Mauritius Meteorological Services
The Republic of Mauritius

PREPARATORY SURVEY REPORT
ON
THE MAURITIUS METEOROLOGICAL SERVICES PROJECT
IN
THE REPUBLIC OF MAURITIUS

November 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN WEATHER ASSOCIATION
INTERNATIONAL METEOROLOGICAL CONSULTANT INC.

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Summary

Summary

Mauritius, a country consisting of small islands, is located in the cyclone-prone area of the Southwest Indian Ocean and is often affected by natural disasters such as heavy storms, tidal waves and floods caused by tropical cyclones, landslides and so on. Recently, climate change caused by global warming has posed a serious problem for Mauritius as it is predicted to have significant negative impacts on small island nations which are particularly vulnerable to a change in the natural environment. In addition, it is said that climate change has a potential to become the greatest threat to the sustainability of the very foundations of human survival. Thus, it is a significant global issue which developed and developing countries alike must deal with in mutually beneficial cooperation.

In line with increasing global concerns on the intensification of disasters caused by climate change, the establishment of effective countermeasures against disasters such as severe storms, storm surges, and floods caused by tropical cyclones, rising sea level, tsunami, etc. has been an urgent task in Mauritius as well as in other countries in the Southwest Indian Ocean.

In order for Mauritius to contribute to the alleviation of natural disasters in the Southwest Indian Ocean, the following are required and strongly desired:

1) An efficient meteorological observation system; and,
2) An Exchange of meteorological observation data and information about cyclones with neighboring countries in the Southwest Indian Ocean on a timely basis.

Small island nations like Mauritius are in an extremely fragile situation because they have three negative aspects: the topographic dimension of being generally susceptible to meteorological calamities, the long distance from each continent, and the insufficiencies of meteorological observation/forecasting abilities and disaster prevention countermeasures. About 10% of tropical cyclones of the world are generated in the Southwest Indian Ocean around Mauritius. Figure below shows the tropical cyclone occurrence average per year in the Southwest Indian Ocean. While the average from 1960 to 1969 was 2.4 per year, it rose to 5.1 per year from 2000 to 2009 indicating that tropical cyclone occurrence almost doubled in forty years.

The number of tropical cyclones which occurred in the area of the Southwest Indian Ocean (Mauritius, La Réunion, and Madagascar) for the past 10 years is 58 and more than half of them developed into an intense tropical cyclone. Once a cyclone hits a country, the entire nation is likely to be damaged and, as a result, the number of victims and the amount of economic losses can become enormous. In terms of human and economic losses, 932 deaths, 2,820,628 victims and 655 million US dollars (500 billion yen) have been lost in 10 years. In Mauritius and La Réunion where the population is concentrated and economic activities are vigorous, extensive damage resulting from tropical cyclones is a determining factor in the significant set-back of social and economic development.

“A Climate Change Action Plan, 1998, Mauritius” clearly articulates the importance of MMS’s role along with data collection and information materials organization for monitoring, assessment of vulnerability and risk, and development of capability/technology to deal with climate change. In addition, in the “Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing Stated, 2005,” the following important points are mentioned in order for the small island developing countries to reduce the damages from natural calamities:

- Strengthening of early warning capability against meteorological phenomena like tropical cyclones;
- Establishment of more effective disaster management measures;
- Increase of public awareness about disaster reduction; and,
- Reinforcement of inter-sectoral and international cooperation.

These points are exactly in accord with the key objective of the Project.

The existing meteorological radar system of Mauritius, which had played the most important role in monitoring tropical cyclones generated in the Southwest Indian Ocean, completely stopped in 2005. This meteorological radar system was installed in 1979 with the assistance of the United Nations Development Program (UNDP) and had been active for over 26 years. However, it became difficult to procure spare parts from its manufacturer, and impossible to conduct or even renovate the radar system itself for a number of other reasons, namely: the transmitted power is down, each circuit in the system is obsolete, and the radar tower building is aging. As a consequence, the meteorological radar system of La Réunion is the only functioning radar system for monitoring tropical cyclones in the region of the Southwest Indian Ocean. Since most of the tropical cyclones come from the north-northeast/northeast/east-northeast, the radar system of La Réunion located at a point of 230 km west-southwest from Mauritius is not sufficient to monitor in advance the tropical cyclones which might invade this area. The fact that the radar system of Mauritius is out of order results in the deterioration and/or insufficient ability to monitor/detect natural calamities and, consequently, makes it unable to conduct effective countermeasures towards disaster prevention and mitigation in the entire region. In essence, it is akin to losing one precious eye to monitor tropical cyclones.

Due to lack of financial and technical capabilities, in 2009 the Government of Mauritius requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities, etc., under Japan’s Grant Aid Assistance scheme. In response to this request, the Government of Japan decided to conduct a Preparatory Survey for Climate Change Program for Mauritius Meteorological Service Project (hereinafter referred to as the “Preliminary Survey”). The Japan International Cooperation Agency (hereinafter referred to as “JICA”) sent the Preliminary Survey Team to Mauritius in April to May 2010 in order to confirm the feasibility and appropriateness of program implementation. During the Team’s stay in Mauritius, the following summarized components were confirmed as the requested items of the Mauritius Meteorological Services (MMS).

Table 1: Main Components requested by MMS

Component	Project Sites	
	MMS Head Office	Trou-aux-cerfs Radar Observation Station
Procurement and Installation of Equipment		
S-Band Doppler Radar System	-	1
Meteorological Rader Data Display System including Software	1	1
Meteorological Data Communication System	1	1
Construction of Radar Tower Building		
• Renovation (including extension) of the existing building, or • Construction of a new building	-	1

Since the necessity and appropriateness of the requested items indicated in the table above were confirmed, the Government of Japan decided to conduct a Preparatory Survey for Mauritius Meteorological Service Project (hereinafter referred to as the "Preparatory Survey (1)").

Consequently, the JICA sent the Preparatory Survey (1) Team to Mauritius from November 7 to December 5, 2011. The Team had a series of discussions with the officials concerned from the Government of Mauritius, 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 Mauritius from various perspectives such as operation & maintenance capabilities of Mauritius Meteorological Services (hereinafter referred to as the "MMS"), best equipment arrangement plan, etc.

In particular, in order to assess the availability of reutilization of Trou-aux-cerfs existing Meteorological Radar Tower Building for the Project (renovation/re-construction), comprehensive structural evaluation for reutilization of Trou-aux-cerfs existing Meteorological Radar Tower Building such as confirmation of the current situation on 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 reutilization of the existing Meteorological Radar Tower Building for the Project is extremely dangerous.

The government of Japan decided to conduct the Preparatory Survey (2), and JICA sent the Preparatory Survey (2) Team to Mauritius and the Team conducted the required survey for construction of a radar tower building from February 10 to February 23, 2012. From those studies indicated above, the Team formulated the draft outline design for the Project through further study in Japan.

JICA then sent the Preparatory Survey (3) Team again to Mauritius from August 18 to August 31, 2012 in order to explain and discuss the outline design & draft survey report. In the course of discussions and field survey, it was confirmed that the requested items are required for the Project in consideration of the Project's objectives and effects.

As a consequence of 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 2: Object components of the Outline Design

Component	Project Sites	
	MMS Head Office	Trou-aux-cerfs Radar Observation Station
Procurement and Installation of Equipment		
S-Band Doppler Pulse Compression Solid State Radar System including Power Back-up System, Lightening System, Measuring Equipment and Spare Parts	-	1
Meteorological Rader Data Display System including Software	1	1
Meteorological Data Communication System	1	1
Construction of Radar Tower Building		
Construction of a new Radar Tower Building	-	1
On-the-job training at each project site for the radar system (hardware and software) operation and maintenance		
Soft Component (Technical Assistance)		

The required implementation period of the Project, including the detailed design study and tendering procedures, is approximately 22.6 months. The capital cost for the Project to be borne by the Mauritian Government is approx. 67.73 million MUR (approx. 191.4 Million JP Yen).

The population to be benefited both directly and indirectly by the Project will be the whole nation of Mauritius (approx. 1.2 million based on below figures). There is also real concern that the number of victims will proportionally increase due to the fact that the population of Mauritius has been increasing by 1% annually, that is, 10% in 10 years. Moreover, it is estimated that the whole population of La Réunion (approx. 82 million) and Madagascar (approx. 1,960 million) will be benefited indirectly through further strengthening of the collaboration among three countries. Furthermore, since the information of meteorological Doppler radar system is planned to be utilized for navigational safety in Mauritius International Airport, the Project is considered to contribute to the safety of passengers (approx. 2.5 million/year) of the civil aviation aircrafts which take off and land in Mauritius International Airport.

The key objective of the Project is the effective mitigation of the devastation caused by tropical cyclones and other severe weather phenomena creating torrential rainfall via the enhancement of the capability of Mauritius and other countries in the Southwest Indian Ocean in tropical cyclone monitoring, forecasting and warning. To achieve this objective, the implementation of personnel training in addition to the installation of the Meteorological Doppler Radar System, Meteorological Radar Data Display System and Meteorological Data Communication System are absolutely essential. These will largely enhance the monitoring capability of hazardous meteorological phenomena such as tropical cyclones and torrential rain and will improve the forecasting/warning systems in Mauritius as well as positively redound to the neighboring countries in the Southwest Indian Ocean. Given the history that the countries in the Southwest Indian Ocean enormously received the human and social and economic damages resulting from tropical cyclones, and Climate Change caused by global warming will accelerate, it is expected that the Project contributes to improving the lives of people and that of the socio-economy in the region.

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 equipment for the Project must be durable, reliable, of a high technical level, and cost effective. In addition, since almost all the Japanese meteorological radar systems established by the Japan's Grant Aid in the 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 WMO, that a Japanese system is the most suitable one for developing countries facing operation and maintenance difficulty.

As adequately pointed out in the careful and comprehensive evaluation of the Project effects and the MMS's good organization capability, considerable and enhanced benefits can be expected to be achieved vis-à-vis the MMS's capabilities in reducing human loss and the recurrent economic set-back brought about by meteorological disasters like a tropical cyclone. Moreover, in order to reduce the MMS's operation and maintenance costs, the equipment was designed to minimize spare parts and consumables. Also, the biggest recurrent cost of the Project is expected to be electricity, therefore, the equipment and facilities were designed to minimize power consumption. As a result, the MMS's budget is expected to be able to cover the Mauritius portion of the capital cost and recurrent cost of the Project. The foregoing indicates and amply confirms the appropriateness and necessity of carrying out the Project under the grant-aid scheme. The Project would substantially contribute to the mitigation of the adverse effects of meteorological disasters and effectively safeguard the basic human needs of the people not only of Mauritius but also of its neighboring countries. The implementation of the Project is therefore considered to be appropriately suitable and worthwhile.

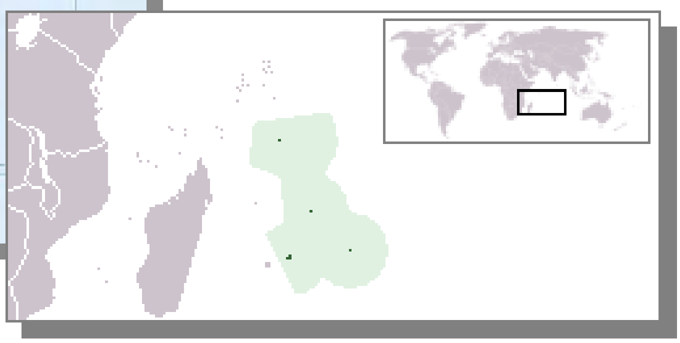
Contents

Appendices

■ Mauritius


N
reef
Goodlands
0 2.5 5 km
Triolet
Indian Ocean
PORT LOUIS
Centre de Flacq
Quatre Bornes
Curepipe
Tamarin
Mahébourg
reef
Chemin Grenier
Souillac
reef
Indian Ocean


Aden
Djibouti
ETHIOPIA
Addis Ababa
Berbera
Arabian Sea
Lakshadweep
Minicoy I.
Laccadive Sea
SOMALIA
MALDIVES
Male
UGANDA
KENYA
Mogadishu
Equator
Nairobi
Chisimayu
Lake Victoria
Mombasa
Pemba
Zanzibar
TANZANIA
Dar es Salaam
Mafia I.
Victoria
Les Amirantes
Mahé
SEYCHELLES
Coetivy
British Indian Ocean Territory
Chagos Archipelago
Diego Garcia
Groupe d'Aldabra
Atoll de Cosmoledo
Atoll de Providence
Atoll de Farquhar
Agalega Is.
INDIAN
OCEAN
Lindi
Moroni
COMOROS
Glorioso Is.
Lake Nyasa
Lilongwe
MALAWI
Mayotte
Mozambique Channel
Juan de Nova I.
MADAGASCAR
Antananarivo
Tromelin I.
Cargados Carajos Shoals
MOZAMBIQUE
Beira
Bassas da India
Europa I.
Port Louis
Mauritus
Saint-Denis
Reunion
Rodrigues
Mascarene Islands
Tropic of Capricorn



Trou-aux-cerfs Meteorological Radar Tower Building

List of Figures

Chapter 1 Background of the Programme

Chapter 2 Present Circumstances on the Programme

Chapter 3 Project Evaluation

List of Tables

Chapter 3 Project Evaluation

ABBREVIATIONS

AMESD	:	African Monitoring of Environment for Sustainable Development
ASEAN	:	Association of Southeast Asian Nations
AVR	:	Automatic Voltage Regulator
BSI	:	British Standards Institution
CAPPI	:	Constant Altitude Plan Position Indicator
CRED	:	Centre for Research on the Epidemiology of Disasters
CSD	:	Civil Status Division
DHA	:	Defense and Home Affairs
ECD	:	External Communications Division
ECO	:	Electoral Commissioner's Office
EIA	:	Environmental Impact Assessment
FSL	:	Forensic Science Laboratory
GIS	:	Government Information Service
GPD	:	Government Printing Department
ICTA	:	Information & Communication Technologies Authority
ITCZ	:	Intertropical Convergence Zone
JICA	:	Japan International Cooperation Agency
MBC	:	Mauritius Broadcasting Corporation
MMS	:	Mauritius Meteorological Services
MOI	:	Mauritius Oceanography Institute
MPA	:	Mauritius Ports Authority
MSB	:	Mauritius Standard Bureau
MT	:	Meteorological Technician
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time To Repair
JT	:	On-the-Job Training
PCB	:	Public Complaints Bureau
PMO	:	Prime Minister’s Office
PMT	:	Principal Meteorological Technician
PRB	:	Pay Research Bureau
RHI	:	Range Height Indicator
RSMC	:	Regional Specialized Meteorological Center
SMT	:	Senior Meteorological Technician
TCWC	:	Tropical Cyclone Warning Center
TICAD	:	Tokyo International Conference on African Development
TMPF	:	The Mauritius Police Force
VAT	:	Value-Added Tax
VSAT	:	Very Small Aperture Terminal
WMO	:	World Meteorological Organization

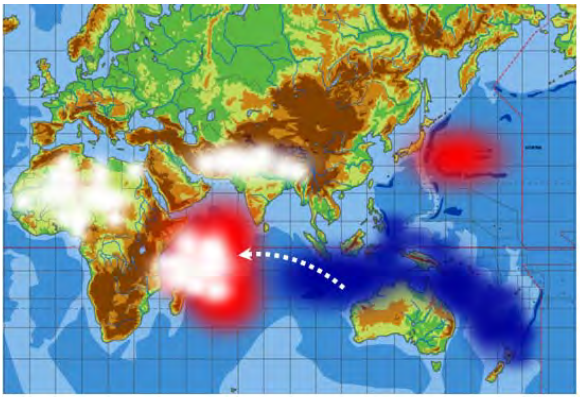
Chapter 1
Background of the Project

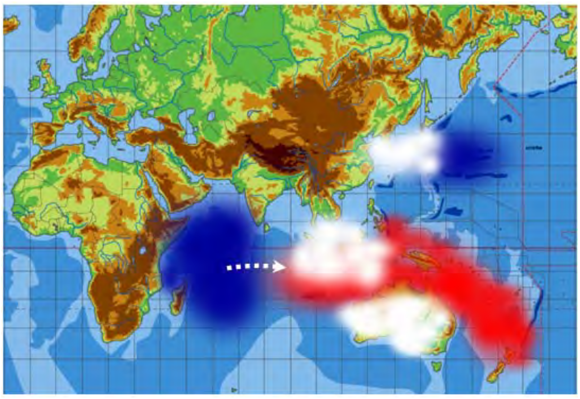
Chapter 1　Background of the Project

1-1　　Background of the Project

Mauritius, a country consisting of small islands, is located in the cyclone-prone area of the Southwest Indian Ocean and is often affected by natural disasters such as heavy storms, tidal waves and floods caused by tropical cyclones, landslides, tsunami and so on. Recently, climate change caused by global warming has posed a serious problem on Mauritius as it is predicted to have significant negative impacts on small island nations which are particularly vulnerable to a change in the natural environment. In addition, it is said that climate change has a potential to become the greatest threat to the sustainability of the very foundations of human survival. Thus, it is a significant global issue which developed and developing countries alike must deal with in mutually beneficial cooperation.

Figure below shows the phenomenon of Indian Ocean Dipole: IOD. Positive IOD is the phenomenon wherein sea water temperature in the summer becomes lower in the eastern part and higher in the western part of the Indian Ocean. If climate change combines with Positive IOD or El Nino/La Nina in the Pacific Ocean, the amount of rainfall would increase around Mauritius and the tropical cyclones would keep the intensity for a long time, which could cause destructive natural disasters. In line with increasing global concerns on the intensification of disasters caused by climate change, the establishment of effective countermeasures against disasters such as severe storms, storm surges, and floods caused by tropical cyclones, rising sea level, tsunami etc., has been an urgent task in Mauritius as well as in other countries in the Southwest Indian Ocean.





Red color: Sea surface temperature higher than the normal year　Blue color: Sea surface temperature lower than the normal year
White color: Increased convective activities (cloud distribution)　White arrow: Anomalous wind directions during IOD events

Figure 1: Positive Phase of Indian Ocean Dipole　Figure 2: Negative Phase of Indian Ocean Dipole

In order for Mauritius to contribute to the alleviation of natural disasters in the Southwest Indian Ocean, the following are required and strongly desired:

1) An efficient meteorological observation system; and,

2) An exchange of meteorological observation data and information about cyclones with neighboring countries in the Southwest Indian Ocean on a timely basis.

Small island nations like Mauritius are in an extremely fragile situation because they have three negative aspects: the topographic dimension of being generally susceptible to meteorological calamities, the long distance from each continent, and the insufficiencies of meteorological observation/forecasting abilities and disaster prevention countermeasures. Climate change may cause such unfavorable conditions to worsen and the extent of damage resulting from the natural calamities will amplify. There are concerns that rainfall and wind velocity of tropical cyclones will be increased and that storm surge damage generated by tropical cyclones will be aggravated by rising sea level as a result of global warming. In addition, drought caused by long spells of dry weather is a major concern in nations where there is a lack of freshwater resources. In such small island nations as Mauritius, once a meteorological disaster occurs, there would be delay in figuring out the extent of damage and in rescuing its victims because of underdeveloped communication infrastructure and the long distance from each continent. For these reasons, it is said that natural calamities caused by climate change will be more and more immeasurable and destructive.

1-2 Tropical Cyclone

About 10% of tropical cyclones of the world are generated in the Southwest Indian Ocean around Mauritius. Figure below shows the tropical cyclone occurrence average per year in the Southwest Indian Ocean. While the average from 1960 to 1969 was 2.4 per year, it rose to 5.1 per year from 2000 to 2009, indicating that tropical cyclone occurrence almost doubled in forty years.

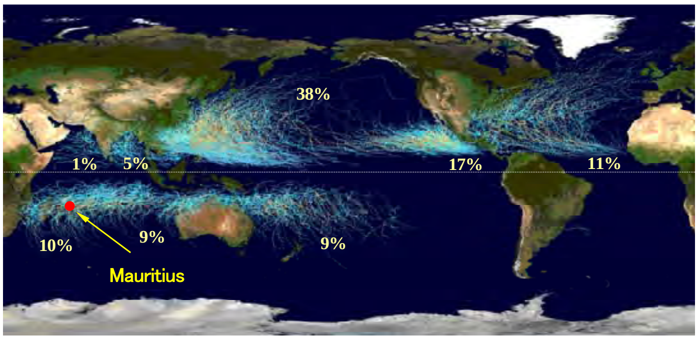


Figure 3: Tropical Cyclone Tracks occurrence in the World

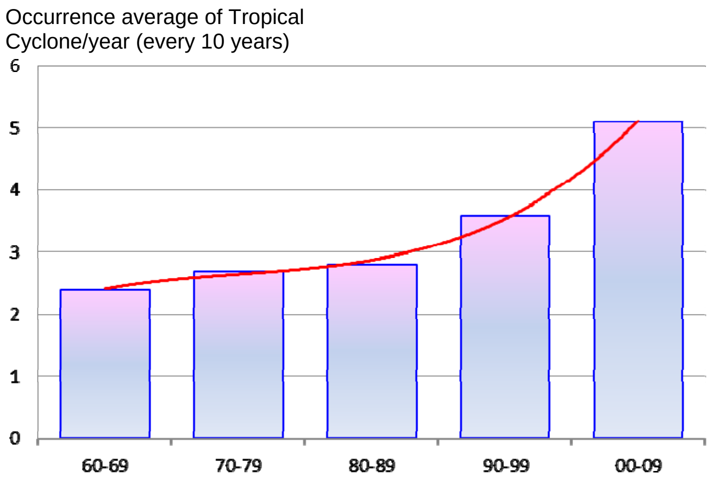


Figure 4: Movement of Tropical Cyclone Occurrence Average in Southwest Indian Ocean every 10 years

The following table shows the total amount of damages caused by tropical cyclones in the area of the Southwest Indian Ocean (Mauritius, La Réunion, and Madagascar) for the past 10 years. Once a cyclone hits a country, the entire nation is likely to be damaged and, as a result, the number of victims and the amount of economic losses can become enormous. In terms of economic losses, 500 billion yen has been lost in 10 years, which means 50 billion annually, calculated at the exchange rate of the yen's appreciation. In Mauritius and La Réunion where the population is concentrated and economic activities are vigorous, extensive damage resulting from tropical cyclones is a determining factor in the significant set-back of social and economic development.

Table 3: Damages by Tropical Cyclones in the Southwest Indian Ocean (2001-2010)

Tropical Cyclones in the Southwest Indian Ocean		Killed	Affected Persons	Estimated Damage (US Million Dollars)
Total	Intense Tropical Cyclone			
58	26	932	2,820,628	655.181

Source: JV prepared with OFDA/CRED Database and Tropical Cyclone Records

The arrows in the figure below represent the dangerous tracks of tropical cyclones which affected Mauritius in the past. Those cyclones occurred in the northeast ocean of Mauritius and mostly moved southwest to south toward Mauritius bringing heavy storm and plenty of rain. The following table is the list of damages caused by natural disasters in Mauritius from 1960 to 2009, in which the tropical cyclones in figure below (track of worst cyclones that affected Mauritius) are marked with red color.

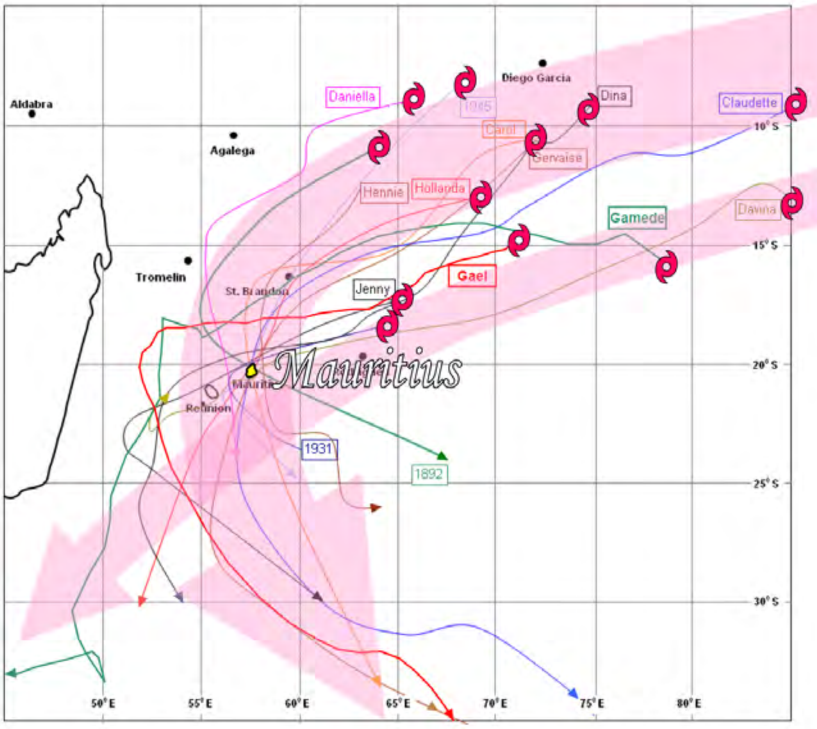


Figure 5: Track of worst cyclones that have affected Mauritius

Table 4: Meteorological Disaster List of Mauritius between 1960 and 2009

Date			Disaster		Numbers		
Start	End	Location	Type	Name	Killed	Total Affected	Estimated Damage (US$ Million)
2007/2/25	2007/2/25	-	Tropical cyclone	Gamède	2	-	-
2002/1/22	2002/1/22	Port Louis	Tropical cyclone	Dina	3	1,050	50
1999/3/10	1999/3/10	-	Tropical cyclone	Davina	-	1,000	-
1999/1	1999/4	Nationwide	Drought	-	-	-	-
1996/12/9	1996/12/9	Western and Southern part	Tropical cyclone	Daniella	3	-	-
1994/2/9	1994/2/11	Port Louis, Rodrigues Isl	Tropical cyclone	Hollanda, Ivy	2	2,300	135.4
1991/1/25	1991/1/25	Rodrigues Isl.	Tropical cyclone	Bella	-	7,500	-
1989/1/29	1989/1/29	-	Tropical cyclone	Firinga	1	4,507	60
1985/1/29	1985/1/29	Rodigues Isl.	Tropical cyclone	Ditra	-	-	-
1984/2/7	1984/2/7	Rodrigues Isl.	Tropical cyclone	Haja	-	-	-
1983/12/8	1983/12/8	Agalega Islands	Tropical cyclone	Andy	1	351	-
1982/2	1982/2	Rodriguez Isl.	Tropical cyclone	Frida	-	500	0.323
1982/1/16	1982/1/16	Rodrigues Isl.	Tropical cyclone	Damia	-	32,000	0.65
1979/12/22	1979/12/22	-	Tropical cyclone	Claudette	5	105,257	175
1979/2	1979/2	Rodrogues Isl.	Tropical cyclone	Celine	-	-	-
1975/2/6	1975/2/6	Entire island	Tropical cyclone	Gervaise	9	826,258	200
1972/2/17	1972/2/17	Rodrigues Isl.	Tropical cyclone	Fabienne	2	25,016	-
1967/12/25	1967/12/25	Rodriguez Isl.	Tropical cyclone	Carmen, Monica		23,524	5
1962/2	1962/2	-	Tropical cyclone	Jenny	18	8,000	-
1960/2	1960/2	-	Tropical cyclone	Carol	42	-	-

By WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED)
Emergency Events Database (EM-DAT) Created on: Jan-25-2010 & MMS

1-3 Current Situation of Tropical Cyclone Monitoring

The existing meteorological radar system of Mauritius, which had played the most important role in monitoring tropical cyclones generated in the Southwest Indian Ocean, completely stopped in 2005. This meteorological radar system was installed in 1979 with the assistance of the United Nations Development Program (UNDP) and had been active for over 26 years. However, it became difficult to procure spare parts from its manufacturer, and impossible to conduct or even renovate the radar system itself for a number of other reasons, namely: the transmitted power is down, each circuit in the system is obsolete, and the radar tower building is aging. As a consequence, the meteorological radar system of La Réunion is the only functioning radar system for monitoring tropical cyclones in the region of the Southwest Indian Ocean. Since most tropical cyclones come from the north-

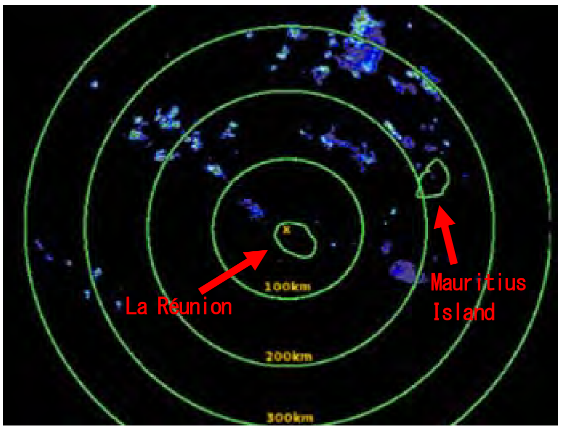


Figure 6: Meteorological Radar Data Image of La Réunion

northeast/northeast/east-northeast, the radar system of La Réunion located at a point of 230 km west-southwest from Mauritius is not sufficient to monitor in advance the tropical cyclones which might invade this area. The fact that the radar system of Mauritius is out of order results in the deterioration and/or insufficient ability to monitor/detect natural calamities and, consequently, makes it unable to conduct effective countermeasures towards disaster prevention and mitigation in the entire region. In essence, it is akin to losing one precious eye to monitor tropical cyclones.

1-4 Brief Summary on the Requests for the Project by Mauritius

As indicated above, the existing meteorological radar system of Mauritius which was located in the most strategic place for monitoring tropical cyclones in the Southwest Indian Ocean has failed and is irreparable leading to a complete halt in radar observation. Due to lack of financial and technical capabilities, in 2009 the Government of Mauritius requested the Government of Japan to procure and install the required equipment as well as to provide the relevant systems and facilities, etc. under Japan's Grant Aid Assistance scheme. In response to this request, the Government of Japan decided to conduct a Preparatory Survey for Climate Change Program for Mauritius Meteorological Service Project (hereinafter referred to as the "Preliminary Survey"). The Japan International Cooperation Agency (hereinafter referred to as "JICA") sent the Preliminary Survey Team to Mauritius in April to May 2010 in order to confirm the feasibility and appropriateness of program implementation. During the Team's stay in Mauritius, the following summarized components were confirmed as the requested items of the Government of Mauritius.

Table 5: Main Components requested by MMS

Component	Project Sites	
	MMS Head Office	Trou-aux-cerfs Radar Observation Station
Procurement and Installation of Equipment		
S-Band Doppler Radar System	-	1
Meteorological Rader Data Display System including Software	1	1
Meteorological Data Communication System	1	1
Construction of Radar Tower Building		
• Renovation (including extension) of the existing building, or • Construction of a new building	-	1

Since the necessity and appropriateness of the requested items indicated in the table above were confirmed, the Government of Japan decided to conduct a Preparatory Survey for Mauritius Meteorological Service Project (hereinafter referred to as the "Preparatory Survey (1)").

Consequently, the JICA sent the Preparatory Survey (1) Team to Mauritius from November 7 to December 5, 2011. The Team had a series of discussions with the officials concerned from the Government of Mauritius, 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 Mauritius from various perspectives such as operation & maintenance capabilities of Mauritius Meteorological Services (hereinafter referred to as the “MMS"), best equipment arrangement plan, etc.

In particular, in order to assess the availability of reutilization of Trou-aux-cerfs existing Meteorological Radar Tower Building for the Project (renovation/re-construction), comprehensive structural evaluation for reutilization of Trou-aux-cerfs existing Meteorological Radar Tower Building such as confirmation of the current situation on 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 reutilization of the existing Meteorological Radar Tower Building for the Project is extremely dangerous.

The government of Japan decided to conduct the Preparatory Survey (2), and JICA sent the Preparatory Survey (2) Team to Mauritius and the Team conducted the required survey for construction of a radar tower building from February 10 to February 23, 2012. From those studies indicated above, the Team formulated the draft outline design for the Project through further study in Japan.

JICA then sent the Preparatory Survey (3) Team again to Mauritius from August 18 to September 01, 2012 in order to explain and discuss the outline design & draft survey report. In the course of discussions and field survey, it was confirmed that the requested items are required for the Project in consideration of the Project’s objectives and effects.

As a consequence of the further study on the requested items in Japan, it has been decided that the following components indicated in the table attached hereunder are object items of the Preparatory Survey for the Project.

Table 6: Object components of the Outline Design

Component	Project Sites: MMS Head Office	Project Sites: Trou-aux-cerfs Radar Observation Station
Procurement and Installation of Equipment		
S-Band Doppler Pulse Compression Solid State Radar System including Power Back-up System, Lightening System, Measuring Equipment and Spare Parts	-	1
Meteorological Rader Data Display System including Software	1	1
Meteorological Data Communication System	1	1
Construction of Radar Tower Building		
Construction of a new Radar Tower Building	-	1
On-the-job training at each project site for the radar system (hardware and software) operation and maintenance		
Soft Component		

1-5 Negative Impact on the Development of the Mauritian Economy

Sugar, a leading export product in Mauritius, has historically supported Mauritius' sustainable national economic growth. The extensive damage on sugarcane plantations and its associated adverse effects on productivity created by hazardous meteorological phenomena is a determining factor for a significant set-back in the national economy. The figure below shows a close correlation between sugarcane productivity and hazardous meteorological phenomena.

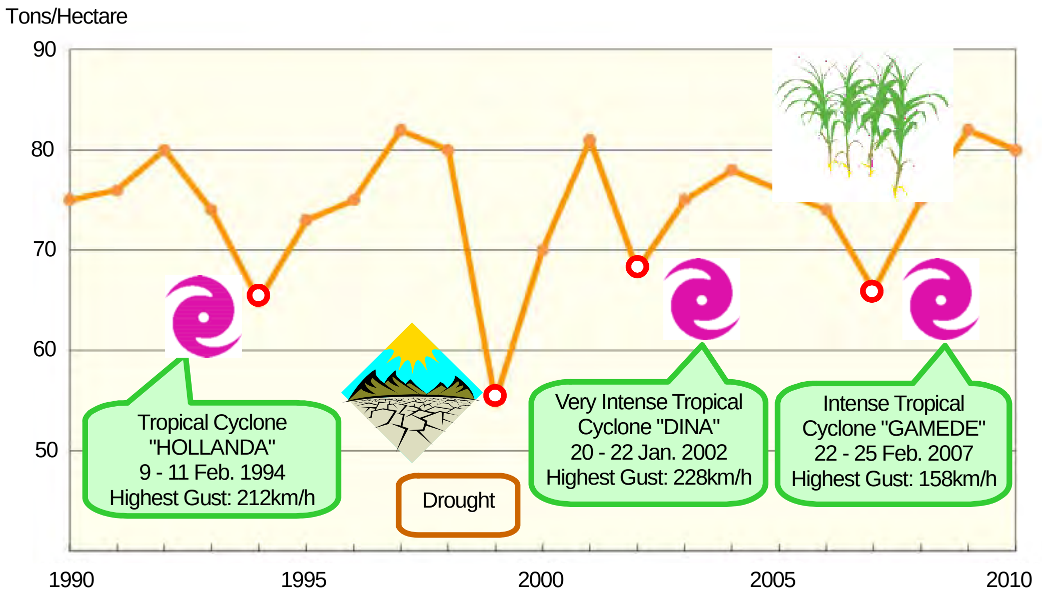


Figure 7: Annual Productivity of Sugarcane and Meteorological phenomena

Data Source: Mauritius Sugar Industry Research Institute & MMS

1-6 Natural Conditions of Mauritius

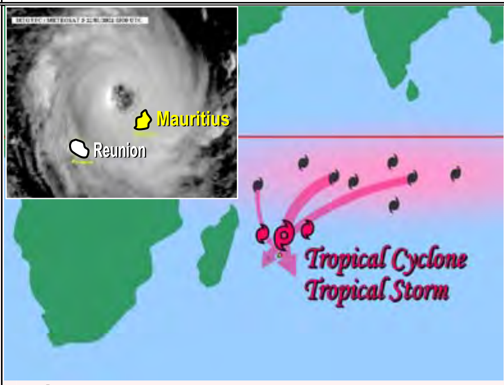
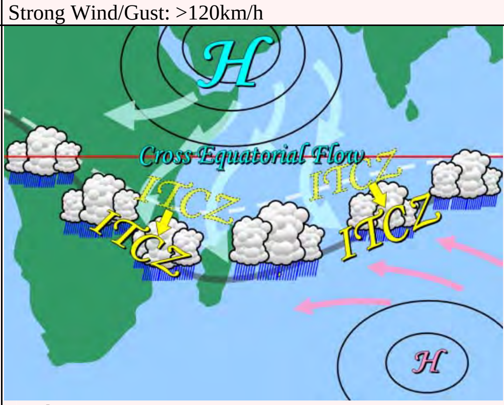
All islands of Mauritius (Mauritius, Rodrigues, Agalega, and St. Brandon) are located in 16-20°S in Southwest Indian Ocean and have temperate and humid climates. Precipitation events in Mauritius are caused not only by tropical disturbances such as cyclones and ITCZ during summer but also by middle-latitude or local scale disturbances. The tables below show the period of typical precipitation events and their details including mechanism and influence on Mauritius.

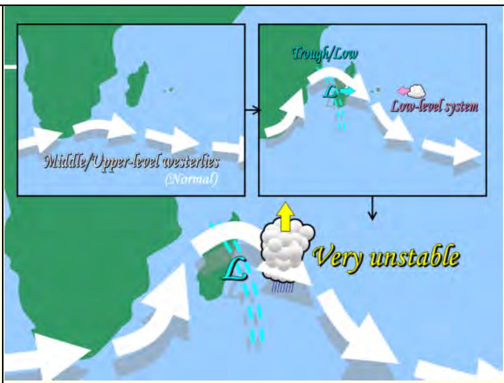
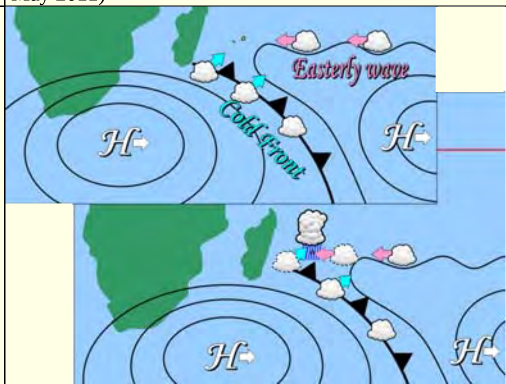
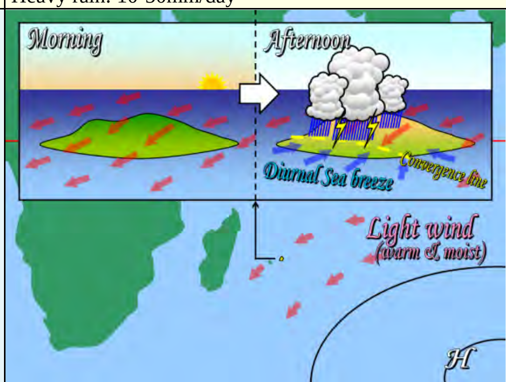
Table 7: Calendar of Typical Precipitation Events in Mauritius

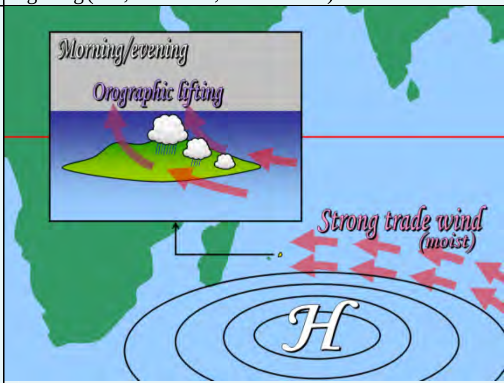
Remarkable Phenomenon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tropical Cyclone /Tropical Storm	◄━	━	━►	—	—►						◄—	—
ITCZ (Inter-Tropical Convergence Zone)	◄—	◄━	━►	—►								
Middle/Upper-Level Trough/Low	◄—	—	—	—	—	—	—	—	—	—	—	—►
Cold Front and Easterly Wave						◄—	—	—	—►			
Thunderstorm induced by Local Sea Breeze Line	—	—	—	—	—►						◄—	—
Orographic Rainfall from Trade Wind					◄—	—	—	—	—►			

◄——► Season of each phenomenon
◄━━► Peak Season of each phenomenon

Table 8: Details of Typical Precipitation Events in Mauritius

Remarkable Phenomenon	Mechanism and Expected Weather	Affected Area	Frequency of Occurrence
Tropical Cyclone /Tropical Storm	 Mechanism Tropical storm in the Southwest Indian Ocean is usually formed in the equatorial region (<10°S) and generally moves southwest and then south along a parabolic path. On average, ten tropical storms with the intensity over "moderate tropical storm" (five over "tropical cyclone") are formed per year, one of which passes within 100km of Mauritius island. Expected Weather Torrential/Heavy Rain: >100 mm/event (1,353mm, Mon Desert Alma, Cyclone Hyacinthe 24-28 Jan. 1980) Strong Wind/Gust: >120km/h	Whole Main Island (Mauritius)	Tropical Cyclone: at least 1 event/season Tropical Storm: 3-4 events/season
ITCZ (Inter-Tropical Convergence Zone)	 Mechanism ITCZ (Inter-tropical convergence zone), usually generated by convergence of winds from Northern and Southern Hemisphere, moves southward down to Mauritius when cross equatorial flow from Arabian High is predominant, and can stay for a few days or even a week over Mauritius. Expected Weather Torrential/heavy rain: >100mm/event (218mm, Antoinette, 20-21 Mar. 2005)	Whole Main Island (Mauritius)	At least 1 event/season

Middle/Upper-Level Trough/Low	 Mechanism 1. Middle/Upper-level westerlies shift northward than normal, and middle/upper-level trough/low is generated accordingly. 2. As the trough/low approaches over Mauritius, the atmosphere becomes very unstable. 3. In case a low-level cloud system is located near Mauritius, it eventually develops. Expected weather Heavy rain: >25 mm/day (340mm, Sans Souci, 06-07 May 2011)	Whole main island (Mauritius)	Occasionally
Cold Front and Easterly Wave	 Mechanism 1. When the two centers of Mascarene Highs are located in the south of Mauritius, a cold front is generated between each High and moves north-eastward up to Mauritius. 2. When easterly wave is generated along the edge of the High which is located to the east of Mauritius, cloud systems associated with the easterly waves move westward to Mauritius one after another. 3. In case the above-mentioned two independent cloud systems merge over Mauritius, both are enhanced. Expected weather Heavy rain: 10-50mm/day	Whole Main Island (Mauritius)	Occasionally
Thunderstorm induced by Local Sea Breeze Line	 Mechanism 1. When the High is weak in summer, synoptic-scale light wind brings warm and moist air into Mauritius. 2. In the afternoon local-scale sea breeze starts to blow	Localized Area	5 times/month in Summer

	toward the island and as a consequence a convergence line called "sea breeze line" is generated where synoptic-scale wind and local-scale sea breeze meet. 3. Eventually thunderclouds are rapidly generated over the convergence line. Expected Weather Heavy rain: >50mm/2-3hours Lightning (Hail, Downburst, Mini-Tornado)		
Orographic Rainfall from Trade Wind	 Mechanism 1. Strong trade wind (easterly wind) derived by the strong and stationary Mascarene High continuously blows and brings moisture to Mauritius in winter. 2. As the moist air is forced to lift along the slope of the island, rain clouds are generated by "orographic effect". Expected weather Rain: Light-Moderate in the morning/night	Wind Facing and High Grounds	Most Days in Winter

1-7 Topographic and Geotechnical Surveys

At Trou-aux-cerfs Meteorological Radar Observation Station, the topographic and geotechnical surveys indicated in the following tables were implemented by a local contractor consigned by the Preparatory Survey Team.

Table 9: Topographic Survey

Required Works	• Plane surveying (0.5m contour line) - Position of the existing building, observation facility, observation field - 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) - Bearing survey of the magnetic north - Calculation of the area planned
	• 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

Table 10: Geotechnical Survey Result of Trou-aux-cerfs Meteorological Radar Observation Station

Boring No.	Depth (m)	Soil Type	N-value	Recovery (cm)
BH-1	2.00-2.50	Weathered Rock	14	32
	4.50-5.00	Weathered Rock	15	30
	6.50-7.00	Weathered Rock	16	32
	8.50-9.00	Scoria	16	31
	10.50-11.00	Scoria	10	36
	13.50-14.00	Weathered Rock	11	39
	16.20-16.70	Scoria	17	35
	18.75-19.25	Scoria	20	29
	29.00-29.50	Weathered Rock	32	28
	30.50-31.00	Weathered Rock	31	27
	32.60-33.10	Scoria	25	27
	34.00-34.50	Scoria	34	27
	36.00-36.50	Scoria	32	24
	38.00-38.50	Scoria	36	22
BH-2	1.50-2.00	Weathered Rock	9	33
	3.50-4.00	Weathered Rock	>51	0
	5.00-5.50	Weathered Rock	>51	0
	6.00-6.50	Scoria	19	31
	8.00-8.50	Scoria	16	32
	11.50-12.00	Scoria	20	29
	14.00-14.50	Scoria	24	28
	16.00-16.50	Scoria	20	26
	18.00-18.50	Weathered Rock	11	32
	20.50-21.00	Scoria	15	36
	22.50-23.00	Scoria	12	35
	25.45-25.95	Weathered Rock	>51	0
	27.00-27.50	Weathered Rock	19	33
	29.50-30.00	Weathered Rock	16	36
	31.00-31.50	Weathered Rock	19	33
	41.00-41.50	Weathered Rock	12	37
BH-3	1.50-2.00	Weathered Rock	9	34
	3.50-4.00	Weathered Rock	>51	0
	5.50-6.00	Weathered Rock	23	20
	8.50-9.00	Scoria	12	23
	10.50-11.00	Scoria	17	29
	12.50-13.00	Weathered Rock	>51	0
	14.00-14.50	Weathered Rock	>51	0
	16.50-17.00	Weathered Rock	20	22
	18.50-19.00	Weathered Rock	>51	0
	21.50-22.00	Weathered Rock	>51	0
	24.00-24.50	Weathered Rock	33	23
	26.00-26.50	Scoria	21	27
	28.00-28.50	Scoria	20	27
	29.50-30.00	Scoria	15	31
	31.50-32.00	Weathered Rock	16	33
	33.50-34.00	Weathered Rock	>51	0
	34.00-34.50	Weathered Rock	23	28
	36.00-36.50	Weathered Rock	15	34
	40.55-41.05	Weathered Rock	>51	0
	42.80-43.30	Weathered Rock	>51	0
	46.50-47.00	Weathered Rock	>51	0

1-8 Mutual Collaboration in the Southwest Indian Ocean Region

On the mutual collaboration among Météo-France, Direction Interrégionale de La Réunion (hereinafter referred to as the "La Réunion (Météo-France)"), MMS and Météorologie de Madagascar after the completion of the Project (and after the installation of meteorological radar system in Mauritius), the JICA Preparatory Survey 1 Team had a discussion with La Réunion (Météo-France) on November 21, 2011, and with Météorologie de Madagascar on December 6, 2011. Details are as follows:

Table 11: Mutual Collaboration after completion of the Project between La Réunion (Météo-France) and MMS (Discussion conducted on November 21, 2011 in La Réunion)

<table>
<tr><th>Mutual Collaboration after completion of the Project</th><th>Result of Discussions</th><th>Reason/Method</th><th>Required Procedures</th></tr>
<tr><td>Radar raw data exchange for composite pictures</td><td>Not to be implemented</td><td>Synchronization of time and operation schedule as well as an arrangement of very high speed dedicated communication links are quite difficult between La Réunion (Météo-France) and MMS</td><td>-</td></tr>
<tr><td>Radar pictures (images) exchange</td><td>To positively implement radar pictures exchange</td><td>Radar pictures are useful for weather forecasting and early tropical cyclone detection for La Réunion and Mauritius.

Practical method of radar pictures exchange:
1. Radar pictures to be individually stored in Web server by La Réunion (Météo-France) and MMS
2. Radar pictures of La Réunion and Mauritius to be individually ingested by the password input by La Réunion (Météo-France) and MMS</td><td>Official mutual agreement between La Réunion (Météo-France) and MMS to be arranged by the Consultant</td></tr>
<tr><td>Uploading to Web page of all the radar pictures for the public</td><td>Not to be implemented</td><td rowspan="2">A result of organizational policy</td><td rowspan="2">-</td></tr>
<tr><td>Uploading to Web page of the selected radar pictures for the public</td><td>To be individually implemented</td></tr>
</table>

Table 12: Mutual Collaboration after completion of the Project among
La Réunion (Météo-France), MMS and Météorologie de Madagascar
(Discussion conducted on December 06, 2011 in Antananarivo)

Mutual Collaboration after completion of the Project	Result of Discussions	Reason/Method	Required Procedures
Radar pictures (images) ingestion	To positively implement radar pictures ingestion	Radar pictures are useful for weather forecasting and early tropical cyclone detection for Madagascar. Météorologie de Madagascar has a strong demand to use the radar pictures of La Réunion and Mauritius. However, technology transfer to Météorologie de Madagascar for utilization of meteorological radar pictures is required. Practical method of radar pictures ingestion: 1. Radar pictures to be individually stored in Web server by La Réunion and MMS 2. Radar pictures of La Réunion and Mauritius to be ingested by the password input by Météorologie de Madagascar	Official request of Météorologie de Madagascar to Réunion and MMS to be arranged by the Consultant

As a result of the discussions above, it was confirmed that each meteorological organization has a common understanding about the importance of further strengthening their collaboration in order to alleviate the adverse effects of disasters caused by tropical cyclones. In addition, Météorologie de Madagascar expressed a strong desire for the installation of a new meteorological radar system since its three existing meteorological radar systems are not operational anymore because of aged deterioration. In the future, as shown in figure below, if the three countries (La Réunion, Mauritius and Madagascar) implement monitoring/detection of tropical cyclones with meteorological radar systems, their mutual collaboration would greatly contribute to the alleviation of the adverse effects of disasters caused by tropical cyclones.

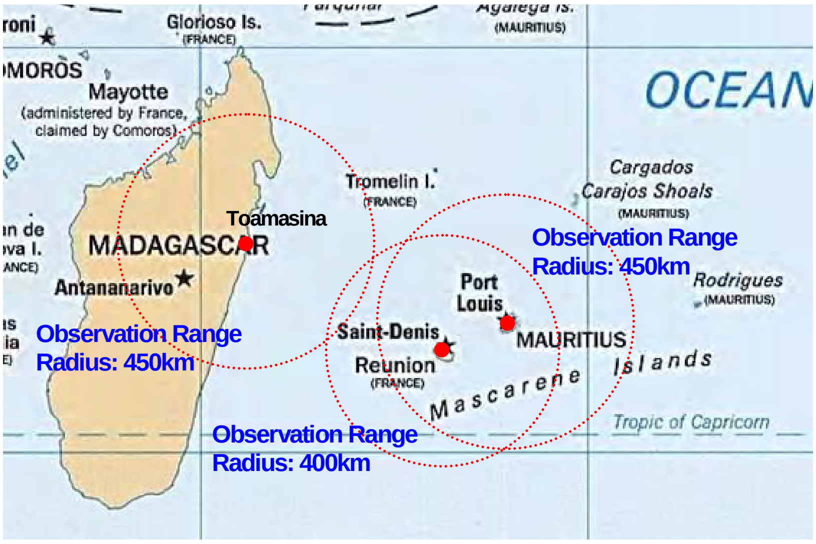


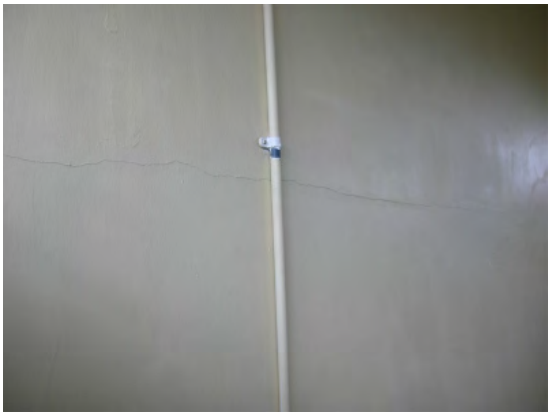
Figure 8: Future Meteorological Observation Network
in the Southwest Indian Ocean

: Maximum Detection Area

1-9 Existing Radar Tower Building

Comprehensive Structural Evaluation for the Trou-aux-cerfs existing Meteorological Radar Tower Building is attached hereunder.

Picture: Current Situation of Trou-aux-cerfs existing Meteorological Radar Tower Building

	
Horizontal cracks on the walls of Standby Generator Room	Concrete cracks on the walls of Work Shop Room
	
Lighting fixture damaged by rain water leakage in Work Shop Room	Water leakage tracks on the walls of Standby Generator Room
	
Water leakage tracks in Work Shop Room	Concrete aggregates dropped off from concrete surface due to concrete degradation (after mortar finish removed)

The result of Schmidt Hammer Test for Concrete Compressive Strength of Trou-aux-cerfs existing Meteorological Radar Tower Building is as follows.

Table 13: Result of Schmidt Hammer Test for Concrete Compressive Strength of Trou-aux-cerfs Existing Meteorological Radar Tower Building

Location	Schmidt Hammer Test			Rejection/ Acceptance Region		Average of Acceptance Value (R)	Concrete Compressive Strength (F) of Trou-aux-cerfs Existing Meteorological Radar Tower Building	
	No.	Rebound Value	Average					
Column	1	32	34.3	Rejection Region: ≥+20% of Average = 34.3×1.2=41.2	32	34.3	F=α×(13R-184)/9.8	16.03 N/mm^2
	2	31			31		α=coefficient of concrete age	
	3	38			38		concrete age ≤ 1,000 days: α=0.6	
	4	43			**43**			
	5	37		Acceptance Region	37			
	6	36			36			
	7	29		Rejection Region: ≤ -20% of Average = 34.3×0.8=27.4	29			
	8	26			**26**			
	9	34			34			
	10	37			37			
Retaining Wall	1	37	33.9	Rejection Region: ≥ +20% of Average =33.9×1.2=40.7	37	33.1		15.08 N/mm^2
	2	24			**24**			
	3	37			37			
	4	31			31			
	5	31		Acceptance Region	31			
	6	33			33			
	7	29		Rejection Region: ≤ -20% of Average =33.9×0.8=27.1	29			
	8	28			28			
	9	50			**50**			
	10	39			39			

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

Table 14: Comprehensive Structural Evaluation
for the Trou-aux-cerfs Existing Meteorological Radar Tower Building

<table>
<tr><td colspan="3">Current Situation on the Main Structures</td></tr>
<tr><td>Column</td><td colspan="2">Several numbers of concrete cracks are available.</td></tr>
<tr><td>Beam</td><td colspan="2">Several numbers of concrete cracks are available.</td></tr>
<tr><td>Floor</td><td colspan="2">Several numbers of concrete cracks are available.</td></tr>
<tr><td>Wall</td><td colspan="2">Many horizontal concrete cracks are found on mortar finishing surface.
Wall paints are come out due to water leakage from the concrete cracks.</td></tr>
<tr><td>Roof Slab</td><td colspan="2">Many water leakage tracks are available.
Wall paints are come out due to water leakage from the concrete cracks.</td></tr>
<tr><td>Re-bar</td><td colspan="2">Reinforce bars are not exposed.</td></tr>
<tr><td colspan="3">Structural Calculation for Replacement of Meteorological Doppler Radar System</td></tr>
<tr><td>Main Structure</td><td>Structural Calculation Result</td><td>Judgment</td></tr>
<tr><td>Column: 200mmx200mm</td><td>Deviated from the Allowable Stress (AIJ)</td><td>Danger</td></tr>
<tr><td>Beam: 200mmx650mm</td><td>Roof Beam & 1st Floor Beams: Deviated from the Allowable Stress (AIJ)</td><td>Danger</td></tr>
<tr><td>Grade Beam: 200mmx450mm</td><td>Deviated from the Allowable Stress (AIJ)</td><td>Danger</td></tr>
<tr><td>Floor: 150mm thickness</td><td>Displacement increased and deviated from the Allowable Stress (AIJ)</td><td>Danger</td></tr>
<tr><td>Foundation</td><td>Deviated from the Allowable Stress (AIJ)</td><td>Danger</td></tr>
<tr><td colspan="3">Result of Schmidt Hammer Test for Concrete Compressive Strength of Trou-aux-cerfs Existing Meteorological Radar Tower Building</td></tr>
<tr><td>Retailing Wall</td><td colspan="2">Current concrete compression strength15～16N/mm^2 (Common design concrete compression strength: 21N/mm^2)</td></tr>
<tr><td colspan="3">Analysis of Horizontal Distortion Angle due to Wind Pressure (Basic Design Wind Speed: 280km/h)</td></tr>
<tr><td>Horizontal Distortion Angle</td><td colspan="2">0.63°-1.0°</td></tr>
<tr><td>Horizontal Displacement</td><td colspan="2">70.6mm-112.8mm</td></tr>
<tr><td>Result</td><td colspan="2">Deviated from the Allowable Design Horizontal Distortion (≤0.075°)</td></tr>
<tr><td>Comprehensive Evaluation Result</td><td colspan="2">The Trou-aux-cerfs existing Meteorological Radar Tower Building is not usable for the Project (Construction of a new meteorological radar tower building is required for installation of a new meteorological Doppler radar system).</td></tr>
</table>

AIJ: Standard of Architectural Institute of Japan

1-10 Consideration for Environmental Conservation

In order to implement the Project, only the Environmental Impact Assessment (EIA) Clearance issued by the Ministry of Environment & Sustainable Development is required (EIA is not required).

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

Mauritius is located in the cyclone-prone area of the Southwest Indian Ocean and is often affected by natural disasters such as heavy storms, tidal waves and floods caused by tropical cyclones, landslides, tsunami and so on. Recently, climate change caused by global warming has posed a serious problem for Mauritius as it is predicted to have significant negative impacts on small island nations which are particularly vulnerable to a change in the natural environment. In order for Mauritius to contribute to the alleviation of the adverse effects of natural disasters in the Southwest Indian Ocean, 1) the strengthening of the meteorological observation, communication, and forecasting/warning system (through monitoring with meteorological radar system) and 2) the reinforcement of the cooperation with other countries in the Southwest Indian Ocean (through the exchange of meteorological observation data and information about cyclones on a timely basis) are the most important and urgent tasks. Principal members in the area of the tropical cyclone disaster prevention located in the Southwest Indian Ocean of Region I (Africa) of the World Meteorological Organization (WMO) are La Réunion, Madagascar, and Mauritius. Since Mauritius is the easternmost country among these three members, the sea around Mauritius becomes the primary approach path of tropical cyclones.

Given the situation indicated above, “A Climate Change Action Plan, 1998, Mauritius” was formulated. In addition, in “Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States, 2005”, the strengthening of early warning capability against meteorological phenomena like tropical cyclones and the further reinforcement of cooperation among neighboring countries in the Southwest Indian Ocean are pointed out as key targets.

Under these circumstances, the existing meteorological radar system of Mauritius, which had played the most important role in monitoring tropical cyclones generated in the Southwest Indian Ocean, completely stopped in 2005 due to aging deterioration. As a consequence, the meteorological radar system of La Réunion is the only functioning radar system for monitoring tropical cyclones in the region of the Southwest Indian Ocean as of present time. However, since most tropical cyclones come from the north-northeast/northeast/east-northeast, the radar system of La Réunion located at a point of 230 km west-southwest from Mauritius is not sufficient and/or inadequately encompassing to monitor in advance the tropical cyclones which invade/attack this area.

Therefore, the key objective of the Project is the effective mitigation of the adverse effects of natural disasters caused by tropical cyclones, torrential rain, etc. To achieve this objective, the implementation of personnel training in addition to the installation of Meteorological Doppler Radar System, Meteorological Radar Data Display System and Meteorological Data Communication System are absolutely essential.

These will largely enhance the monitoring capability of hazardous meteorological phenomena such as tropical cyclones and torrential rain and will improve the forecasting/warning systems in Mauritius as well as create a positive spill-over effect on the neighboring countries in the Southwest Indian Ocean.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Basic Design Policy of the Project

a) To design a meteorological observation system to contribute to disaster prevention in Mauritius and other countries in the Southwest Indian Ocean.
b) To enable MMS 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 the Southwest Indian Ocean Region including Mauritius.
c) To enable MMS to monitor weather conditions around-the-clock on a real time basis.
d) To enable MMS to promptly issue a public storm signal warning and/or a tropical cyclone information to the public.
e) To ensure the improvement of MMS's overall function and capacity in reducing human loss and economic setback brought about by tropical cyclone disasters through the upgrading of MMS's tropical cyclone monitoring capabilities.
f) To determine and set up the size and components of the Project to match with the technical, operational and maintenance capabilities of MMS.

[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 the Southwest Indian Ocean.
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 MMS.
d) To design the 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 MMS.
e) To design the 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 detecting rainfall distribution at each altitude.

f) To design that all of the meteorological radar data produced are delivered to the MMS Head Office every 15 minutes by high-speed satellite communication to enable the timely dissemination of tropical cyclone forecasts.
g) To design the equipment so that the pictures taken by the radar system are sent to Direction Interrégionale de La Réunion (Météo-France) and Météorologie de Madagascar and also to ensure that the pictures taken by La Réunion's existing radar system are ingested by the MMS.
h) To design the system so that it is within the MMS's capability to operate, maintain and repair.
i) To select equipment for which spare parts and consumables can be easily procured and replaced.
j) To select reliable and durable equipment suitable for the local environment.
k) To minimize the recurrent costs of the MMS for the operation, maintenance and repair of the equipment.
l) To ensure the accuracy of radar data through meticulous adjustment and proper calibration.
m) To design the equipment so as to minimize lightning damage.
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 design policy is to construct a meteorological radar tower building that will ensure appropriate and effective operations and will accommodate the required systems, equipment and personnel. It is a basic policy that the designed Radar Tower 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 building is not more than 0.075 degrees.
c) To adopt the basic wind speed (Vs=280km/h, approx. 77.8m/s: based on 50-year mean recurrence interval to the structural design) stipulated by the National Development Unit, Land Transport & Shipping.
d) To ensure that the working environment for the MMS's 24-hour/day work schedule of observations is conducive to ensuring effective and efficient performance.
e) 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.
f) To be sufficiently robust to withstand extreme weather and ensure uninterrupted radar observations and continuous provision of weather forecast & warnings to the public, even during a cyclone attack.

g) To make use of local building materials for easy maintenance of the radar tower building by the MMS.

h) 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 rooms where the equipment is to be installed since Mauritius has a high temperature and a very humid climate all throughout the year.

2) Rainfall

The meteorological data should be transmitted and received even when tropical cyclones hit Mauritius. A maintenance stair-case is located at the center of the building, covered by the upper concrete slab, to enable MMS personnel to easily reach each room for the regular maintenance of the radar equipment without getting wet during raining.

3) Lightning

Lightning might cause a serious damage to each system. A lightning protector is, therefore, planned to prevent damage to the building and to the equipment.

4) Tropical Cyclone (Stormy Wind)

To ensure highly accurate radar observations, in accordance with the regulation of the Ministry of Public Infrastructure, Land Transport and Shipping, the meteorological radar tower should be designed to withstand a wind velocity of 280km/h (approx. 77.8m/s). In general, the wind load design in Mauritius is based on British Standard.

5) Earthquake

According to the “National Earthquake Information Center” which stores all seismic data since 1973, there is no record of earthquake in Mauritius. Therefore, the seismic load is not incorporated into the structural design and calculation in Mauritius.

6) Load Bearing Layer

The structural design of the radar tower building is implemented according to the result of the geotechnical survey conducted at Trou-aux-cerfs existing Meteorological Radar Observation Stations by a local contractor consigned by the Preparatory Survey Team. Foundation type of the radar tower building is as follows:

Table 15: Foundation Type of the Proposed Radar Tower Building

	Trou-aux-cerfs Meteorological Radar Observation Station
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 treatment into the soil at each site.

2) Use of Locally Procurable Materials

Most of the construction materials can be procured in the local market. For the Project, durable maintenance materials not containing asbestos will be selected from the 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 Mauritius. In order to utilize local laborers as much as possible, reinforced concrete structure with which local workers are familiar will be used.

(4) Policy for Use of Local Construction Companies

1) Construction Work of the Radar Tower Buildings

Generally, in Mauritius, the technical skills and competence of the major local construction companies are adequate, so they will be used in 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 equipment installation work.

(5) Design Considerations to Simplify Operation and Maintenance for MMS

1) User-friendly equipment

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

2) Easy maintenance and affordable recurrent costs of the equipment

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

3) Consideration of minimizing operation & maintenance costs

In order for the MMS to meet the increased operation and maintenance costs of the system the following measures have been included in the planning for the equipment and the radar tower building:

- The ability to restrict the operation of air-conditioning systems and the electricity supply only in the operational rooms within the radar tower buildings
- The utilization of natural light to reduce energy requirements by minimizing the hours of artificial lighting required.
- The usage of LED for artificial lightning
- The 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, even during tropical cyclone attacks, the equipment and buildings must be sufficiently robust to withstand tropical cyclones, local severe storms and lightning strikes and enable the provision of meteorological services 24 hours per day.

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

Locally procurable materials and the local construction methods must be used in the building design.

The equipment to be installed in the radar tower building such as the specialized power backup systems and meteorological equipment is not available in the local market. 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 equipment for the Project must be durable, reliable, of a high technical level, and cost effective.

2-2-2 Basic Plan

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

Table 16: Main Components requested by Mauritius

Component	Project Sites	
	MMS Head Office	Trou-aux-cerfs Radar Observation Station
Procurement and Installation of Equipment		
S-Band Doppler Pulse Compression Solid State Radar System including Power Back-up System, Lightening System Measuring Equipment and Spare Parts	-	1
Meteorological Rader Data Display System	1	1
Meteorological Data Communication System	1	1
Construction of Radar Tower Building		
Construction of a new Radar Tower Building	-	1

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

(1) Equipment Plan

1) Meteorological Radar System

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

The requested meteorological radar system for Mauritius is an S band. An S band radar system is the most suitable type of radar system for the observation of precipitation over a very wide area. It has several important characteristics, including lower attenuation by rain and the atmosphere than other types of radar, and the ability to transmit at high power, providing a "long range", "real time" system. For these reasons, it has been selected as the most suitable system to monitor large-scale and distant phenomena such as tropical cyclones. In addition, the S band radar system must be a Doppler system with a changeable function with quantitative rainfall observation and air-turbulence observation capability in real time.

Table 17: Major Features of Meteorological Radar System

Major Features	Existing Radar System	Proposed Radar System
Main Purpose	Tropical Cyclone Monitoring	Tropical Cyclone and Torrential Rain Monitoring
Band	S band	S band
Frequency	2,800MHz	2,800MHz
Rainfall Resolution	16 gradation level indication	256 gradation level indication
Detectable Range of Precipitation Intensity 1mm/h or more	300km	450km
Doppler Function	None	Available
Accumulated Rainfall	None	Available

As indicated in the table attached hereunder, the existing meteorological radar system can detect a precipitation rate of 1mm/h or more only within a 300km radius. However, the proposed meteorological Doppler radar system is designed to be able to detect a precipitation rate of 1mm/h or more within a 450km radius.

Table 18: 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 Radar System (Antenna Diameter: 3.6m) Reception Power: -110dBm							
Distance (km)	Precipitation Intensity (mm/h)						
	0.50	**1.00**	**5.00**	**10.00**	**20.00**	**40.00**	**100.00**
10	-80.7	-75.9	-64.7	-59.9	-55.1	-50.2	-43.9
50	-95.1	-90.3	-79.1	-74.3	-69.4	-64.6	-58.3
100	-101.6	-96.8	-85.6	-80.8	-76.0	-71.1	-64.8
150	-105.6	-100.8	-89.6	-84.8	-80.0	-75.2	-68.8
200	-108.6	-103.8	-92.6	-87.8	-83.0	-78.2	-71.8
250	-111.1	-106.2	-95.1	-90.2	-85.4	-80.6	-74.2
300	-113.1	-108.3	-97.1	-92.3	-87.5	-82.7	-76.3
350	-115.0	-110.2	-99.0	-94.2	-89.3	-84.5	-78.2
400	-116.6	-111.8	-100.6	-95.8	-91.0	-86.2	-79.8
450	-118.2	-113.3	-102.2	-97.3	-92.5	-87.7	-81.3

Detection Range of the proposed 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 MMS to monitor the movement and development of severe weather systems for the preparation of a more accurate and timely weather forecast and warning. The Doppler mode is essential to allow for more accurate forecasting and longer forecast prediction times.

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

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

[3] Required Radar Display and Output Information Functions

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

Table 19: Required Radar Display and Output Information Functions

	Radar Display and Output Information Functions	Purpose of Observation	Necessary Data for Tropical Cyclone Monitoring	Necessary Data for Improvement of Forecast Accuracy
1	PPI Display	Rainfall	○	○
2	RHI Display			○
3	Cyclone Tracking Display and Prediction		○	○
4	Heavy Rainfall Warning Output		○	○
5	Accumulated Rainfall		○	○
6	Specific District Rainfall Amount Display and Warning		○	○
7	Surface Rain Display		○	○
8	Composite Picture Display	Wind Velocity and Direction	○	○
9	Wind Velocity and Direction		○	○
10	Wind Profile of the Upper Layer			○
11	Wind Shear Alert		○	○
12	Specific District Strong Wind Display and Warning		○	○
13	CAPPI Display	3-dimensional	○	○
14	Echo Tops and Echo Bottom Display		○	○
15	Vertically Integrated Liquid		○	○
16	Maximum Rainfall Display		○	○
17	3-dimensional data Display			○
18	Cross Section			○
19	JPG Image Output	Display, Data Output	○	○
20	Animation		○	
21	Map Edit		○	

Figure of “Before & After the Project, and Future Meteorological Radar Observation Network in the Southwest Indian Ocean Region” is attached hereunder.

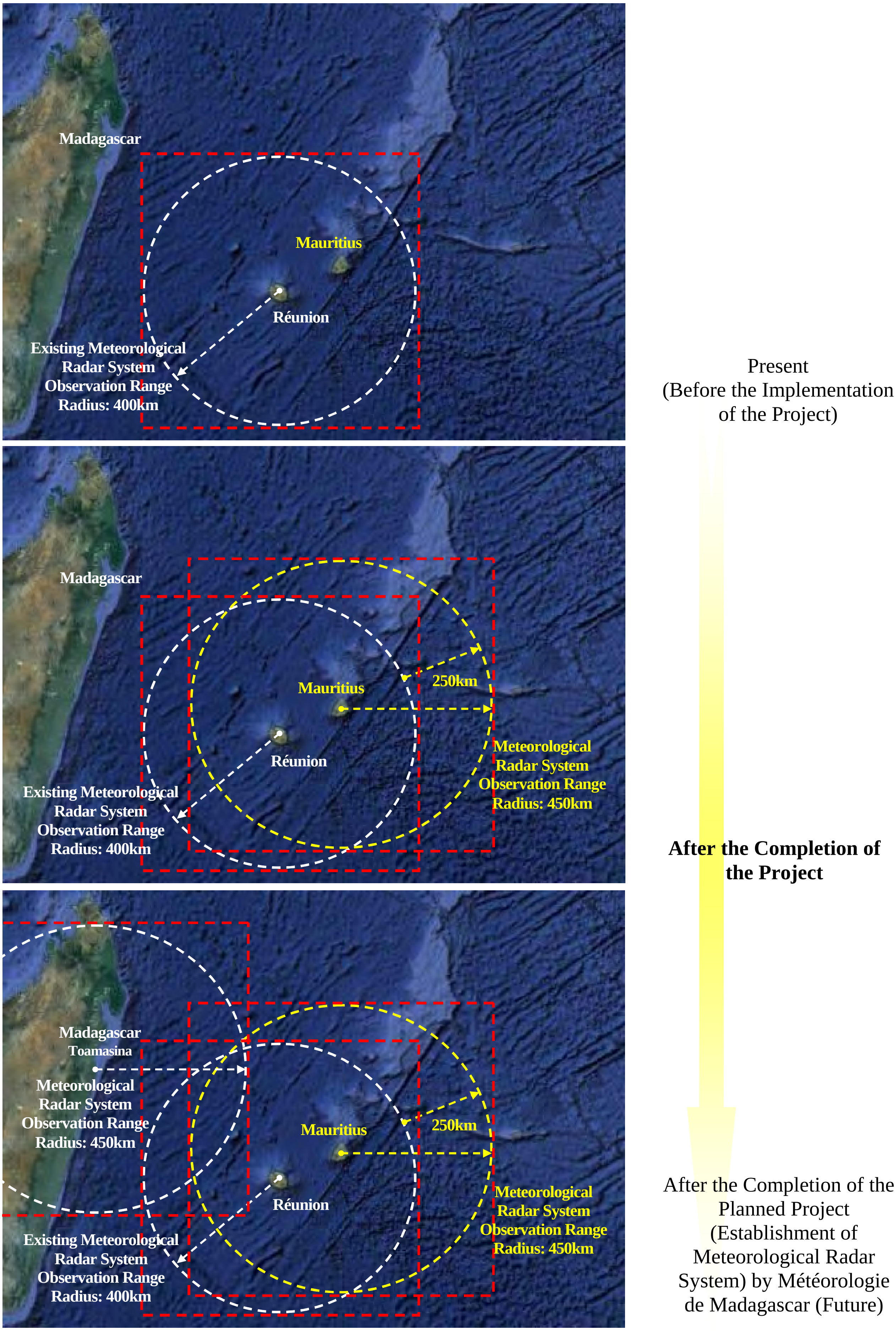


Figure 9: Before & After the Project, and Future Meteorological Radar Observation Network in the Southwest Indian Ocean Region

: Maximum Detection Area : Observed Data Processing Area

2) Meteorological Radar Data Display System

A meteorological radar data display system must have the ability to receive and display all meteorological products in real time because the MMS's forecasters must obtain the meteorological radar data in real time for routine weather forecasting & warning. In addition, the MMS's forecasters are required to do a substantial amount of work in a short time, so the meteorological radar data display systems are to be installed in the MMS Head Office and the proposed Trou-aux-cerfs Radar Tower Building so that they do not need to leave the area. Displays of the system must have minimized heat production for effective room cooling, power-saving type and less screen reflections for smooth and long time operation. The meteorological radar data display system will be designed to store data file of the radar pictures as binary data of hourly accumulated precipitation data of 2.5 km mesh.

3) Meteorological Data Communication System

Scan Test and Diag Test of Wireless LAN (2.4GHz、4.9GHz、5.6GHz) have been conducted between the MMS Head Office and Trou-aux-cerfs Existing Meteorological Radar Observation Station (direct distance: approx. 3 km). All the test results are indicated below.

Table 20: Scan Test Result of 2.4GHz Wireless LAN

	Channel (ch)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
MMS Head Office	■	■	■	■	■	■	■				■	■	
Trou-aux-cerfs Existing Meteorological Radar Observation Station	■	■	■	■	■	■	■	■	■	■	■	■	■

Table 21: Scan Test Result of 4.9GHz Wireless LAN

	Channel (ch)									
	20mW System				10mW System					
	184	188	192	196	H183	H184	H185	H187	H188	H189
MMS Head Office										
Trou-aux-cerfs Existing Meteorological Radar Observation Station										

Note: A 10-mW system shall not be used because of low power

Table 22: Scan Test Result of 5.6GHz Wireless LAN

	Channel (ch)									
	100	104	108	112	120	124	128	132	136	140
MMS Head Office			■							
Trou-aux-cerfs Existing Meteorological Radar Observation Station			■							

■ : Occupied channel

Table 23: Diag Test Result of 2.4GHz Wireless LAN

	Percentage of Packet Error	Communication Rate	Receiving Level in Self-station	Receiving Level in Opposite Station	Number of Transmission Failure
MMS Head Office	12%	20,738kbps	-69.70dBm	-69.10dBm	7
Trou-aux-cerfs Existing Meteorological Radar Observation Station	1%	22,454kbps	-69.50dBm	-69.00dBm	0

Table 24: Diag Test Result of 4.9GHz Wireless LAN

	Percentage of Packet Error	Communication Rate	Receiving Level in Self-station	Receiving Level in Opposite Station	Number of Transmission Failure
MMS Head Office	0%	15,726kbps	-79.30dBm	-78.50dBm	0
Trou-aux-cerfs Existing Meteorological Radar Observation Station	2%	17,305kbps	-75.80dBm	-78.40dBm	0

Table 25: Diag Test Result of 5.6GHz Wireless LAN

	Percentage of Packet Error	Communication Rate	Receiving Level in Self-station	Receiving Level in Opposite Station	Number of Transmission Failure
MMS Head Office	3%	17,935kbps	-79.10dBm	-76.40dBm	1
Trou-aux-cerfs Existing Meteorological Radar Observation Station	15%	18,410kbps	-76.40dBm	-79.50dBm	More than 50

Table 26: Conclusion of Scan Test and Diag Test and Recommendation

Wireless LAN	2.4GHz Wireless LAN	4.9GHz Wireless LAN	5.6GHz Wireless LAN
Channel Occupation	All	None	1
Percentage of Packet Error	12%	2%	15%
Number of Transmission Failure	7	0	More than 50
Expectable Interference	Serious	None	Quite Serious (Interferences are not appeared in the Scan Test Result)
Countermeasure for Interference	Some of Interferences (not all of them) can be avoidable due to use of High Gain Yagi Antenna (19dBi)	Not Required	None
Recommendation	-	In Mauritius, 4.9GHz is not yet opened (ICTA does not allow to use)	-

As indicated in the above tables, there is no recommended frequency for Wireless LAN between the MMS Head Office and Trou-aux-cerfs existing Meteorological Radar Observation Station. Therefore, it was decided that the 7.5GHz band compact link communication system will be used for the Project.

As a consequence of the technical study indicated above, it has been decided that the 7.5GHz band compact link communication system will be used to avoid frequency interference with any other communication equipment in the future. At present, the MMS has duly received the consent of the Information & Communication Technologies Authority (ICTA) towards the utilization of the 7.5GHz band compact link communication system for the Project. Features of the 7.5GHz band compact link communication equipment are indicated in the following table.

Table 27: Features of 7.5GHz Band Compact Link Communication Equipment

Description	7.5GHz band compact link radio equipment
Frequency	7.5GHz Band（7,125～8,500MHz）
Traffic capacity	10Mbps or more
Transmission power	0.5W
Modulation method	4PSK
Power consumption	Less than 100W
Reliability	High durability and reliability
Serviceability	Easy maintenance
Maintenance cost	Low cost maintenance.

The 7.5GHz band compact link communication system has the following predominant points as compared with other communication systems.

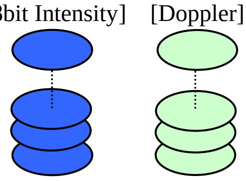
- High-speed communication is possible.
- Fixed wireless system regulations are applied and fixed rate transmission speed is always secured.
- Communication reliability is guaranteed based on the international regulations of ITR-R F.1668, and frequencies are allocated by ITU-R F.385.
- System configurations are simple to extend for computer and network equipment.
- Communication system includes duplicate data transmission, remote control and operation supervising.
- Lightweight and compact antenna can be used in a microwave system.
- Since it has a frequency band not more than "10GHz", it is hard to be influenced by rain (rain attenuation).
- It has highly advantage of interference from adjacent links or noise.

The required transmission time and data volume for the radar products to be transmitted by the Meteorological Data Communication System between MMS Head Office and Trou-aux-cerfs existing Meteorological Radar Observation Station is indicated in the following tables.

Table 28: Required Transmission Time at Transmission Speed 64kbps

Meteorological Radar Data	Data Transmission Time to MMS Head Office	Total	Required Time
Intensity RAW Data and Doppler RAW Data for a Fixed Elevation Angle (120kBytes)	0.6min	⇒ 13.4min	⇒ **15min**
Intensity RAW Data and Doppler RAW Data for 10 elevation Angle (2.4MBytes)	12.8min		

Table 29: Data Volume and Products of the Proposed Meteorological Radar System

Descriptions of Data	Data Volume of Single Observation	Radar Display
1 Elevation Angle: Long Pulse Observation (450km radius) Intensity RAW Data [8bit Intensity]	・Polar coordinate format ・320range×360 angle ・8bit data (Intensity) **Total:120kbytes**	<Radar Products> ・PPI/RHI Display ・Cyclone Tracking Indication and Forecast ・Heavy Rainfall Warning Output ・N-hour Accumulated Rainfall ・Composite Display ・Catchment Area Rainfall Amount Display
2 Elevation Angles: Long Pulse Observation (450km radius) 8 Elevation Angles: Short Pulse Observation (200km radius) Intensity RAW Data and Doppler RAW Data [8bit Intensity] [Doppler] 	・Polar coordinate format ・320range×360 angle ・8bit data (Intensity /Doppler) ・10 elevation angle **Total: 2.4Mbytes**	<Radar Products indicated above + below> ・CAPPI Display ・Echo Top Display ・Vertical Cross Section ・Surface Rain Indication ・Vertical Integrated Liquidation ・3-Dimensional Data Display ・Wind Velocity and Direction ・Wind Profile of the Upper Layer ・Wind Shear Alert

The "Schematic Diagram of Meteorological Radar Observation System" is attached hereto.

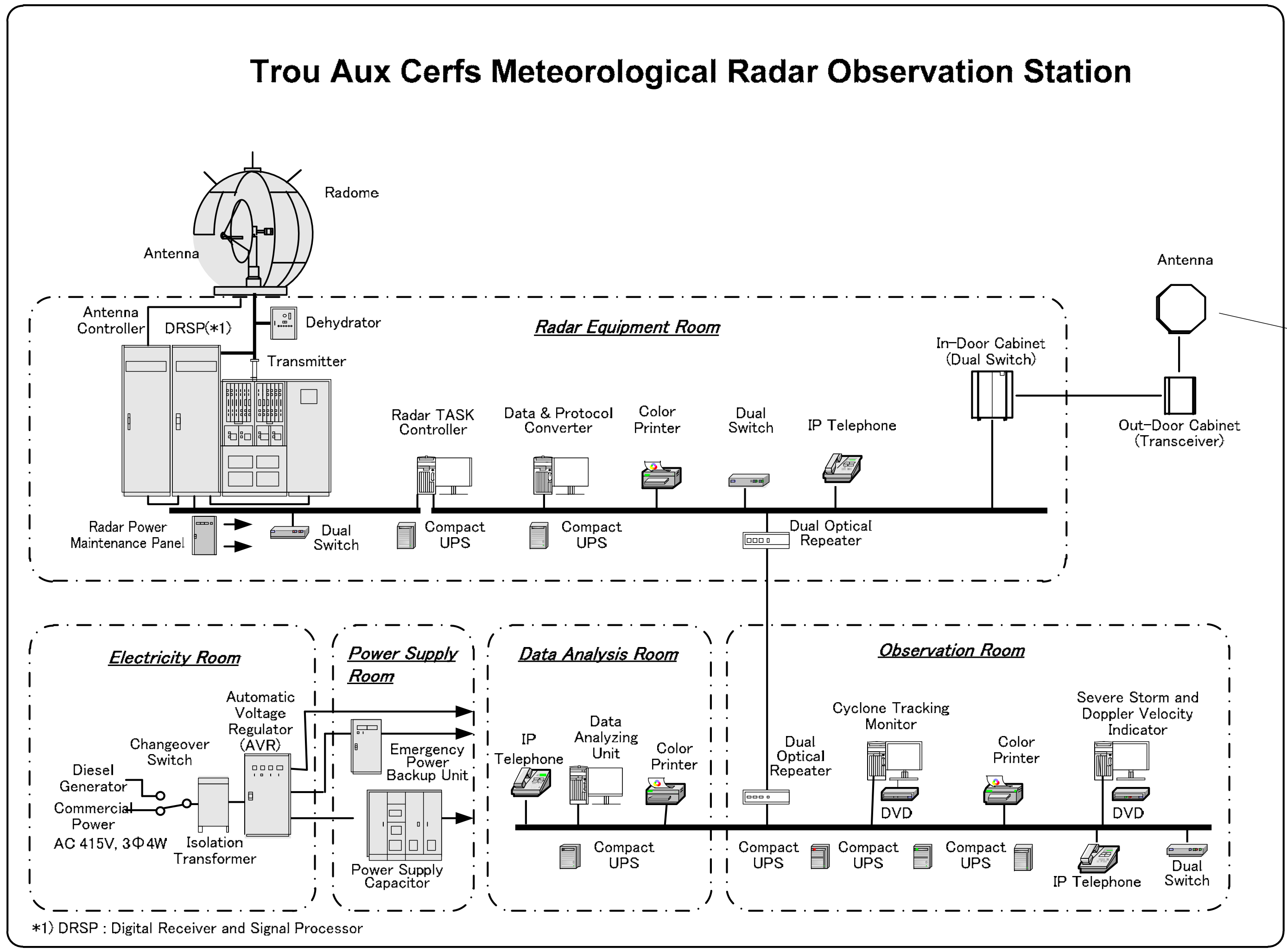
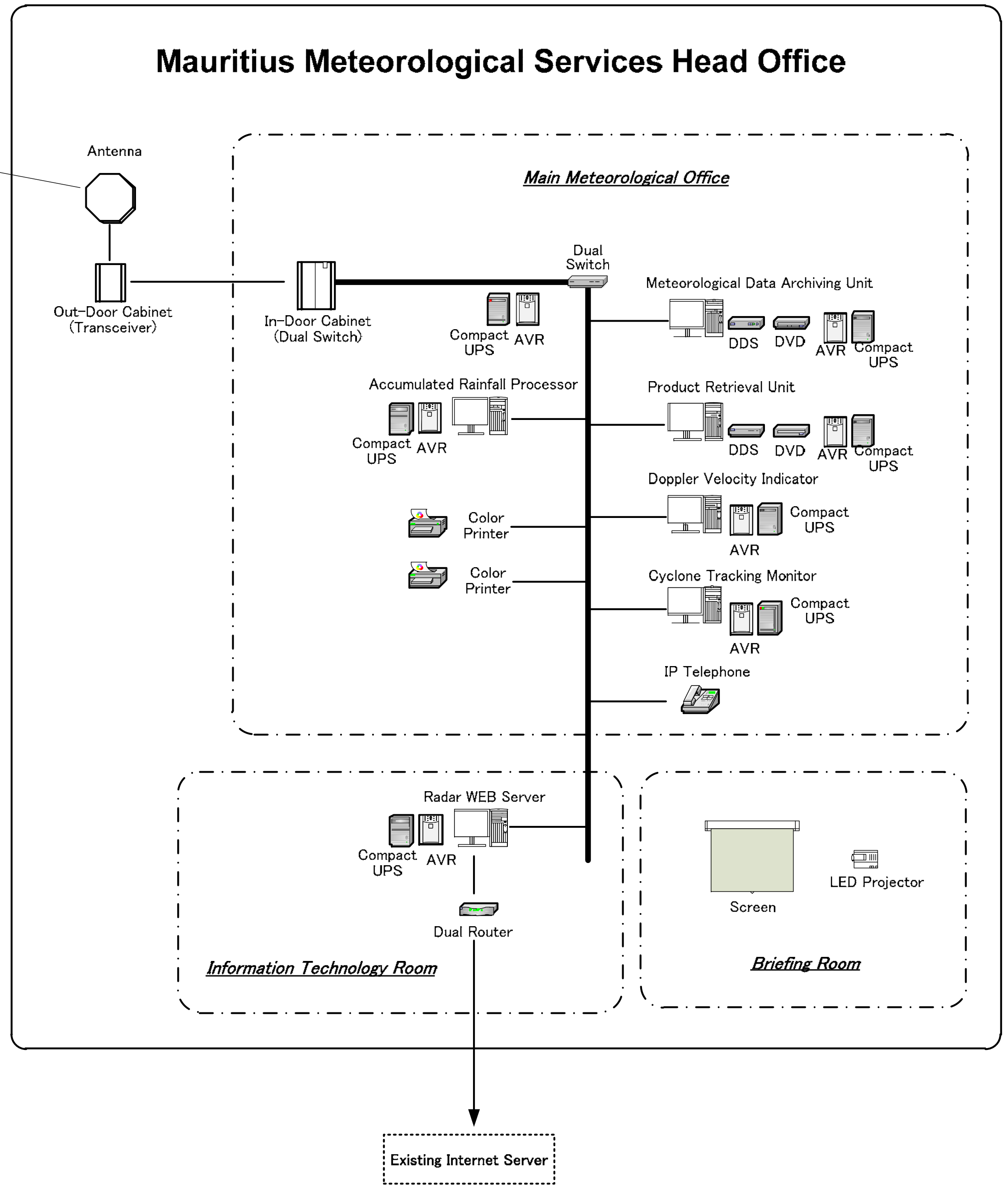


Figure 10: Schematic Diagram of Meteorological Radar Observation System



(2) Major Equipment List

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

Table 30: Main Components

Equipment	MMS Head Office	Trou-aux-cerfs Radar Observation Station
S-Band Doppler Pulse Compression Solid State Radar System	-	1
Meteorological Rader Data Display System	1	1
Meteorological Data Communication System	1	1

Major Equipment List

Meteorological Radar System (Trou-aux-cerfs Meteorological Radar Tower Building)

Name of Site: Trou-aux-cerfs Meteorological Radar Tower Building		
Equipment	Quantity	Purpose
Radome	1 set	For protecting the radar antenna assembly (a parabolic dish reflector) and 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 as 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 the 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 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 wave traveling between the antenna and TX/RX.
Radar TASK Controller	1 set	For operating the radar system, monitoring 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, Antenna local/maintenance mode status.
Data & Protocol Converter	1 set	For sending Raw data to central system according to specified interval.
Radar Power Maintenance Panel	1 set	For distributing and supplying AC power to radar system.
Compact UPS	2 sets	For supplying back-up AC power to computer equipment in order to enable proper shutdown procedure of the system in case of power failure.
Dual Switch	2 sets	For connecting all the computing equipment on LAN.
Color Printer	1 set	For printing radar image.
Dual Optical Repeater	1 set	For converting electrical signal and optical signal on LAN for surge protection.
Isolation Transformer	1 set	For protecting each equipment from surge voltage in main power.
Automatic Voltage Regulator (AVR)	1 set	For supplying the constant or regulated voltage to the radar system.
Power Supply Capacitor	1 set	For supplying the uninterrupted power by Electric Dual Layer Capacitor energy to the radar system when power failure occurred.
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 Angle Signal)	1 set	For maintenance of the system.
	Timing Belt for Antenna (For Elevation Angle Signal)	1 set	
	Encoder for Antenna (For Azimuth Angle Signal)	1 set	
	Encoder for Antenna (For Elevation Angle Signal)	1 set	
	Motor for Antenna (For Azimuth Angle Signal)	1 set	
	Motor for Antenna (For Elevation Angle Signal)	1 set	
	Servo Unit for Antenna Controller (For Azimuth Angle Signal)	1 set	
	Servo Unit for Antenna Controller (For Elevation Angle Signal)	1 set	
	Power Supply Unit for Antenna Controller	1 set	
	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	
	Hard Disk Unit for Computer (not less than 250GB)	1 set	
	LAN Arrester	1 set	
	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 (Trou-aux-cerfs Meteorological Radar Tower Building)

Name of Site: Trou-aux-cerfs Meteorological Radar Tower Building		
Equipment	Quantity	Purpose
Severe Storm and Doppler Velocity Indicator	1 set	For monitoring and alerting severe storm condition by various doppler radar products.
Cyclone Tracking Monitor	1 set	For tracking cyclone course and predicting cyclone course and time.

Color Printer		2 sets	For printing radar image.
Dual Switch		1 set	For connecting all the computer equipment with LAN.
Dual Optical Repeater		1 set	For converting electrical signal and optical signal on LAN for surge protection.
DVD Drive		2 sets	For storing of radar and weather information in DVD media.
Compact UPS		4 sets	For supplying back-up AC power to computer equipment in order to enable proper shutdown procedure of the system in case of power failure.
Data Analyzing Unit		1 set	For analyzing weather phenomena by observed radar data.
SIP IP Telephone		3 sets	For voice communication through IP network.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	1 set	For maintenance of the system.
	LAN Arrester	1 set	
Service Manuals		2 sets	For maintenance of the system.

Meteorological Radar Data Display System (MMS Head Office)

Name of Site: MMS Head Office			
Equipment		Quantity	Purpose
Meteorological Data Archiving Unit		1 set	For storing of radar and weather information to selected media.
Product Retrieval Unit		1 set	For retrieving and displaying of radar data.
Accumulated Rainfall Processor		1 set	For generating and sending accumulated rainfall data.
Doppler Velocity Indicator		1 set	For generating various wind profile with each mesh by doppler data.
Cyclone Tracking Monitor		1 set	For tracking cyclone course and predicting cyclone course and time.
Radar WEB Server		1 set	For output of various products with WEB based image.
Color Printer		2 sets	For printing radar image.
Dual Router		1 set	For forwarding data packets between computer networks.
Dual Switch		1 set	For connecting all the computer equipment with LAN.
DVD Drive		2 sets	For storing of radar and weather information in DVD media.
DDS Drive		2 sets	For storing of radar and weather information in DDS media.
SIP IP Telephone		1 set	For voice communication through IP network.
Compact UPS		7 sets	For supplying back-up AC power to computer equipment in order to enable proper shutdown procedure of the system in case of power failure.
Automatic Voltage Regulator (AVR)		7 sets	For supplying the constant or regulated voltage to the computer system.
LED Projector		1 set	For meeting and discussion of meteorological services.
Screen		1 set	For LED Projector.
Spare Parts	Hard Disk Unit for Computer (not less than 250GB)	4 sets	For maintenance of the system.
	LAN Arrester	4 sets	
Service Manuals		1 set	For maintenance of the system.

Meteorological Data Communication System (Trou-aux-cerfs Meteorological Radar Tower Building)

Name of Site: Trou-aux-cerfs Meteorological Radar Tower Building			
Equipment		Quantity	Purpose
7.5GHz Band Radio Equipment		1 set	For high rate transmission using radio.
Parabolic Antenna		1 set	For combination use with radio equipment.
Spare Parts	7.5GHz Band Radio Equipment-ODU	2 sets (High ch And Low ch)	For maintenance of the system.
	-IDU	1 set	
Service Manuals		2 sets	For maintenance of the system.

Meteorological Data Communication System (MMS Head Office)

Name of Site: MMS Head Office		
Equipment	Quantity	Purpose
7.5GHz Band Radio Equipment	1 set	For high rate transmission using radio.
Parabolic Antenna	1 set	For combination use with radio equipment.

Spare Parts	7.5GHz Band Radio Equipment-ODU	2 sets (High ch & Low ch)	For maintenance of the system.
	-IDU	1 set	
Service Manuals		2 sets	For maintenance of the system.

(3) Basic Plan of the Facility

1) Site and Facility Layout Plan

The existing Meteorological Radar Observation Station which is located at the most strategic place for monitoring tropical cyclones in the Southwest Indian Ocean is owned by the MMS as a government property.

Table 31: Outline and Current Situation of Infrastructures at the Existing Meteorological Radar Observation Station

	Trou-aux-cerfs Existing Meteorological Radar Observation Station			
Location	Latitude(S)	20º 19'07.8"	Longitude(E)	57º 30'34.9"
Altitude	608m			
Area of Property (Inside of the existing fence/boundary wall)	Approx. 1,200m^2			
Space availability for construction of the proposed radar tower building	Minimum required space can be made available as a result of some strategic technical realignment as well as adjustments in building and layout plans. An access road in the premises for delivery of engine generator fuel is required.			
Access Road	Approx. 5m width paved road			
Description/Outline of the Premises	On the outer rim of an inactive Trou-aux-cerfs volcanic crater			
Commercial Power	Current: 230V, Single Phase, 50Hz			
Water Supply	Available			
Waste water and Sewage	Not available			
Telephone	Available			
Mobile phone in the property area	Accessible			
Internet	Not available			

2) Architectural Design

[1] Floor Plan

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

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

Table 32: Calculation Base of Each Room In the Proposed Meteorological Radar Tower Building

Name of Room	Floor Area (m^2)	Room Function	Calculation Base
Radome Room	30.19	Installation space for radar antenna apparatus.	Maintenance space for radar antenna apparatus. Room area depends upon radome base 6.2m in diameter.
Radar Equipment Room (including	76.95	Installation space for antenna controller, transmitter, solid state power amplifier,	Operation and maintenance space for all the apparatuses described in the left column. For

Spare Parts Room)		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.	installation of all the required equipment, at least $77m^2$ is required.
Observation Room	44.10	For weather observation terminals (2), optical repeater, dual switch, printer, IP telephone, UPS for PCs, filing cabinets, white board, etc.	For radar observation space and installation space for all the equipment described in the left column.
(Data Analysis Space)		For data analysis terminal (1), desk for the terminal and data storage cabinets (high type: 3).	A space for data analysis terminal (1), desk, data storage cabinets and also working space.
(Data Storage Space)		For data storage cabinets (high type: 4) for keeping observation records and observed data of the radar system for analysis.	Necessary space for keeping all data secured.
Maintenance Room	21.08	For maintenance instruments, measuring equipment, cabinets for operation & maintenance manuals and spare parts & consumables.	Maintenance space for various types of the equipment and keeping space for maintenance instruments, measuring equipment.
Engine Generator Room	34.92	For 2 engine generators, oil pumps: 2, service tank, accessories, etc	Operation and maintenance space for 75kVA engine generators (2) with 1,000 liter service tank, automatic change-over switch, etc.
Electricity Room	17.05	For isolation transformers, power distribution boards, cable rack, test terminals, AVR, etc.	Installation, operation and maintenance space and cabling space for all the apparatuses described in the left column. Approx.
Power Supply Room	12.87	For radar power back-up unit and control rack.	Installation, operation and maintenance space for all the apparatuses described in the left column.
Toilet	10.38	European Style Commode: M1+F1, Wash basin: M1+F1, Urinal:1, Slop Sink: 1	—
Tea Kitchen	12.42	Kitchen: 1	—
Changing Room	1.35	Changing space for taking shower	—
Shower Room	1.59	Space for taking shower.	—
Storage	5.23	Storage space for spare materials and miscellaneous goods.	Storage space for spare materials and miscellaneous goods.
Pump Room	7.88	Well pump: 2 Pump for water reservoir tank: 2	For maintenance space and installation space for pumps: approx. 8 m^2 required.
Exhibition Hall	29.96	Weather Information exhibition space	Exhibition Panels: 6

[2] Sectional Plan

I. Height of the Radar Tower Building

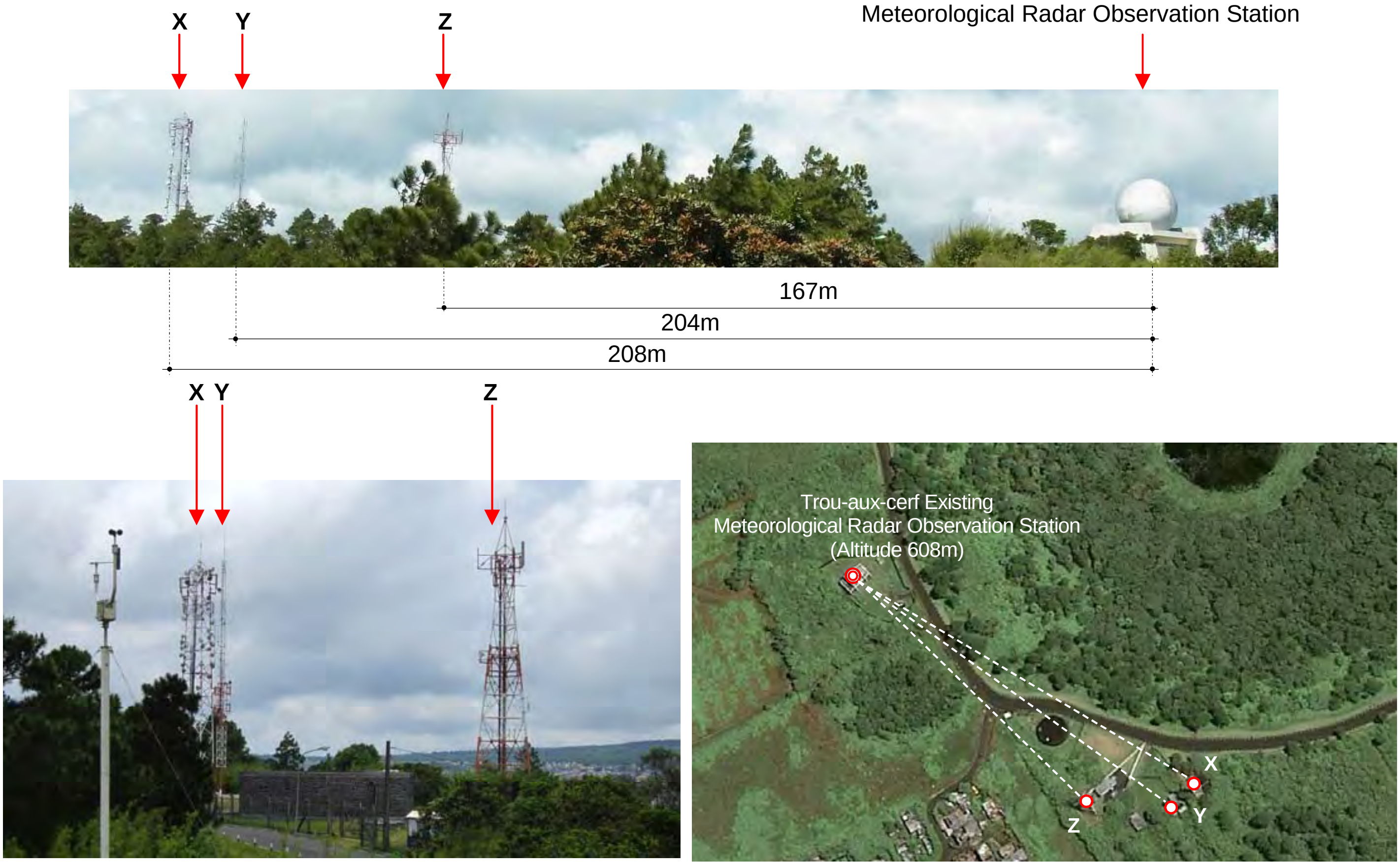
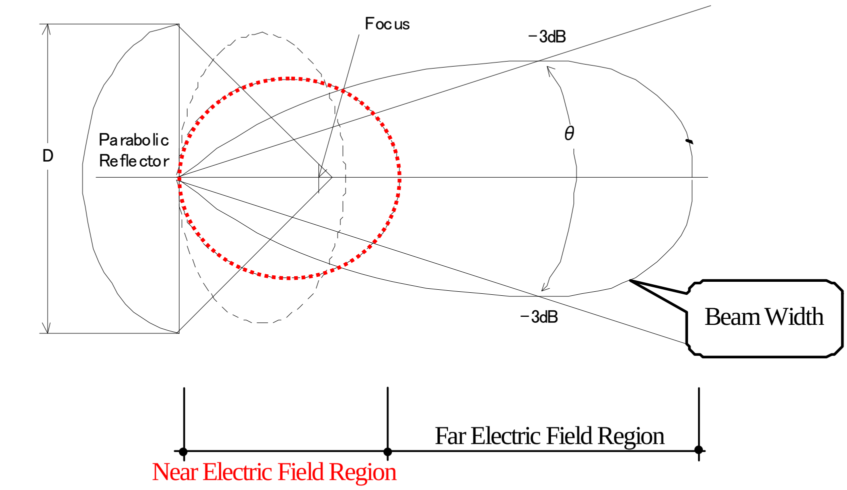


Figure 11: Obstructive Existing Communication Steel Towers located just near Trou-aux-cerf Existing Meteorological Radar Observation Station

Table 33: Obstructive Existing Communication Steel Towers for Radar Observation

	X	Y	Z
Height of Existing Communication Steel Tower	30m	30m	30m
Height of Existing Communication Steel Tower from the Ground Level of Trou-aux-cerf existing Meteorological Radar Observation Station	29.2m	28.1m	28.1m

3 obstructive existing communication steel towers are located in the Near Electric Field Region (radar beam unstable zone: any obstructions must be kept out) of a 5m diameter radar antenna as indicated in the Figure. A radar parabolic antenna must be higher than any obstructions.



$$r = \frac{2D^2}{\lambda}$$

Antenna Diameter: D=5 m Beam Length : λ=10.5 cm
Near Electric Field Region: r=476 m

Figure 12: Near Electric Field Region of 5m Diameter Radar Antenna

<Calculation of the required height of Radar Antenna Center>

Required Radar Antenna Center: 29.2 m + 2.5 (Radar Antenna Radius) + (Tan 0.8°×208 m) = 31.7 m + 2.9 m = 34.6m + Clearance (2m) ≈ **37 m**

- Designed Radar Antenna Diameter: 5m
- 29.2 m: Height of X Existing Communication Steel Tower from the Ground Level of Trou-aux-cerf Existing Meteorological Radar Observation Station
- Tan 0.8°×208 m = 2.9 m: radar beam width of bottom half

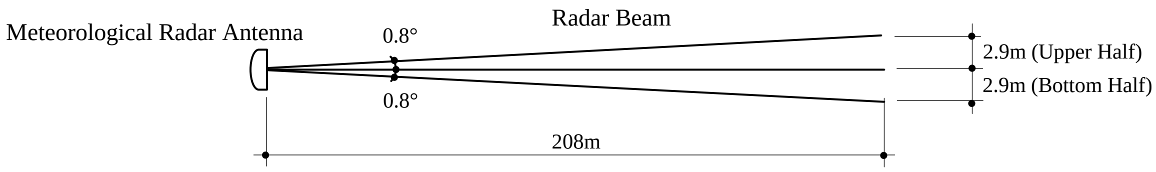


Figure 13: Radar Beam Width

As a result of the site surveys at Trou-aux-cerf Existing Meteorological Radar Observation Station, the required height of the radar antenna center from the ground level for the proposed radar system is 37 m.

II. Ground Level

At the project site, there is a bench mark 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, the large opening would be undesirable from the standpoint of air-tightness and dust proofing. The equipment will, therefore, be brought in via a loading balcony through the adjacent staircase room. For lifting the equipment, a lifting hook with a capacity of 2-tons will be installed on the upper part of this balcony.

[3] Elevation Plan

The structural columns and beams will extend outside the building, 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 15-18cm for easy wiring of power and signal cables, trouble-free maintenance and simple future expansion. An antistatic, heavy-duty access floor has been selected for the radar equipment room in which a high power radar transmitter weighing about 1 ton is to be installed.

b) External Walls

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

c) Ceiling

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

d) Window

Since the sustained wind pressure to be used for windows of the Radar Observation Room located at the height of 27m is expected to reach approximately 4,800 N/m^2, a laminated glass with reinforced film will be used. In order to ensure double protection for keeping 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 exterior and interior finishing, which are all available locally, have been selected with a view to ease maintenance for the MMS and are stated as follows.

Table 34: Finishing Materials of Proposed Meteorological Radar Tower Building

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

Interior Finishing	**Floors**	Carpet tiles Vinyl tiles Porcelain tiles Cement sand mortal base, Epoxy resin paint finish
	Skirtings	Wooden skirting, Synthetic resin oil paint finish Cement sand mortar, Vinyl paint finish Cement sand mortar, Epoxy resin paint finish 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 and doors Aluminum grilles Aluminum doors, Steel doors
	Interior	Aluminum doors, Steel doors, Wooden doors

Table 35: Bases for Adoption of Materials
of 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.	To be procured locally
Interior Finishing	**Floors**	Materials will be selected on the basis of superior durability and ease of maintenance. Vinyl tiles around offices, corridors and staircases will be applied. In rooms where dust must be avoided, a dust-proof paint finish will be specified.	To be procured locally
		In the offices where computer systems will be installed, access floors shall be applied for cabling under floor.	To be procured locally
	Walls	Cement sand mortal (trowel-coated) will be applied primarily for its durability, and vinyl paint will be applied to avoid dirt. Glazed ceramic tiles will be laid in the toilets and the slop sink booth.	To be procured locally
	Ceilings	In order to enhance the environment and efficiency of air-conditioning, 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 cement and sand mortal.	To be procured locally
Windows and Door	**Exterior**	Aluminum and steel will be chosen all throughout for reasons of durability, ease of handling and accuracy.	To be procured locally
	Interior	Wooden and steel with synthetic oil resin paint will be employed throughout for its handling ease during construction and from a maintenance standpoint.	To be procured locally

[5] Structural Plan

I. Structural Design Standard

There is no exclusive structural design standard for Mauritius. A structural engineer is able to use a major structural design standard such as the British Standard and/or the Japanese Architectural Standard.

However, the use of more than one standard is not allowed. For the Project, the Building Standard Law of Japan and other building codes for government facilities will be applied.

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 Meteorological Radar Tower Building are indicated in the following table.

Table 36: Bearing Layer, Pile and Foundation of the Proposed Meteorological Radar Tower Building

	Trou-aux-cerf Meteorological Radar Observation Station
Depth of Bearing Layer	32.0m
N value of Bearing Layer	Over 50 (Weathered Basalt)
Piling	Required
Designed Pile Length	32.8m
Required Number of the Designed Pile	20
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 because reinforced concrete construction is the most typical structural type in Mauritius. The floor slabs are to be reinforced concrete while exterior walls and partition walls are locally made of concrete blocks.

IV. Design Load

a) Dead load

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

Table 37: 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 Room	Isolation Transformer and Auto Voltage Regulator (for Equipment and Building)	4.0 tons
Power Supply Room	Capacitor	2.0 tons

b) Live load

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

c) Wind load

In accordance with the regulation of the Ministry of Public Infrastructure, Land Transport and Shipping, the meteorological radar tower should be designed to withstand a wind velocity of 280km/h (approx. 77.8m/s). In general, the wind load design in Mauritius is based on the British Standard.

- $q=1/2\times1.22\times Vs^2$ $k=1/2\times1.22=0.61=1/16.39$ (constant) $q=1/1.639\times77.8^2=3{,}693(N/m^2)$
- $F=Cf\cdot q\cdot Ac$

- F= wind pressure
- Cf= coefficient of wind force (due to building type and part)
- q= velocity pressure (Kg/m^2)
- Vs=design wind speed (m/s)
- Ac=projected net area (m^2)
- k＝constant value (BS: =1/16)

d) Seismic load

According to the "National Earthquake Information Center" which stores all the seismic data since 1973, there is no record of earthquake in Mauritius. Therefore, the seismic load is not incorporated into the structural design and calculation in Mauritius.

V. Structural Building Material

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

- Concrete : Conventional concrete specified concrete strength $Fc= 25N/mm^2$
- Cement : Japan Industrial Standard (JIS) or equivalent
- Deformed reinforcing bars : Grade 60 or equivalent

[6] Electrical Facility Design

I. Power intake facility

Table 38: Power intake facility

	Trou-aux-cerf Meteorological Radar Tower Building
Intake Power (Nominal Voltage of the Existing Wattmeter)	400V, 3-phase 4-wire, 50Hz

II. Power generating facility

Table 39: Power Generating Facility

	Trou-aux-cerf 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.

Table 40: Trunk line and power facility

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

IV.	Lighting and power outlet

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

Table 41: Approximate lighting levels in the various rooms

	Trou-aux-cerf Meteorological Radar Tower Building
Radome Room	200 Lx
Radar Equipment Room	300 Lx
Observation Room (including Data Analysis Space and Data Storage Space)	300 Lx
Maintenance Room	300 Lx
Engine Generator Room	200 Lx
Electricity Room	200 Lx
Power Supply Room	200 Lx
Pump Room	200 Lx
Entrance Hall	200 Lx
Exhibition Hall	300 Lx
Other Rooms	200 Lx

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

V.	Telephone system

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

VI.	Intercom system

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

VII. Alarm system

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

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

VIII. Grounding system

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

IX. Lightning protection system

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

X. Aviation obstruction light

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

XI. Fire detection and alarm system

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

[7] Water Supply, Drainage and Sanitary Fixture Design

I. Water supply system

Public water supply is available in Trou-aux-cerf so a water supply gate valve will be installed for the water inflow for the radar tower building. To supply the 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 by a seepage pit into the ground. Miscellaneous drainage will be fed directly into a seepage pit. A septic tank and a seepage pit must be constructed. The capacity of the septic tank and seepage pit for the radar tower building have been designed for 12 MMS personnel in the operations area and for some visitors.

III. Sanitary fixtures

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

IV. Fire extinguisher

Fire extinguishers will be supplied in the following rooms.

Table 42: Fire extinguisher

	Trou-aux-cerf Meteorological Radar Tower Building
Radome Room	CO_2 type
Radar Equipment Room	CO_2 type
Observation Room (including Data Analysis Space and Data Storage Space)	CO_2 type
Maintenance Room	CO_2 type
Engine Generator Room	ABC type
Electricity Room	CO_2 type
Power Supply Room	CO_2 type
Pump Room	CO_2 type
Tea Kitchen	ABC type

[8] Air-conditioning and Ventilation System Design

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

Table 43: Air-conditioning and Ventilation System

	Trou-aux-cerf Meteorological Radar Tower Building
Radome Room	Fan forced ventilation
Radar Equipment Room	Air-conditioning system Heat exchange system
Observation Room (including Data Analysis Space and Data Storage Space)	Air-conditioning system Fan forced ventilation
Maintenance Room	Air-conditioning system Fan forced ventilation
Engine Generator Room	Fan forced ventilation
Electricity Room	Fan forced ventilation
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 power supply room, the electricity room, pump room, etc., forced ventilation systems will be adopted. Furthermore, appropriate ventilation systems will be installed in the other rooms to meet the following conditions.

<Environmental conditions>

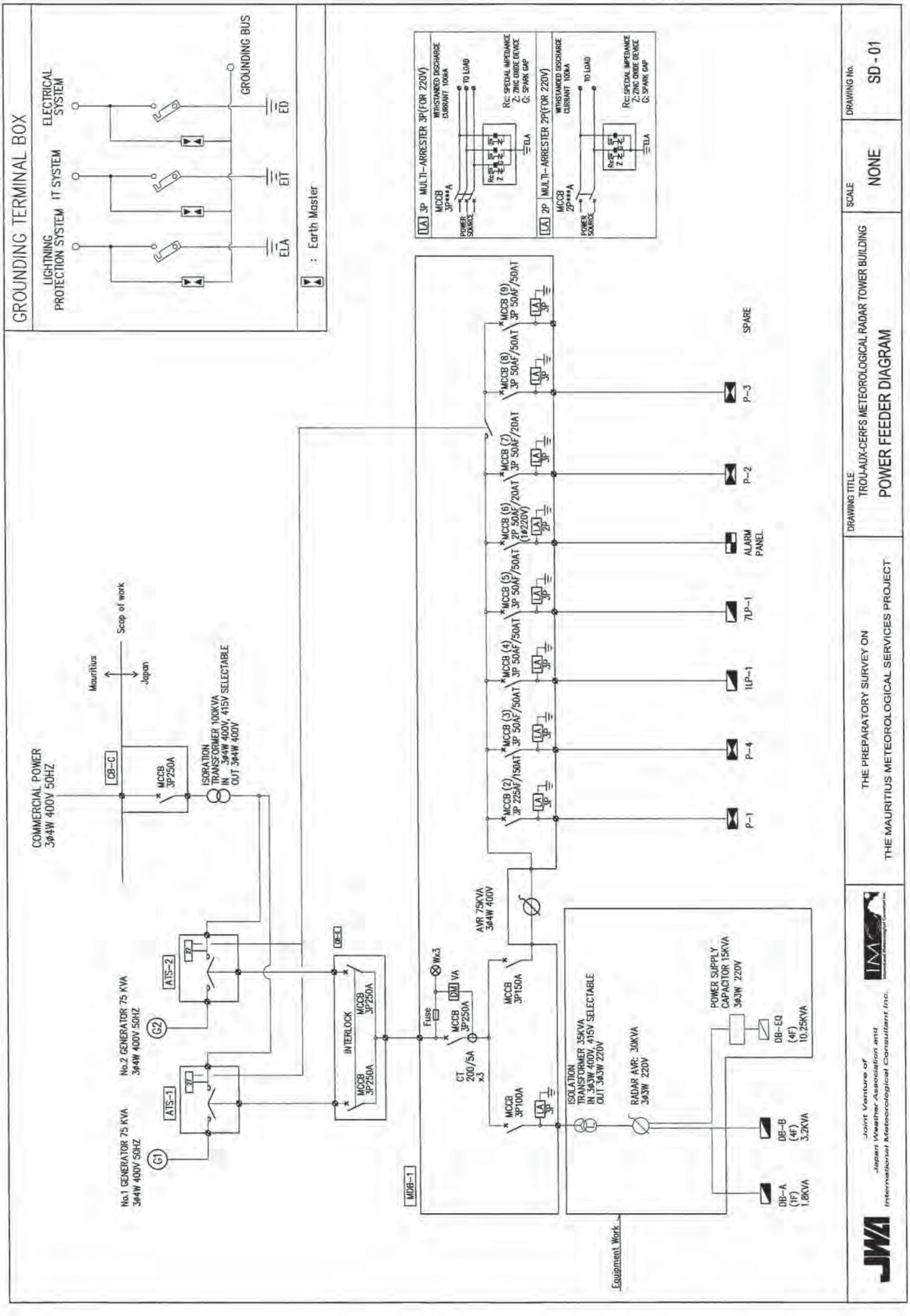
- Outside condition: 32°C (maximum temperature at the MMS Head Office, Vacoas: 31.6°C)
- Indoor condition: temperature 26°C humidity 40-60%

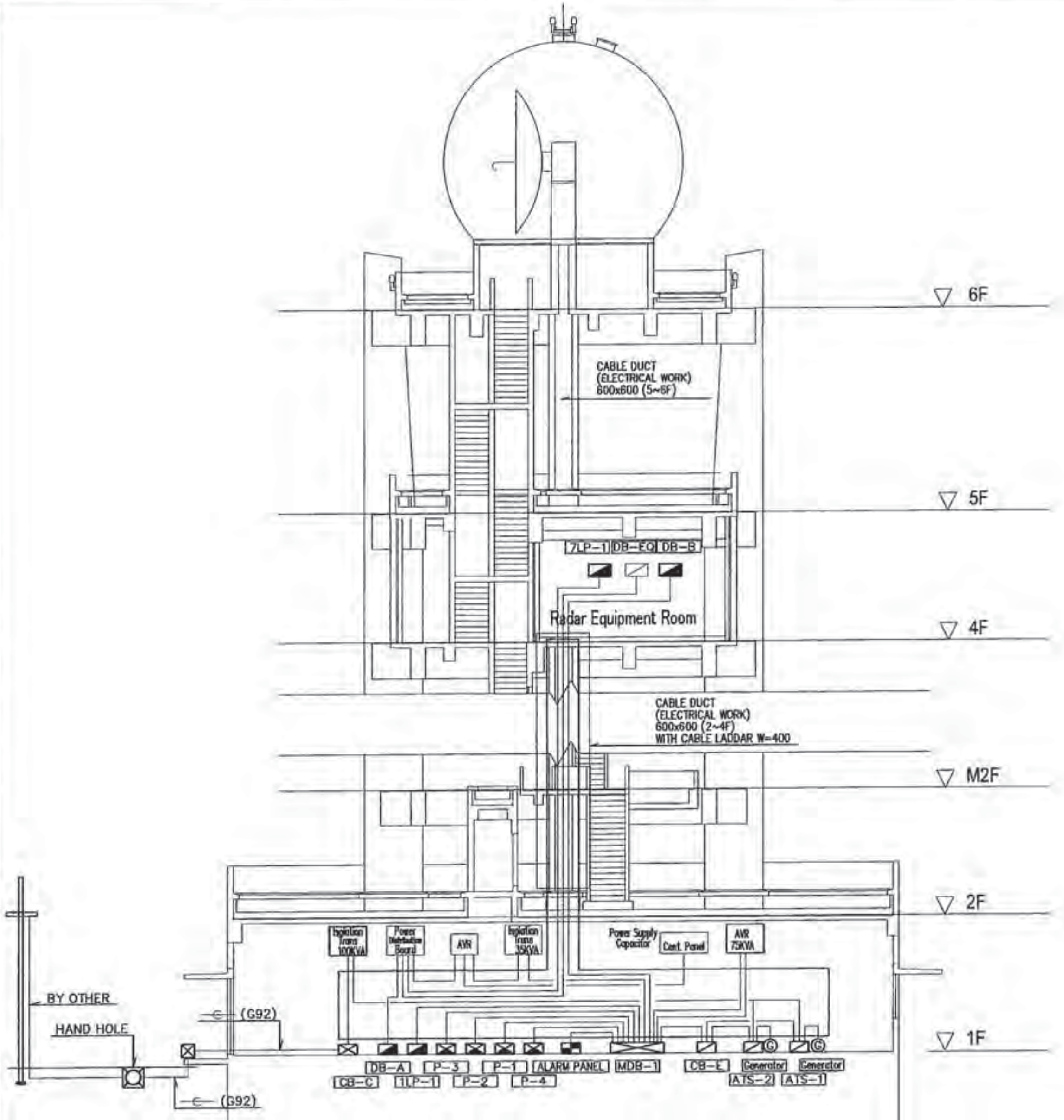
  In the radar equipment room and the power supply room: temperature 25°C humidity 40-60%

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

<Trou-aux-cerf Meteorological Radar Tower Building>

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


GROUNDING TERMINAL BOX
LIGHTNING PROTECTION SYSTEM
IT SYSTEM
ELECTRICAL SYSTEM
GROUNDING BUS
ELA
EIT
ED
: Earth Master
LA 3P MULTI-ARRESTER 3P(FOR 220V)
LA 2P MULTI-ARRESTER 2P(FOR 220V)
COMMERCIAL POWER 3φ4W 400V 50HZ
CB-C
MCCB 3P250A
ISORATION TRANSFORMER 100KVA IN 3φ4W 400V, 415V SELECTABLE OUT 3φ4W 400V
Mauritius
Japan
Scop of work
No.1 GENERATOR 75 KVA 3φ4W 400V 50HZ
No.2 GENERATOR 75 KVA 3φ4W 400V 50HZ
G1
G2
ATS-1
ATS-2
INTERLOCK
MCCB 3P250A
MDB-1
CT 200/5A x3
Fuse
MCCB 3P250A
MCCB 3P150A
MCCB 3P100A
AVR 75KVA 3φ4W 400V
MCCB (2) 3P 225AF/150AT
MCCB (3) 3P 50AF/50AT
MCCB (4) 3P 50AF/50AT
MCCB (5) 3P 50AF/50AT
MCCB (6) 2P 50AF/20AT (1φ220V)
MCCB (7) 3P 50AF/20AT
MCCB (8) 3P 50AF/50AT
MCCB (9) 3P 50AF/50AT
P-1
P-4
1LP-1
7LP-1
ALARM PANEL
P-2
P-3
SPARE
ISOLATION TRANSFORMER 35KVA IN 3φ3W 400V, 415V SELECTABLE OUT 3φ3W 220V
RADAR AVR: 30KVA 3φ3W 220V
POWER SUPPLY CAPACITOR 15KVA 3φ3W 220V
DB-A (1F) 1.8KVA
DB-B (4F) 3.2KVA
DB-EQ (4F) 10.25KVA
Equipment Work
JWA
Joint Venture of Japan Weather Association and International Meteorological Consultant Inc.
THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT
DRAWING TITLE
TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING
POWER FEEDER DIAGRAM
SCALE
NONE
DRAWING No.
SD - 01



POWER CABLE LIST

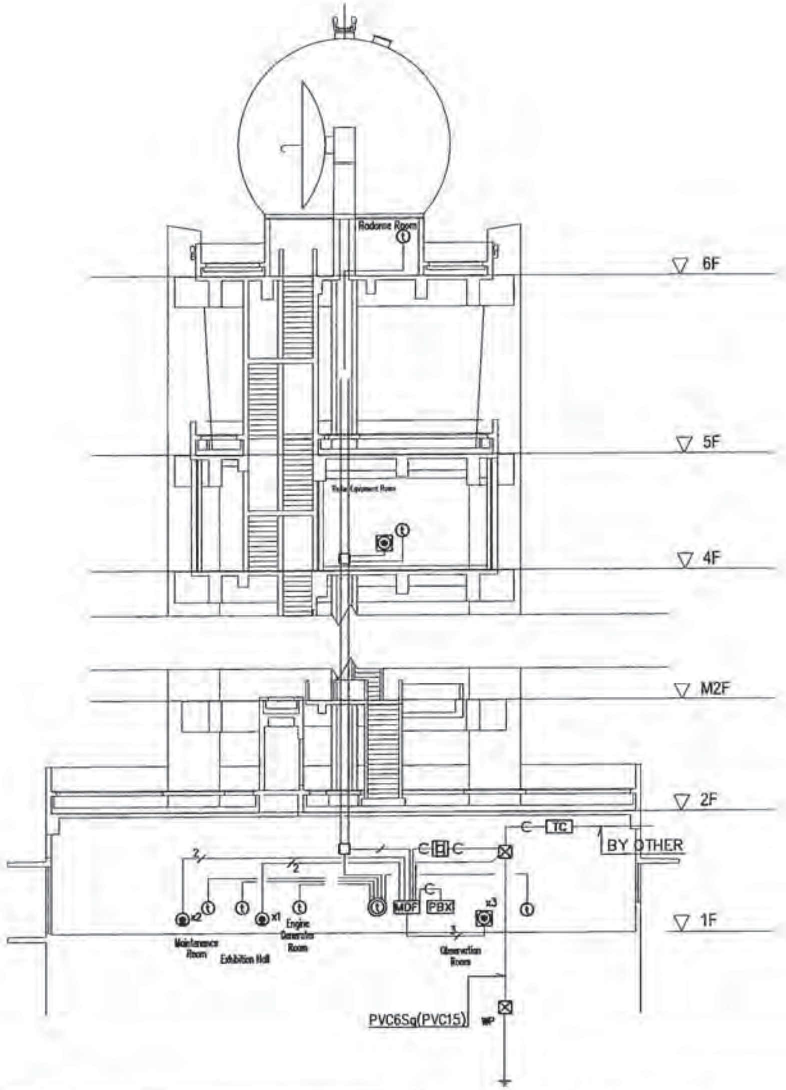
FROM	TO	CABLE SIZE	CONDUIT
CB-C	ISOLATION TRANS 100KVA	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
ISOLATION TRANS	ATS-2	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR
GENERATOR	ATS-1	XLPE/PVC 1C-4x120sq +E70sq	(G80) / CABLE LADDAR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

SPARE PARTS FOR LIGHTNING DAMAGE LIST

FROM	DESCRIPTION	UNIT
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

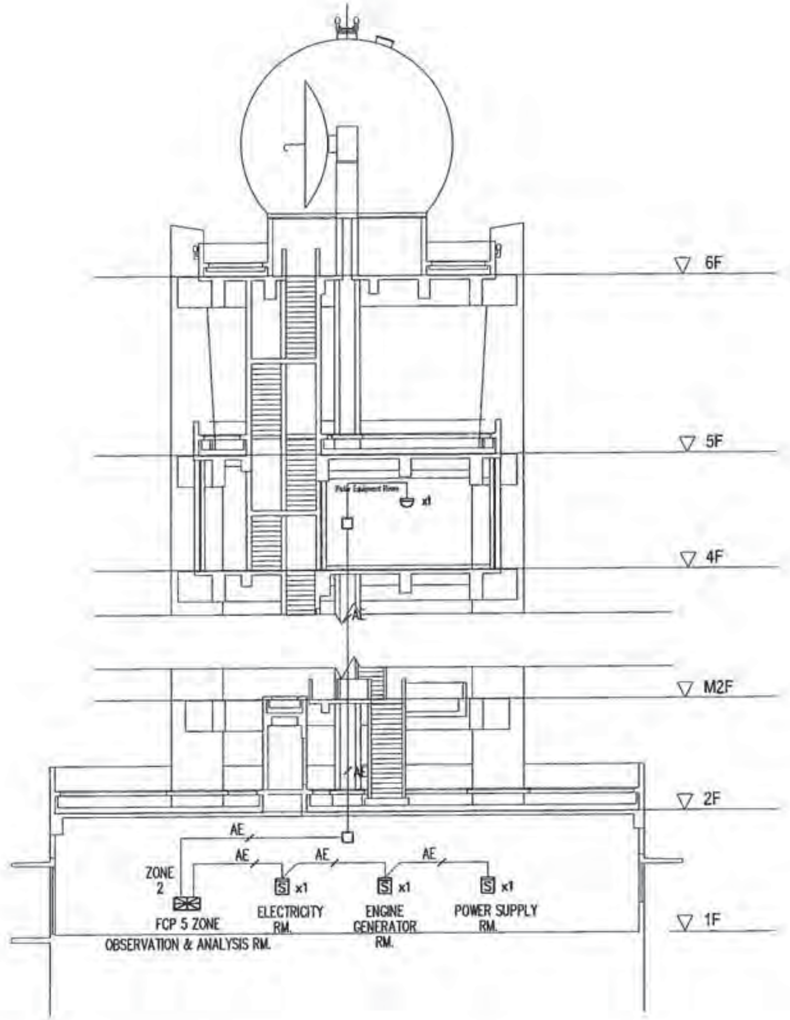
JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING POWER RISER SYSTEM	SCALE NONE	DRAWING No. SD - 02



REMARK

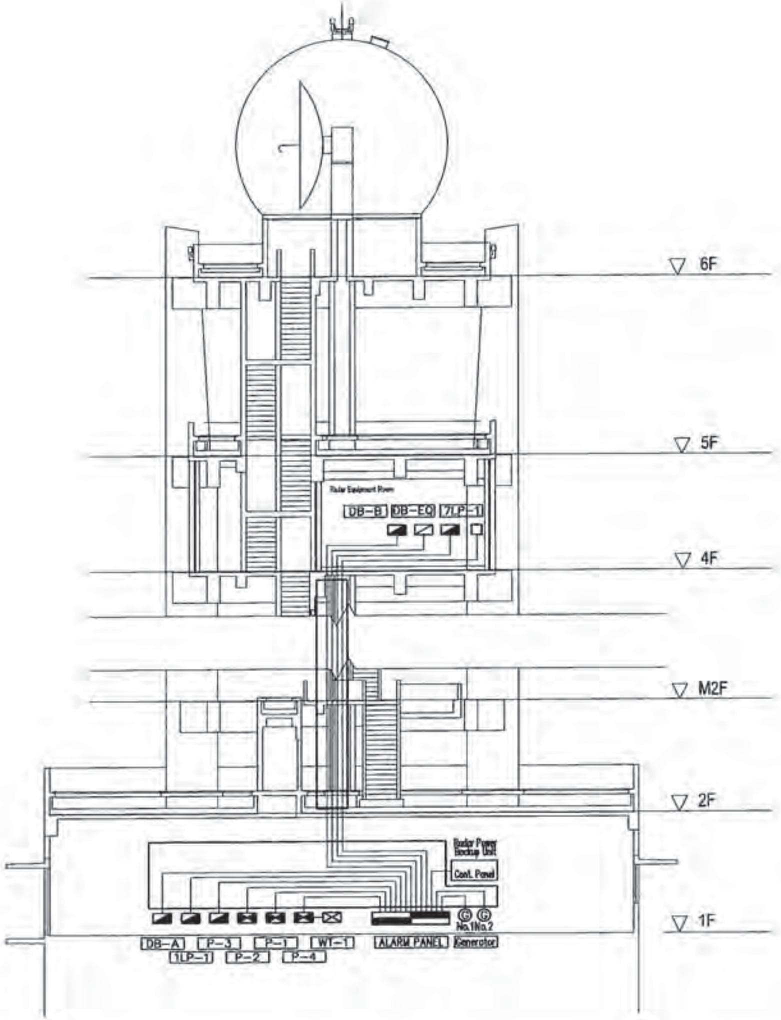
- —C— : —C— (G36)
- : TIEV 0.65–4C (G20)
- 2 : TIEV 0.65–4Cx2 (G20)
- 3 : TIEV 0.65–4Cx3 (G25)
- : TIEV 0.65–4C (UNDER THE ACCESS FLOOR)
- 2 : TIEV 0.65–4Cx2 (UNDER THE ACCESS FLOOR)
- 3 : TIEV 0.65–4Cx3 (UNDER THE ACCESS FLOOR)
- : AE 0.9–2C (G20)
- : AE 0.9–2C (UNDER THE ACCESS FLOOR)
- PBX : PBX COT. 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

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING INTERPHONE SYSTEM &TEL DIAGRAM	SCALE NONE	DRAWING No. SD - 03



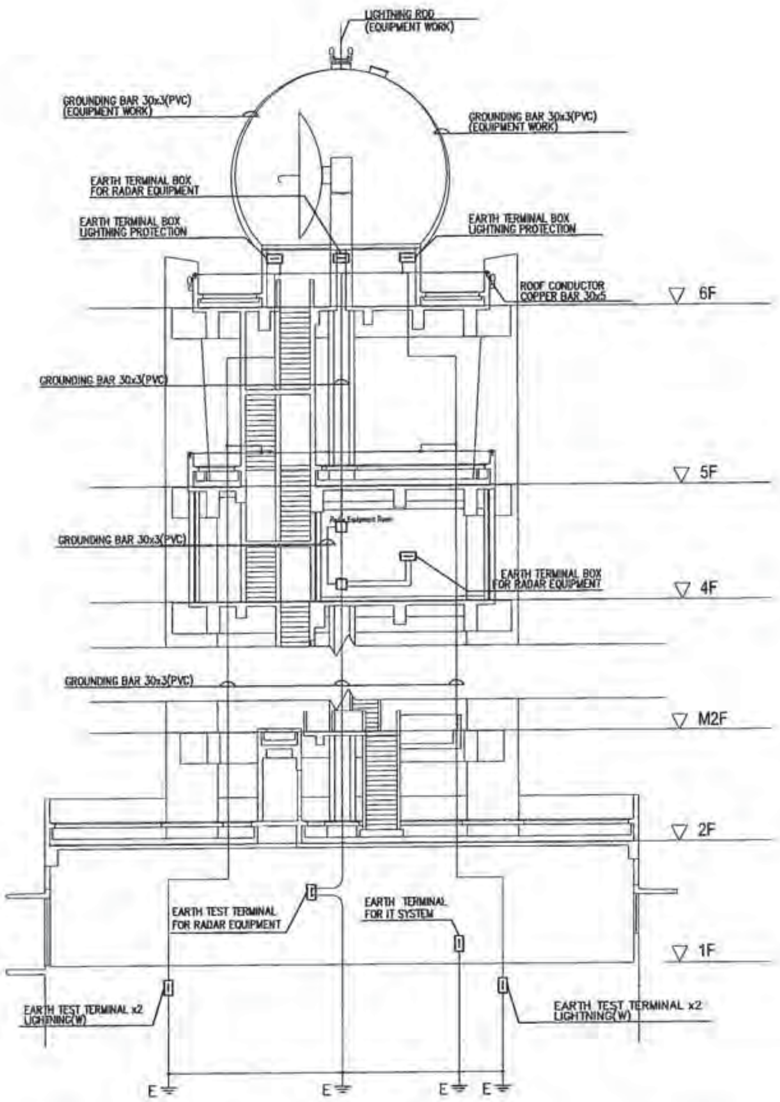
⊠	FIRE ALARM CONTROL PANEL 5 ZONE
S	SMOKE DETECTOR (PHOTO TYPE)
⊖	RATE OF RISE HEAT DETECTOR

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc.	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING RISER FIRE ALARM SYSTEM	SCALE NONE	DRAWING No. SD - 04

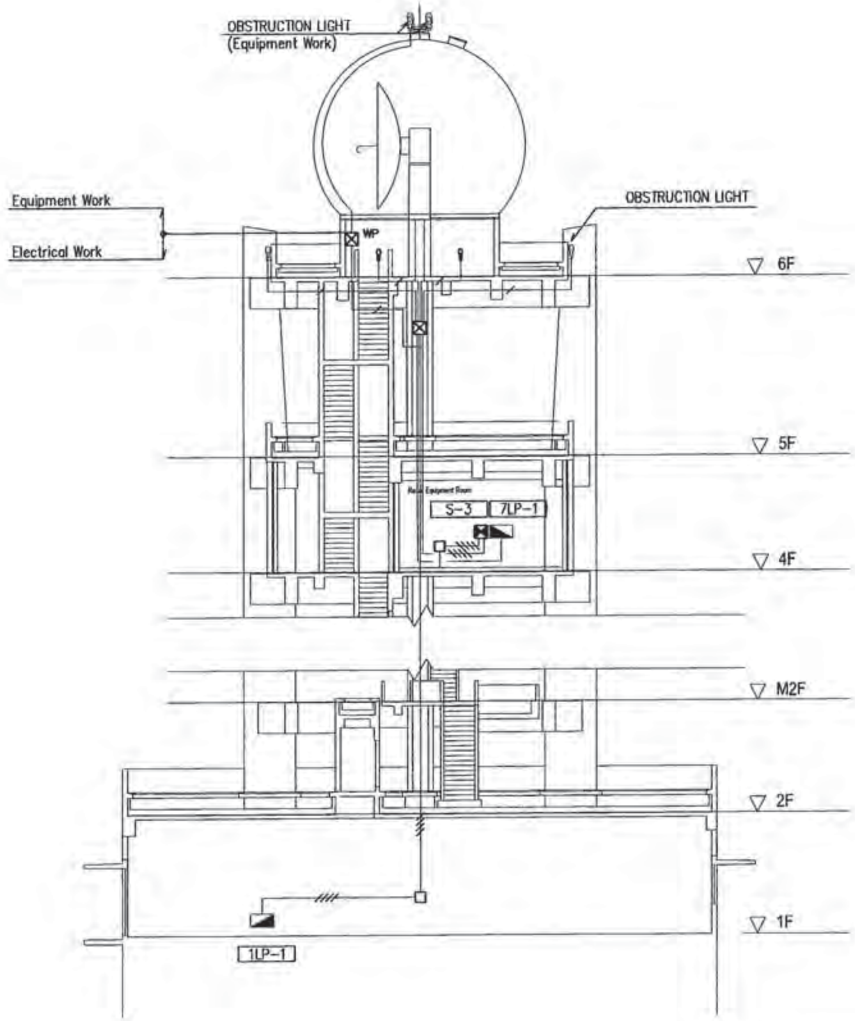


☐ TEMPERATURE SWITCH
FOR ROOM TEMPERATURE ALARM

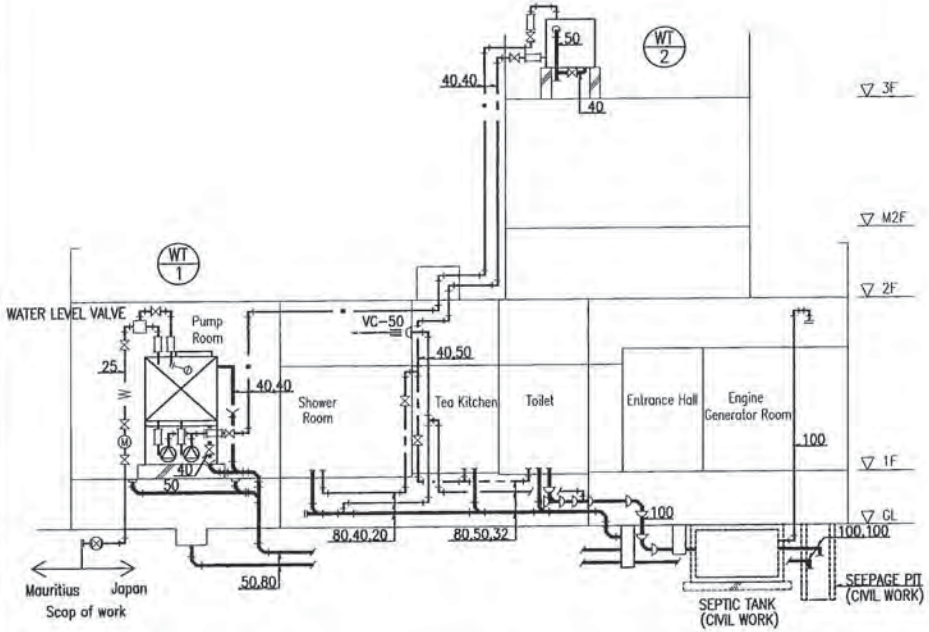
JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING ALARM SYSTEM DIAGRAM	SCALE NONE	DRAWING No. SD - 05



JWA — Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. — IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE: TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING RISER DIAGRAM LIGHTNING PROTECTION AND GROUNDING SYSTEM	SCALE: NONE	DRAWING No. SD - 06



JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING RISER DIAGRAM OBSTRUCTION LIGHTING	SCALE NONE	DRAWING No. SD - 07



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

NO.	NAME	SPECIFICATION	Q'TY	POWER SUPPLY PHASE	VOLT (V)	FREQUENCY (Hz)	MOTOR (KW)	EMERGENCY POWER SUPPLY	LOCATION	REMARKS
WT-1	POTABLE WATER TANK / PUMP	FPR Tank	1					O	Pump Room	RC FOUNDATION
		Rated capacity 2.5 m^3								(CIVIL WORK)
		Dimension 1,000 x 1,500 x 2,000H								1.8x1.8x0.3mH
		Accessories Manhole 600ϕ Breather								
		Ball tap 25A , overflow and drain pipe 40A								
		Electrode 4P								
		Constant pressure type pump	2	3	220	50	1.5			
		40 ϕ x 100 l/min x 180 kpa x 2 pcs (1 spare)								
		Accessories Flexible connector for suction 40A								
WT-2	POTABLE WATER GRAVITY TANK	FRP tank	1						3F Roof	RC FOUNDATION
		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 ϕ								
		Electrode 4P								
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 (CIVIL WORK)	Septic tank & Seepage pit (RC type, Civil work)	1						Out door	
		Blower pump (Civil work)								

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc.

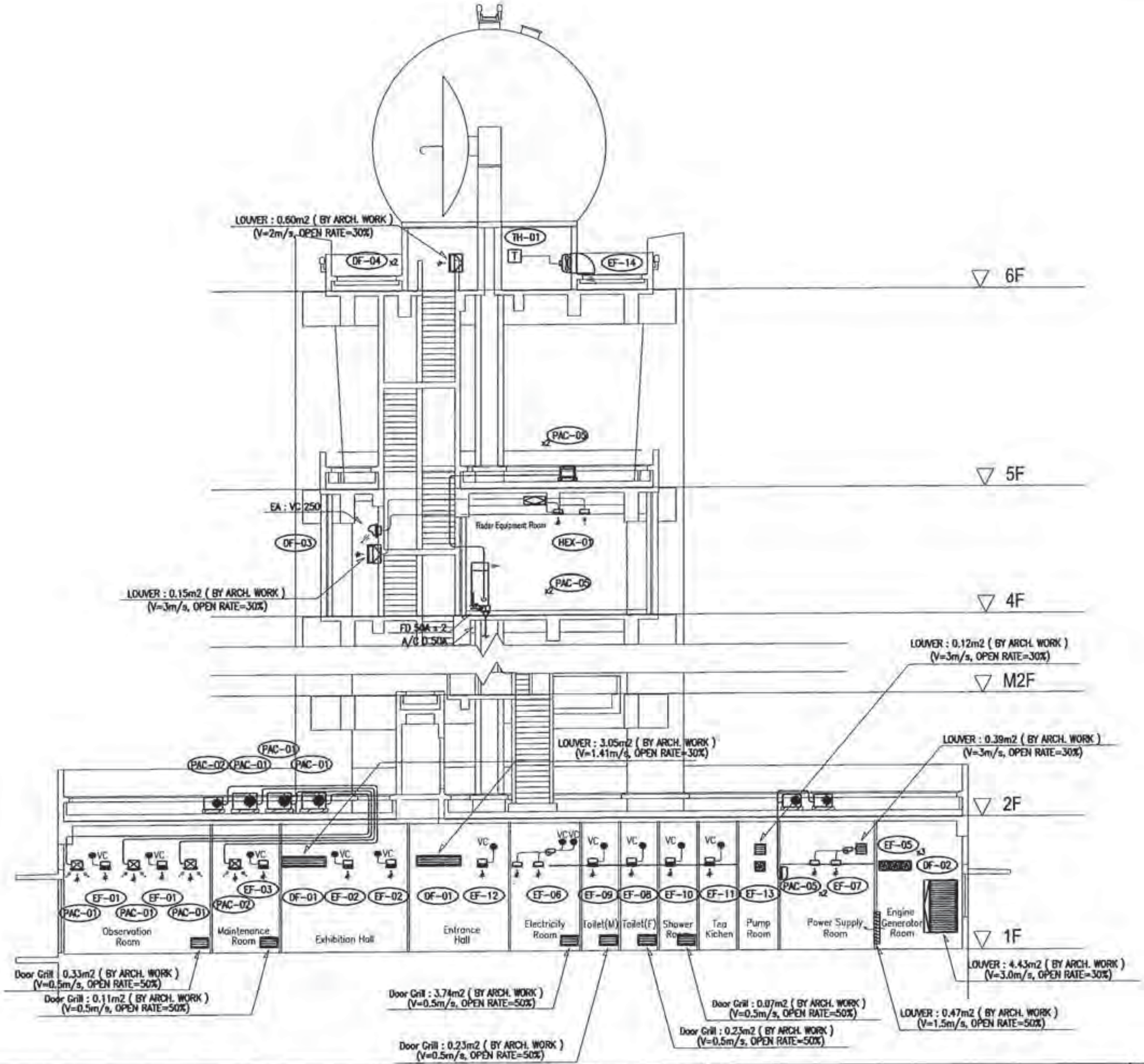
THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT

DRAWING TITLE: TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING

PLUMBING EQUIPMENT LIST/FLOW

SCALE: NONE

DRAWING No.: SD - 08



JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING AIR-CONDITIONING & VENTILATION SYSTEM DIAGRAM	SCALE NONE	DRAWING No. SD - 09

2-2-3 Outline Design Drawing

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

<Trou-aux-cerf Meteorological Radar Tower Building>

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

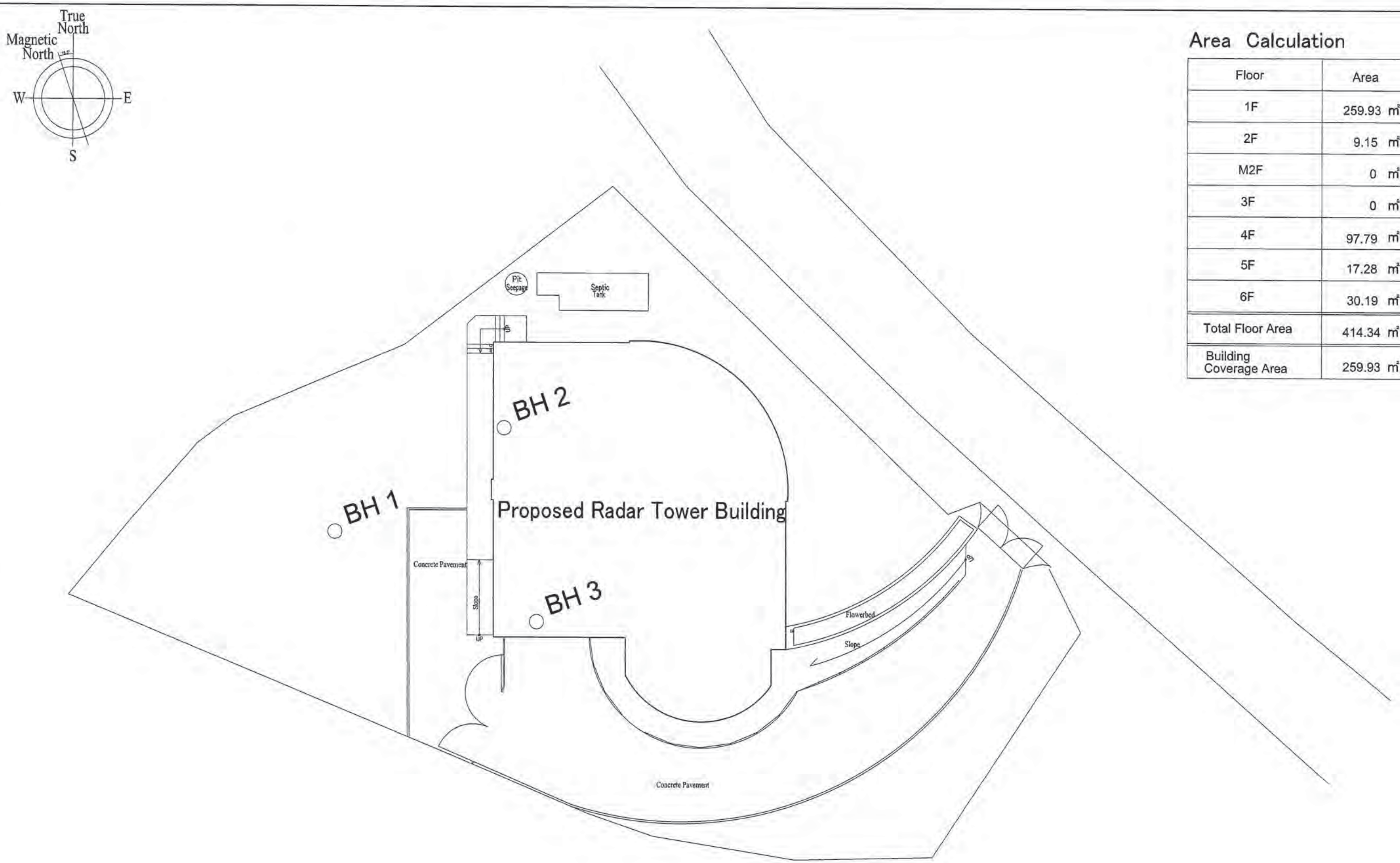
- Equipment Layout 1 : EQ-01
- Equipment Layout 2 : EQ-02

<MMS Head Office>

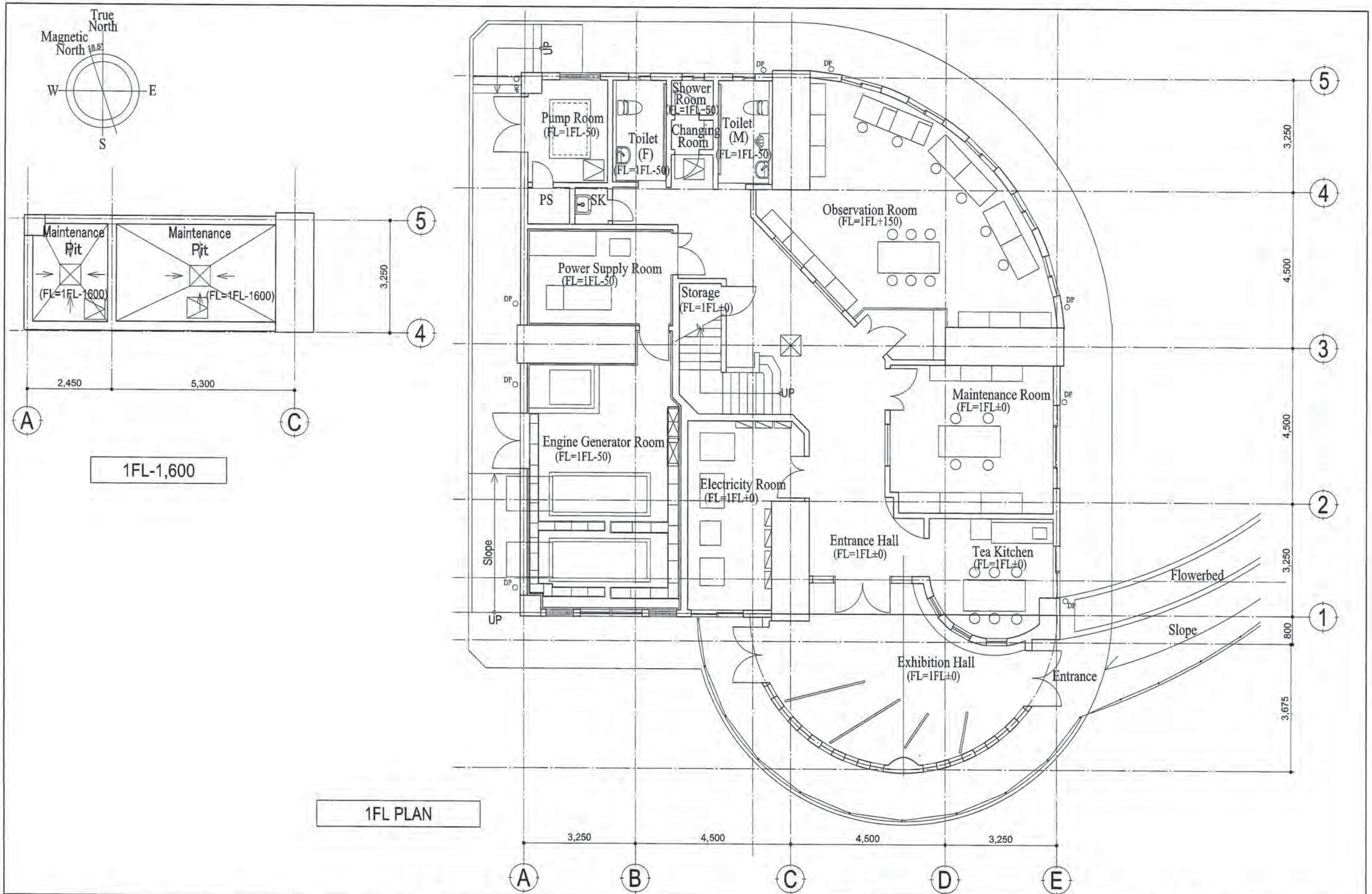
- Equipment Layout 3 : EQ-03

Area Calculation

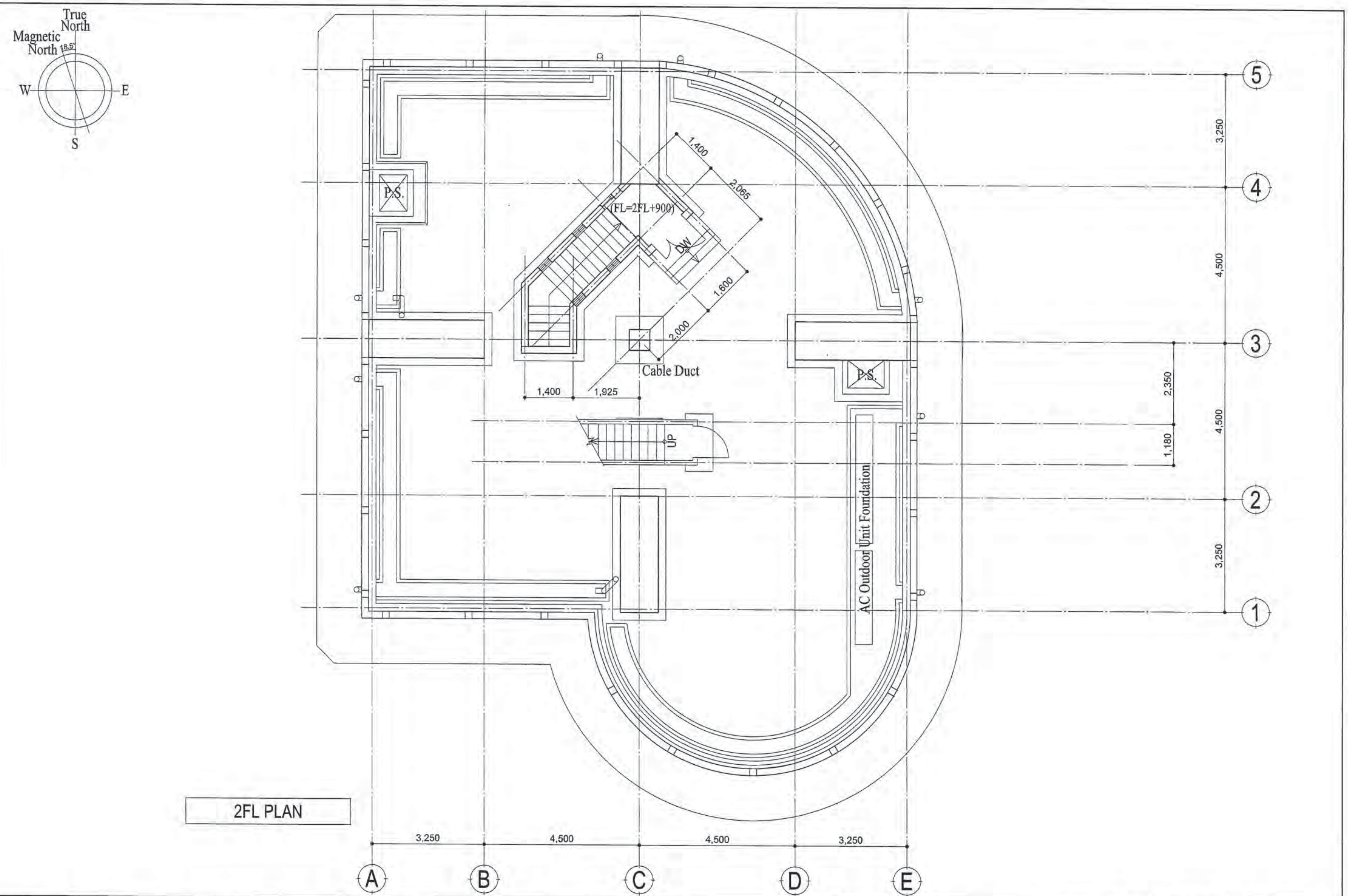
Floor	Area
1F	259.93 m²
2F	9.15 m²
M2F	0 m²
3F	0 m²
4F	97.79 m²
5F	17.28 m²
6F	30.19 m²
Total Floor Area	414.34 m²
Building Coverage Area	259.93 m²



JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING SITE PLAN	SCALE 1:200	DRAWING No. A - 01



JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 1	SCALE 1:100	DRAWING No. A - 02



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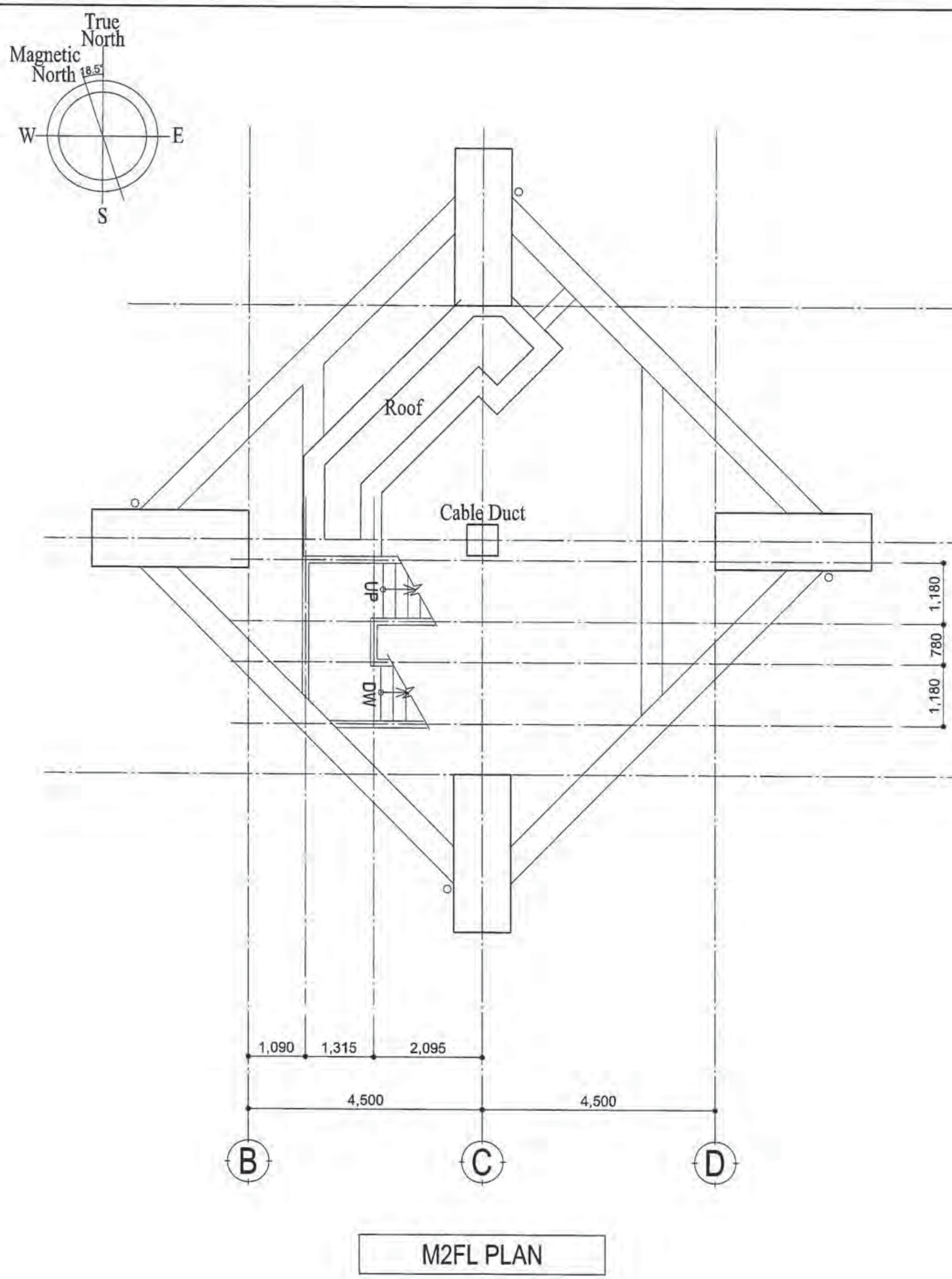
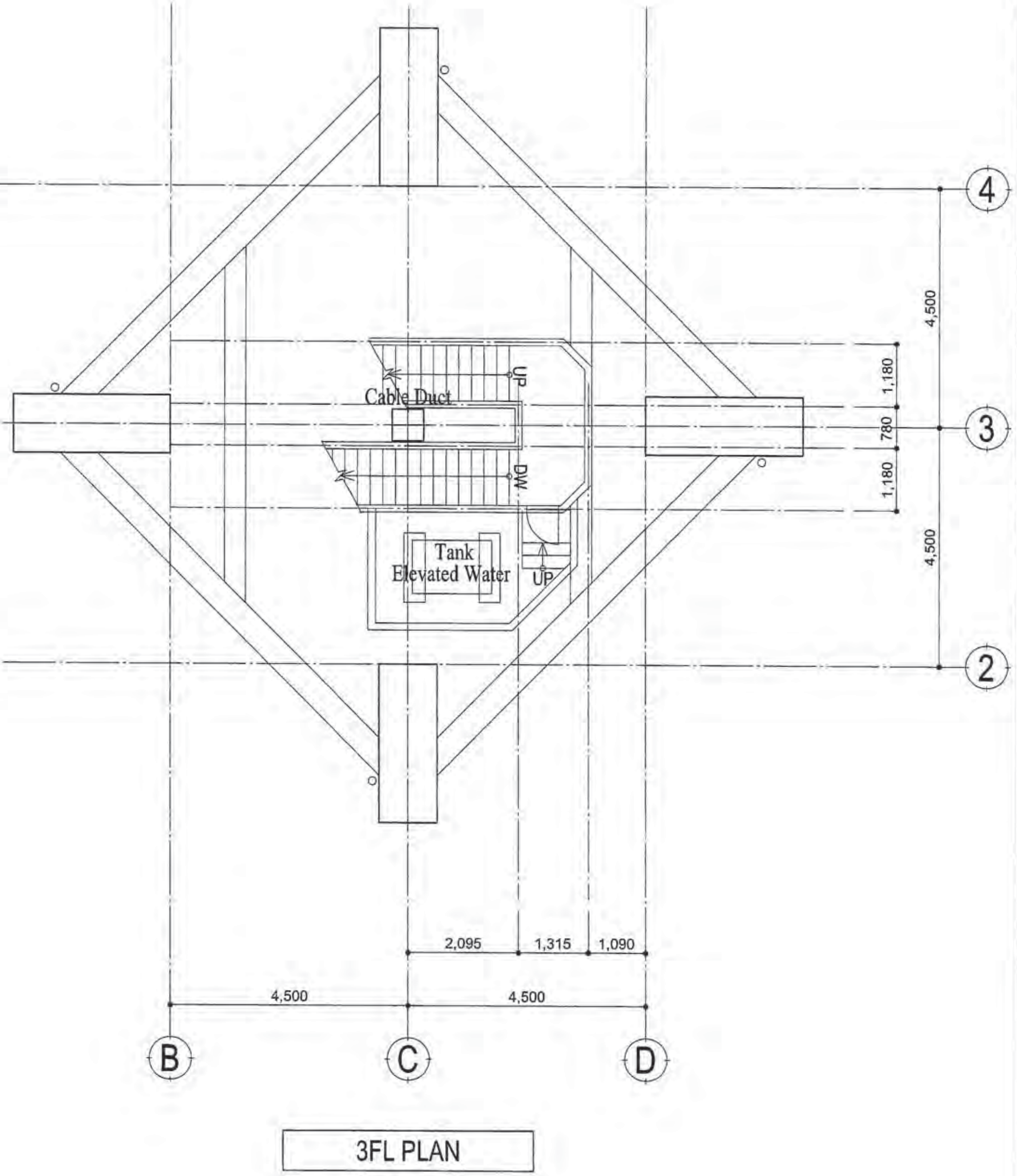
THE PREPARATORY SURVEY ON
THE MAURITIUS METEOROLOGICAL SERVICES PROJECT

DRAWING TITLE
TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 2

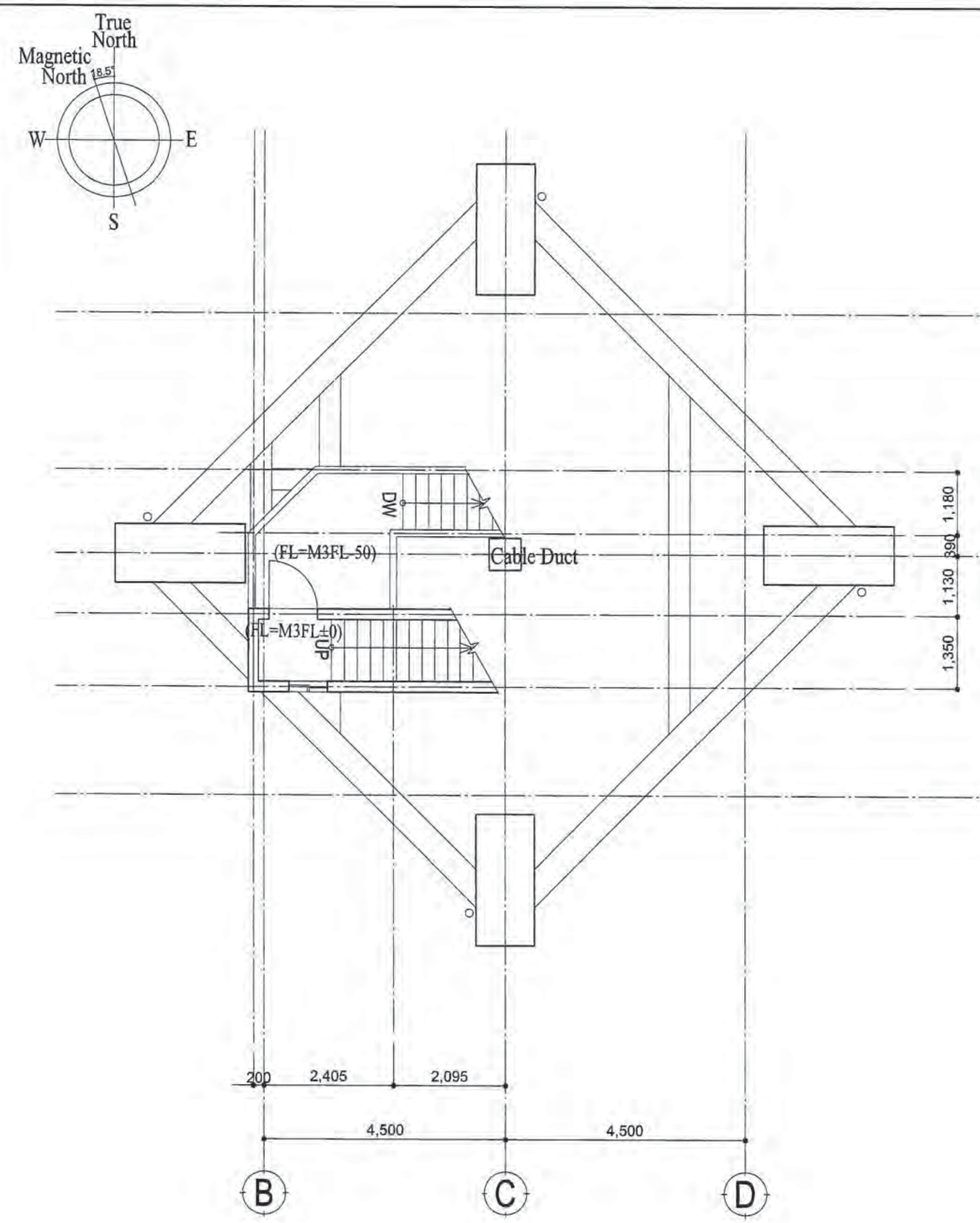
SCALE
1:100

DRAWING No.
A - 03

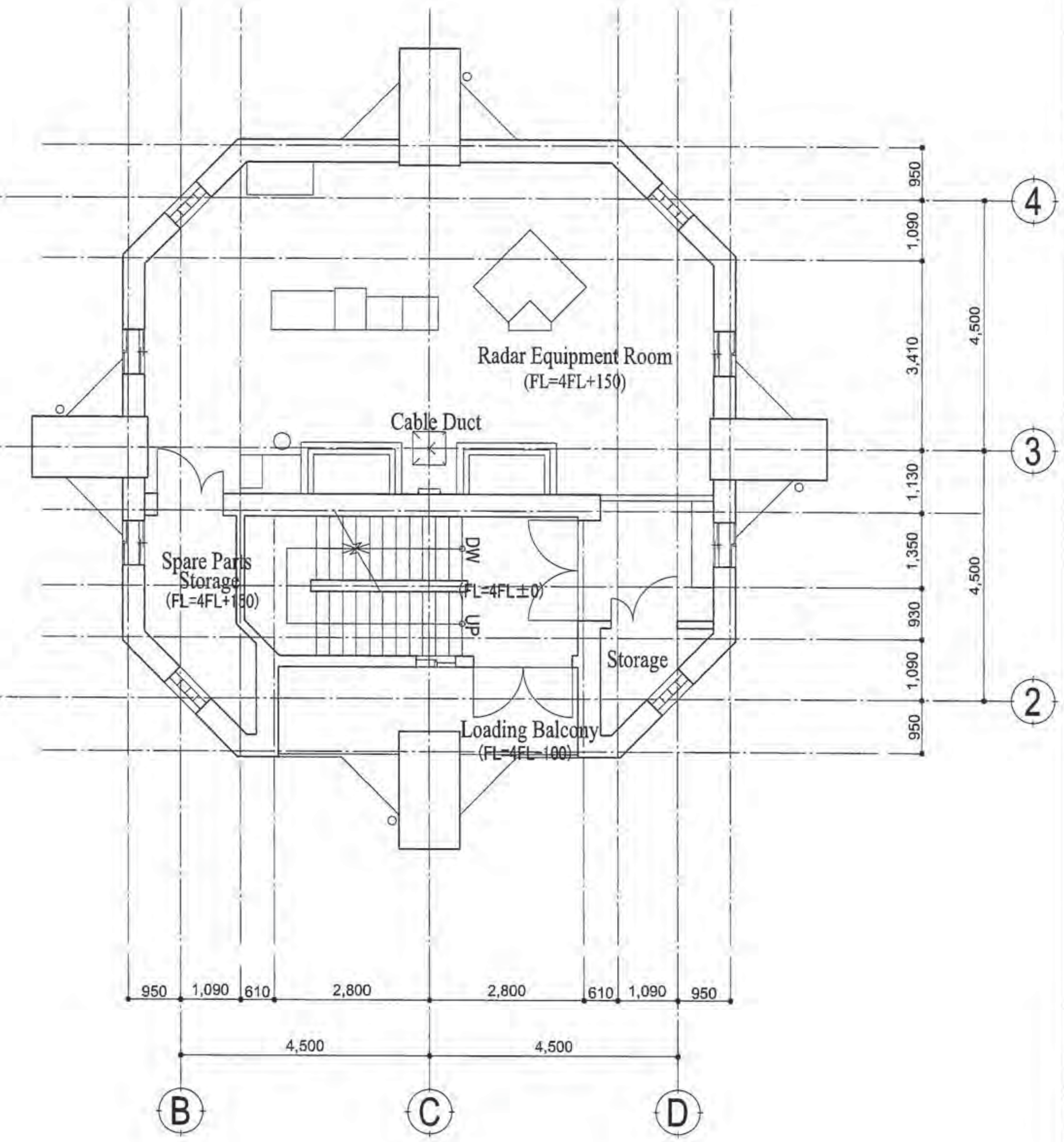




Joint Venture of Japan Weather Association and International Meteorological Consultant Inc.	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 3	SCALE 1:100	DRAWING No. A - 04



M3FL PLAN



4FL PLAN

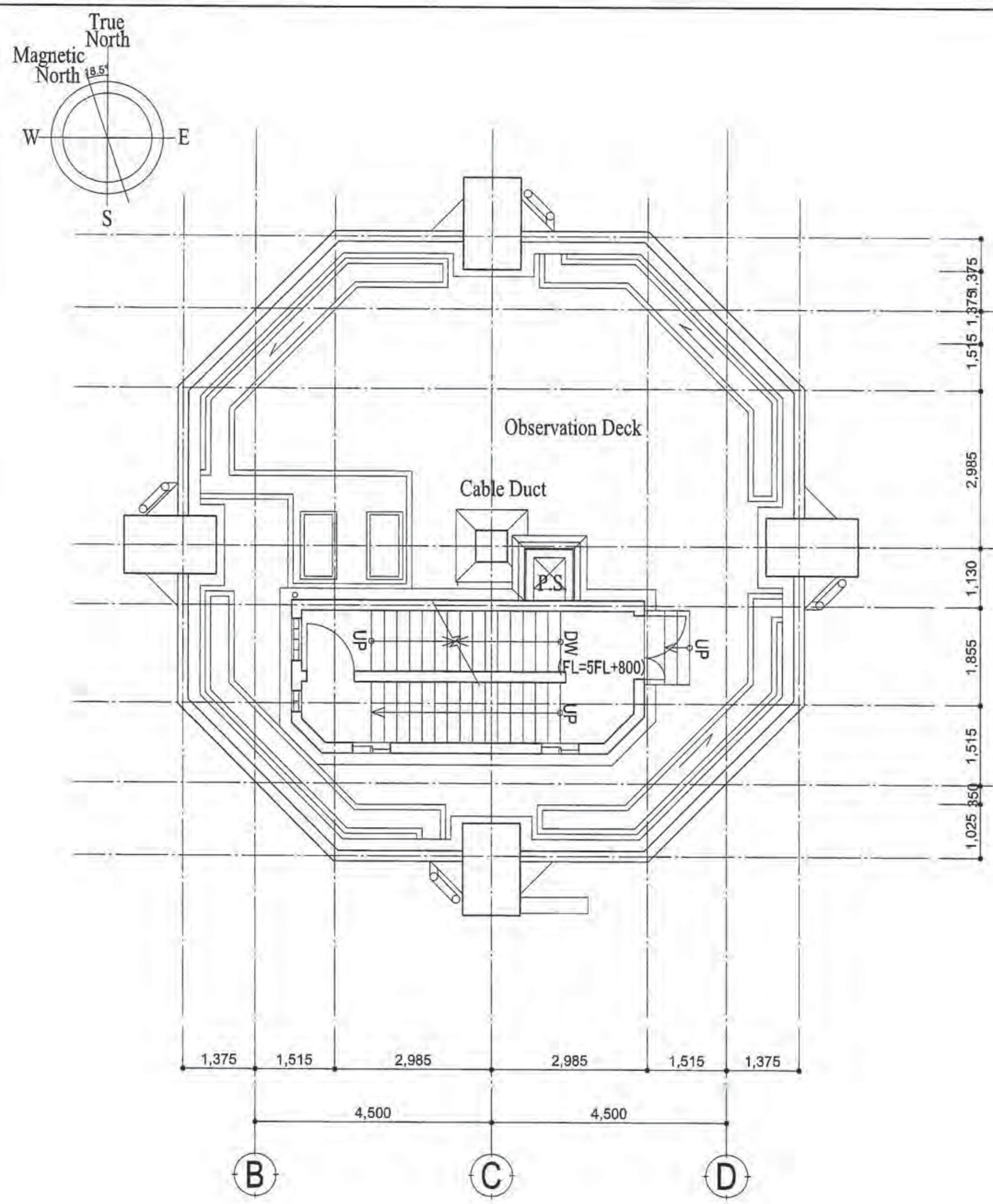
Joint Venture of
Japan Weather Association and
International Meteorological Consultant Inc.

THE PREPARATORY SURVEY ON
THE MAURITIUS METEOROLOGICAL SERVICES PROJECT

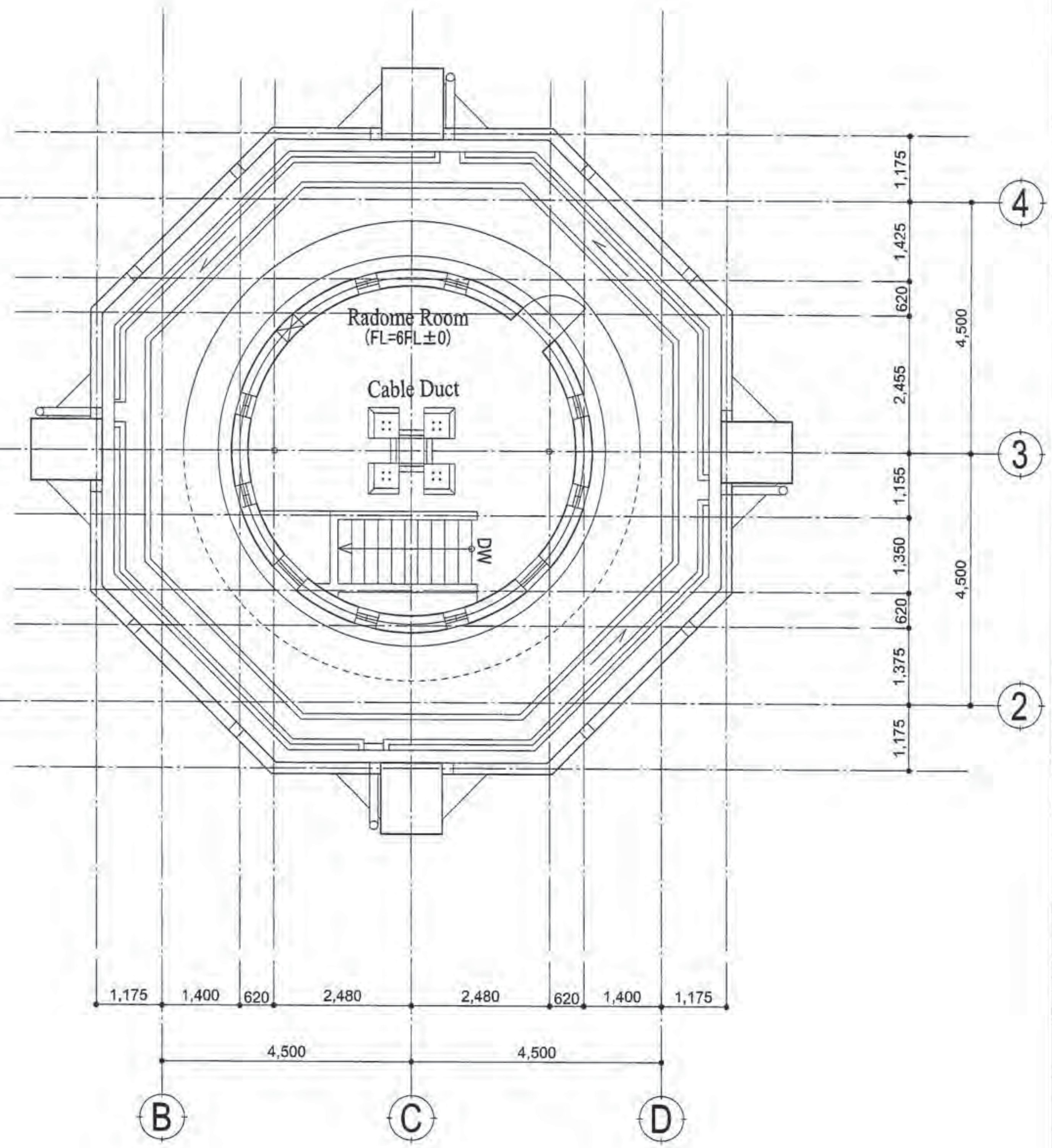
DRAWING TITLE
TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING
FLOOR PLAN 4

SCALE
1:100

DRAWING No.
A - 05

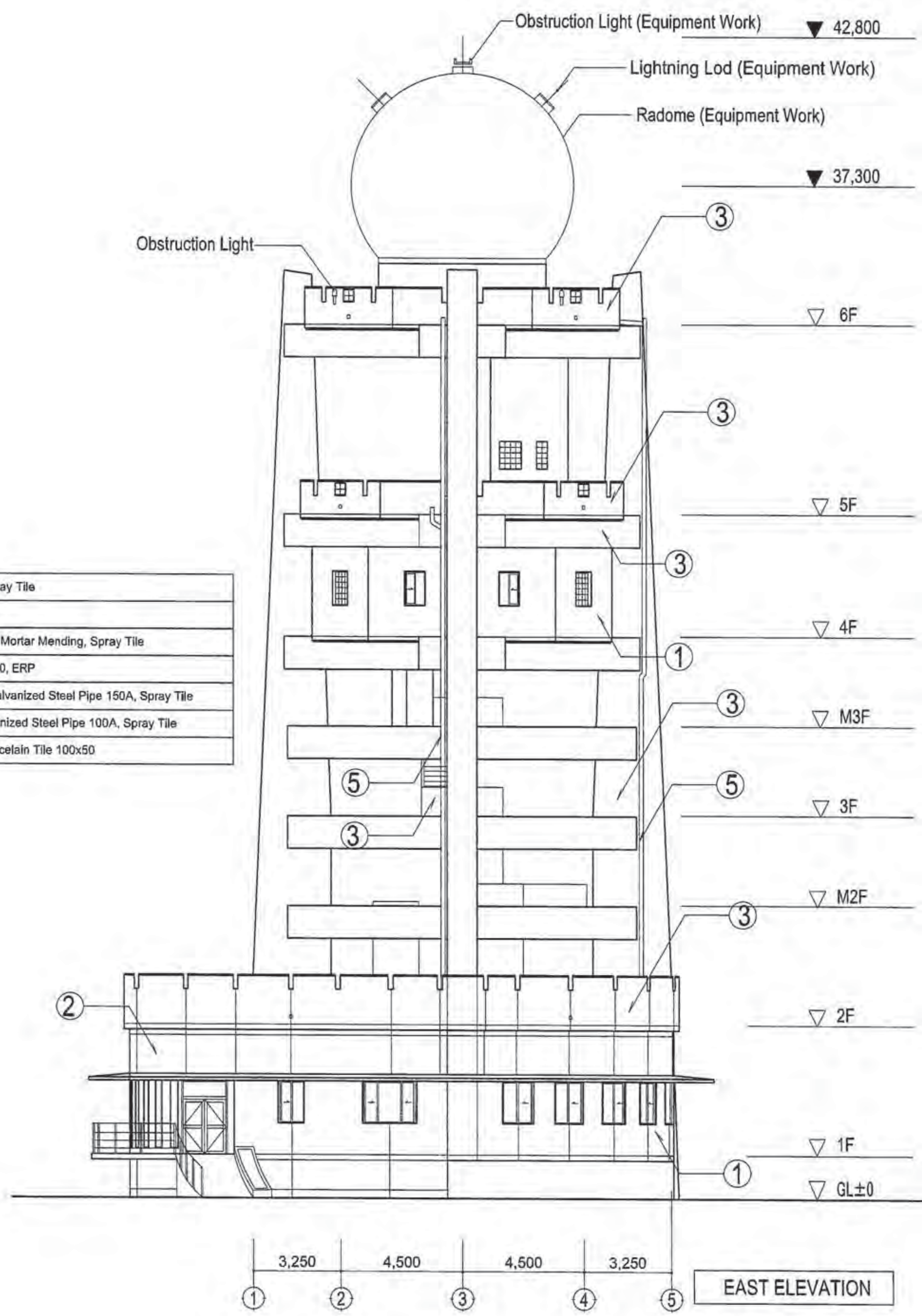


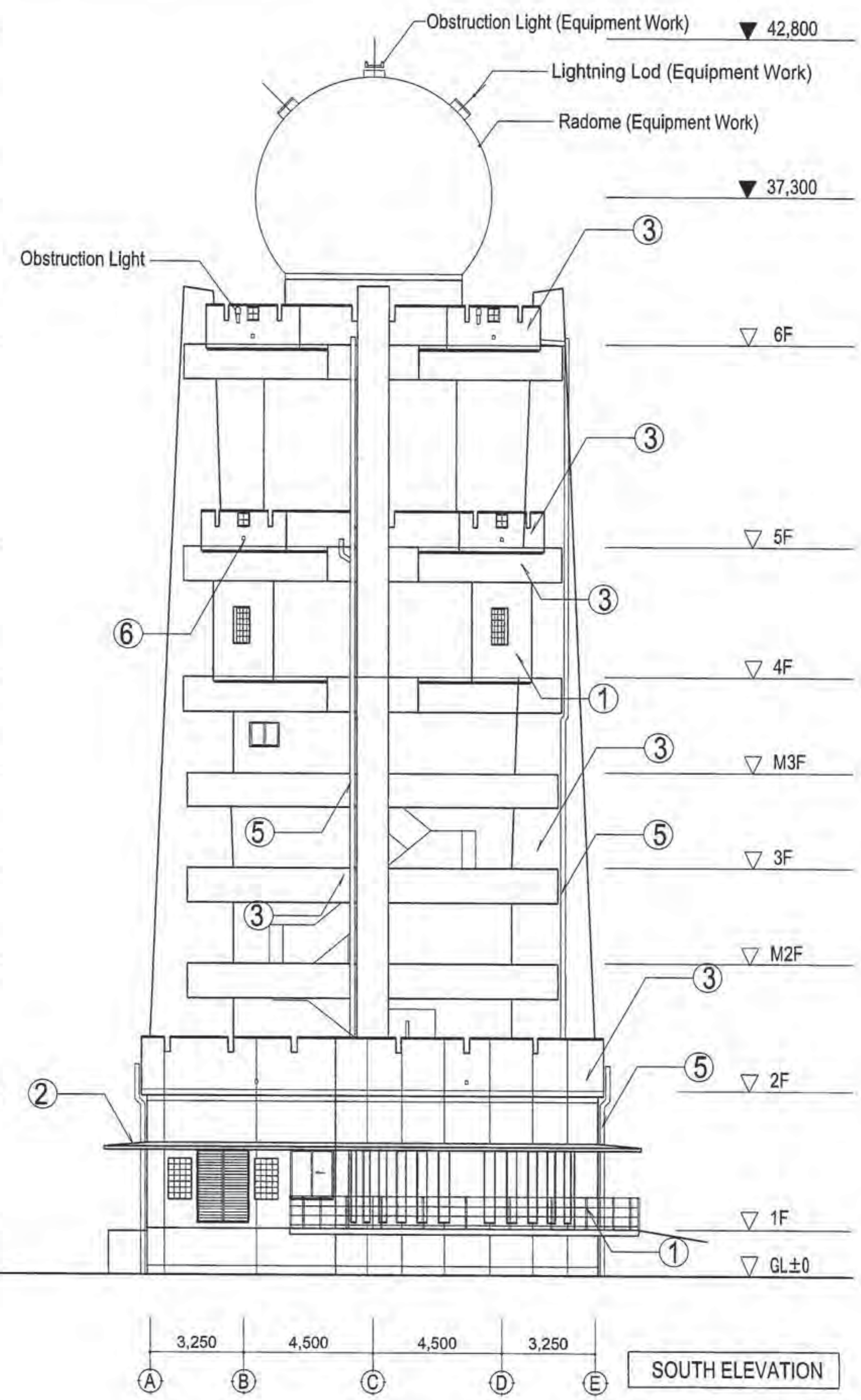
5FL PLAN



6FL PLAN

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING FLOOR PLAN 5	SCALE 1:100	DRAWING No. A - 06

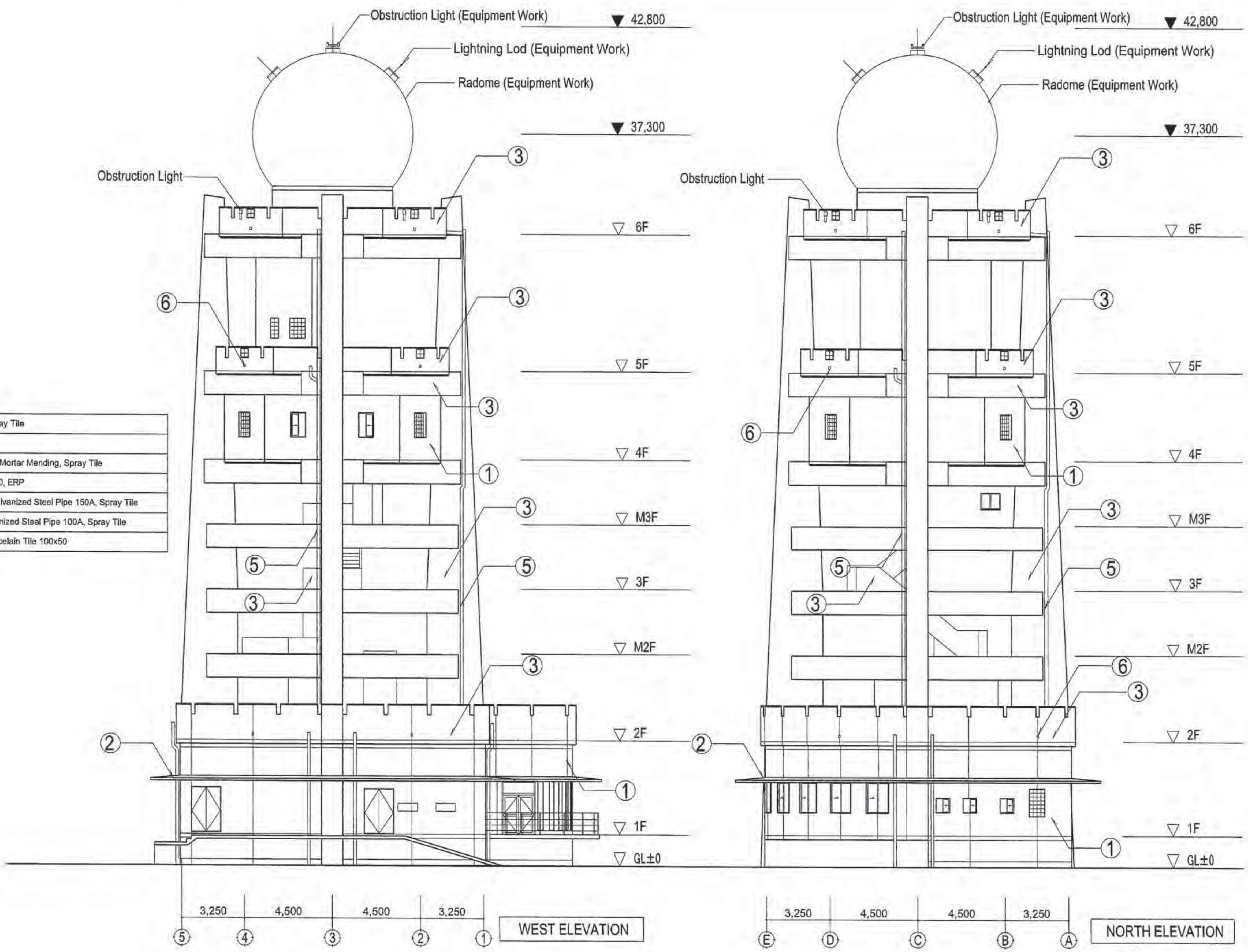




LEGEND

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
7	C.S. Mortar t=25 Porcelain Tile 100x50

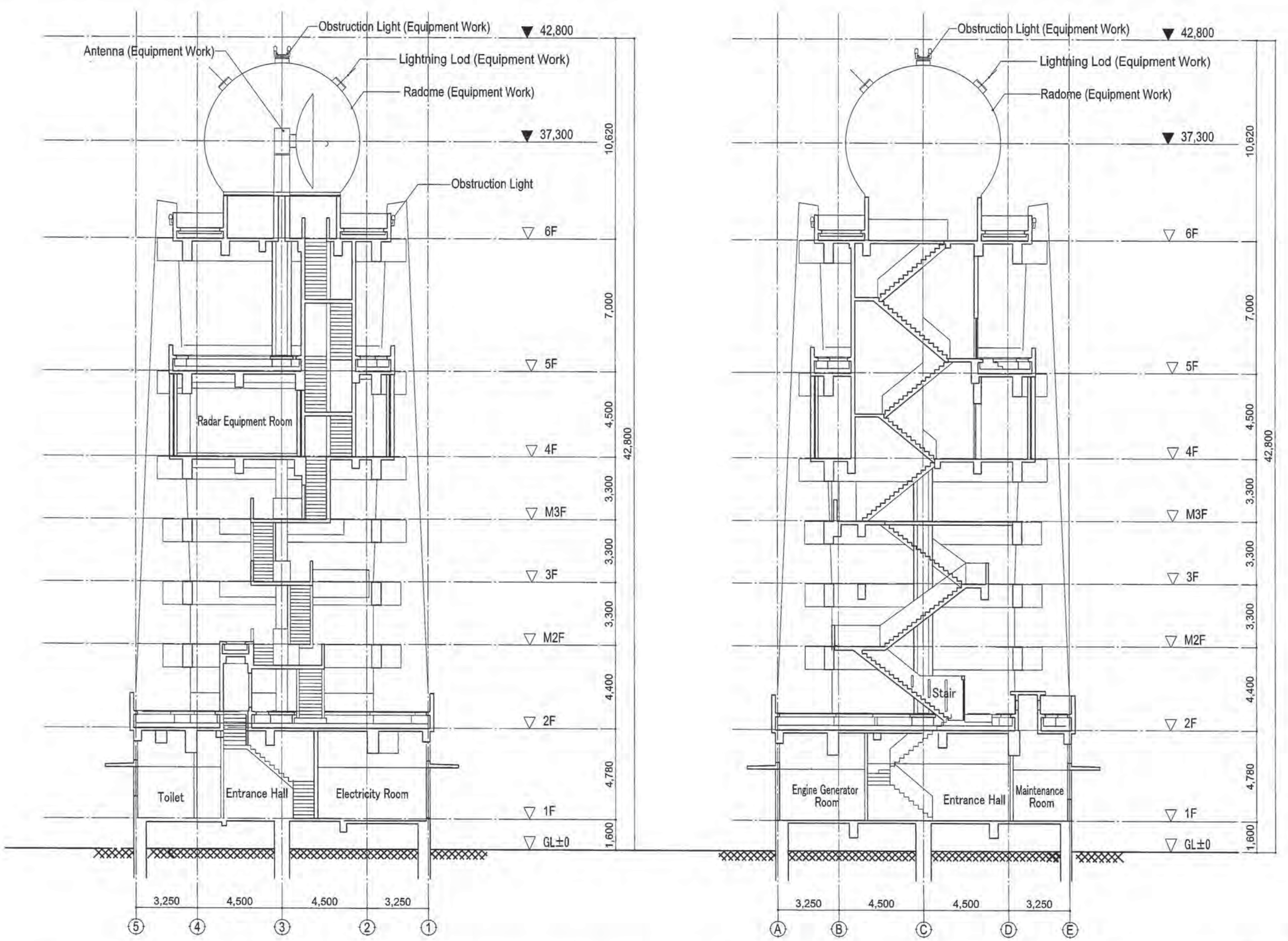
JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING ELEVATION 1	SCALE 1:200	DRAWING No. A - 07



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
7	C.S. Mortar t=25 Porcelain Tile 100x50

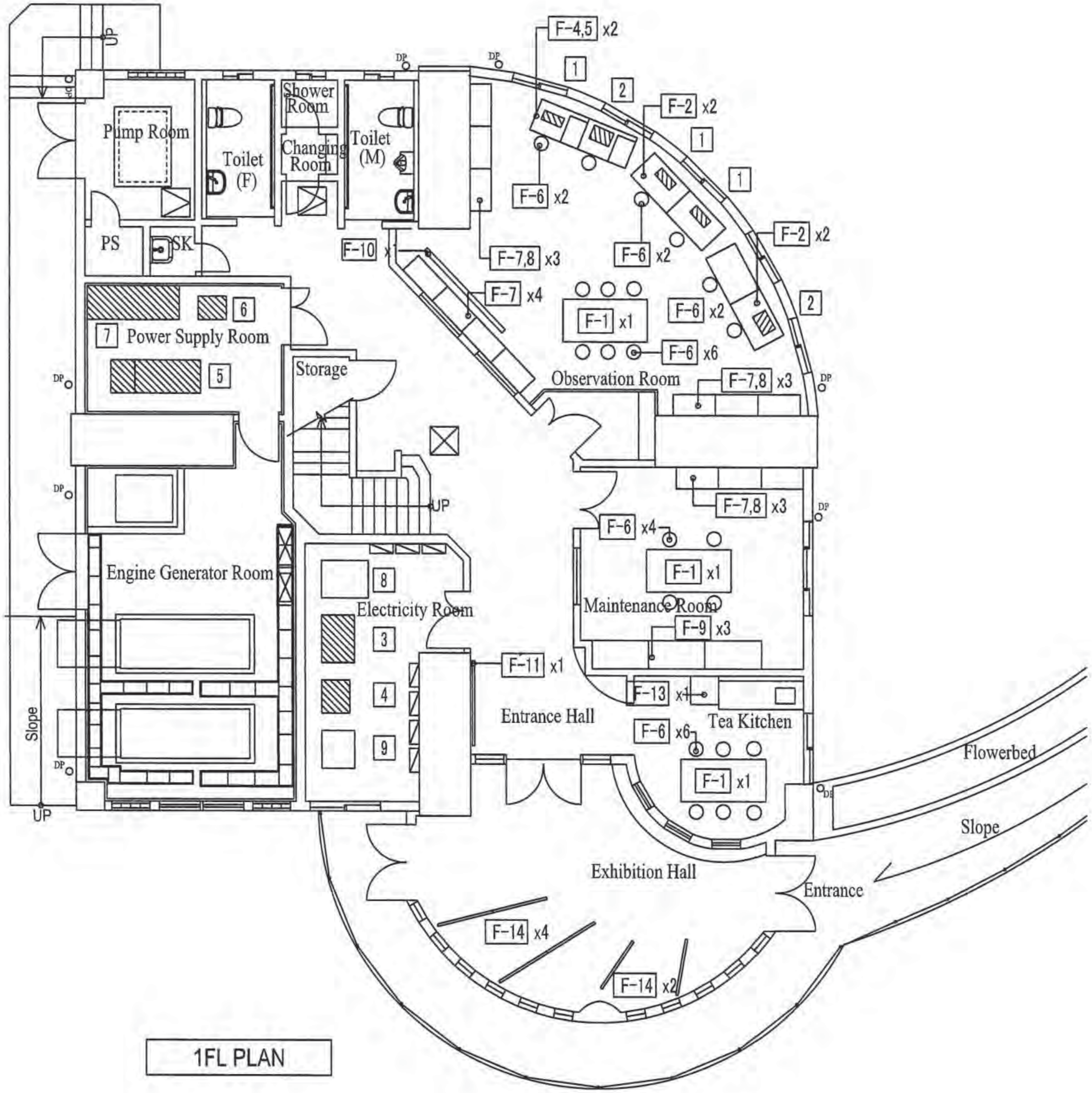
JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc.	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE: TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING ELEVATION 2	SCALE 1:200	DRAWING No. A - 08



Joint Venture of Japan Weather Association and International Meteorological Consultant Inc.

THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT

DRAWING TITLE	SCALE	DRAWING No.
TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING SECTION	1:200	A - 09



1FL PLAN

EQUIPMENT (EQUIPMENT WORK)

1	Indicator
2	Coolor Printer
3	Radar AVR
4	Isolation Transformer
5	Power Supply Capacitor
6	Emergency Power Backup Unit
7	Emergency Power Backup Battery

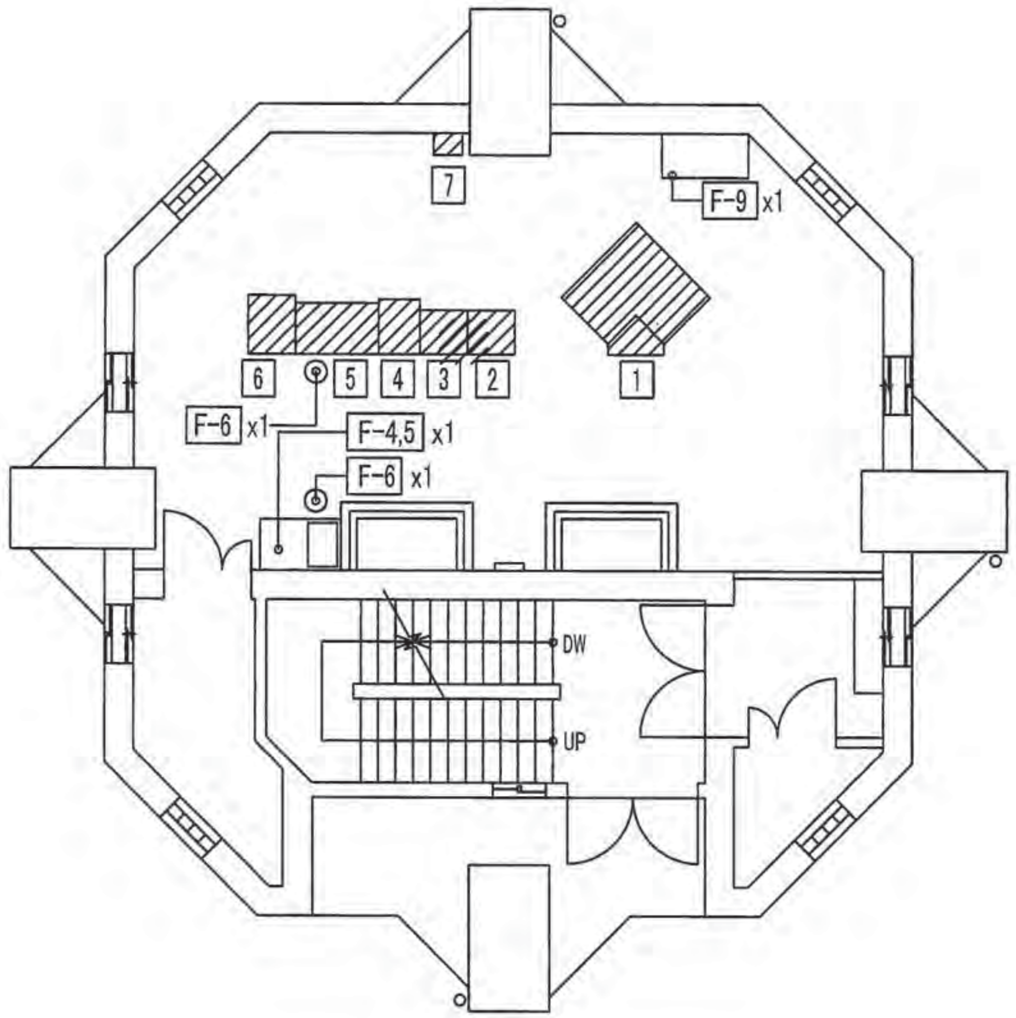
EQUIPMENT (CONSTRUCTION WORK)

8	AVR
9	Isolation Transformer

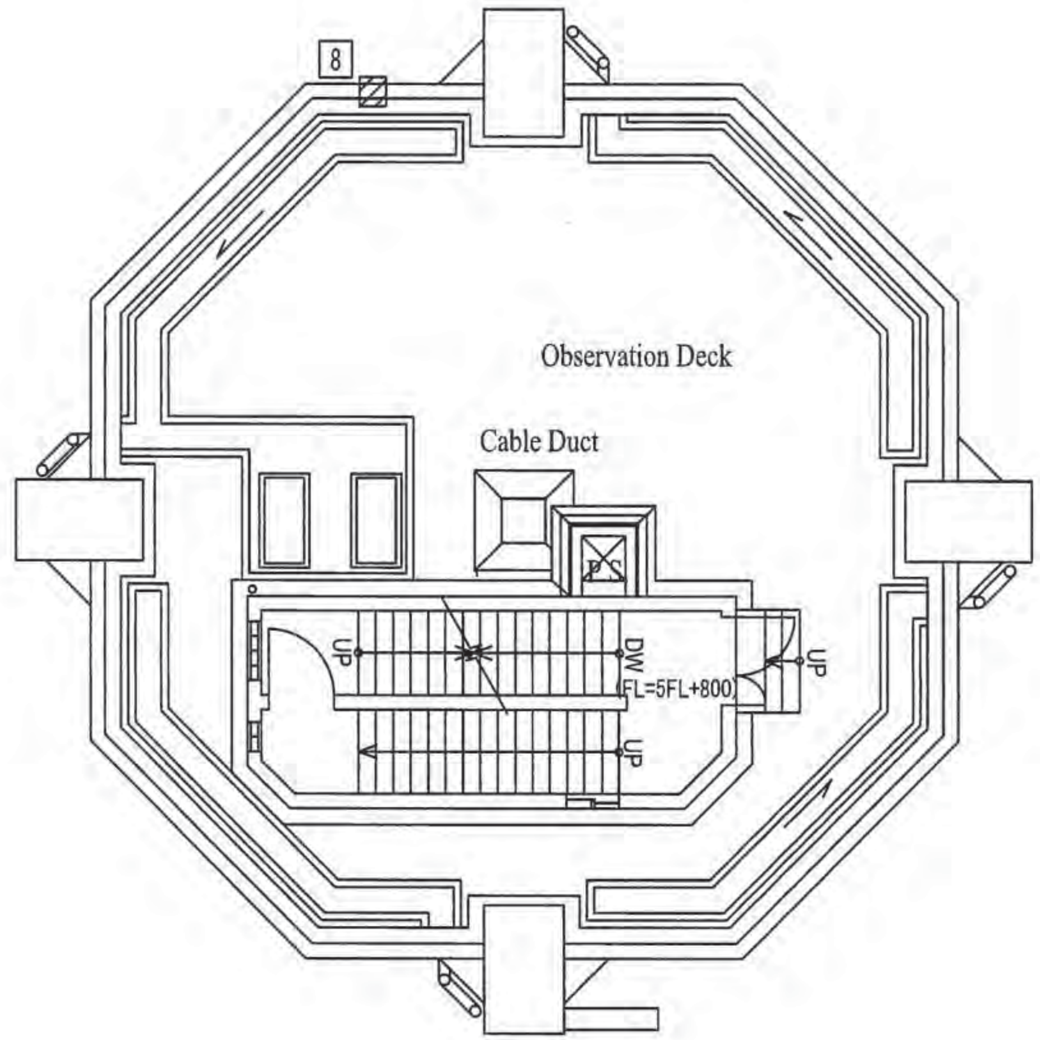
FURNITURE (CONSTRUCTION WORK)

F-1	Meeting Table (W900xL1,800)
F-2	Single Pedestal Desk (W1,200xD700)
F-3	Pedestal-free Desk (W1,500xD700)
F-4	Pedestal-free Desk (W1,100xD700)
F-5	Drawer Unit with Casters
F-6	Chair
F-7	Lateral Filling Cabinet H1,100
F-8	Cabinet (Double Hinged Doors) H1,000
F-9	Shelves (Double Hinged Doors) H2,100
F-10	White Board: W1,800xH900
F-11	Pin Board: W1,800xH900
F-12	White Screen: W2,400xH1,800
F-13	Water Dispenser
F-14	Exhibition Panel Board (W1,200xH1,800)

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING EQUIPMENT LAYOUT PLAN 1	SCALE 1:100	DRAWING No. EQ - 01



4FL PLAN



5FL PLAN

EQUIPMENT (EQUIPMENT WORK)

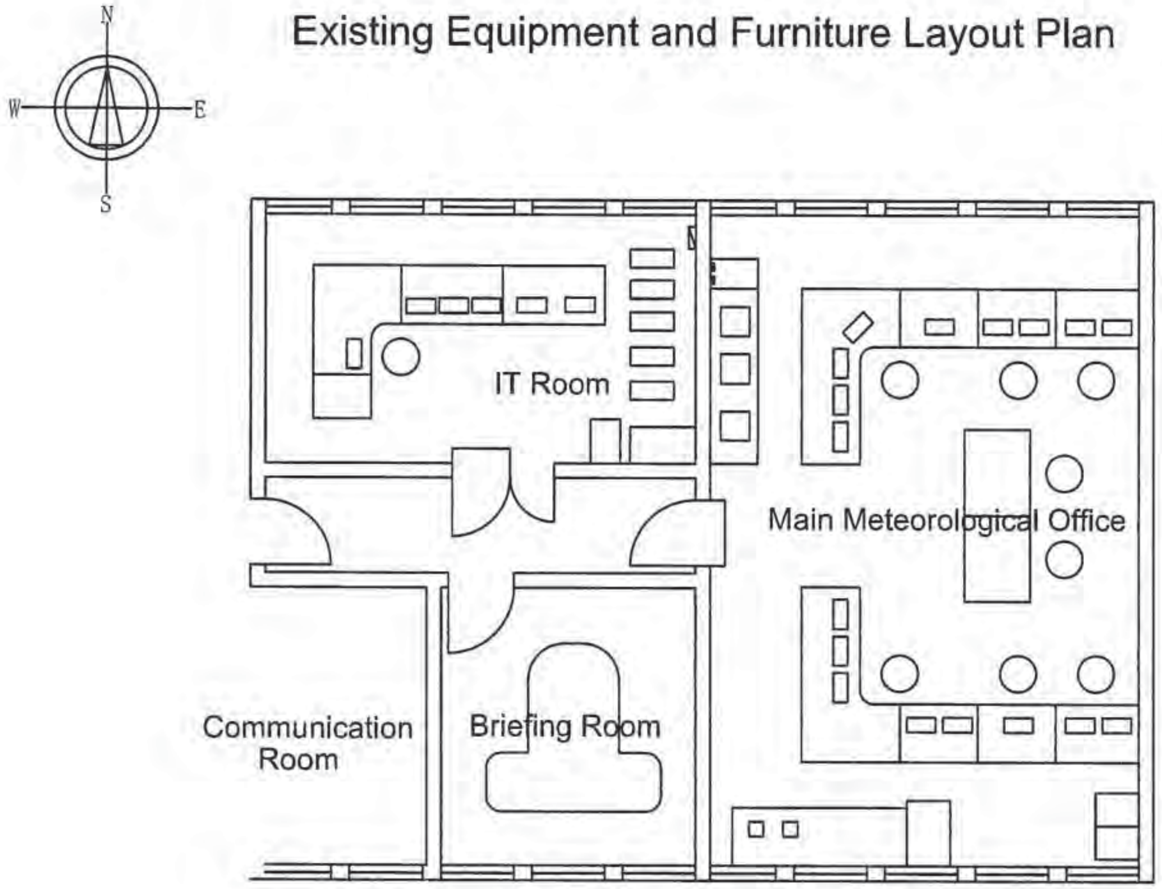
1	Transmitter
2	Antenna Controller & Dehydrator
3	DRSP
4	Data & Protocol Converter
5	Radar TASK Controller
6	VSAT In-Door Unit (IDU)
7	Radar Power Maintenance Panel
8	Parabolic Antenna

FURNITURE (CONSTRUCTION WORK)

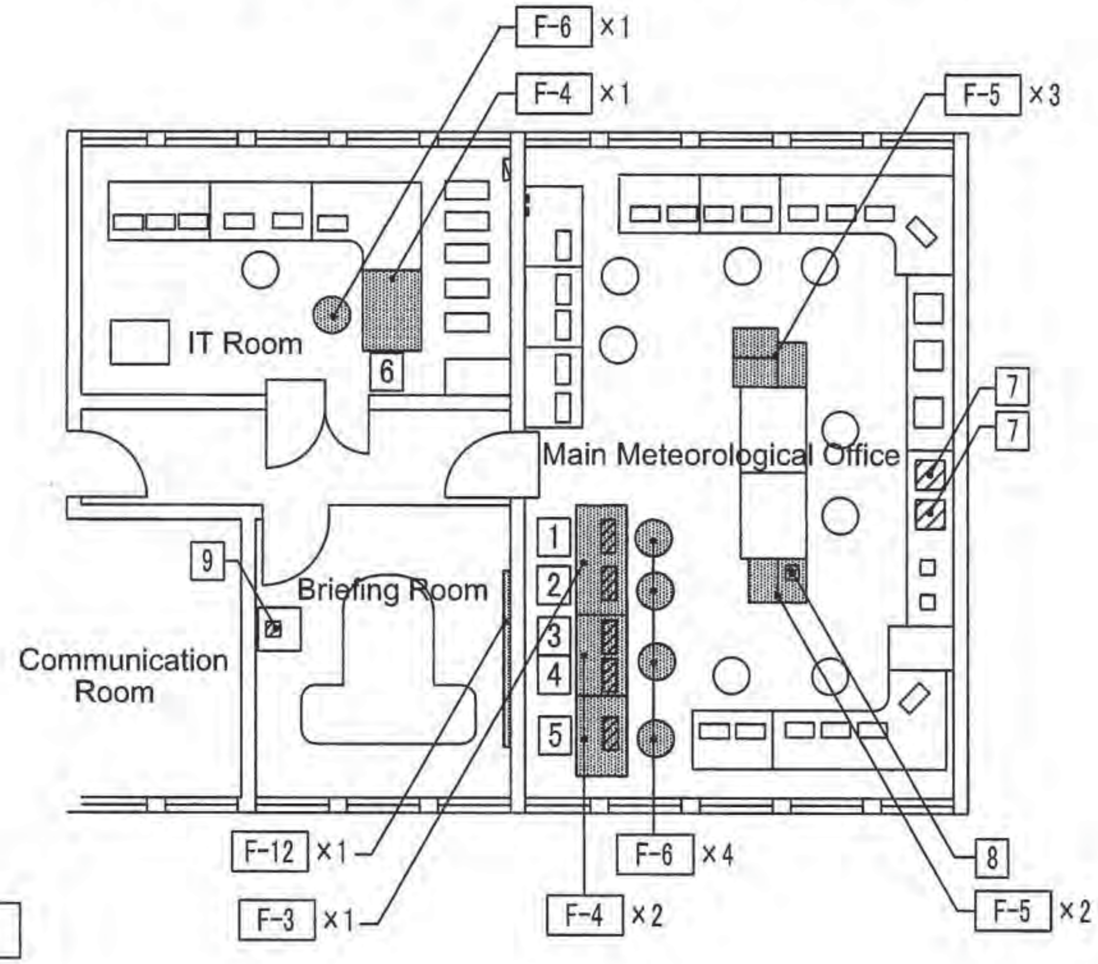
F-4	Pedestal-free Desk (W1,100xD700)
F-5	Drawer Unit with Casters
F-6	Chair
F-9	Shelves (Double Hinged Doors) H2,100

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE TROU-AUX-CERFS METEOROLOGICAL RADAR TOWER BUILDING EQUIPMENT LAYOUT PLAN 2	SCALE 1:100	DRAWING No. EQ - 02

Existing Equipment and Furniture Layout Plan



Proposed Equipment and Furniture Layout Plan



2FL PLAN

FURNITURE (CONSTRUCTION WORK)

F-3	Pedestal-free Desk (W1,500xD700)
F-4	Pedestal-free Desk (W1,100xD700)
F-5	Drawer Unit with Casters
F-6	Chair
F-12	White Screen: W2,400xH1,800

EQUIPMENT (EQUIPMENT WORK)

1	Cyclone Tracking Monitor
2	Doppler Velocity Indicator
3	Product Retrieval Unit
4	Meteorological Data Archiving Unit
5	Accumulated Rainfall Processor
6	Radar WEB Server
7	Color Printer
8	IT Telephone
9	Projector

JWA Joint Venture of Japan Weather Association and International Meteorological Consultant Inc. IMC	THE PREPARATORY SURVEY ON THE MAURITIUS METEOROLOGICAL SERVICES PROJECT	DRAWING TITLE MAURITIUS METEOROLOGICAL SERVICES HEAD OFFICE EQUIPMENT LAYOUT PLAN 1	SCALE 1:100	DRAWING No. EQ - 03

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. Since the periods November 01 to May 15 is the cyclone season in Mauritius and because there are significant lead times in manufacturing meteorological equipment, the management of the implementation schedule should be given particular attention.

1) Implementing agency for the Project

The responsible government agency of Mauritius for the implementation of the Project is the MMS under the supervision of the Prime Minister's Office. The MMS, 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 Mauritius and the Government of Japan and the Grant Agreement (G/A) between the Government of the Mauritius 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 MMS and a Japanese consulting firm, having its principal office in Japan and recommended by the JICA.

The consulting firm will become the Consultant for the Project by signing the Agreement. The Consultant then will conduct a detailed design study in Mauritius with the MMS and in Japan, and prepare tender documents including technical specifications, drawings, diagrams, etc. In addition, the Consultant instead of the MMS 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 MMS.

2-2-4-2 Implementation Conditions

1) Natural Disaster in the Southwest Indian Ocean

The decadal frequency of tropical cyclone in the Southwest Indian Ocean, decadally 58 tropical cyclones generated and 26 tropical cyclones, approximatelly half of them, became very intense tropical cyclones. The project implementation schedule should be given particular attention to the probable occurence/season of tropical cyclones and heavy rains.

2) Conditions for the Installation of Equipment

The meteorological radar system, computing equipment and other sophisticated equipment with electric and electronic circuits will be installed in the radar tower building. In accordance with the construction schedule, the dispatch of an electrical engineer is required at the time of the installation, adjustment and wiring of the electric power supply and power back-up equipment (auto voltage regulator: AVR, radar power back-up unit, etc.). During the construction period, it is important that there should be smooth procurement of 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 MMS staff, specialized highly skilled engineers are required as on-the-job trainees to ensure that the MMS can operate and maintain the equipment efficiently.

2-2-4-3 Scope of Works

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

1) Construction of the Radar Tower Building

<Scope of works to be undertaken by Japan's Grant Aid Assistance>

a) Architectural and civil works
b) Electrical works
c) Air-conditioning and Ventilation works
d) Plumbing works

<Scope of works to be undertaken by the Mauritius side>

a) Obtaining the required permission/approval for construction of a radar tower building
b) Securing the Project site
c) Removal/relocation/demolition of the existing facilities that may obstruct during Project implementation

d) External and planting works, as necessary
e) Renovation work for the existing boundary wall/fence
f) Power supply intake work
g) Public water supply intake work
h) Telephone line intake work
i) Procurement of furniture for other purpose of radar observation (if required)

2) Installation Work for the Equipment

<Scope of works to be undertaken by Japan’s Grant Aid Assistance>

a) Procurement of the required equipment
b) Transport of the equipment to the Project site
c) Installation and adjustment works for the equipment
d) Commissioning for the total system

<Scope of works to be undertaken by the Mauritius side>

a) Provision of stable commercial power supply at the Project site
b) Securing the required frequencies for the Meteorological Radar System and the Meteorological Data Communication System
c) Removal/relocation/demolishment of the existing equipment that may obstruct during Project implementation
d) Protection against any damage and possible theft of the equipment & systems

2-2-4-4 Consultant Supervision

1) Principal Guidelines

a) To take responsibility for expediting the project implementation as well as smooth supervision, in accordance with the guidelines of Japan's Grant Aid Assistance and the Outline Design.
b) To communicate closely with 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 MMS and the contractor.
d) To ensure the safety of the project implementation as its top priority by earlier/advance detection of severe weather phenomena.

2) Consultant Supervision

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

3) Scope of Work for Supervision

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

2-2-4-5 Quality Control Plan

Mauritius is an area of high temperature and high humidity reaching more than 82% almost all year round. According to past local meteorological data at the MMS Head Office in Vacoas, the temperature could reach more than 30°C. In view of this, the ambient temperature and the concrete temperature will be measured during concrete pouring, to ensure correct concrete quality. The quality control plan for the main work is described in the table below.

Table 44: 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 the Project site. Chloride quantity test and alkali aggregate reactivity test will be conducted by the Mauritius Standard Bureau, Moka.
	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 the Mauritius Standard Bureau, Moka.
	Pile work	Material, bearing capacity	Bearing capacity check	
Finishing Work	Roof work	Workmanship, leakage	Visual inspection, water spray test	
	Tile work	Workmanship	Visual inspection	
	Plastering work	Workmanship	Visual inspection	
	Door & window work	Products, Installation accuracy	Factory inspection sheet check Visual inspection, dimension check	
	Painting work	Workmanship	Visual inspection	
	Interior work	Products, workmanship	Visual inspection	
Electrical Work	Power Receiving & Transforming	Performance, operation installation check	Factory inspection sheet check; withstand voltage, megar, operation, visual inspection	
	Conduit work	Bending, support check	Visual inspection, dimension	
	Wiring and cable work	Sheath damage, loose connection check	Performance sheet check, cleaning before laying, marking after bolt fixing	
	Lightning work	Resistance, conductor support pitch check	Resistance measuring, visual inspection, dimension	
	Lighting work	Performance, operation, installation check	Performance sheet check, illumination measurement, visual inspection	
Mechanical Work	Water Piping Work	Support pitch, leakage	Visual inspection, leakage, water pressure test	
	Pump Installation	Slope, Support pitch, leakage	Visual inspection, leakage, flow test	
	Air-Con. work	Performance, operation installation check	Performance sheet check, temperature measurement	
	Sanitary Fixture	Operation, installation, leakage check	Visual inspection, flow test	

2-2-4-6 Procurement Plan

(1) Equipment Procurement

Maintenance requirements and the availability of the necessary parts and consumables in Mauritius 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, etc. to be supplied under the Project is produced in Mauritius. 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 transmitter for this system is more than 100,000 hours and the designed mean time to repair (MTTR) of transmitter is 0.5 hours. In addition, since almost all the Japanese meteorological radar systems established by Japan's Grant Aid in the developing countries have been working well over the years, Japanese systems have received a high degree of confidence in the world. Therefore, it is surely recognized, even by the WMO, that a Japanese system is the most suitable one for developing countries normally faced with operation and maintenance difficulty.

The activities of the private sector in Mauritius will be useful in support of the computer systems and other sophisticated systems. There are major computing equipment manufactures and local agents/suppliers. 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 Mauritius. Some construction materials imported from South Africa, Australia and the Association of Southeast Asian Nations (ASEAN) are marketed throughout Mauritius. As these imported materials can be easily procured locally, they are considered as part of the procurement of local products. In order to ensure the easy maintenance of the radar tower building, locally available materials will be utilized for construction.

2) Procurement Plan of Construction Materials

[1] Structural Work

Ordinary portland cement packed in a 50kg bag is imported from Indonesia and South Africa. Concrete coarse aggregate can be obtained from quarries located in the suburbs of Port Louis. Since quarrying fine aggregate such as sand for concrete is prohibited in Mauritius, sand made from crushed-stone (particle size: relatively large size of approx. 2mm) can be procured. Almost all reinforcing bars and steel materials which are available in Mauritius are imported from South Africa and those can be procured at a high price. The main materials for the structural works, such as fresh concrete, plywood for form works, etc., can be procured locally. Locally made concrete blocks are available and are a common material for building construction.

[2] Building Exterior and Interior Work

Timber, tiles, paint, glass, aluminum window frames, etc. used for the exterior and interior of a building are imported and, as such, are readily available in the local market. In the market, imported aluminum sash is also available, but the quality may be a problem, and some of the sashes are at a higher price than that of a Japanese product. 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, etc. are popular in Mauritius. As a result, those products can be procured in the local market 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 Mauritius for the convenience of repair and maintenance. Custom-made building equipment such as control panels, power distribution boards and switch boards imported from South Africa, Australia and ASEAN countries can be procured in the local market.

Table 45: Major Materials Procurement Plan (Architectural Work)

Materials	Local Market		Procurement Plan		
	Condition	Import	Mauritius	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 (Cyclone glass)	○		○		
Access floor panel	○		○		
Access floor panel (heavy duty type)	△		○		
Paint	○		○		
Gypsum board (T-bar)	○		○		
Cement board	○		○		
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 Mauritius
△ : Available in the local market in Mauritius but model and quantity are limited
× : Difficult to procure in Mauritius

Table 46: Major Materials Procurement Plan (Mechanical and Electrical Work)

Work type	Materials	Local Market		Procurement Plan		
		Condition	Import	Mauritius	Third Country	Japan
Air-conditioning work	Air conditioner	△		○		
	Heat exchanger	△		○		
	Exhaust fan (salt-proof)	△		○		
Plumbing work	Sanitary fixture	○		○		
	Pipe	○		○		
	Fire extinguisher	○		○		
	Water lifting pump	○		○		
	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 Mauritius
△ : Available in the local market in Mauritius but model and quantity are limited
× : Difficult to procure in Mauritius

3) Transportation Plan

Port Louis which is the major sea port of Mauritius and a hub sea port in the West Indian Ocean is managed by the Mauritius Ports Authority. The required number of days and the schedule of vessels from the major importing countries to Port Louis are indicated in the following table.

Table 47: Scheduled Vessels to Port Louis

Country	Name of Port	Schedule	Number of Days
Japan	Yokohama, Osaka, Kobe	1 ship/week	Approx. 35days
Australia	Sydney	1 ship/week	Approx. 30days
EU Countries	Antwerp, Rotterdam, Hamburg, etc.	1 ship/week	Approx. 40days
United States of America	East Coast (New York, Baltimore)	1 ship/week	Approx. 45days
	West Coast (Long Beach)	1 ship/week	Approx. 55days

<Inland Transport>

All the roads between Port Louis and Trou-aux-cerf Meteorological Radar Observation Station are paved and the width of the access road to the Station is approximately 5m. Given these road conditions, cargo containers can be transported directly to the Station. However, generally, large-sized vehicles such as trucks and buses and even small vetches at morning and early-evening are prohibited from entering into Trou-aux-cerf located at the outer rim of an inactive volcanic crater which is a jogging trail for sport promotion. Therefore, the access permission of Trou-aux-cerfs for Radar Tower Building

Construction and Radar System Installation Works from the Municipal Council of Curepipe is required.

2-2-4-7 Operational Guidance Plan

The required operation guidance will be implemented through the practical operation simulation of each system in 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, etc. of the meteorological radar system will be imparted to the MMS. As such, operational guidance for the said items will no longer be implemented after the completion of the equipment installation. The operational guidance for each system will be implemented at the following places indicated in the table attached hereunder.

Table 48: Operation and Maintenance Training (OJT)

Equipment	MMS Head Office, Vacoas	Trou-aux-cerf Meteorological Radar Observation Station
Meteorological Radar System • Power Unit • Antenna • Radar Unit • Meteorological Radar Transmission Unit • Computer Network Unit • Application Software	-	○
Meteorological Radar Data Display System • Power Unit • Computer Network Unit • Application Software	○	○
Meteorological Data Communication System • Power Unit • Communication Unit • Computer Network Unit • Application Software	○	○

Apart from Operation and Maintenance Training (OJT), technology transfer through practical installation and adjustment works to be carried out by the MMS 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, etc. which require disassembling the radar system to be able to see them. In addition, software installation by the MMS staff themselves repeatedly 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 MMS staff are required. Therefore, all the significant parts of technology transfer must be completed during the installation work period.

2-2-4-8 Soft Component Plan

<Soft Component>

Since the existing meteorological radar system of Mauritius completely stopped in 2005, already 7 years have been passed and only 2 technicians who have practical experience to operate the existing meteorological radar system are remaining now. Most all of the MMS's technicians are proficient in the use of computers and computerized meteorological observation equipment. However, no technician in MMS has practical experience to operate a digital meteorological radar system which is planned to be procured under the Project. For smooth operation and maintenance of the digital meteorological radar system and assurance of the required sustainability of the project outcomes, implementation of the following technology transfers in the soft component (soft component schedule is indicated in the Implementation Schedule attached hereunder) is required.

<Soft Component Target>

The Soft Component Targets are as follows.

- Operation, maintenance, fault finding, remedy and recovery to be appropriately carried out by the MMS
- Prompt and appropriate meteorological radar operation and maintenance utilizing the meteorological radar system manual summary and the meteorological radar system maintenance & management record book
- Meteorological radar observation in accordance with the sequence & schedule for Intensity Mode and Doppler Mode in order to appropriately understand weather phenomena and to utilize the observed radar data for forecasting.

<Soft Component Outputs>

Soft Component Outputs are as follows.

Table 49: Soft Component Outputs

No.	Item	Output
1	Meteorological Doppler Radar Operation, Maintenance, Fault Finding, Remedy and Recovery	Implementation of operation, maintenance, fault finding, remedy and recovery appropriately by the MMS 1) Routine maintenance using measuring instruments and tools 2) Practice of replacement of spare parts to actual system and confirmation of system operation 3) Practice of countermeasures, fault finding, remedy and recovery
2	Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing Meteorological Radar System Manual Summary and Meteorological Radar System Maintenance & Management	Implementation of prompt and appropriate meteorological Doppler radar operation and maintenance utilizing meteorological radar system manual summary and meteorological radar system maintenance & management record book

	Record Book	
3	Meteorological Radar Observation in accordance with Sequence & Schedule for Intensity Mode and Doppler Mode	Implementation 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 Soft Component are as follows.

Table 50: Soft Component Indicators

No.	Item	Objectively Verifiable Indicators	Means of Verification
1	Meteorological Doppler Radar Operation, Maintenance, Fault Finding, Remedy and Recovery	Operation, maintenance, fault finding, remedy and recovery are carried out appropriately by the MMS	· Confirmation of proficiency through 1) routine maintenance using measuring instruments and tools, 2) practice of replacement of spare parts to actual system and confirmation of system operation, and 3) practice of countermeasures, fault finding, remedy and recovery
2	Prompt and Appropriate Meteorological Doppler Radar Operation and Maintenance utilizing Meteorological Radar System Manual Summary and Meteorological Radar System Maintenance & Management Record Book	Meteorological Doppler radar operation and maintenance utilizing meteorological radar system manual summary and meteorological radar system maintenance & management record book are implemented promptly and appropriately.	· Evaluation of using frequency of the meteorological 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 Sequence & Schedule for Intensity Mode and Doppler Mode Sequence & Schedule	Meteorological radar observation is implemented according to 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.

Table 51: 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 Operation, Maintenance, Fault Finding, Remedy and Recover	Engineer who has a meteorological radar adjustment and fault finding technique	Since technicians in the MMS have no practical experience of adjustment and fault finding of a digital meteorological radar system, it is required that the MMS technicians should obtain meteorological radar adjustment	Indicated in the table below	Routine maintenance using measuring instruments and tools	Expert Consultant on meteorological radar adjustment and fault finding: 1.3 MM (Period of Technology Transfer in Mauritius: 35 days)	Manual of routine maintenance using measuring instruments and tools
				Practice of replacement of spare parts to actual system and confirmation of system operation		Manual of replacement of spare parts to actual system and confirmation of
				Practice of countermeasures, fault finding, remedy and recovery		

		and fault finding technique.		Production of operation and maintenance manual	Direct Support	system operation Manual of fault finding, remedy and recovery
2. Meteorological Doppler Radar System Manual Summary and Meteorological Radar System Maintenance & Management Record Book	Engineer who has a meteorological radar operation and maintenance technique	Since technicians in the MMS have no practical experience of operation and maintenance of a digital meteorological radar system, it is required that the MMS technicians should obtain meteorological radar operation and maintenance technique utilizing meteorological Doppler radar system manual summary and meteorological radar system maintenance & management record book.	Indicated in the table below	Discussion with the MMS technicians Selection of the most important points from meteorological Doppler radar system manual Production of meteorological Doppler radar system manual summary Production of meteorological radar system maintenance & management record book Utilization of meteorological Doppler radar system manual and meteorological radar system maintenance & management record book by the MMS technicians	Expert Consultant on meteorological radar operation and maintenance: 1.3 MM (Period of Technology Transfer in Mauritius: 35 days) Direct Support	Meteorological Doppler radar system manual summary Meteorological radar system maintenance & management record book ➧ Date and time of occurrence of system failure/trouble ➧ Cause/s of system failure/trouble (abnormal noise, part degradation, etc.) ➧ Repair procedures implemented ➧ Name and quantity of replaced parts ■ Name of engineer/s who perform the repair /troubleshooting
3. Preparation of Sequence & Schedule for Intensity Mode and Doppler Mode	Engineer who can identify Sea Clutter and Blind Area by radar observation data and prepare sequence & schedule for meteorological radar observation which is suitable to weather phenomena in Mauritius	Since technicians in the MMS have no practical experience of CAPPI observation using digital meteorological Doppler radar system and has no technique of sequence & schedule for Intensity Mode and Doppler Mode, it is required that the MMS technicians should obtain preparation technique of sequence & schedule for meteorological radar observation under awareness of the importance.	Indicated in the table below	Discussion with the MMS technicians and lecture Identification of Sea 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 MM (Period of Technology Transfer in Mauritius: 26 days) Direct Support	Sequence & Schedule for Intensity Mode and Doppler Mode

Table 52: Target Personnel in MMS for Technology Transfer in Soft Component

Technology Transfer of No. 1 & 2		Technology Transfer of No. 3	
Electronic Technician Section: Position	Number	Forecasting Section: Position	Number
System Engineer to be recruited	1	Meteorologist	12
Communication Engineer to be recruited	1	System Engineer to be recruited	1
Electronic Technician to be recruited	10	Communication Engineer to be recruited	1
Chief Electronic Technician	1	Chief Electronic Technician	1
Principal Electronic Technician	4		
Senior Electronic Technician	4		
Trainee Electronic Technician	4		

<Soft Component Product>

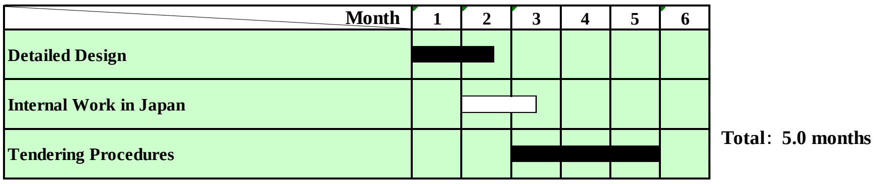
Soft Component Products are as follows.

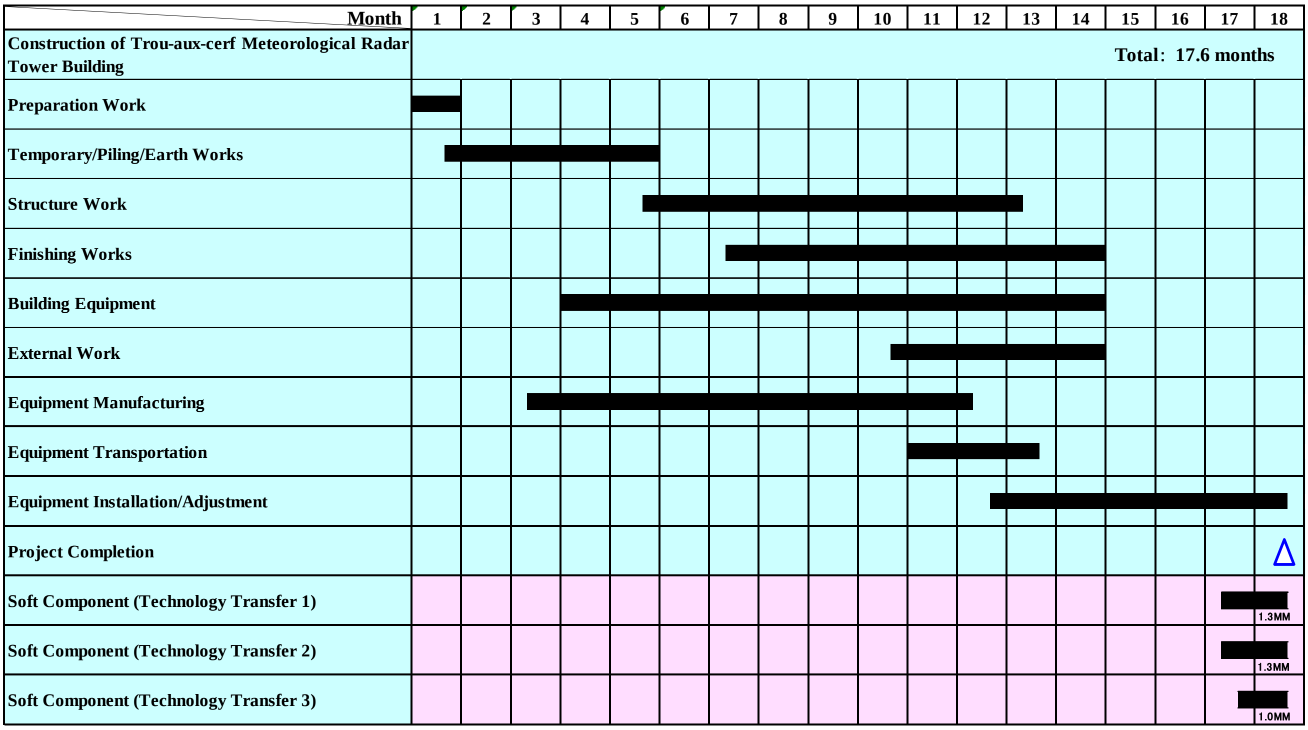
Table 53: Soft Component Product in Technology Transfer

<table>
<tr><th colspan="2">Product Name</th><th>Submission Time</th><th>No. of Pages</th></tr>
<tr><td colspan="2">Implementation report on 1) routine maintenance using measuring instruments and tools, 2) practice of replacement of spare parts to actual system and confirmation of system operation, and 3) practice of countermeasures, fault finding, remedy and recovery</td><td rowspan="4">After Technology Transfer</td><td>20</td></tr>
<tr><td colspan="2">Meteorological radar system manual summary</td><td>30</td></tr>
<tr><td colspan="2">Meteorological radar system maintenance and management record book</td><td>10</td></tr>
<tr><td colspan="2">Radar observation sequence & schedule for Intensity Mode and Doppler Mode</td><td>10</td></tr>
<tr><th>Output Name</th><th>Content</th><th>Submission Time</th><th>No. of Pages</th></tr>
<tr><td>Soft Component Completion Report</td><td>• Scheduled Activities and Actual Achievement
• Scheduled Outputs and Achievement
• Factors influenced on Outputs Achievement
• Recommendation
• Outputs</td><td>Completion of Soft Component</td><td>50</td></tr>
</table>

2-2-4-9 Implementation Schedule

Table 54: Implementation Schedule





2-3 Obligations of Recipient Country

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

Table 55: Major Undertakings to be done by MMS under Implementation of the Project

No	Items
	General Items
1	To undertake all necessary institutional and juridical procedures in Mauritius
2	To conduct Environmental Impact Assessment Clearance
3	To facilitate duty (Tax) exemption and/or reimbursement procedures and to take necessary measures as well as provide requisite legal and/or administrative documentations for customs clearance to customs broker/forwarder to be employed by Contractor at the port of disembarkation for the materials and equipment imported for the Project
4	To provide necessary working spaces at the MMS Head Office for the Consultant and the Contractor for the implementation of the Project, if required

5	To support Japanese and other foreign nationals, 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 Mauritius and stay therein for the performance of their work
6	To exempt Japanese and other foreign nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the signed contracts
7	To bear all the expenses, other than those to be borne by the Japan's Grant Aid, necessary for the implementation of the Project
8	To ensure the security of the project sites prior to the commencement of the Project implementation
For Construction of Radar Tower Building at Trou-aux-cerfs Existing Radar Observation Station	
9	To clear, level and reclaim the land prior to the commencement of the construction
10	To provide spaces at the Project site for temporary facilities such as a contractor's office, workshop, building materials storage, etc. for the construction work
11	To obtain Access Permission of Trou-aux-cerfs for Radar Tower Building Construction Work
12	To obtain necessary permissions/approvals for construction of Radar Tower Building; such as Demolishment of the existing Radar Tower Building, Building Height Clearance, Clearance for Waste Water on Site Treatment, Approval for Radar Tower Building Construction, etc.
13	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz) supply (capacity: 100kVA) and other incidental facilities such as water supply and telephone line for Radar Tower Building
14	To install the required step-down transformers for the commercial power supply for Radar Tower Building
15	To provide temporary facilities for distribution of electricity, water and for the construction work
16	To construct buildings other than Radar Tower Building, if required
17	To undertake incidental outdoor works such as gardening, fencing, gates, boundary walls and exterior lighting in and around the site, if necessary
18	To procure furniture for other purpose of radar observation, if required
For Installation Work of the Equipment	
19	To obtain Access Permission of Trou-aux-cerfs for Radar System Installation Work
20	To remove and relocate the existing facilities if available for the installation of the Equipment, if necessary.
21	To obtain the required frequency(s) for the requested meteorological radar system and meteorological data communication system
22	To secure effective space at the MMS Head Office for installation of the Equipment to be supplied
23	To install 2 air-conditioning systems in the Main Meteorological Office (MMO)
After the completion of the Project	
24	To assign staff necessary for smooth operation and maintenance of the Equipment
25	To procure the required spare parts and consumables for smooth operation and maintenance of the Equipment
26	To provide adequate maintenance of Radar Tower Building(s) constructed under the Project, so as to ensure that they can function effectively
27	To operate, maintain, and properly and effectively utilize the facilities constructed and the Equipment procured under the Project
28	To allocate the necessary budget and personnel for appropriate meteorological radar observation and forecasting works

2-4 Project Operation Plan

(1) Operation and Maintenance Plan for the Equipment

1) Operational Plan of Meteorological Radar System

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

Table 56: Calendar of Typical Precipitation Events in Mauritius

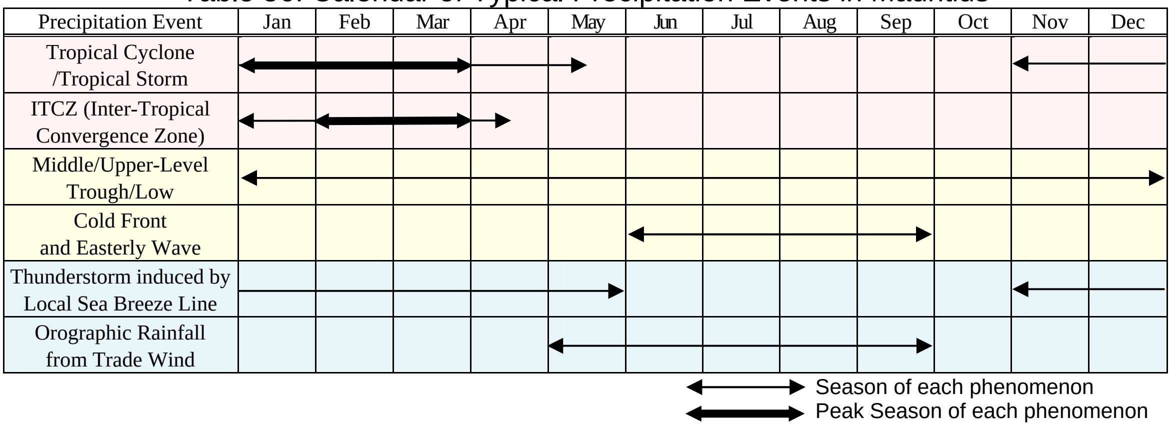


Table 57: Estimated Annual Radar Operation Hours

Precipitation Event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tropical Cyclone /Tropical Storm	5.2 Cyclone×108h(4.5d)=**562h**											
ITCZ (Inter-Tropical Convergence Zone)	24h×1e=**24h**											
Middle/Upper-Level Trough/Low	3h×(122d-4.5d)=**352h**				3h×183d=**549h**						3h×61d=**183h**	
Cold Front and Easterly Wave						2h×122d=**244h**						
Thunderstorm induced by Local Sea Breeze Line	3h×3e×5M=**45h**										3h×3e×2M=**18h**	
Orographic Rainfall from Trade Wind					3h×153d=**459h**							

H: hour e: event d: day M: month

Estimated Annual Radar Operation Hours: **2,436hours**

2) Staff Allocation and Radar Observation System Plan Trou-aux-cerfs Radar Observation Station

For the appropriate operation of the meteorological radar systems, the following staff allocation and radar observation system are required.

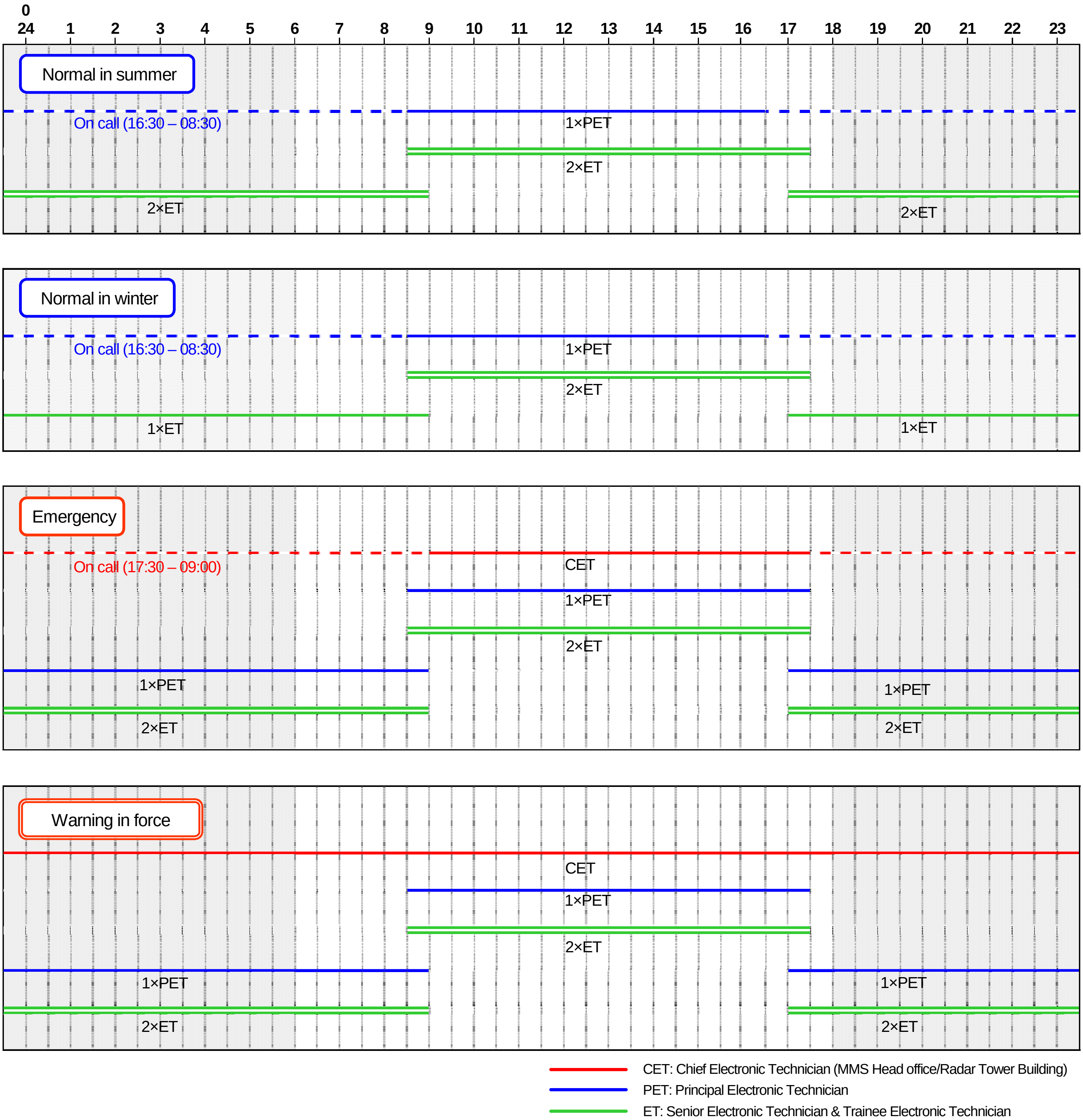


Figure 14: Staff Allocation and Radar Observation System Plan Trou-aux-cerfs Radar Observation Station

3) Operation and Maintenance Plan for the S Band Meteorological Doppler Radar System and Meteorological Data Communication System

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

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

<Recruitment of Electrical Engineer/Staff >

Operation and maintenance of the meteorological radar systems is carried out mainly by the MMS electronic technicians; however, there is no engineer in the MMS and the number of electronic technicians to do this is not sufficient, so it is essential to recruit capable engineer(s) and technical staff. The MMS fully recognizes the need to strengthen the technical section/s. The JICA Preparatory Survey Team therefore strongly recommends recruiting capable engineer(s) and technical staff indicated in the following table. For staff recruitment, the Prime Minister's Office is the supervising organization of the MMS and should give its effective cooperation and special attention on this matter.

In order for the MMS to become self-reliant in technical areas such as the operation and maintenance of radar systems, it is essential that it makes continued efforts to recruit and fill vacancies and promote technology transfer for all staff levels, from training electric technicians to engineer(s).

Table 58: Required Number of Engineers and Technicians to be recruited in MMS

	2013	2014	2015
System Engineer	1	-	-
Communication Engineer	1	-	-
Electronic Technician	4	4	2

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

There are three key issues for the maintenance of the radar tower building to be implemented by the MMS: (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 gives a good impression on the visitors/users and encourages people to respect the building and the equipment in it. Cleaning is also important to ensure the equipment continues to operate correctly. It helps in the rapid detection and repair of damaged equipment and prolongs the life of the building equipment. The main repair work will be refurbishing or replacing the exterior and interior materials protecting the building structure. The required inspections are outlined below.

Table 59: Outline of Regular Inspection for the building

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

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

It is essential to establish a proper maintenance structure in the MMS, involving the rigorous implementation of regular inspection and maintenance procedures. This work may be assigned to the private sector (local agents), if required. The general life expectancy of the major building equipment is shown below.

Table 60: Life Expectancy of Building Equipment

System	Building Equipment	Life Expectancy
Electrical System	• Distribution panels • LED lamps • Fluorescent lamps • Incandescent lamps	20 - 30 years 20,000 - 60,000 hours 5,000 - 10,000 hours 1,000 - 1,500 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 Project Cost and Capital Cost to be borne by the MMS

The required capital cost for the Project to be borne by the MMS have been estimated and are shown in the following tables.

Project Cost to be borne by Mauritius

Total Project Cost: 67,729,538 MUR (approx. 191.4 Million JP Yen)

Table 61: Estimated Capital Cost to be borne by MMS

No.	Items	Capital Cost (MUR)
For Construction of Radar Tower Building and Installation of Meteorological Doppler Radar System at Trou-aux-cerfs Meteorological Radar Observation Station		
1	To demolish the existing Radar Tower Building	252,000
2	To provide the commercial power (400V, 3-phase, 4-wire, 50Hz, capacity: 100kVA) supply (including installation of the required step-down transformer, if required for the commercial power supply) for Radar Tower Building	583,338
3	To provide the water supply for Radar Tower Building	102,000
4	To provide the telephone line for Radar Tower Building	30,000
5	To provide the Internet Access for Radar Tower Building	48,000
6	To renovate the existing guard house	800,000
7	To renovate the exiting gates, boundary walls and exterior lighting in and around the site	4,000,000
8	To make gardening	120,000
9	To remove and relocate the existing Automatic Weather Observation System	840,000
10	To relocate the existing telecommunication links of Emtel Ltd	754,200
11	Value Added Tax Fund (Approx. Project Cost×15%)	60,000,000
	For Installation of the Equipment procured under the Project	
12	To install 2 air-conditioning systems in the Main Meteorological Office (MMO)	200,000
	Total	67,729,538

Applied Exchange Rate: US$ 1 = 78.23 JP Yen, 1 MUR = 2.825 JP Yen

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

(1) Recurrent Cost to be borne by the MMS

The annual recurrent costs to be borne by the MMS 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 MMS
- Appropriate operation in accordance with the operations manuals
- Regular and proper maintenance according to the maintenance manuals

The recurrent costs considered 5% of the annual inflation rate of Trou-aux-cerfs Meteorological Radar Observation Station and the MMS Head Office, which mainly consisted of operation and maintenance costs of the equipment and the radar tower buildings to be borne by the MMS have been calculated as shown in the following tables.

Table 62: Recurrent Cost of MMS 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
1	Product Monitor	Hard disk	11	0	0	0	123,982	0	0	0	150,700	0	0	Every 4 years
	(11sets)	CD for archiving product data (20sheets/1set)	2	1,220	1,281	1,345	1,412	1,483	1,557	1,635	1,717	1,803	1,893	
2	Printer	Printer ink cartridge	4	5,430	5,702	5,987	6,286	6,600	6,930	7,277	7,641	8,023	8,424	
		Paper(500sheets/1set)	2	300	315	331	348	365	383	402	422	443	465	
3	Compact UPS	Battery	11	0	0	34,563	0	0	40,011	0	0	46,318	0	Every 3 years
		Subtotal (MUR)		6,950	7,298	42,226	132,028	8,448	48,881	9,314	160,480	56,587	10,782	

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	98,757	103,694	108,879	114,323	120,039	126,041	132,343	138,960	145,908	153,203	※1
2	Special maintenance	System brush-up by manufacture's engineer	1	0	0	330,750	0	0	382,884	0	0	443,237	0	For 5 days at site
		Subtotal (MUR)		98,757	103,694	439,629	114,323	120,039	508,925	132,343	138,960	589,145	153,203	
		Total (MUR)		**105,707**	**110,992**	**481,855**	**246,351**	**128,487**	**557,806**	**141,657**	**299,440**	**645,732**	**163,985**	
		Total (JPY)		**¥288,029**	**¥302,431**	**¥1,312,956**	**¥671,256**	**¥350,101**	**¥1,519,907**	**¥385,986**	**¥815,913**	**¥1,759,488**	**¥446,826**	

Estimate of annual electricity charge

	Item	Unit	Value		Parameter	Value	Unit
	Annual operation hours of Radar System	(H)	2,436				
	Annual operation hours of Radar System by DEG	(H)	0				
	Annual operation hours of Radar System by commercial power	(H)	2,436				
	Annual power consumption of commercial power	(kWh)	9,866		Power consumption=	4.05	KW
	Annual power consumption of DEG	(kWh)	0				
	Annual fuel consumption	(L)	0		Fuel consumption of DEG=	0.25	L/kWh
*1	Annual electricity charge of commercial power	(MUR)	98,757		Electrical charge=	10.01	MUR/kWh
*2	Annual fuel cost of DEG	(MUR)	0		Fuel cost=	41.20	MUR/L
*3	Annual water supply charge	(MUR)	0		Exchange rate	0.367	MUR/JPY
*4	Inflation: 5%/year considered						

Table 63: Recurrent Cost of Trou-aux-cerfs Meteorological Radar Observation Station

Estimated Recurrent Cost

	Equipment	Item	Q'ty	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	Remarks
1	Antenna	Grease (For AZ/EL)	1	0	0	0	0	9,104	0	0	0	0	11,619	16kg/can,Every 5 years
	Estimated Recurrent Cost	Timing belt (For AZ/EL)	2	0	0	0	0	0	0	0	8,400	0	0	Every 8 years
2	Antenna controller	AC fan (3sets)	3	0	0	0	0	0	0	0	0	0	21,052	Every 10 years
3	Transmitter/Receiver	AC fan (24sets)	24	0	0	0	0	0	0	0	0	0	168,319	Every 10 years
4	Receiver	AC fan (3sets)	3	0	0	0	0	0	0	0	0	0	21,052	Every 10 years
5	Product Monitor(5sets)	Hard disk	5	0	0	0	56,376	0	0	0	68,526	0	0	Every 4 years
		CD for data storage (20sheets/1set)	1	610	641	673	707	742	779	818	859	902	947	
6	Data Communication System	Wireless LAN Transmitter/Receiver	1	0	0	0	0	36,465	0	0	0	44,324	0	
7	Printer	Printer ink cartridge	2	2,700	2,835	2,977	3,126	3,282	3,446	3,618	3,799	3,989	4,188	
		Paper (500sheets/1set)	1	150	158	166	174	183	192	202	212	223	234	
8	Compact UPS	Battery	7	0	0	22,050	0	0	25,526	0	0	29,549	0	Every 3 years
9	1kVA UPS	Battery	1	0	0	4,410	0	0	5,105	0	0	5,910	0	Every 3 years
10	Emergency Power Back-up Unit	Battery	1	0	0	0	0	0	0	399,349	0	0	0	Every 7 years
11	Electric Double Layer Capacitor typed UPS	AC fan (3sets)	3	0	0	0	0	0	0	0	0	0	20,943	Every 10 years
		Arrester (6sets)	1	0	0	0	0	0	0	0	0	0	9,277	Every 10 years
12	Diesel Engine Generator	Oil seal and filter	2	0	1,229	7,111	1,354	7,840	1,493	8,644	1,646	9,530	1,815	Every 1 and 2 years
		Battery for Engine start	2	0	0	0	0	0	382,884	0	0	0	465,398	Every 5 years
		Sub total (MUR)		3,460	4,863	37,387	61,737	57,616	419,425	412,631	83,442	94,427	724,844	

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	448,432	470,854	494,397	519,117	545,073	572,327	600,943	630,990	662,540	695,667	*1
2	Fuel cost	Fuel consumption of DEG	1	50,429	52,950	55,598	58,378	61,297	64,362	67,580	70,959	74,507	78,232	*2
3	Water supply charge		1	9,770	10,259	10,772	11,311	11,877	12,471	13,095	13,750	14,438	15,160	*3
4	Special maintenance	System brush-up by manufacture's engineer	1	0	0	330,750	0	0	382,884	0	0	443,237	0	For 5 days at site
5	Radome	Caulking repair	1	60,000	63,000	66,150	69,458	72,931	76,578	80,407	84,427	88,648	93,080	
6	Pest-control	Exterminating vermination	1	7,000	7,350	7,718	8,104	8,509	8,934	9,381	9,850	10,343	10,860	
7	Communication charge	Data/Internet communication	1	9,600	10,080	10,584	11,113	11,669	12,252	12,865	13,508	14,183	14,892	
		Sub total (MUR)		585,231	614,493	975,969	677,481	711,356	1,129,808	784,271	823,484	1,307,896	907,891	
		Total (MUR)		**588,691**	**619,356**	**1,013,356**	**739,218**	**768,972**	**1,549,233**	**1,196,902**	**906,926**	**1,402,323**	**1,632,735**	
		Total (JPY)		**¥1,604,062**	**¥1,687,619**	**¥2,761,188**	**¥2,014,218**	**¥2,095,292**	**¥4,221,343**	**¥3,261,313**	**¥2,471,188**	**¥3,821,044**	**¥4,448,869**	

Estimate of annual electricity charge

	Annual operation hours of Radar System	(H)	2,436
	Annual operation hours of Radar System by DEG	(H)	240
	Annual operation hours of Radar System by commercial power	(H)	2,196
	Annual power consumption of commercial power	(kWh)	44,798
	Annual power consumption of DEG	(kWh)	4,896
	Annual fuel consumption	(L)	1,224
*1	Annual electricity charge of commercial power	(MUR)	448,432
*2	Annual fuel cost of DEG	(MUR)	50,429
*3	Annual water supply charge	(MUR)	9,770
*4	Inflation: 5%/year considered		

Power consumption=	20.40	KW
Fuel consumption of DEG=	0.25	L/kWh
Electrical charge=	10.01	MUR/kWh
Fuel cost=	41.20	MUR/L
Exchange rate	0.367	MUR/JPY

(2) Annual Budget Trends

The estimated recurrent cost of the MMS is only approximately 1% of the total amount of the MMS budget. In addition, the Prime Minister's Office as the supervising ministry of the MMS and the Ministry of Finance and Economic Development responsible for the national budget allocation have committed to the Preparatory Survey Team to allocate the required budget for the Project. In addition, the required budget for the capital cost for the Project implementation has already been considered in the planned MMS budgets of 2013 and 2014. Therefore, it has been assessed that there is no problem in this regard.

Table 64: Movement of MMS Budget (In Thousand MUS)

Year	Budget	Comparison with the previous year (%)
July 2004 - June 2005	37,294	100.9
July 2005 - June 2006	38,500	103.2
July 2006 - June 2007	39,228	101.9
July 2007 - June 2008	40,573	103.4
July 2008 - June 2009	46,800	115.3
July 2009 - Dec. 2009 (*)	31,100	-
Jan. 2010 - Dec. 2010 (*)	59,405	-
Jan. 2011 - Dec. 2011	70,317	118.4
Jan. 2012 - Dec. 2012	76,472	108.8
Jan. 2013 - Dec. 2013 (Planned)	93,515	122.3
Jan. 2014 - Dec. 2014 (Planned)	126,270	135.0

(*) Period of the Fiscal Year was changed in 2010.

Chapter 3
Project Evaluation

Chapter 3 Project Evaluation

3-1 Preconditions

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

Table 65: Required Procedures for Tax Exemption and Import Permit

Required Procedures	Apply to	Submission Time	Required Period	Required Documents	Applicant
Tax Exemption Clearance for the Import Goods	Ministry of Finance and Economic Development	After commencement of the Project	1 month	Request Letter of MMS (through Mauritius Prime Minister's Office): 1 set Exchange Note: 1 copy Contract: 1 copy Equipment Master List: 1 copy	MMS (Mauritius Meteorological Services)
Import Permit	Not required for Mauritius Government’s project				

Table 66: Required Procedures for Custom Clearance at the Sea Port

Required Procedures	Apply to	Submission Time	Required Period	Required Documents	Applicant
Custom Clearance	Mauritius Revenue Authority	After arrival of shipment	3 days	Request Letter of MMS: 1 set Radio Frequency Permit (Clearance) of ICTA: 1 copy Shipping Documents · Shipping Invoice: 1 original · Bill of Lading: 1 original · Packing List: 1 original	MMS (Mauritius Meteorological Services)

Table 67: Details of Procedures required for the Project Implementation to be carried out by MMS

Required Procedures	Apply to	Approximate Period required	Required Documents	Applicant
Building Height Clearance for Radar Tower Building to be constructed	Department of Civil Aviation	2 months	Request Letter of MMS (through Mauritian Prime Minister's Office): 1 set Architectural Drawings: 1 set Site Location Drawing: 1 set	MMS (Mauritius Meteorological Services)
Radiation Permit for Meteorological Radar System	Information & Communication Technologies Authority (ICTA)	2 months	Request Letter of MMS: 1 set Application Form Technical Specification Equipment Brochure, if any	
Frequency Permit for Meteorological Data Communication System	Information & Communication Technologies Authority (ICTA)	2 months	Request Letter of MMS: 1 set Application Form Technical Specification Equipment Brochure, if any	
Approval of the Permanent Secretary of the Ministry of Public Infrastructure, Land Transport and Shipping for the Demolition of the existing Radar Tower Building	Ministry of Public Infrastructure, Land Transport and Shipping	2 months	Request Letter of MMS (through Mauritian Prime Minister's Office): 1 set Report of Structural Analysis for the existing Radar Tower Building: 1 set Structural Calculation Sheet: 1 set	
Approval of the Permanent Secretary of the Ministry of Public Infrastructure, Land Transport and Shipping for Radar Tower Building Construction	Ministry of Public Infrastructure, Land Transport and Shipping	3months	Request Letter of MMS through Mauritian Prime Minister’s Office: 1 set Architectural Drawings: 7 sets Structural Drawings: 3 sets Structural Calculation Sheet: 3 sets Electrical Drawing: 3 sets Air-conditioning & Ventilation Drawing: 3 sets Plumbing Drawing: 3 sets Geotechnical Survey Report: 3 sets Cost Estimate Summary: 3 sets	

Clearance for Waste Water on Site Treatment	Waste Water Authority	1 month	◆ Request Letter of MMS through Mauritian Prime Minister's Office: 1 set ◆ Plumbing Drawing: 1 set	
Environment Impact Assessment (EIA) Clearance (EIA is not required according to the Environment Protection Act of 2002)	Ministry of Environment & Sustainable Development	3 weeks	◆ Request Letter of MMS through Mauritian Prime Minister's Office: 1 set ◆ Site Location Drawing: 1 set ◆ Architectural Drawings (Plan, Elevation and Section): 1 set	
Access Permission of Trou-aux-cerfs for Radar Tower Building Construction and Radar System Installation Works	Municipal Council of Curepipe	2 weeks	Request Letter of MMS (addressed to the CEO of the Municipal Council of Curepipe and copy to the Chief Engineer)	
Application for Commercial Power Supply and Step-down Transformer Installation for Radar Tower Building to be constructed	Central Electricity Board (CEB)	3 weeks	◆ Request Letter of MMS: 1 set ◆ Site Location Drawing: 1 set ◆ Electrical Drawing: 1 set (Commercial Power Supply and Step-down Transformer Installation: 2 months)	

- Value Added Tax (VAT)

Value Added Tax (VAT) imposed to the main contractor to be selected in accordance with the tendering procedures of the Japan's Gant Aid Assistance will be refunded to the main contractor by the MMS in accordance with the following procedures advised by the Mauritius Revenue Authority (MRA).

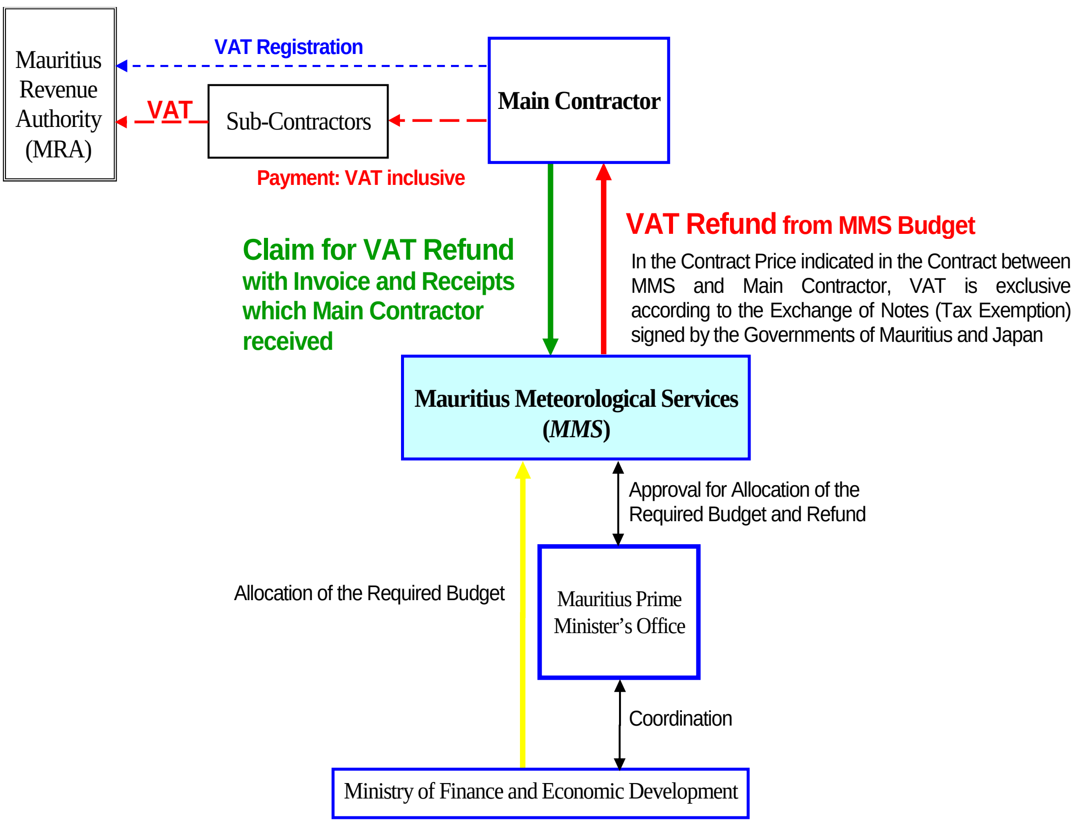


Figure 15: VAT Refund Method (Building Equipment and/or Construction Materials procured in Mauritius)

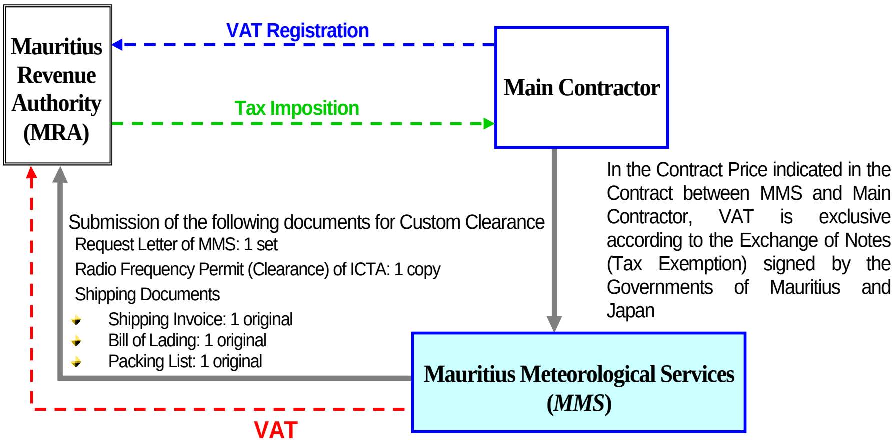


Figure 16: VAT Refund Method (Equipment and/or Construction Materials imported from Overseas (Japan))

3-2 Necessary Inputs from the Recipient Country

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

1) Manpower Development

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

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

2) Natural Disaster Prevention and Management

   a) Further strengthening of the collaboration among various government agencies, mass media and the meteorological organizations in the area of the Southwest Indian Ocean for a more effective disaster prevention and management strategy;

   b) Setting up of redundancies in the announcement of warnings and other information disseminated through multi-channels to ensure reaching out to the general populace;

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

3) Longer Life Span of the Equipment procured and the Radar Tower Building 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 protection of the building, equipment and facilities against theft and vandalism;

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

3-3 Important Assumptions

1) Utilization of meteorological information/data (including meteorological radar images) and forecasts/warnings by the mass media (TV, radio, newspaper), the Prime Minister's Office, the Ministry of Education and Human Resources and other government ministries, police departments, fire stations and other government-affiliated organizations, the Department of Civil Aviation, the Port Authority, etc.

2) No change in global warming countermeasures, natural disaster countermeasures, and meteorological service policies as determined by the government of Mauritius.

3) Maintenance of cooperative structure among the mass media (TV, radio, newspaper), the Prime Minister's Office, the Ministry of Education and Human Resources and other government ministries, police departments, fire stations and other government-affiliated organizations, the Department of Civil Aviation, the Port Authority, etc.

4) Continuance of service by an MMS staff who has received the relevant technical trainings related to the Project

Upon the materialization of this Project, the MMS will be able to implement fundamental routine works such as meteorological observation and forecasting using the meteorological Doppler radar system including its operation and maintenance. However, for further improvement of the MMS's technical skill and capability and the effective and longer utilization of the meteorological radar system, technical training and technology transfer are vital and indispensable for the MMS staff. The knowledge, technical skills and ability of the MMS personnel can be enhanced by specialized training in Japan in radar meteorology, and the operation and maintenance of the meteorological Doppler radar system. This can also be augmented by the MMS's own training.

3-4 Project Evaluation

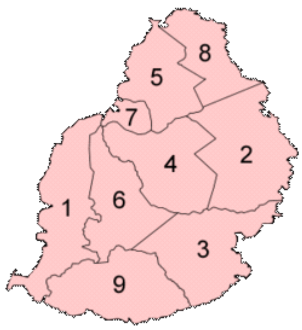
3-4-1 Relevance

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

The overall objective of this Project is to reduce the devastation caused by tropical cyclones and torrential rain. This could be achieved by improving the MMS's meteorological observation capability and forecasting/warning system through the replacement of their existing meteorological radar system. Tropical cyclones and torrential rain are extreme manifestations of nature that may lead to immeasurable damage and distress for quite a number of people. The extensive losses from tropical cyclones and torrential rain are the determining factors for the significant set-back of the national economy. Therefore, the population to be benefited both directly and indirectly by the Project will be the whole nation of Mauritius (approx. 1.2 million based on below figures). There is also real concern that the number of victims will proportionally increase due to the fact that the population of Mauritius has been increasing by 1% annually, that is, 10% in 10 years. Moreover, it is estimated that the whole population of La Réunion (approx. 82 million) and Madagascar (approx. 1,960 million) will be benefited indirectly through further strengthening of the collaboration among three countries.

Table 68: Administrative District and Population of Mauritius

No	Administrative District	Capital	Area (km²)	Population(2005)
1	Black River	Bambous	259	68,794
2	Flacq	Centre de Flacq	298	134,999
3	Grand Port	Rose-Belle	260	112,323
4	Moka	Quartier Militaire	231	79,130
5	Pamplemousses	Triolet	179	131,203
6	Plaines Wilhems	Rose-Hill	203	375,133
7	Port Louis	Port Louis	43	130,410
8	Rivière du Rempart	Mapou	148	105,187
9	Savanne	Souillac	245	69,167
		Mauritius Island (Total)	1,866	1,206,346



Furthermore, since the information of meteorological Doppler radar system is planned to be utilized for navigational safety in Mauritius International Airport, the Project is considered to contribute to the safety of passengers (approx. 2.5 million/year) of the civil aviation aircrafts which take off and land in Mauritius International Airport.

2) Objectives of the Project

In line with the increasing global concerns on the outspread of disasters further aggravated by climate change, the establishment of effective countermeasures against disasters such as severe storms, storm surges, and floods, etc. caused by tropical cyclones has been an urgent task in Mauritius as well as in other countries in the Southwest Indian Ocean. Since Mauritius is composed of small islands, it is particularly vulnerable to natural disasters with immeasurable negative impacts given by the continued and progressive climate change mainly due to global warming. Therefore, the key objective of this Project is the effective mitigation of the devastation caused by natural disasters. To achieve this objective, the establishment of the facilities and equipment like the meteorological radar system is crucially important. These will enhance the monitoring capability of hazardous meteorological phenomena such as tropical cyclones and torrential rain and will improve the forecasting/warning systems in Mauritius and its neighboring countries.

3) Development Plan of Mauritius

"A Climate Change Action Plan, 1998, Mauritius" clearly articulates the importance of the MMS's role along with data collection and information materials organization for monitoring, assessment of vulnerability and risk, and development of capability/technology to deal with climate change. In addition, in the "Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States, 2005," the following important points are mentioned in order for the small island developing countries to reduce the damages from natural calamities:

- Strengthening of early warning capability against meteorological phenomena like tropical cyclones;
- Establishment of more effective disaster management measures;
- Increase of public awareness about disaster reduction; and,
- Reinforcement of inter-sectoral and international cooperation.

These points are in accord with the key objective of the Project.

4) Aid Policy of Japan

In the "Midterm Policy of Official Development Assistance" of Japan, efforts to solve global issues, sustainable development and poverty reduction are considered as priority issues. Examples of efforts to solve global issues are adaptations to negative impacts caused by climate change including meteorological disaster countermeasures and support for developing countries through the utilization of Japanese experience and science technology. During the "Tokyo International Conference on African Development (TICAD IV)", "support for African countries vulnerable to climate change," "establishment of early warning systems," "Cool Earth Promotion Programme of Japan," and "reinforcement of partnership" were indicated as responses to issues of the environment and of climate change. Therefore, it is truly significant to improve the MMS's monitoring capability of meteorological phenomena and to strengthen the collaboration between Mauritius and other countries in the Southwest Indian Ocean through Grand Aid from Japan as it is in congruence with Japanese priorities in terms of international cooperation.

3-4-2 Effectiveness

Table 69: Achievement Indicator

Indicator	Present (Base Line)	Target
Enhancement of Tropical Cyclone and Severe Weather Monitoring Capability	No capability for monitoring tropical cyclonic wind velocity and precipitation intensity	Tropical cyclonic wind velocity in the radar detection range: maximum 75m/s in 200km radius
		Precipitation intensity 1mm/h or more in the radar detection range: 450km radius
	Spatial resolution and observation intervals of precipitation data of the existing automatic weather observation systems in Mauritius island: approximately 9.85km mesh (square root of 2,040km^2/21 AWS) at 30 minutes observation intervals	Spatial resolution and observation intervals of precipitation data in the radar detection range: 2.5 km mesh at 10 minutes observation intervals within a 450km radius
	Receiving intervals of satellite images showing tropical cyclone location and track: 15-30 minutes intervals by METEOSAT-7 & 8	Observation intervals of wind direction, wind velocity rainfall intensity, location and track of tropical cyclone in the radar detection range: 1 minute observation intervals at PPI mode and 10 minutes observation intervals in CAPPI mode (11 angles)
Enhancement of capability for downburst and wind shear monitoring around the International Airport	Subjective observation in the area surrounding the International Airport	Radar observation of downburst and wind shear as objective observation in 200km radius
	No provision of downburst and wind shear information to the International Airport	Provision of downburst and wind shear information (radar images) to the International Airport through the Internet
Enhancement of Torrential Rain Prediction Capability	No activity of short range prediction for precipitation cloud movement	Implementation of 1-2 hours short range prediction for precipitation cloud movement by radar observation data (images)
	No identification of area(s) of precipitation over 100 mm precipitation within the last 12 hours (issuance of single torrential rain warning for Mauritius island)	Identification of area(s) of precipitation over 100 mm within the last 12 hours by radar accumulated rainfall data for issuance of area wise torrential rain warning
Improvement of Dissemination Capability for Tropical Cyclone and Torrential Rain Information	Only provision of satellite animation pictures for TV broadcasting	Provision of radar animation images for TV broadcasting
	Provision of tropical cyclone information indicating cyclone intensity and past tracks to mass media	Provision of tropical cyclone information indicating cyclone intensity, location, tracks (past and predicted) and area of 120 km/h gusts in the radar detection range to mass media
	No provision of torrential rain information indicating the area(s) of precipitation over 100 mm within the last 12 hours to mass media	Provision of torrential rain information indicating the area(s) of precipitation over 100 mm within the last 12 hours to mass media

As adequately pointed out in the aforementioned careful and comprehensive evaluation of the effects of the Project and the MMS's good organizational capability, considerable and enhanced benefits can be achieved vis-à-vis the MMS's capabilities in reducing human loss and in addressing the recurrent economic set-back brought about by meteorological disasters including tropical cyclone. The Project would substantially contribute to the mitigation of the adverse effects of meteorological disasters and effectively safeguard the basic human needs of the Mauritian people as well as those of its neighboring countries. The implementation of the Project is therefore considered to be appropriately suitable and worthwhile. Moreover, in order to reduce the MMS's operation and maintenance costs, the equipment was designed to minimize spare parts and consumables. Also, the biggest recurrent cost of the Project is expected to be electricity as such the equipment and facilities were designed to minimize power consumption. As a result, the MMS's budget is expected to be able to cover the Mauritian portion of the capital and recurrent costs of the Project.