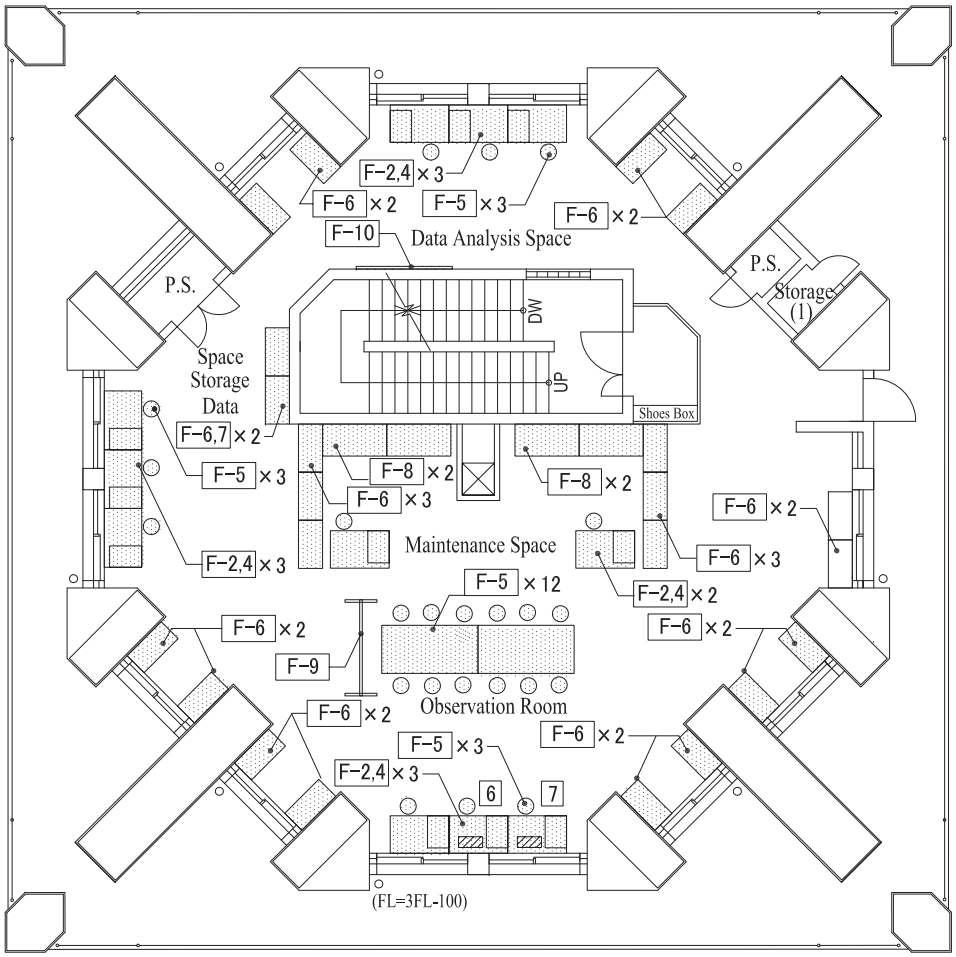
EQUIPMENT (CONSTRUCTION WORK)

4	AVR
5	Isolation Transformer

FURNITURE (CONSTRUCTION WORK)

F-11	Water Dispenser

Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING EQUIPMENT LAYOUT PLAN 1	SCALE 1:100	DRAWING No. EQ - 01



3FL PLAN

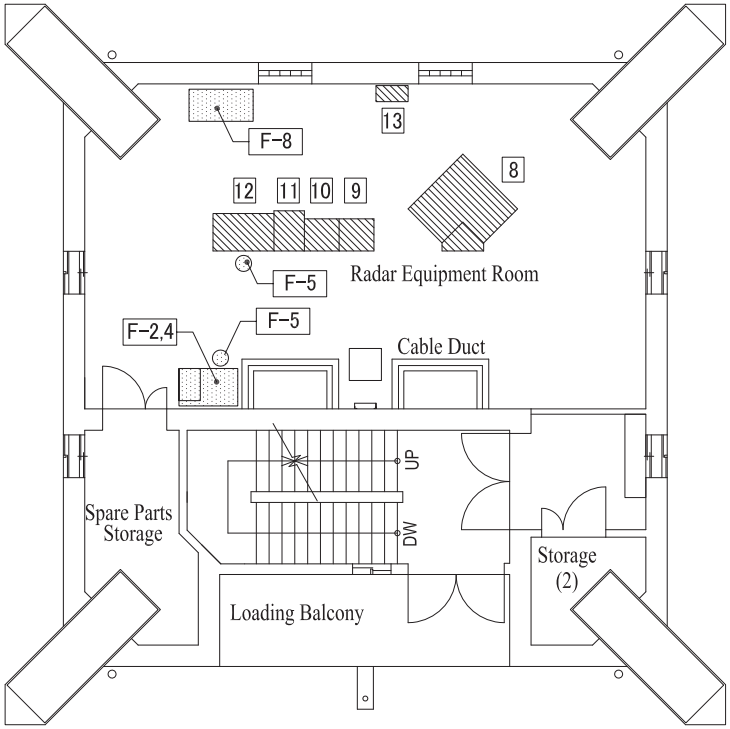
EQUIPMENT (EQUIPMENT WORK)

6	Data Analyzing Unit
7	Colour Printer

FURNITURE (CONSTRUCTION WORK)

F-1	Meeting Table (W900 × L1,800)
F-2	Pedestal-free Desk (W1,100 × D700)
F-4	Drawer Unit with Casters
F-5	Chair
F-6	Lateral Filling Cabinet H1,100
F-7	Cabinet (Double Hinged Doors) H1,000
F-8	Shelves (Double Hinged Doors) H1,800
F-9	White Board : W1,800 × H900
F-10	Pin Board

Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING EQUIPMENT LAYOUT PLAN 2	SCALE 1:100	DRAWING No. EQ - 02



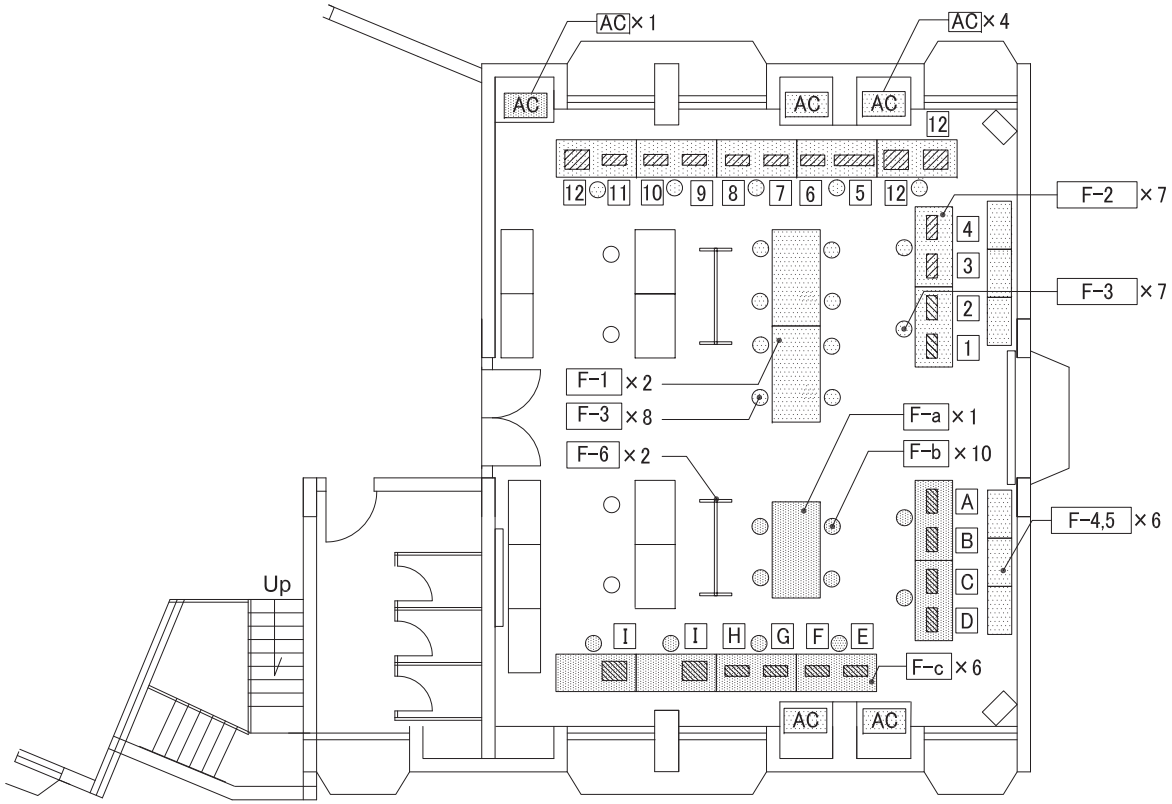
EQUIPMENT (EQUIPMENT WORK)

8	Transmitter
9	Antenna Controller & Dehydrator
10	DRSP
11	Data & Protocol Converter
12	Radar TASK Controller
13	Radar Power Maintenance Panel

FURNITURE (CONSTRUCTION WORK)

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

Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE KARACHI METEOROLOGICAL RADAR TOWER BUILDING EQUIPMENT LAYOUT PLAN 3	SCALE 1:100	DRAWING No. EQ - 03



Proposed Equipment and Furniture Layout Plan

2FL PLAN

FURNITURE (CONSTRUCTION WORK OF THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM)

F-1	Meeting Table (W900 × L1,800)
F-2	Pedestal Desk (W1,500 × D700)
F-3	Chair
F-4	Lateral Filling Cabinet H1,100
F-5	Cabinet (Double Hinged Doors) H1,000
F-6	White Board (W1,800 × H900)

FURNITURE (CONSTRUCTION WORK OF THE PROJECT)

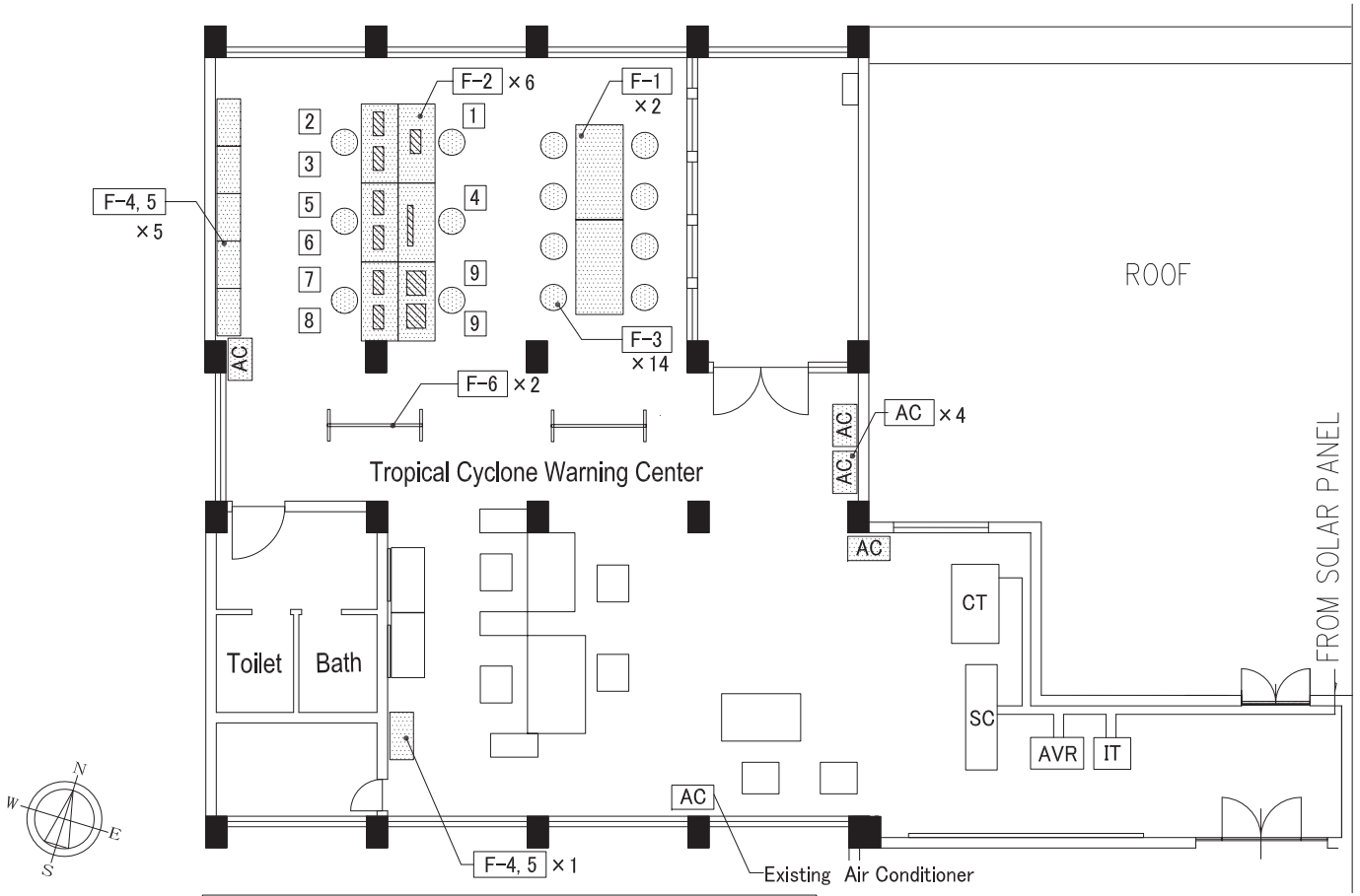
F-a	Meeting Table (W900 × L1,800)
F-b	Chair
F-c	Pedestal Desk (W1,500 × D700)

EQUIPMENT (EQUIPMENT WORK OF THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM)

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

EQUIPMENT (EQUIPMENT WORK OF THE PROJECT)

A	Data Analyzing Unit
B	Severe Storm and Doppler Velocity Indicator
C	Accumulated Rainfall Processor
D	Meteorological Product Display
E	Meteorological Data Archiving Unit
F	Product Retrieval Unit
G	Doppler Velocity Indicator
H	Cyclone Tracking Monitor
I	Colour Printer
AC	Air-Conditioning Indoor Unit



Proposed Equipment and Furniture Layout Plan

FURNITURE (CONSTRUCTION WORK)

- F-1 Meeting Table (W1,800 × L900)
- F-2 Pedestal Desk (W1,500 × D700)
- F-3 Chair
- F-4 Lateral Filling Cabinet H1,100
- F-5 Cabinet (Double Hinged Doors) H1,000
- F-6 White Board (W1,800 × H900)

EQUIPMENT (EQUIPMENT WORK)

- 1 Data Analyzing Unit
- 2 Severe Storm and Doppler Velocity Indicator
- 3 Accumulated Rainfall Processor
- 4 Meteorological Product Display
- 5 Meteorological Data Archiving Unit
- 6 Product Retrieval Unit
- 7 Doppler Velocity Indicator
- 8 Cyclone Tracking Monitor
- 9 Colour Printer
- CT Capacitor
- AVR Automatic Voltage Regulator
- IT Isolation Transformer
- SC Isolation Transformer
- AC Floor Mounted and Split Type Air Conditioner Cooling capacity: 7kW or higher

2-31

Consortium of
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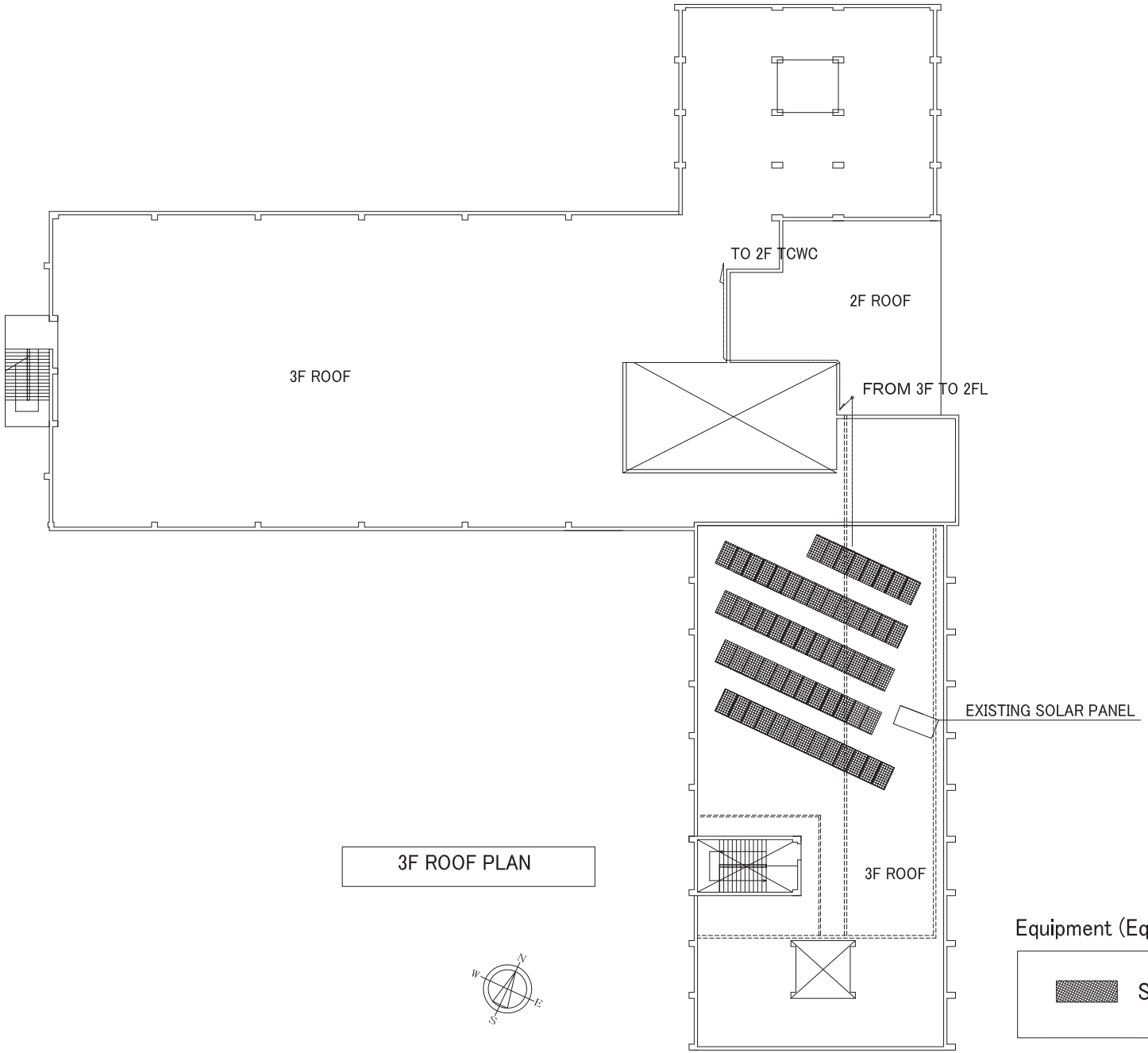
THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
PMD KARACHI, TROPICAL CYCLONE WARNING CENTER
EQUIPMENT LAYOUT PLAN 5

SCALE
1:100

DRAWING No.
EQ - 05



3F ROOF PLAN

Equipment (Equipment Work)

Solar Panel

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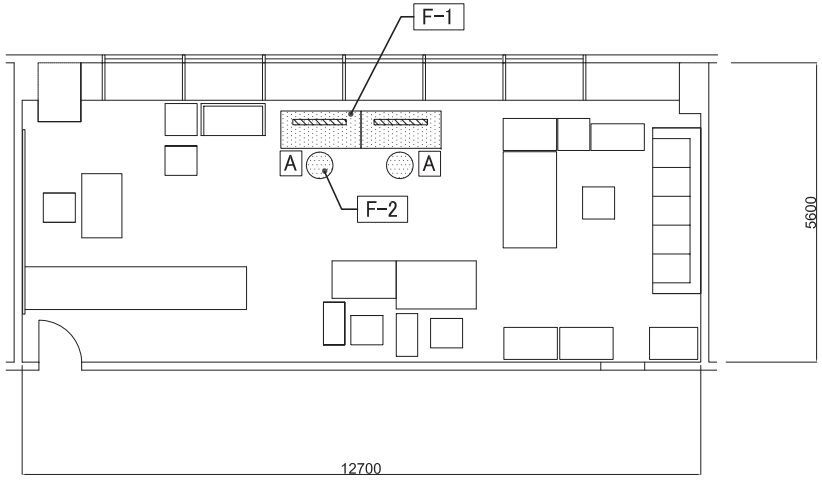
THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
PMD KARACHI
EQUIPMENT LAYOUT PLAN 6

SCALE
1:250

DRAWING No.
EQ - 06



Equipment and Furniture Layout Plan

FURNITURE (CONSTRUCTION WORK)

F-1 Pedestal Desk (W1,500 × D700)

F-2 Chair

EQUIPMENT (EQUIPMENT WORK)

A Aviation Weather Indicator

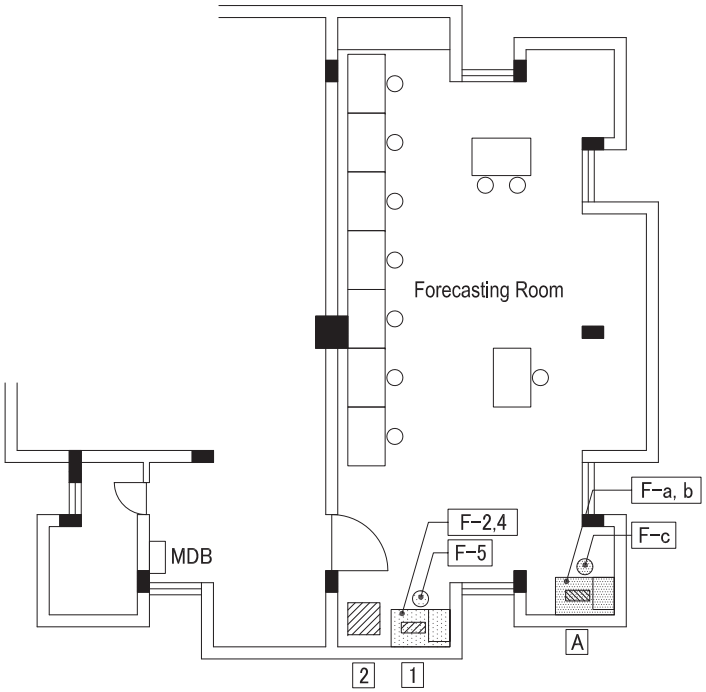
Consortium of
Japan Weather Association and
International Meteorological Consultant Inc.

THE PROJECT FOR INSTALLATION OF
WEATHER SURVEILLANCE RADAR AT KARACHI
IN THE ISLAMIC REPUBLIC OF PAKISTAN

DRAWING TITLE
METEOROLOGICAL OFFICE IN KARACHI INTERNATIONAL AIRPORT
EQUIPMENT LAYOUT PLAN 7

SCALE
1:100

DRAWING No.
EQ - 07



Proposed Equipment and Furniture Layout Plan

2FL PLAN

EQUIPMENT (EQUIPMENT WORK OF THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM)

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

EQUIPMENT (EQUIPMENT WORK OF THE PROJECT)

A	Accumulated Rainfall Processor

FURNITURE (CONSTRUCTION WORK OF THE PROJECT FOR ESTABLISHMENT OF SPECIALIZED MEDIUM RANGE WEATHER FORECASTING CENTER AND STRENGTHENING OF WEATHER FORECASTING SYSTEM)

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

FURNITURE (CONSTRUCTION WORK OF THE PROJECT)

F-a	Pedestal Desk (W1100 × D700)
F-b	Drawer Unit with Casters
F-c	Chair

Consortium of Japan Weather Association and International Meteorological Consultant Inc.	THE PROJECT FOR INSTALLATION OF WEATHER SURVEILLANCE RADAR AT KARACHI IN THE ISLAMIC REPUBLIC OF PAKISTAN	DRAWING TITLE: PMD LAHORE FLOOD FORECASTING DIVISION EQUIPMENT LAYOUT PLAN 8	SCALE: 1:100	DRAWING No.: EQ - 08

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

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

1) Implementing agency for the Project

The responsible government agency of Pakistan for the implementation of the Project is the PMD under the supervision of the Secretary Aviation Division, Cabinet Secretariat. The PMD, as the Client, will be a signatory to the Consultancy Agreement and to the Contract.

2) Consultant

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

Table32: Major Undertakings to be done by the Government of Pakistan/PMD under Implementation of the Project

No	Items	To be covered by Japan's Grant Aid	To be covered by Pakistan (PMD)
	General Items		
1	To undertake all necessary institutional and juridical procedures in Pakistan.		●
2	To undertake the 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 customs clearance to customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project.		●
4	To provide necessary working spaces with Internet Connection at the PMD Islamabad Head Office and the PMD Karachi for the Consultant and the Contractor for the implementation of the Project.		●
5	Marine (Air) transportation of the materials and equipment imported from overseas (Japan).	●	
6	In-land transportation from the port of disembarkation in Pakistan to each Project site.	●	
7	To accord Japanese and other foreign nationals including their dependent/s (if any), whose services may be required in connection with the supply of products and services under the signed contracts, such facilities as may be necessary for their entry into Pakistan and stay therein for the smooth and uninterrupted performance of their work (i.e. to secure the appropriate Visa including its extension/s required by the recipient country in connection thereof).		●
8	To exempt 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 pay bank commission for the issuance of the Authorization to Pay (A/P) and amendments of A/P, if required, for the Consultant and the Contractor.		●
10	To bear all the expenses, other than those to be borne by the Japan's Grant Aid, necessary for the implementation of the Project.		●
11	To ensure the security of the whole Project site/s and of the Japanese and other		●

	foreign nationals assigned to the Project prior to the commencement of and during Project implementation.		
	For the Construction of the Radar Tower Building		
12	To clear, level and reclaim the land prior to the commencement of construction work.		●
13	To secure sufficient spaces at the respective Project site/s for temporary facilities such as a contractor's office, workshop, building materials storage, etc. needed for the construction work.		●
14	To obtain necessary permissions from the relevant agencies for the construction of the Radar Tower Building in the PMD Karachi.		●
15	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) along with electric poles/wires, etc. from the main supply line to the proposed site for the Karachi Radar Tower Building.		●
16	To install the required step-down transformer as well as service entrance connections for the commercial power supply at the PMD Karachi for the Radar Tower Building.		●
17	To provide incidental facilities, such as water supply, telephone lines and internet provision, for the Radar Tower Building in the PMD Karachi.		●
18	To provide temporary facilities for the availability or accessibility of electricity, water, etc. for the construction work.		●
19	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 d) Plumbing works	●	
20	To procure and install standard furniture for the Radar Tower Building	●	
21	To undertake incidental outdoor works such as gardening, fencing, constructing gates, boundary walls and exterior lighting in and around the site, if necessary.		●
22	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.	●	
23	To shoulder dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any.		●
24	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		
25	To provide and allocate secure temporary storage area/room for the materials, tools and equipment needed during the installation process.		●
26	To provide reliable and high-speed Internet environment at the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Karachi, Meteorological Office Karachi International Airport, Meteorological Office New Benazir Bhutto International Airport Islamabad and the PMD Flood Forecasting Division (FFD), Lahore for establishment of a Virtual Private Network (VPN).		●
27	To set up new assigned IP addresses in the computing equipment supplied under the Project.		●
28	To secure ample and strategically located space/s at the existing facilities (the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Karachi Tropical Cyclone Warning Center, Meteorological Office Karachi International Airport, Meteorological Office New Benazir Bhutto International Airport Islamabad and the PMD Flood Forecasting Division (FFD), Lahore) for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project.		●
29	To procure, install and adjust the required Equipment (including the lightning protection system) for the Project implementation.	●	
30	To procure and install furniture for the Equipment to be procured under the Project.	●	
31	To conduct the commissioning for the total system.	●	

32	To provide On-the-job Trainings (Initial Trainings) by the contractor on the operation and maintenance of the Equipment for the PMD.	●	
33	To shoulder the dispatching cost of the trainees 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 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		
35	To renovate the existing gates, boundary walls and exterior lighting in and around the sites.		●
36	To assign the required staff for the smooth operation and maintenance of the Equipment.		●
37	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment.		●
38	To provide adequate maintenance of the Radar Tower Building constructed under the Project so that they may function long lasting and effectively.		●
39	To properly operate and maintain, and also effectively utilize the facilities constructed and the Equipment procured/installed under the Project.		●
40	To allocate the necessary budget and personnel for the smooth conduct of meteorological radar observation and forecasting works.		●
41	To periodically update all the operation/antivirus/application software(s).		●

2-2-4-4 Consultant Supervision

1) Principal Guidelines

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

2) Consultant Supervision

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

d) Qualified engineer(s) will be dispatched for data transmission tests in Pakistan.

3) Scope of Work for Supervision

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

2-2-4-5 Quality Control Plan

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

Table33: 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 in Japan (a test institute is not available in Pakistan).
	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 & Transforming	Performance, operation installation check	Factory inspection sheet 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 Doppler radar system which has already been put into practical use for meteorological observation and has confirmed its reliability, durability, accuracy and performance is only available and made in Japan. The designed mean time between failure (MTBF) of the transmitter for this system is more than 100,000 hours and the designed mean time to repair (MTTR) of the transmitter is 0.5 hours. In addition, since almost all the Japanese meteorological radar systems established under Japan's Grant Aid in other developing countries have been working well over the years, Japanese systems have received a high degree of confidence in the world. Therefore, it is certainly recognized, even by the WMO, that a Japanese system is the most suitable system for developing countries normally faced with operational and maintenance difficulties.

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

(2) Procurement of Construction Material

1) Procurement Policy of Construction Material

As the main construction materials can be procured locally, they will, in principle, be procured in Pakistan. Some construction materials imported from the Association of Southeast Asian Nations (ASEAN) are marketed throughout Pakistan. As these imported materials can be easily procured locally, they are considered as locally procurable products. In order to ensure the easy maintenance of the radar tower building, locally available materials will be utilized for its construction.

2) Procurement Plan of Construction 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 Karachi. The main materials for the structural works, such as fresh concrete, plywood for form works, and etc., can be procured locally. Locally made concrete blocks are available and are a common material for building construction.

[2] Building Exterior and Interior Work

Timber, tiles, paint, glass, aluminum window frames, and etc. used for the exterior and interior of a building are imported and, as such, are readily available in the local market. For the proposed buildings, airtight aluminum and steel doors & windows, treated for salt-corrosion, are required.

[3] Air-Conditioning and Plumbing Work

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

[4] Electrical Work

Imported and local lighting fixtures, switches, lamps, electrical wires and cables, conduits and other items are available in the local market. They will be procured in Pakistan for the convenience of repair and maintenance. Custom-made building equipment such as control panels, power distribution boards and switch boards imported from ASEAN countries can also be procured in the local market.

Table34: 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 (T-bar)	○		✓		
Cement board	○		✓		
Rockwool acoustic board (T-bar)	○		✓		

Glass wool, glass cloth	○		✓		
Carpet tile	△		✓		
PVC tile	○		✓		
Porcelain tile	○		✓		
Ceramic tile	○		✓		
Floor maintenance hatch	○		✓		
Kitchen	○		✓		
Roof drain	○		✓		
Steel drainage pipe (galvanized)	○		✓		
Concrete pavement block	○		✓		
Spray tile	○		✓		
Caulking	○		✓		

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

Table35: 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.

Table36: Scheduled Vessels to Karachi Port from Japan

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

＜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.

Table37: 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 Karachi and Islamabad via a container-trailer. The longest road is approximately 1,800km which requires 4-5 days to traverse. In some sections of the country, countermeasures for safe transportation of the equipment, such as avoidance of night driving, may be required.

Figure16: Transport Route

Japan	→ **Container Vessel** → · Days: Approx. 22-48days · Shipping Frequency: 1-6 ship/week · Transshipment Port: Singapore, Shanghai, etc.	Karachi Port		→ **Container** → **Trailer**	1 day	20km	→ PMD Karachi Karachi International Airport
					4-5days	1,800km	→ PMD Islamabad
		Custom Clearance 10days			2 days	1,000km	→ PMD Lahore

Figure17: Transportation Period to the Project Sites

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.

Table38: Operation and Maintenance Training (OJT)

Component	PMD Islamabad Head Office National Weather Forecasting Center	PMD Karachi	Meteorological Office Karachi International Airport	Meteorological Office New Benazir Bhutto International Airport Islamabad	PMD Flood Forecasting Division (FFD), Lahore
Meteorological Radar System • Power Supply Unit • Antenna • Radar Unit • Meteorological Radar Transmission Unit • Computer Network Unit • Power Back-up Equipment • Software	-	○	-	-	-
Meteorological Radar Data Display System • Power Supply Unit • Computer Network Unit • Software	○	○ (PMD Karachi Radar Tower Building & Tropical Cyclone Warning Center)	○	○	○

Apart from the Operation and Maintenance Training (OJT), technology transfer through practical installation and adjustment works to be carried out by the PMD staff together with the Consultant and the contractor will be necessary and quite effective if done during the installation period. If technology transfer is conducted after completion of the installation work, it is difficult to simulate training on some parts/areas located in deeper places within the system such as cabling and wiring routes, connecting points of each unit, and etc. which would require disassembling the radar system to be able to see them. In addition, repeated software installation by the PMD staff themselves is important to have further familiarization and technical knowledge. In case of a down in the system, disassembling the system and software reinstallation by the PMD staff may be required. Therefore, all the significant parts of technology transfer must be completed during the installation work period.

2-2-4-8 Technical Cooperation

<Soft Component>

Majority of the PMD's technical staff is proficient in the use of computers and computerized meteorological observation equipment. Unfortunately, none of them have the practical experience in operating a digital meteorological radar system which is planned to be procured under the Project as Karachi's existing meteorological radar system is of the analog type. For the smooth operation and maintenance of the digital meteorological radar system, for the dissemination of high accuracy medium range weather forecasts to be prepared through weather guidance to the public, and for the assurance of the required sustainability of the project outcomes, the implementation of the technology transfers in the soft component mentioned below (soft component schedule is indicated in the Implementation Schedule attached hereunder) is required.

<Soft Component Target>

The Soft Component Targets are as follows.

- Inspection, adjustment, minor fault finding, remedy and recovery, and major fault countermeasures (report to the Consultant and Manufacturer and collection of technical advice, etc.) to be appropriately carried out by the PMD.
- Prompt and appropriate meteorological radar operation and maintenance utilizing the meteorological Doppler radar system manual summary and the meteorological radar system maintenance & management record book.
- Meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecasting.

<Soft Component Outputs>

Soft Component Outputs are as follows.

Table39: Soft Component Outputs

No.	Item	Output
1	Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery, and Major Fault Countermeasures	Acquisition of technical know-how on appropriate inspection, adjustment, minor fault finding, remedy and recovery. 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 fault finding, remedy and recovery. Acquisition of know-how on major fault countermeasures (report to the Consultant and Manufacturer and collection of technical advice, etc.).
2	Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing the Meteorological Doppler Radar System Manual Summary and the Meteorological Radar System Maintenance & Management Record Book	Technical knowledge acquisition of prompt and appropriate meteorological Doppler radar operation and maintenance utilizing the meteorological Doppler radar system manual summary and the meteorological radar system maintenance & management record book.
3	Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode	Commencement of meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecast operation.

<Means of Verification for Outputs Achievement>

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

Table40: Soft Component Indicators

No.	Item	Objectively Verifiable Indicators	Means of Verification
1	Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery and Major Fault Countermeasures	Inspection, adjustment, minor fault finding, remedy and recovery, and major fault countermeasures are carried out appropriately by the PMD.	Confirmation of proficiency through 1) routine maintenance using measuring instruments and tools; 2) practice of replacing spare parts into the actual system and the subsequent confirmation of system operation; 3) practice of minor fault finding, remedy and recovery; and 4) major fault countermeasures.
2	Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing the Meteorological Radar System Manual Summary and the Meteorological Radar System Maintenance & Management Record Book	Meteorological Doppler radar operation and maintenance utilizing the meteorological radar system manual summary and the meteorological radar system maintenance & management record book are implemented promptly and appropriately.	· Evaluation of the frequency of usage of the meteorological Doppler radar system manual summary. · Confirmation of indication (daily, weekly, monthly) in the meteorological radar system maintenance & management record book.
3	Meteorological Radar Observation in accordance with the Sequence & Schedule for Intensity Mode and Doppler Mode Sequence & Schedule	Meteorological radar observation is implemented according to the radar observation sequence & schedule for Intensity Mode and Doppler Mode.	Confirmation of meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecast operation.

<Scheduled Activities of Soft Component>

Scheduled Activities of Soft Component are as follows.

Table41: Scheduled Activities of Soft Component

Output	Required Technique and Field	Current Technique and Required Technique Level	Target Group	Means of Implementation	Source of Implementation	Product
1. Meteorological Doppler Radar Inspection, Adjustment, Minor Fault Finding, Remedy and Recovery, and Major Fault Countermeasures	An engineer capable of meteorological radar adjustment and fault finding.	Since technicians in the PMD have no practical experience of adjusting and fault finding in a digital meteorological radar system, it is imperative that the PMD technicians should acquire such capability.	Indicated in the table below	Routine maintenance using measuring instruments and tools.	Expert Consultant on meteorological radar adjustment and fault finding: 0.77 Man-Months. (Period of Technology Transfer in Pakistan: 23days) Direct Support	Manual on routine maintenance using measuring instruments and tools.
				Practice of replacing spare parts into the actual system and the subsequent confirmation of system operation.		Manual on replacing spare parts into the actual system and the subsequent confirmation of system operation.
				Practice of countermeasure, minor fault finding, remedy and recovery.		Manual on fault finding, remedy and recovery.
				Practice of major fault countermeasures.		
				Production of operation and maintenance manual.		Manual on major fault countermeasures.
2. Preparation of Meteorological Doppler Radar System Manual Summary and Meteorological Radar System Maintenance &	An engineer capable of meteorological radar operation and maintenance.	Since technicians in the PMD have no practical experience of operating and maintaining a digital meteorological radar system, it is imperative that the PMD technicians	Indicated in the table below	Discussion with the PMD technicians.	Expert Consultant on meteorological radar operation and maintenance: 0.77 Man-Months (Period of Technology Transfer in Pakistan: 23 days)	Meteorological Doppler radar system manual summary
				Selection of the most important points from the meteorological Doppler radar system manual.		Meteorological radar system maintenance & management record book · Date and time of
				Production of the meteorological Doppler		

Management Record Book		should obtain the capability to conduct meteorological radar operation and maintenance utilizing the meteorological Doppler radar system manual summary and the meteorological radar system maintenance & management record book.		radar system manual summary. Production of the meteorological radar system maintenance & management record book. Utilization of the meteorological Doppler radar system manual and the meteorological radar system maintenance & management record book by the PMD technicians.	Direct Support	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
3. Preparation of the Sequence & Schedule for Intensity Mode and Doppler Mode	An engineer who can identify Clutter and Blind Area by using radar observation data and prepare a sequence & schedule for meteorological radar observation which is suited to the weather phenomena in Pakistan	Since technicians in the PMD have no practical experience CAPPI observation using a digital meteorological Doppler radar system and has no capability in preparing sequences & schedules for Intensity Mode and Doppler Mode, it is imperative that the PMD technicians should obtain the capability to prepare sequences & schedules for meteorological radar observation with an awareness of its importance.	Indicated in the table below	Discussion with the PMD technicians and lecture. Identification of Clutter of meteorological radar system and Blind Area at antenna elevation angle (0.5 interval degree, between 1-3 degree). Preparation of Blind Area at antenna elevation angle (0.5 interval degree, between 1-3 degree). Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode. Implementation of radar observation using Sequence & Schedule for Intensity Mode and Doppler Mode.	Expert Consultant on meteorological radar observation: 1.0 Man-Month (Period of Technology Transfer in Pakistan: 30 days) Direct Support	Sequence & Schedule for Intensity Mode and Doppler Mode and Changing Procedures

Table42: Target Personnel in the PMD for the Technology Transfer in the Soft Component

Technology Transfer of No. 1 & 2			Technology Transfer of No. 3	
	Weather Surveillance Radar Section	Development Section	PMD Karachi Tropical Cyclone Warning Center (TCWC)	
Senior Electronic Engineer	1	1	TCWC Personnel	20
Electronic Engineer	3	3		
Assistant Electronic Engineer	1	-		
Sub-Engineer	12	6		
Technical Assistant	1	-		
Junior Staff	4	4		

<Soft Component Product>

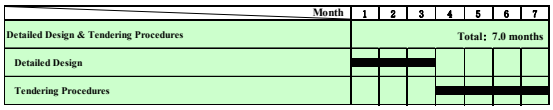
Soft Component Products are as follows.

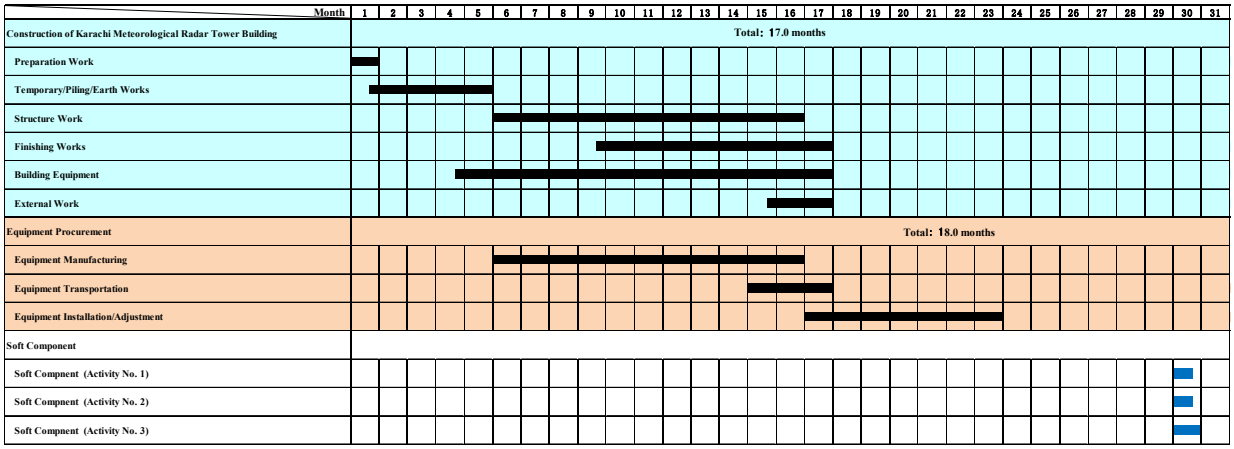
Table43: Soft Component Products in Technology Transfer

Product Name		Submission Time	No. of Pages
Implementation report on 1) routine maintenance using measuring instruments and tools, 2) practice of replacing spare parts into the actual system and the subsequent confirmation of system operation, 3) practice of minor fault finding, remedy and recovery, and 4) major fault countermeasure.		After Technology Transfer	20
Meteorological Doppler radar system manual summary			30
Meteorological radar system maintenance and management record book			10
Radar observation sequence & schedule for Intensity Mode and Doppler Mode and Changing Procedures			10
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

Table44: Implementation Schedule





2-3 Obligations of Recipient Country

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

Table45: Major Undertakings to be done by the Government of Pakistan/PMD under 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 customs clearance to customs broker/forwarder to be employed by the Contractor at the port of disembarkation for the materials and equipment imported for the Project.
4	To provide necessary working spaces with Internet Connection at the PMD Islamabad Head Office and the PMD Karachi for the Consultant and the Contractor for the implementation of the Project.
5	To accord Japanese and other foreign nationals, if required, 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 pay bank commission for the issuance of the Authorization to Pay (A/P) and amendments in A/P, if required, for the Consultant and the Contractor.
8	To bear all the expenses, other than those to be borne by the Japan’s Grant Aid, necessary for the implementation of the Project.
9	To ensure the security of the whole Project site/s and of the Japanese and other foreign nationals assigned to the Project prior to the commencement of and during Project implementation.
	For the Construction of the Radar Tower Building
10	To clear, level and reclaim the land prior to the commencement of construction work.
11	To secure sufficient spaces at the respective Project site/s for temporary facilities such as a contractor's office, workshop, building materials storage, etc. needed for the construction work.
12	To obtain necessary permissions from the relevant agencies for the construction of the Radar Tower Building in the PMD Karachi.
13	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) along with electric poles/wires, etc. from the main supply line to the proposed site for the Karachi Radar Tower Building in the PMD Karachi.
14	To install the required step-down transformer as well as service entrance connections for the commercial power supply at the PMD Karachi for the Radar Tower Building.
15	To provide incidental facilities, such as water supply, telephone lines and internet provision, for the Radar Tower Building in the PMD Karachi.
16	To provide temporary facilities for the availability or accessibility of electricity, water, etc. for the construction work.
17	To undertake incidental outdoor works such as gardening, fencing, constructing gates, boundary walls and exterior lighting in and around the site, if necessary.
18	To shoulder dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any.
	For Installation Work of the Equipment
19	To provide and allocate secure temporary storage area/room for the materials, tools and equipment needed during the installation process.
20	To provide reliable and high-speed Internet environment at the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Karachi, Meteorological Office Karachi International Airport, Meteorological Office New Benazir Bhutto International Airport Islamabad and the PMD Flood Forecasting Division (FFD), Lahore for

	establishment of a Virtual Private Network (VPN).
21	To set up new assigned IP addresses in the computing equipment supplied under the Project.
22	To secure ample and strategically located space/s at the existing facilities (the PMD Islamabad Head Office National Weather Forecasting Center, the PMD Karachi Tropical Cyclone Warning Center, Meteorological Office Karachi International Airport, Meteorological Office New Benazir Bhutto International Airport Islamabad and the PMD Flood Forecasting Division (FFD), Lahore) for the installation of the equipment (PC terminals and peripherals) to be supplied under the Project.
23	To shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, if any.
After the completion of the Project	
24	To renovate the existing gates, boundary walls and exterior lighting in and around the sites.
25	To assign the required staff for the smooth operation and maintenance of the Equipment.
26	To procure the required spare parts and consumables for the smooth operation and maintenance of the Equipment.
27	To provide adequate maintenance of the Radar Tower Building constructed under the Project so that they may function long lasting and effectively.
28	To properly operate and maintain, and also effectively utilize the facilities constructed and the Equipment procured/installed under the Project.
29	To allocate the necessary budget and personnel for the smooth conduct of meteorological radar observation and forecasting works.
30	To periodically update all the operation/antivirus/application software(s).

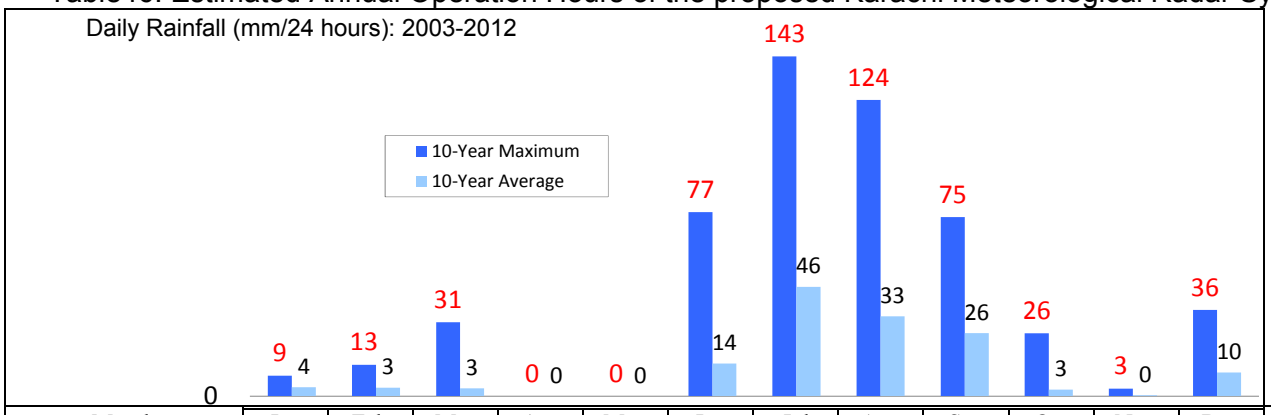
2-4 Project Operation Plan

(1) Operational and Maintenance Plan for the Equipment

1) Operational Plan of the Meteorological Radar System

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

Table46: Estimated Annual Operation Hours of the proposed Karachi Meteorological Radar System



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Operation Hours
Operation hours/day	3	3	6	3	3	12	24	24	12	6	3	6	
Days/month	31	28	31	30	31	30	31	31	30	31	30	31	
Operation hours/month	93	84	186	90	93	360	744	744	360	186	90	186	**3,216**

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

The PMD has a plan to establish a Radar Maintenance & Operation Division under the Chief Meteorologist as indicated in the Figure on the right and plan to allocate thirty six engineers for the Karachi Meteorological Radar System.

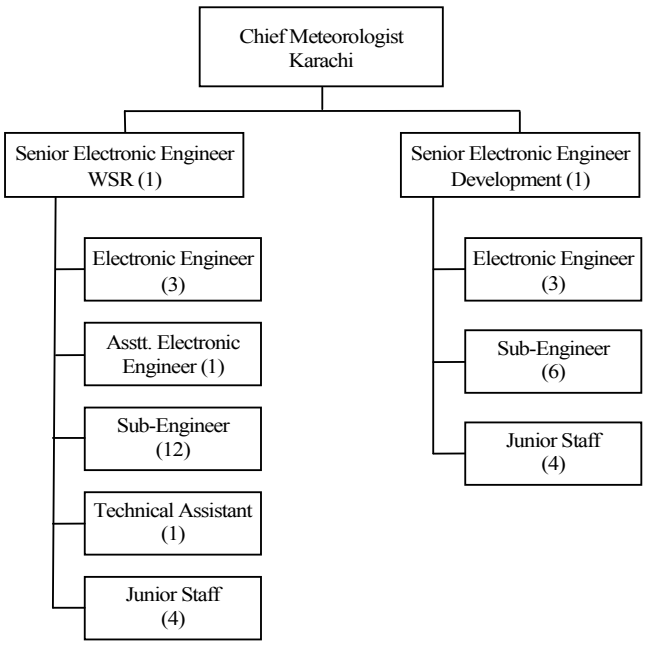


Figure18: Planned Organization of the PMD Karachi Meteorological Radar Station

3) Operational and Maintenance Plan for the Equipment

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

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

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

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

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

Table47: 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.

Table48: Life Expectancy of Building Equipment

System	Building Equipment	Life Expectancy
Electrical System	• Distribution panels • LED lamps • Fluorescent lamps	20 - 30 years 20,000 - 60,000 hours 5,000 - 10,000 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 Estimate

2-5-1 Estimate of the Project Capital Cost

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

Estimated Total Project Capital Cost: 33,300,000 PKR (approx. 37 Million JP Yen)

Table49: Estimated Project Capital Cost to be borne by the Government of Pakistan/PMD

No.	Items	Capital Cost (PKR)
1.	To pay bank commission for issuance of the Authorization to Pay (A/P) and FED etc. to the Consultant and the Contractor.	6,000,000
2.	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) along with electric poles/wires, etc. from the main supply line to the proposed site for the Karachi Radar Tower Building in the PMD Karachi.	2,000,000
3.	To install the required step-down transformers as well as service entrance connections for the commercial power supply at the PMD Karachi for the Radar Tower Building.	4,000,000
4.	To provide water supply for the Radar Tower Building in the PMD Karachi.	1,000,000
5.	To provide reliable and high-speed Internet environment at the PMD Karachi Tropical Cyclone Warning Center (TCWC) and the Meteorological Office in Karachi International Airport for the establishment of a Virtual Private Network (VPN).	1,000,000
6.	To recruit security personnel (10 persons) equipped with ammunition to ensure the security of the Project site of PMD Karachi during Project implementation.	4,000,000
7.	To shoulder the dispatching cost of the trainees to the training sites, such as daily allowance, transportation fee, accommodation, etc.	300,000
8.	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).	1,000,000
9.	To construct an access road (L=110m, W=5m) in the premises of the PMD Karachi	3,000,000
10.	To construct boundary walls with a gate	4,000,000
11.	To renovate the existing gates, boundary walls and exterior lighting of the PMD Karachi	7,000,000
	Total	33,300,000

Applied Exchange Rate: US$ 1 = 103.45 JP Yen, 1 PKR= 1.115 JP Yen

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

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

The estimated annual recurrent costs (considered 5% of the annual inflation rate) for all the systems procured under the Project to be borne by the PMD for the first decade after the completion of the Project are attached hereunder. The recurrent costs have been calculated in accordance with the following fundamental conditions.

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

Table50: Estimated Annual Recurrent Cost of the PMD Islamabad Head Office

Estimated Recurrent Cost

	Equipment	Item	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
	National Weather Forecasting Center													
1	Product Monitor	CD for data storage (20sheets/1set)	2	4,600	4,800	5,100	5,300	5,600	5,900	6,100	6,500	6,800	7,100	
2	Printer	Printer ink cartridge	2	8,200	8,600	9,100	9,500	10,000	10,500	11,000	11,600	12,200	12,800	
		Paper (500sheets/1set)	6	3,200	3,300	3,500	3,700	3,900	4,100	4,300	4,500	4,700	4,900	
3	Compact UPS	Battery	8	0	0	92,400	0	0	106,900	0	0	123,800	0	Every 3 years
	Specialized Medium Range Weather Forecasting Center (SMRFC)													
1	Compact UPS	Battery	1	0	0	11,500	0	0	13,400	0	0	15,500	0	Every 3 years
	Meteorological Office in New Banazir Bhutto International Airport (NBBIA)													
1	Compact UPS	Battery	1	0	0	11,500	0	0	13,400	0	0	15,500	0	Every 3 years
		Sub total (PKR)		16,000	16,700	133,100	18,500	19,500	154,200	21,400	22,600	178,500	24,800	

Others

	Cost Item	Details	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
1	Electricity Charge		1	39,061	41,015	43,065	45,218	47,479	49,853	52,346	54,963	57,712	60,597	*1
2	Fuel cost	Fuel consumption of Existing DEG (*3)	1	18,970	19,919	20,915	21,960	23,058	24,211	25,422	26,693	28,028	29,429	*2
3	Communication charge	Data/Internet communication	1	288,000	302,400	317,520	333,396	350,066	367,569	385,948	405,245	425,507	446,783	
		Sub total (PKR)		346,031	363,334	381,500	400,574	420,603	441,633	463,716	486,901	511,247	536,809	
		Total (PKR)		**362,031**	**380,034**	**514,600**	**419,074**	**440,103**	**595,833**	**485,116**	**509,501**	**689,747**	**561,609**	
		Total (JPY)		**¥341,539**	**¥358,523**	**¥485,472**	**¥395,353**	**¥415,192**	**¥562,107**	**¥457,657**	**¥480,661**	**¥650,705**	**¥529,820**	

Estimate of annual electricity charge		
Annual power consumption of PMD Islamabad Head Office	(kWh)	4,018
Annual power consumption of Meteorological Office in New Banazir Bhutto International Airport (NBBIA)	(kWh)	1,382
Total annual power consumption	(kWh)	5,400
Annual power consumption by commercial power (88%)	(kWh)	4,752
Annual power consumption by DEG (12%)	(kWh)	648
Annual fuel consumption	(Litter)	162

*1 Annual electricity charge of commercial power	(PKR)	39,061	
*2 Annual fuel cost of DEG	(PKR)	18,970	

Fuel consumption of DEG =	0.25	Litter/kWh
Electrical charge =	8.22	PKR/kWh
Fuel cost =	117.10	PKR/Litter
Exchange rate	1.06	PKR/JPY

*3 Existing DEG: supplied under "the Project for Establishment of Specialized Medium Range Weather Forecasting Center and Strengthening of Weather Forecasting System"

*4 Inflation: 5%/year considered

Table51: Estimated Annual Recurrent Cost of the PMD Karachi Tropical Cyclone Warning Center

Estimated Recurrent Cost

	Equipment	Item	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
	PMD Karachi Cyclone Warning Center													
1	Product Monitor	CD for data storage (20sheets/1set)	2	4,600	4,800	5,100	5,300	5,600	5,900	6,100	6,500	6,800	7,100	
2	Printer	Printer ink cartridge	2	8,200	8,600	9,100	9,500	10,000	10,500	11,000	11,600	12,200	12,800	
		Paper (500sheets/1set)	6	3,200	3,300	3,500	3,700	3,900	4,100	4,300	4,500	4,700	4,900	
3	Laptop or Prtable PC	Battery	4	0	0	77,800	0	0	90,100	0	0	104,300	0	Every 3 years
4	Power Supply Capacitor	AC fan	3	0	0	0	0	0	0	0	0	0	71,200	Every 10 years
		Arrester	6	0	0	0	0	0	0	0	0	0	105,900	Every 10 years
	Karachi Meteorological Radar Tower													
1	Antenna	Grease (16kgs/can, For AZ/EL)	1	0	0	0	0	28,600	0	0	0	0	36,500	Every 5 years
		Timing belt (For AZ/EL)	2	0	0	0	0	0	0	0	26,500	0	0	Every 8 years
2	Antenna controller	AC fan	3	0	0	0	0	0	0	0	0	0	45,900	Every 10 years
3	Transmitter	AC fan	24	0	0	0	0	0	0	0	0	0	367,100	Every 10 years
4	Receiver	AC fan	3	0	0	0	0	0	0	0	0	0	45,900	Every 10 years
5	Printer	Printer ink cartridge	2	8,200	8,600	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	
		Paper (500sheets/1set)	4	1,900	2,000	2,100	2,200	2,300	2,400	2,500	2,600	2,800	2,900	
6	Compact UPS	Battery	3	0	0	34,600	0	0	40,100	0	0	46,400	0	Every 3 years
7	Power Supply Capacitor	AC fan	3	0	0	0	0	0	0	0	0	0	71,200	Every 10 years
		Arrester	6	0	0	0	0	0	0	0	0	0	105,900	Every 10 years
8	Diesel Engine Generator	Oil seal	2	0	4,700	4,900	5,200	5,400	5,700	6,000	6,300	6,600	6,900	Every 1 year
		Filter	2	0	0	18,200	0	20,000	0	22,100	0	24,300	0	Every 2 years
		Battery for Engine start	2	0	0	0	0	0	24,000	0	0	0	29,200	Every 5 years
	Meteorological Office in Karachi International Airport													
1	Compact UPS	Battery	2	0	0	23,100	0	0	26,700	0	0	30,900	0	Every 3 years
		Sub total (PKR)		26,100	32,000	186,600	34,100	84,000	217,700	60,200	66,200	247,200	921,600	

Others

	Cost Item	Details	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
1	Electricity Charge		1	465,916	489,212	513,672	539,356	566,324	594,640	624,372	655,590	688,370	722,788	*1
2	Fuel cost	Fuel consumption of DEG	1	226,272	237,586	249,465	261,938	275,035	288,787	303,226	318,388	334,307	351,022	*2
3	Water supply charge		1	12,500	13,125	13,781	14,470	15,194	15,954	16,751	17,589	18,468	19,392	*3
4	Special maintenance	System brush-up by manufacture's engineer	1	0	0	1,037,600	0	0	1,201,200	0	0	1,390,500	0	For 5 days at site
5	Radome	Caulking repair	1	25,900	27,200	28,500	30,000	31,500	33,000	34,700	36,400	38,200	40,200	
6	Pest-control	Exterminating vermination	1	23,300	24,500	25,700	27,000	28,300	29,700	31,200	32,800	34,400	36,100	
7	Communication charge	Data/Internet communication	1	288,000	302,400	317,520	333,396	350,066	367,569	385,948	405,245	425,507	446,783	
		Sub total (PKR)		1,041,888	1,094,023	2,186,238	1,206,160	1,266,419	2,530,850	1,396,197	1,466,012	2,929,752	1,616,285	
		Total (PKR)		**1,067,988**	**1,126,023**	**2,372,838**	**1,240,260**	**1,350,419**	**2,748,550**	**1,456,397**	**1,532,212**	**3,176,952**	**2,537,885**	
		Total (JPY)		**¥1,007,536**	**¥1,062,286**	**¥2,238,526**	**¥1,170,057**	**¥1,273,980**	**¥2,592,972**	**¥1,373,959**	**¥1,445,483**	**¥2,997,125**	**¥2,394,231**	

Estimate of annual electricity charge

Annual power consumption of PMD Karachi Cyclone Warning Center	(kWh)	14,243	(70% of Actual consumption, 30% supplied by solar panel)
Annual power consumption of Karachi Meteorological Radar Tower	(kWh)	47,057	
Annual power consumption of Meteorological Office in Karachi International Airport	(kWh)	3,110	
Total annual power consumption	(kWh)	64,410	
Annual power consumption by commercial power (88%)	(kWh)	56,681	
Annual power consumption by DEG (12%)	(kWh)	7,729	
Annual fuel consumption	(Litter)	1,932	

Fuel consumption of DEG = 0.25 Litter/kWh

*1 Annual electricity charge of commercial power (PKR) 465,916

*2 Annual fuel cost of DEG (PKR) 226,272

Electrical charge = 8.22 PKR/kWh

Fuel cost = 117.10 PKR/Litter

*3 Annual water supply charge (PKR) 12,000

*4 Inflation: 5%/year considered

Exchange rate 1.06 PKR/JPY

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

Estimated Project Annual Recurrent Cost: 7,090,000 PKR (approx. 8 Million JP Yen)

Table52: Estimated Project Annual Recurrent Cost to be borne by the Government of Pakistan/PMD

No.	Description	Recurrent Cost (PKR)
1	Electricity Charges	1,000,000
2	Salary of 10 Security personnel	1,440,000
3	Water and Gas Charges	200,000
4	Telephone, Fax, Leased Lines, Internet Connections	1,250,000
5	Spare Parts, Consumables and Special Maintenance of the Systems	900,000
6	Consumables, Stationary, etc.	500,000
7	Books & Journals	100,000
8	Contingencies	200,000
9	P.O.L. Charges (for engine generators, vehicles, etc.)	800,000
10	Communication System	500,000
11	Miscellaneous Expense	200,000
	Total	7,090,000

(2) Annual Budget Trends

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

Table53: Movement of the PMD Annual Budget (In Thousand PKR)

Fiscal Year	Budget	Comparison with the previous year (%)
2008	394,991	-
2009	417,880	105.8
2010	451,327	108.0
2011	578,825	128.2
2012	680,347	117.5
2013	754,197	110.9
2014	797,220	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.

Table54: Details of the Procedures required for the Project Implementation

Required Procedures	Office Concerned	Approximate Period required	Required Documents to be submitted to Aviation Division, Cabinet Secretariat by the Pakistan Meteorological Department (PMD)	Applicant
Application for Commercial Power Supply and Step-down Transformer Installation for Radar Tower Building to be constructed	Karachi Electric Supply Company (KESC)	2 months	• Application Form: 1 set • Site Location Map: 1 set • Allotment Letter: 1 set	PMD
Frequency Permit for Meteorological Radar System	Pakistan Telecommunication Authority (PTA)/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	

<General Sales Tax (GST)>

The General Sales Tax (GST) imposed on the materials and equipment to be locally purchased by the main contractor under this Project will be exempted in accordance with the following figure of GST exemption procedures 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. It has to be noted that the GST imposed on materials and equipment to be purchased by a subcontractor(s) shall not be exempted.

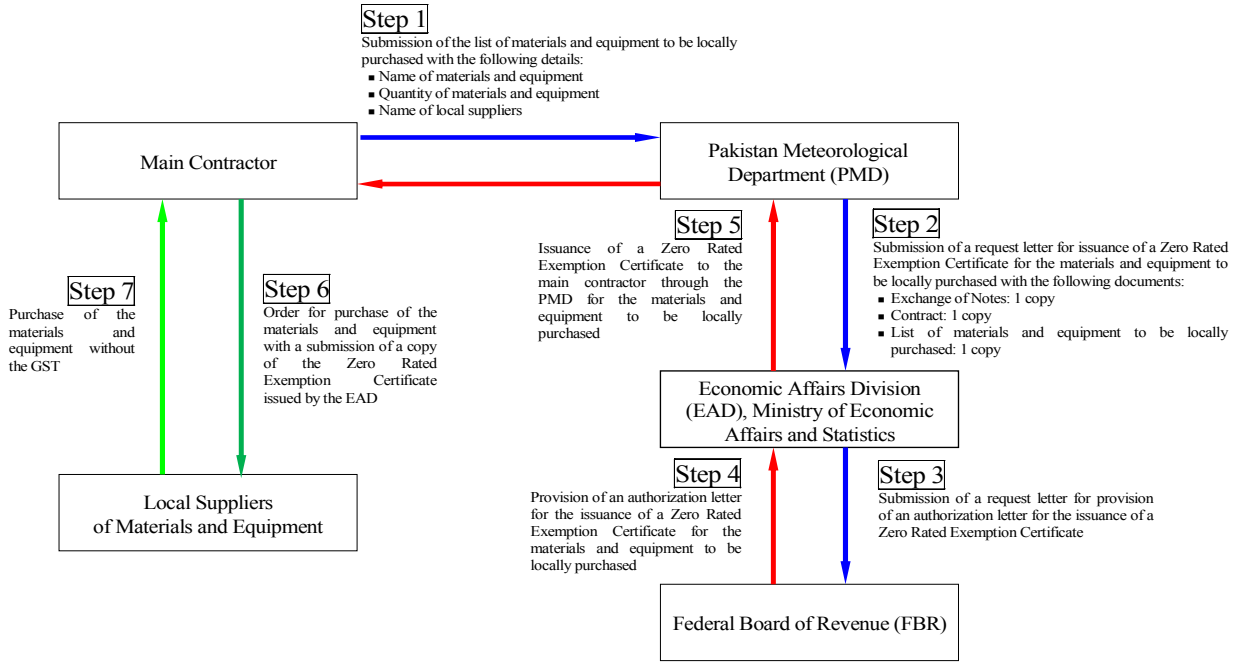


Figure19: GST Exemption Procedures for Materials and Equipment to be locally purchased

3-2 Necessary Inputs by 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) Objectives of the Project

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

The existing Karachi meteorological radar system located in the capital city of Sindh Province, which is the biggest city of Pakistan, established in 1991 has played an important role in monitoring meteorological phenomena in the southern area or tropical cyclones for more than more than 20 years already. However, its function deteriorates day by day and could completely stop in a few years despite the appropriate maintenance done by the radar engineers of the PMD. In addition, since many parts transit from analog to digital and the supply of spare parts and consumables from the manufacturer has become limited, it would be extremely difficult to restore the radar system once a serious failure occurs. Therefore, as a permanent measure, the replacement of the existing Karachi meteorological radar system is an urgent task in Pakistan. Given the situation indicated above, the key objectives of the Project are to improve the PMD's capabilities in meteorological observation, weather forecasting and dissemination of forecasts/warnings through the replacement of the existing Karachi C-band ordinary meteorological radar system with a state-of-the -art S-band Doppler pulse compression solid state radar system.

2) Development Plan of Pakistan

In response to the fact that enormous damages caused by abnormal weather due to climate change have been increasing, the National Climate Change Policy has been developed under the Ministry of Climate

Change in August 2012. In this policy, vulnerability to climate change and its adoption plan are described according to each sector (water resource, agriculture, forestry, ecosystem, disaster preparedness etc.). Under disaster preparedness, the Government of Pakistan is supposed to implement the following measures in cooperation with the related organizations:

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

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

As indicated above, this Project accords with the climate change policy and disaster prevention policy in Pakistan.

3) 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

Table55: Achievement Indicator

Indicator	Present (Base Line)	Target
Enhancement of Severe Weather Monitoring Capability	Wind velocity: only manual observation	Wind velocity within the radar detection range: maximum 75m/s within a 200km radius
	Precipitation intensity 1mm/h or more within the radar detection range: within a 350km radius from the existing meteorological radar system	Radar precipitation intensity 1mm/h or more within the radar detection range: within a 450km radius from the meteorological radar system
	No hourly radar accumulated rainfall data within a 350km radius from the existing meteorological radar system	Hourly radar accumulated rainfall data within a 450km radius from the meteorological radar system
	Spatial resolution and observation intervals of the existing 120 synoptic observation stations in Pakistan: 81.9km mesh on average at 180 minutes observation intervals	Spatial resolution and observation intervals of precipitation data within the radar detection range: not more than 2.5 km mesh within a 450km radius from the meteorological radar systems
	Observation intervals of rainfall intensity within the radar detection range: PPI mode	Observation intervals of wind direction, wind velocity, and rainfall intensity within the radar detection range: PPI mode and CAPPI mode
	6 gradation level rainfall qualitative data	0-250mm/h rainfall intensity quantitative data
Enhancement of the capability for downburst and wind shear monitoring around the Karachi International Airport	Subjective observation of the area surrounding the Karachi International Airport	Objective observation of downburst and wind shear through radar observation
	No provision of radar images to the Karachi International Airport	Provision of radar images to the Karachi International Airport

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

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

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