BASIC DESIGN STUDY REPORT

ON

THE PROJECT
FOR
ESTABLISHMENT OF
DISASTROUS WEATHER MONITORING SYSTEM
IN VIENTIANE
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

JUNE, 2004

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN WEATHER ASSOCIATION
KUME SEKKEI CO., LTD.

PREFACE

In response to a request from the Government of Lao People's Democratic Republic, the Government of Japan decided to conduct a basic design study on the Project for Establishment of Disastrous Weather Monitoring System in Vientiane in Lao People's Democratic Republic and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Laos a study team from February 15 to March 15, 2004.

The team held discussions with the officials concerned of the Government of Laos, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Laos in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of Lao People's Democratic Republic for their close cooperation extended to the teams.

June, 2004

Yasuo MATSUI
Vice-President
Japan International Cooperation Agency

June, 2004

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Establishment of Disastrous Weather Monitoring System in Vientiane in Lao People's Democratic Republic.

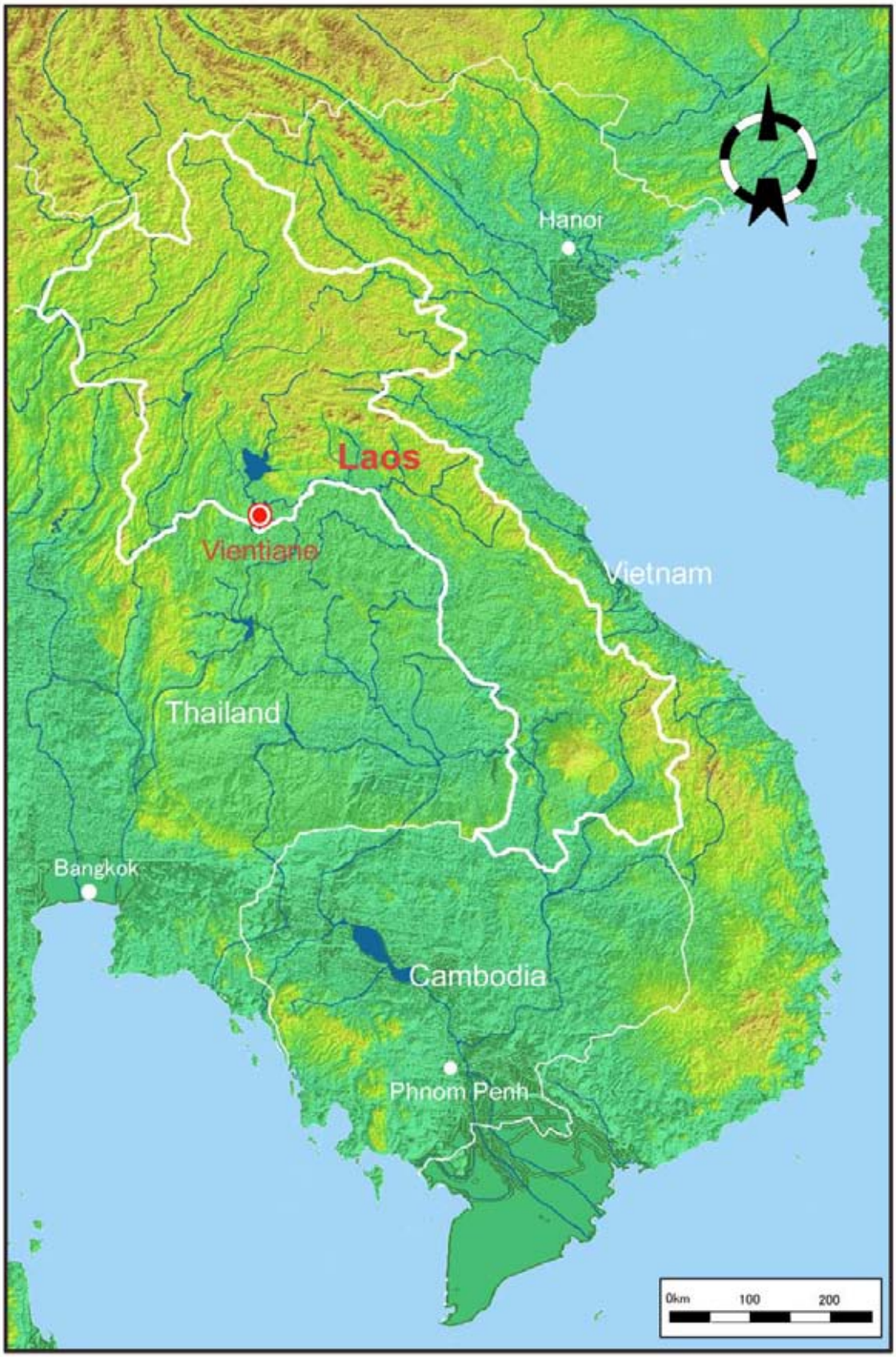
This study was conducted by Japan Weather Association in consortium with Kume Sekkei Co., Ltd, under a contract to JICA, during the period from January, 2004 to June, 2004. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Laos and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

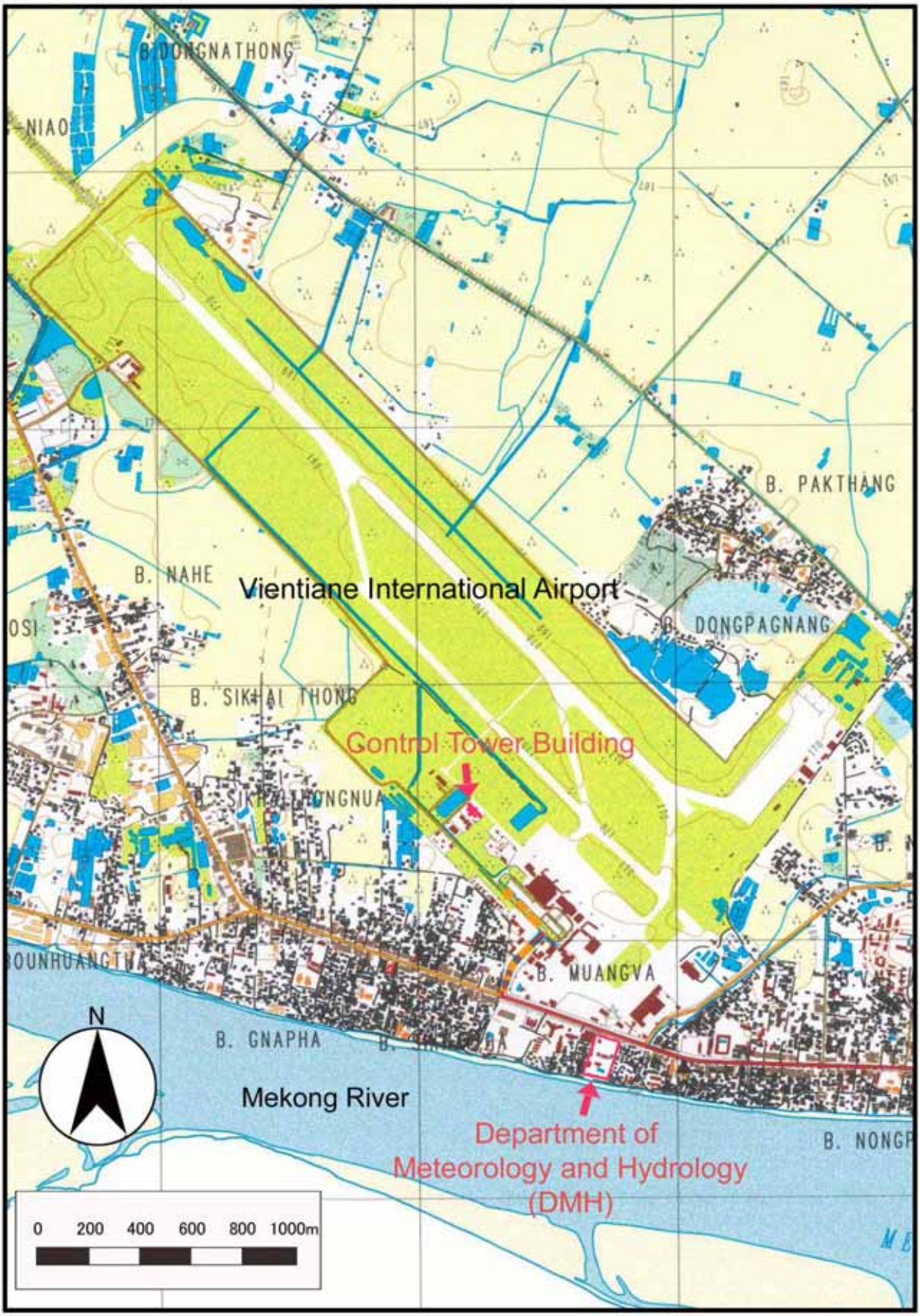
Very truly yours,

Takehiko FURUKAWA
Project Manager
Basic design study team on the Project for
Establishment of
Disastrous Weather Monitoring System
in Vientiane in Lao People's Democratic Republic

Japan Weather Association
in consortium with
Kume Sekkei Co., Ltd.



Map of Lao People's Democratic Republic and Neighboring Countries



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Summary

Lao People's Democratic Republic (hereinafter referred to as "Laos") is located in the area where there is the most amount of rainfall in Indo-china Peninsula including the Mekong River basin, especially the mountainous areas in the northern and central part of the country receive more than 3,000mm of annual rainfall. Southwestern wind containing large amount of water vapor blows from the Indian Ocean into the country and a tropical depression or typhoon approaching from the South China Sea strengthen the influx of the wet air. Such situations frequently generate cumulonimbus bringing about torrential rain and strong wind in the country and cause into the heavy floods along the Mekong River or its branch rivers, lightning accidents, strong wind disaster and aircraft accidents.

As a matter of fact, the meteorological disasters such as heavy rain, flash flood, flood, etc. of 1992 were the longest unprecedented one in living memory and loss of property was to the tune of 302 million US Dollars. Over the past several years, yearly average of damage from the meteorological disaster was about 2 million US Dollars. In addition, 5 air crash accidents occurred during the last 20 years in the surrounding areas of Vientiane and they gave great losses including casualties to the country and several cases that aircrafts returned near Vientiane back to the place of departure due to severe weather conditions have occurred every year. Since Laos is a landlocked country, the air transport is a major mean of transport to have access to each province and the neighboring countries.

Under these circumstances described above, the Five-year Development Strategy Plan (2001-2005) of the Government of Laos raises "development of collection and dissemination of meteorological and hydrological observation data". The Development Plan of the Ministry of Agriculture and Forestry indicates "development of DMH for development of agricultural sector and contribution to natural disaster mitigation". In accordance with these plans, DMH has prepared its Development Plan 2001-2010 which includes the program of improvement of forecasting capacity to aim at improvement of meteorological observation and monitoring capability and upgrade of forecasting and warning.

DMH is the sole organization as a national meteorological and hydrological service provider in Laos under supervision of the Ministry of Agriculture and Forestry. Its main duties on hydro-meteorology as a national meteorological service are recording meteorological observation round the clock and providing weather information, forecasts, advisories and warnings necessary for mitigation and prevention of meteorological disasters and development of socio-economic activities.

DMH receives observed data from approximately 160 rainfall observation stations once a few months. Thereby, DMH is not able to detect ever-changing disastrous weather such as torrential rain, heavy wind, etc. As the preset situation, DMH faces the following issues.

[1] Unable to provide the accurate public information (observed data, forecasts and warnings) on heavy rain and torrential rain generated in and spread out from the Central area that is a very heavy rainfall area of Laos (annually more than 3,000mm rainfall).

[2] Unable to implement advance dissemination of information on possibility of occurring meteorological disaster to the residents and the government officials.

[3] Unable to monitor air-turbulence (wind-shear, down-burst) in the surrounding area of Vientiane International Airport necessary for safe operation of the aircrafts.

[4] Unable to provide authentic information on disastrous weather conditions in the surrounding area of the airport for air-crafts in landing and take off being vulnerable to air-turbulence.

In order to achieve the objectives of the Development Strategy Plan of the Government of Laos, improvement of disastrous weather monitoring capability and promptly announce and disseminate weather forecasts and warnings to the public are indispensable.

Based on the recognition of impossibility with satisfy the objectives by the existing systems, the Government of Laos had officially requested to the Government of Japan for Japan's Grant Aid Assistance for establishing the required meteorological observation systems.

In response to a request from the Government of Laos, the Government of Japan decided to conduct the Basic Design Study on the Project and the Japan International Cooperation Agency (JICA) sent to Laos the basic design study team from February 15 to March 15, 2004. The team held a series of discussions with the officials concerned of the Government of Laos, and conducted surveys and collected necessary information and data on the Project.

After the team returned to Japan, the team conducted further studies such as examination of feasibility, rationale and scale of the Project and its components with due consideration to the present situation of Laos including operation and maintenance capability of DMH and formulated the draft basic design for the Project. Then, the team was sent to Laos in order

to discuss the draft basic design from May 28 to June 6, 2004, and as this result, the basic design for the Project was finalized.

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

a) Procurement and Installation of Equipment

- Meteorological Radar System: 1 set
- Meteorological Satellite Data Receiving System (MTSAT): 1 set
- Meteorological Data Communication System: 1 link
- Meteorological Radar / Meteorological Satellite Data Display System: for 2 sites

b) Construction of Facility

- Radar Tower Building: 1

The required implementation period of the Project including a detailed design study and tendering procedures is approximately 19 months and the total project cost estimated in the basic design study is 740 million JP Yen (grant aid: 739 million JP Yen, capital cost for the Project to be borne by DMH: approx. 48,000,000 kip).

After the completion of the Project, rainfall monitoring capacity of DMH will be greatly improved and rainfall monitoring at a spatial resolution of 2.5km in a part of Northern area and Central area of Laos which receives the largest volume of precipitation in the Mekong River basin will become possible. In addition, air turbulence monitoring by objective observation in the area of 250km surrounding Vientiane International Airport will be actualized so that severe weather information in the surrounding area of the Airport will be delivered to the airport officials in real time. Furthermore, forecast period of the river water level in order to provide longer lead time for the public and the governmental officials concerned with disaster management for contributing to effective implementation of disaster mitigation will be extended to 3 days.

DMH as the implementation agency of the Project has higher organized capability and many staff educated in study abroad and received academic degrees. In addition to the main duties on hydro-meteorology as a national meteorological service, DMH conducts various types of its own research and development and collaborative research with the overseas institutes. All the required capital cost and recurrent cost for the Project to be borne by DMH are expected to be available.

As a consequence of careful and comprehensive evaluation on the Project effects, capability of DMH, etc., the implementation of the Project is considered quite significant since the human damage and the economic injury in Laos by the meteorological disasters are expanding and exacerbating and the Project is expected to produce the considerable benefits as mentioned above. The Project would substantially contribute to the mitigation of natural disaster as the basic human needs in the people of Laos, the appropriateness of carrying out the Project under a grant-aid has been amply confirmed. Therefore, the implementation of the Project is considered truly advisable.

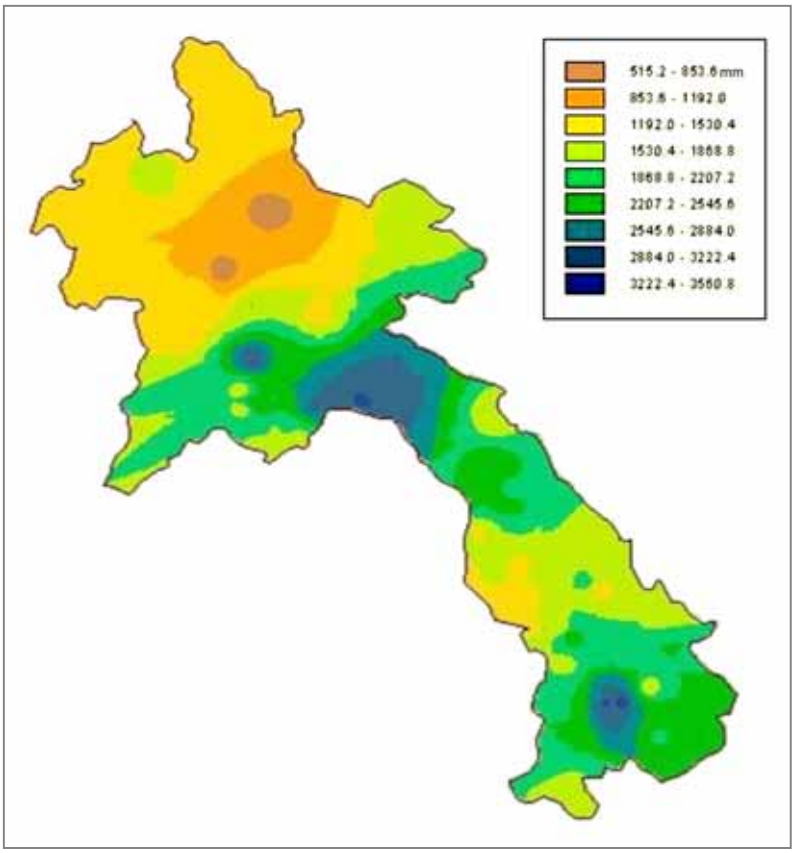
Chapter 1 Background of the Project

Lao People's Democratic Republic (population: approx. 5.377 million, GDP/C US$329) (hereinafter referred to as "Laos") is a landlocked country located in the Indo-china Peninsula, stretching its land from north to south at about 1,000km length. The Mekong River coming from China runs through the mountainous area of the northern part of the country, flows along the border between Laos and Thailand and goes to Cambodia. On the contrary, high mountains some of which exceed 2,000m altitude covers most of the northern and central part of Laos and areas except the Mekong main river basin in southern area of Laos. Most of rivers originating in the mountainous areas flow into the Mekong main river.

Map of Laos and Vicinity

Laos is located in the area where there is the most amount of rainfall in Indo-china Peninsula including the Mekong River basin, especially the mountainous areas in the northern and

central part of the country receive more than 3,000mm of annual rainfall. Southwestern wind containing large amount of water vapor blows from the Indian Ocean into the country and a tropical depression or typhoon approaching from the South China Sea strengthen the influx of the wet air. Such situations frequently generate cumulonimbus bringing about torrential rain and strong wind in the country and cause into the heavy floods along the Mekong River or its branch rivers, lightning accidents, strong wind disaster and aircraft accidents. As the meteorological phenomena such as torrential rain, lightning strike and strong gust wind occur in small area of 1 – 100km and in short period of a few minutes to a few hours, monitoring in high spatial and timely resolution is required to issue forecasts and warnings for such phenomena in timely manner.



Map of Annual Rainfall Distribution in Laos

Source: DMH (2003)

However, Laos does not have meteorological observation systems to monitor such severe meteorological phenomena at present. Under these circumstances described above, the Government of Lao P.D.R has officially requested to the Government of Japan for obtaining the following equipment and related facility containing a meteorological radar system, meteorological satellite data receiving system, meteorological data communication system, etc.

a) Equipment

- Meteorological Radar System
  - Project Site: Department of Meteorology and Hydrology (hereinafter referred to as "DMH") Head Office
  - Radar Data Display System: at the Meteorological Office and the Control Tower at Vientiane International Airport
  - Components: Antenna, radome, radar equipment, meteorological radar data display system, power supply

- Meteorological Satellite Data Receiving System (MTSAT)
  - Project Site: DMH Head Office
  - Meteorological Satellite Data Display System: the Meteorological Office at Vientiane International Airport
  - Components: Antenna, data receiving and display equipment, related equipment, power supply

- Meteorological Data Communication System
  - Project Site: DMH Head Office and Vientiane International Airport
  - Components: Antenna, data communication equipment, related equipment, power supply

b) Facility

- Radar Tower Building
  - Project Site: DMH Head Office

Based upon this request, the Preparatory Study Team was dispatched in July, 2003 to Laos to identify and examine the contents, the objective of the said request and operation and maintenance capability of the implementing agency of Laos. The mission had concluded the following;

a) Only 21 primary meteorological observation stations are scattered in Laos countrywide implementing hourly meteorological observation. This observation network is not sufficient to monitor heavy rain and strong wind.
b) Enhancement of weather forecasting and warning system of Laos will foresee occurrence of disasters and lead to appropriate disaster management activities. Especially, it is expected that acquisition of rainfall data throughout each river basin on real time basis can improve accuracy of flood forecast. This enhancement will

contribute to mitigation of damage due to severe weather phenomena (ex. in agriculture).

c) Taking the present circumstances of social infrastructure of Laos into consideration, establishment of a large number of new local observation facilities in a large area will consume much cost and time for enhancement of weather monitoring system. Establishment of real-time weather monitoring system using a small number of weather radar in short time has more advantage from viewpoint of cost-benefit.

d) It is required to confirm the budgetary plan of the implementation agency and to carefully evaluate the relevancy of the Project.

This Basic Design Study has been implemented based upon the above conclusion made by the Preparatory Study.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

Frequently being victim of natural calamities like floods and flash floods triggered by heavy or torrential rain of typhoon or south-west monsoon, Laos has received so far tremendous amount of damage to the various fields including air-transport.

Laos is a landlocked country therefore Vientiane International Airport is the most important entrance gate of the country for trading, tourism, diplomatic relations and policy, foreign investment, international cooperation, etc. As a matter of fact, several tragic air-crash accidents during recent years in the Vientiane area and they gave great losses including casualties to the country and created a decline in the reliability on safe operation of the civil aviation.

In order to promptly announce and disseminate weather forecasts and warnings concerning heavy or torrential rains occurred at many places in the country to the public, the establishment of disastrous weather monitoring structure is required.

DMH is the sole organization as a meteorological and hydrological service provider in Laos. However, DMH is unable to appropriately play its main duties on hydro-meteorology and to timely provide weather information such as forecasts, advisories and warnings necessary for prevention and mitigation of meteorological disasters to the public under the existing weather monitoring system of DMH.

For improvement of the present situation as described above, the objective of the Project is establishment of the meteorological radar system, the meteorological satellite data receiving system, etc. for monitoring heavy rain, thunderstorm, strong wind, etc. to contribute to prevention and mitigation of meteorological disasters and safe operation of the civil aviation by strengthening the monitoring capability of DMH for disastrous weather phenomena and by timely providing more accurate hazardous weather information.

Due to real time monitoring for cloud movements in the whole areas of Laos and the neighboring countries by the meteorological satellite data receiving system and due to fine spatial and timely observation for severe weather conditions such as turbulence, heavy rain, thunderstorm, etc. around Vientiane that is the capital city of Laos having the international airport receiving frequent heavy rainfall by the meteorological radar system, quantitative observation data in real time will be obtained to know what & when & where dangerous

weather conditions occur. Based upon various meteorological observation data from these systems, accurate forecast of heavy rain, flood, turbulence, etc. will be prepared and meteorological-hydrological forecasts and warnings will be precisely distributed to the agencies concerned with disaster preparedness and management to contribute to expediting effective and efficient disaster prevention.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy for the Basic Design of the Project

a) To enable DMH to precisely supply weather information necessary for prevention and mitigation of meteorological disasters and development of socio-economic activities to agencies concerned with the disaster preparedness and management.
b) To establish a meteorological observation system by the Project for monitoring hazardous meteorological phenomena by the Project for contributing to meteorological disaster prevention.
c) To contribute to expediting disaster preparedness and effective disaster management activities and also formulating appropriate measures and making prompt relief action for the mitigation of impacts and rehabilitation of affected areas by meteorological disasters.
d) To enable DMH to promptly release accurate forecasts and warning prepared through real-time monitoring of hazardous meteorological phenomena to the public.
e) To continuously provide more authentic information on disastrous weather conditions in round-the-clock operation by DMH for ensuring meteorological disaster prevention and reliable operation of aircrafts and the international airport in Vientiane.
f) To satisfy the national development plan of the Government of Lao P.D.R and the project targets described in this report.
g) To design size and components of the Project suitable for technical level and operation & maintenance capability of DMH.

1) Design Policy

[1] Design Policy of the Equipment

The design policy of the equipment to be supplied under the Project is as follows.

a) To design all the equipment to conform to operation and maintenance on technical capabilities of DMH.
b) To make appropriate compatibility between the equipment and the technical requirements of the World Meteorological Organization (WMO).
c) To consider suitability between the equipment and the observation and forecasting routine works of DMH.
d) To select the equipment whose spare parts and consumables can be easily procured and replaced.
e) To select the reliable and durable equipment in consideration of suitability for the local environment.
f) To minimize the recurrent costs of operation & maintenance of the equipment to be borne by DMH and DCA.
g) To clarify task sharing between DMH and DCA for operation and maintenance of the equipment.
h) To design the equipment adjustable accuracy of radar data by calibration.
i) To make the equipment design to minimize lightning damage.

[2] Design Policy of the Radar Tower Building

Based on the future plans of DMH, the design policy is to make a building plan for achieving duties as meteorological radar facility becoming an operating base for weather observation and forecasting. The plan is to construct a meteorological radar tower building in the premises of DMH Head Office that will ensure appropriate and effective operations and will accommodate the required systems, equipment and manpower.

The design policy of the Radar Tower Buildings have incorporating with the following several features.

a. To be capable of carrying out various meteorological services as the "Radar Tower Building."
b. To provide necessary environment where services are performed effectively and efficiently in accordance with the flow of the meteorological services.

c. To be capable of responding to 24hours/day shift work schedule of forecasting and observation section in DMH.
d. To be furnished with suitable power supply back-up equipment (engine generator, radar power backup unit, auto voltage regulator, etc.) for performing the meteorological services of 24 hours a day, 365 days a year, in round-the-clock operation.
e. To be robust by adequate countermeasures taken against meteorological disasters in order to perform the mission of uninterrupted radar observation and supplying weather forecast & warning even during heavy rain, flooding, etc.
f. To be capable of installing the weather surveillance doppler radar system and other related equipment supplied under the Project.
g. To use building construction materials available in the local market for easy maintenance for the radar tower building by DMH.
h. To make the building equipment design to minimize lightning damage.

2) Design Conditions

[1] Design Conditions of the Equipment

I. Meteorological Radar System

a) To enable fine spatial and timely observation of severe weather conditions such as air-turbulence, heavy rain, thunderstorm, etc.
b) To be C Band (wave length: appox. 5 cm) which is able to make precipitation observation over a very wider area in real time.
c) To use 5,300MHz band, ± 2MHz band provided by the Department of Telecommunication to DMH as the radar frequency.
d) To be able to monitor rain cloud in the theoretical observation range with 400km radius and the quantitative rainfall observation range with 250km radius from Vientiane excluding some areas affected by higher mountains.
e) To be a doppler system with a changeable functions which are quantitative rainfall observation (range with 250km radius) and air-turbulence observation (range with 120km radius) to contribute toward safe operation of the capital city and the civil aviation by accurate observation in real time for severe weather condition generated in the lower atmosphere around the Vientiane International Airport.
f) To be able to promptly and precisely provide pilots and air-traffic controllers with accurate & timely information required for appropriate air-traffic control especially during taking-off and landing of aircrafts.
g) To furnish with all the required and standardized functions of data preparation and display by DMH to play its roles in 3 fields, meteorology, river water control and

aviation meteorology.

II. Meteorological Satellite Data Receiving System (MTSAT)

a) To be able to receive the digital data from the Multi-functional Transport Satellite (hereinafter referred to as “MTSAT”) every hour, to grasp cloud distribution in the whole area of the country and to analyze a cloud types.
b) To be complied with the SATAID software (it is a high performance software for data analysis and weather forecast using MTSAT data and the radar data can also be ingested) donated to DMH by Japan Meteorological Agency.

III. Meteorological Data Communication System

a) To establish high-speed link between the radar tower building to be constructed under the Project and the Control Tower Building located in the Vientiane International Airport by high-speed and radio data communication link without any fee.
b) To be usable the allocated frequency (2.4GHz band) for DMH from the Department of Telecommunication.
c) To enable transmission of radar image data every 5 minutes and satellite image data every hour.
d) To be easily connectable with any digital PCs or other digital devices.
e) To enable voice communication among the weather observation & forecasting room to be located in the radar tower building and the meteorological office, the area control center and the flight control room located in the Control Tower Building.

IV. Meteorological Radar / Meteorological Satellite Data Display System

a) To be suitable for the specific routine works at the weather observation & forecasting room and the meteorological office, the area control center and the flight control room.
b) To be furnished with some special features such as display durability for long time operation, generating less heat, minimizing the required space for its installation and less screen surface reflection.

[2] Design Conditions of the Radar Tower Building

I. Facility Plan

a) To secure enough space to allow DMS’s staff to work efficiently and also to effectively accommodate and utilize the equipment to be supplied under the Project.
b) To make appropriate size and scale of the building determined on the basis of the

plans of staff allocation, system and equipment required for accurate weather observation and forecasting works.

c) To not affect the existing synoptic observation station registered at the World Meteorological Organization (hereinafter referred to as "WMO") located in the premises of DMH Head Office, whose observed data is being hourly transmitted to the whole world through the Global Telecommunication System (hereinafter referred to as "GTS").

d) To be furnished with necessary protections of lightning and flood.

II. Building Equipment Plan

a) To determine the power supply capability taking into consideration of sufficient support to the equipment to be installed under the Project and power consumption of the equipment, general lightings, air-conditioning systems.

b) To include uninterrupted power supply equipment such as a radar power backup unit and an engine generator system to ensure proper operation of the meteorological equipment in order to carry out the role of the building to operate around the clock throughout the year, conducting radar observation and issuing forecasts and warnings even during power stoppage generated by meteorological disasters.

c) To assess the capacity of air-conditioning systems according to heating values of the personnel the equipment installed under the Project, lighting and other heat-generating items and thereby to determine a type of the air-conditioning system.

(2) Design Policy on Natural Conditions

1) Temperature

According to the meteorological data for the last few years, the annual mean maximum and minimum temperatures in Vientiane are 31.4°C and 23.3°C respectively. The annual mean maximum and minimum temperatures in December as the coolest month are 28.2°C and 17.4°C respectively. Due to the high temperature for a whole year in Vientiane, air-conditioning system is required for each operation rooms located in the radar tower building.

2) Rainfall

The annual mean rainfall in Vientiane is 1,783mm, of which 85% is recorded in the rainy season from May to September. The maintenance star-case has been located at the center of the building covered by the upper concrete slab to enable DMH personnel to easily reach each room for regular maintenance of the radar equipment without getting wet with

rain even during the rainy season which is the most busy period of the radar system.

3) Flood

The previous flood disaster record indicates that the maximum flooded water level of Mekong River in Vientiane was 1.1-1.2m from the ground level. In order to avoid serious affection from a bad flood that may be occurred in the future, the first floor concrete slab of the radar tower building must be set at 1.5m from the ground level.

4) Lightning

Vientiane is located in one of distribution areas having 20-40 lightning days in a year (Tokyo is half of it) according to the World Meteorological Organization (WMO). The frequent lightning occurs especially during the rainy season. A lightning protector is, therefore, planned to prevent damage to the building and to the equipment.

5) Earthquakes

Earthquakes have been recorded in the north-western part of the Laos bordering Myanmar but no earthquake adversely affecting building structures has been recorded in Vientiane and its surrounding area. The seismic design standards recently established in Thailand designates the Nong Khai Province, which is adjacent to Vientiane, as an area where it is unnecessary to consider the seismic force for building design, earthquake-proof measures are not considered under the Project.

6) Bearing Layer

As a consequence of the boring test at the site, the most suitable bearing layer (silty clayey gravel with sand) for the building construction (N value: 70) has been confirmed at approximately 20m in depth from the ground level. For securing higher accuracy of the radar observation, allowable horizontal distortion angle of the building must be not more than 0.07 degree. Therefore, cast-in-place concrete piles constructed into the bearing layer at least 0.5-1m will be necessary.

(3) Design Policy on Economizing Operation & Maintenance Cost

After the completion of the Project, in order to ensure steady ingestion of additional annual budget by DMH for the recurrent cost such as operation and maintenance costs for the Project, the following measures have been included in planning for the equipment and the radar tower building.

a) To enable both air-conditioning systems and electricity system to be restrictively

operated only in the rooms in use located in the radar tower building and also to utilize the natural light for minimizing operation hours of lighting system for economizing the energy.

b) To incorporate solid-state type parts into the radar system as many as possible for reducing the exchange frequency of parts and also for resource saving.

c) To maximize use of construction materials and computer peripherals available in the local market.

(4) Design Policy on Construction Work

1) Building Construction Permission

Regulation on height limit and issuance of a construction permission for a large scale building to be constructed by the Government of Lao P.D.R are controlled by the Ministry of Communication, Transportation, Post and Construction (hereinafter referred to as "MCTPC") and regulation on height limit and issuance of a construction permission for a ordinary building to be constructed in Vientiane are controlled by the Vientiane Urban Development and Administration Authority (hereinafter referred to as "VUDAA"). For obtaining a construction permission for the radar tower building, submission of the application to VUDAA is required because the radar tower building is not classified as a large scale building.

The radar tower building has been designed at 800m away from the transitional line of the approach surface and located under the obstacle limitation surface prescribed by the International Civil Aviation Organization (hereinafter referred to as "ICAO"). As a process of the construction permission for the radar tower building stipulated by VUDAA, an agreement signed by and between DMH and DCA must be attached to the application form since construction of a building taller than 15m is not permitted by VUDAA in the area surrounding the Vientiane International Airport. Regarding the construction permission, it was confirmed with VUDAA that no issue is expected because the agreement on construction of the radar tower building 45m high between DMH and DCA has been concluded and the Project has been recognized one of the Government's important projects.

2) Environmental Regulation

Sewage water purifying regulation prescribed by VUDAA is applied to any buildings to be constructed in the Vientiane city. For the radar tower building, the required septic tank and seepage pit must be designed and constructed in accordance with the regulation.

3) Use of Locally Procurable Materials

Gravel, sand, some secondary concrete products such as blocks, floor materials, reinforced bars, etc. are produced in Laos while other construction materials are imported from Thailand. However, most of all the construction materials are procurable from the local market. For the Project, durable materials with good maintainability will be selected among locally procurable materials.

4) Use of Local Construction Methods and Workers

The common local construction method involves RC columns, beams and slabs, concrete block wall with a mortar trowel and paint finish. Thereby this method will be applied to the Project. There is currently a shortage of manpower for plastering and parts of the finishing work and skilled Thai workers fill this shortage. While the minimum number of skilled workers is required for plastering and parts of the finishing work, the selection of the local construction method with which local workers are familiar is panned so that local workers can be used as much as possible.

(5) Design Policy on Use of Local Construction Companies

Construction companies in Laos are still very small and lack competitive strength because of the fact that the country's short history of a market economy makes work opportunities for these construction companies limited to small buildings/facilities. For construction of the radar tower building, the local construction methods applied by a local construction company which would be a local subcontractor, has been selected.

(6) Design Policy on Operation and Maintenance Capability of Implementation Agency

1) Easy to operate the equipment

The equipment to be supplied under the Project is used for timely supporting DMH's routine works as the national meteorological agency for the meteorological disaster prevention. Therefore, various types of data processing, analysis, display and transmission/receiving must promptly be implemented through less complicated operation procedure by DMH.

2) Easy maintenance and affordable recurrent cost for the equipment

For designing the equipment, less spare parts and consumables, easiness of regular maintenance and short time replacement of any parts must be considered. In order to minimize electricity charge which is the biggest cost impact in the expected recurrent cost for the Project, technical considerations for economizing power consumption should be

given to the equipment and facility planning.

(7) Design Policy for Equipment & Building Grade

To play the role of supplying uninterrupted weather forecast & warning to the public even in the event of meteorological disaster, the equipment & building grade must be aimed at being sufficiently robust with against meteorological disasters and lightning attack and performing the meteorological services of 24 hours in round-the-clock operation.

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

Locally procurable materials and the most common local construction method are applied to the building design. The equipment to be installed in the radar tower building such as specialized power backup apparatus and various types of the meteorological equipment, which is not available in the local market, is planned to be mainly procured from Japan primarily considering the best durability, reliability, technical level and cost.

It should be considered that outside works of the equipment installation in the implementation schedule is not coinciding with the rainy season in Laos between May and September as much as possible since the radar antenna, radome, etc. will be installed on the top of the radar tower building. In addition, installation of the radar system must also be completed in the dry season for avoiding any damage from rainwater by all possible mean.

2-2-2 Basic Plan

(1) Basic Plan of the Equipment

1) Meteorological Radar System

Establishing the meteorological radar system at DMH Head Office enables timely observation of heavy and torrential rain occurred in the central area of Laos which annually receives the largest volume of precipitation in the Mekong River basin and its surrounding area in real time. In addition, the radar system is quite suitable for the aviation meteorological services since the proposed site for the radar tower building in the premises of DMH Head Office is located approximately 1,100m at a direct distance from the Control Tower Building.

A meteorological radar system is the only equipment to be able to timely and spatially observe occurrence, movement, distribution and intensity of rainfall and other

meteorological phenomena related to rainfall and to provide quantitative observed data of a large geographic area in real time. C band (wave length: approx. 5cm) type which is the most suitable for precipitation observation over a very wider area has been adopted because the meteorological radar system must accurately observe rainfall in the central area of Laos and its surrounding areas.

Frequency of the C band meteorological radar system is 5,300MHz, ±2MHz band width allocated by the Department of Telecommunication for DMH. Any mutual interference among the existing aviation control radar system (2,800MHz band), the existing meteorological radar systems (5,400-5,900MHz band) in Thailand and the radar system with this frequency is not expectable.

The C band meteorological radar system is designed to be able to observe a rain cloud in the theoretical observation range with 400km radius and the quantitative rainfall observation range with 250km radius (excluding very high mountainous areas) from Vientiane and also the system must have the doppler mode with a changeable function of the observation ranges which are quantitative rainfall observation range with 250km radius and air-turbulence observation range with 120km radius to contribute toward safe operation of the capital city and the civil aviation by accurate observation in real time for severe weather condition generated around the Vientiane International Airport.

In an attempt to accomplish the project target, the radar system must be furnished with the following essential functions.

[1] Doppler Mode

When the doppler mode is used, a meteorological radar system not only detect and measure the power received from a observation target, also measure speed and direction of the wind in the theoretical observation range with 120km radius. Such information is quite useful for severe weather detection such as windshear and microburst.

The meteorological radar system is designed to apply doppler mode, which detect wind motions and wind patterns of severe weather phenomena, front lines, etc. so that forecasters are able to monitor movement and development of storms for preparing more accurate weather forecasts and warnings. Especially, doppler feature must be included in the system for aviation weather forecasting purpose.

[2] CAPPI (Constant Altitude PPI) Mode

CAPPI is the horizontal cross-section display at the altitude specified by the user. It is derived from interpolation calculation from volume data. Data from all azimuth and

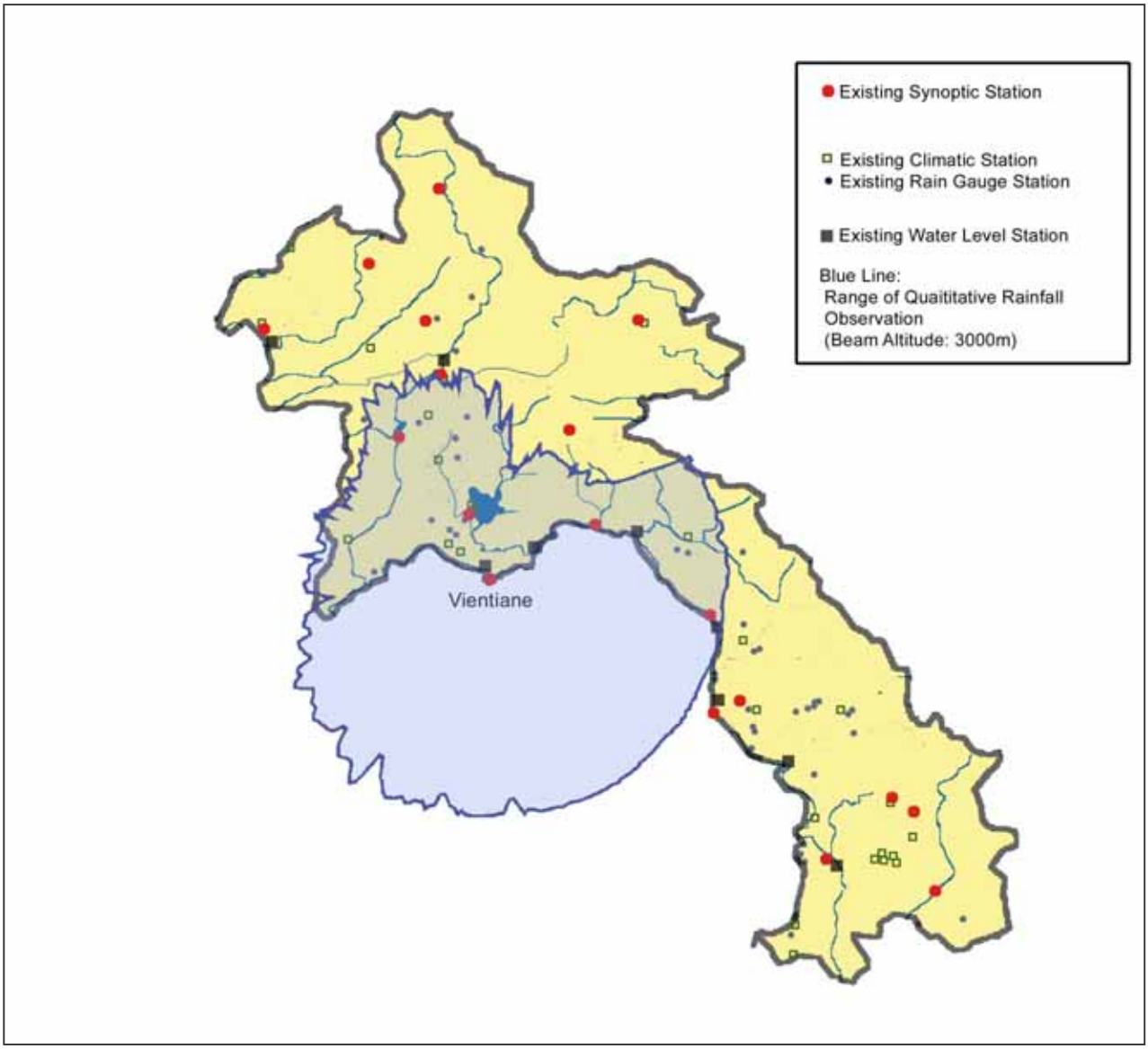
elevation points must be used in the calculation of precipitation intensity in order to generate the diagram according to the specified altitude from 500m to 15km. The product indicates the constant altitude information from 3-dimensional raw data obtained by multiple elevations. To get such a 3-dimensional data, the radar antenna is operated by the "volume scan" changing the antenna elevation at regular time intervals.

[3] Required and Standardized Functions for Display and Output Information

In order to effectively and efficiently generate the project effects by the meteorological doppler radar system, the following functions are required and these enable DMH accomplish the role of meteorology, river water control and aviation meteorology as its 3 main tasks.

No.	ITEM	Meteorology	Water Control	Aviation Meteorology
1.	PPI Display	○	○	○
2.	RHI Display	○		
3.	CAPPI	○		○
4.	Echo Tops	○		○
5.	Cross Section	○		○
6.	Vertical Integrated Liquidation	○		○
7.	Wind Velocity and Directions	○	○	○
8.	Wind Profile of the Upper Layer	○		○
9.	Accumulated Rainfall		○	
10.	Flood Warning		○	
11.	Surface Rain Display		○	
12.	Wind Shear Alert			○
13.	Micro Burst Warning			○
14.	JPG Image Output	○	○	○

Rainfall observation range of the meteorological radar system is shown in the drawing attached in the next page.



Rainfall Observation Range of Weather Radar

(The range is drawn at beam height of 3000m above sea level)

Note: The line of the range is calculated based on the altitude data of US Geological Survey

2) Meteorological Satellite Data Receiving System (MTSAT)

For monitoring cloud movements in the whole areas of Laos and the neighboring countries, the meteorological satellite data receiving system for MTSAT has been designed to be installed at the weather observation and forecasting room in the radar tower building, DMH Head Office as the center of weather forecasting. In order to prepare accurate weather forecasts with enough lead time for disaster preparedness and evacuation for the public by DMH, it is necessary to grasp distribution and movement of rain cloud and tropical depression approaching to Laos in advance using the system. In addition, conducting meteorological watch for the northern and the southern parts of Laos located in out of the radar observation range and perceiving disastrous rain occurring in short time and bad weather in these areas in real time, preparation of warnings and dissemination of information to all concerned with the civil aviation by DMH are significant. Unfortunately DMH is not able to monitor to know more about thunderclouds occurring and developing in shot time since the existing receiving system only receives analog data of GOES-9 (American Geostationary Meteorological Satellite) and is not capable of data analysis.

New transmission methods for improvement of the data dissemination from the satellite will be introduced in MTSAT series to transmit digital cloud images with high quality in a short time. MTSAT deploys the imager with a new infrared channel (IR4) in addition to the four channels (VIS, IR1, IR2 and IR3) currently used on GMS-5. IR4 channel will be useful for detection of low-level cloud at night. As a result of analysis for the digital data from MTSAT every hour by the system, cloud distribution and its structure in the whole area of the country will be accurately grasped. During the transition period of about three years from March 2005 to the end of the meteorological mission on transmitting analogue cloud images, MTSAT will transmit only digital cloud images. Since transmission method and data format are totally different with the current services, it is necessary for users to install a new receiving system or change the receiver and the data processing software of the existing system to receive images transmitted with new methods.

DMH has had solid accomplishments to dispatched its technical personnel in twice to “International Seminar on MTSAT/LRIT Data Utilization” conducted at Japan Weather Association (JWA). In the seminars, mainly technical training for utilization of the SATAID software (cloud image analysis software) was conducted. The SATAID is multifunctional software donated to DMH by Japan Meteorological Agency (JMA). For optimizing achievement of the International Cooperation in Meteorology by the Government of Japan, the system to be supplied under the Project must accept the SATAID software. No issue on operation of SATAID by DMH after the completion of the Project is expected because DMH has already been conversant with operation of the SATAID software through the seminars.

3) Meteorological Data Communication System

All the meteorological products of the radar system and the satellite data receiving system will be directly optimized by the DMH's forecasters, DMH's personnel making a briefing for an aircraft pilot in the meteorological office and the air-traffic controllers in the Vientiane International Airport. Therefore, a high-speed communication link (digital spread spectrum system) for transmitting the radar and satellite data form the radar tower building to be constructed under the Project to the Control Tower Building located in the Vientiane International Airport is required. The radar tower building in the premises of DMH Head Office is located approximately 1,100m direct distance from the Control Tower Building.

Items	**Spread Spectrum Radio Link**
Frequency	2.4GHz Band
Data Transmission Rate	56Mbps
Transmission Power	Not more than 3mW/MHz
Power Consumption	Not more than 5W
Communication Fee	Free
Reliability and Durability	High
Maintainability	Easy
Maintenance Cost	Quite Small

The digital spread spectrum system of 2.4GHz Band has the following advantages.

a) Very high-speed data communication.
b) Specifications and modulation standard of spread spectrum radio equipment is based on International Standard IEEE802.11g (IEEE: the Institute of Electrical and Electronic Engineers under International Telecommunication Union, ITU).
c) The system has "10Base-T Ethernet Interface (IEEE802.3)" and performs TCP/IP protocol for unification of all the equipment digital signal interfaces for easy networking and wider expansion.
d) The system has two-way communication function for data collection and remote control & monitoring of the system.
e) Due to employing microwave, antenna is a high gain antenna which is smaller and lighter than an ordinary yagi antenna.
f) Rain attenuation of radio signal is 0.01dB per 1 km under more than 100mm/h raining (no attenuation by rain).

g) The system has security function in accordance with IEEE802.11 of Wired Equivalent Privacy Algorithm (WEP) using Media Access Control ID (MAC) address and Set (ESS) ID.

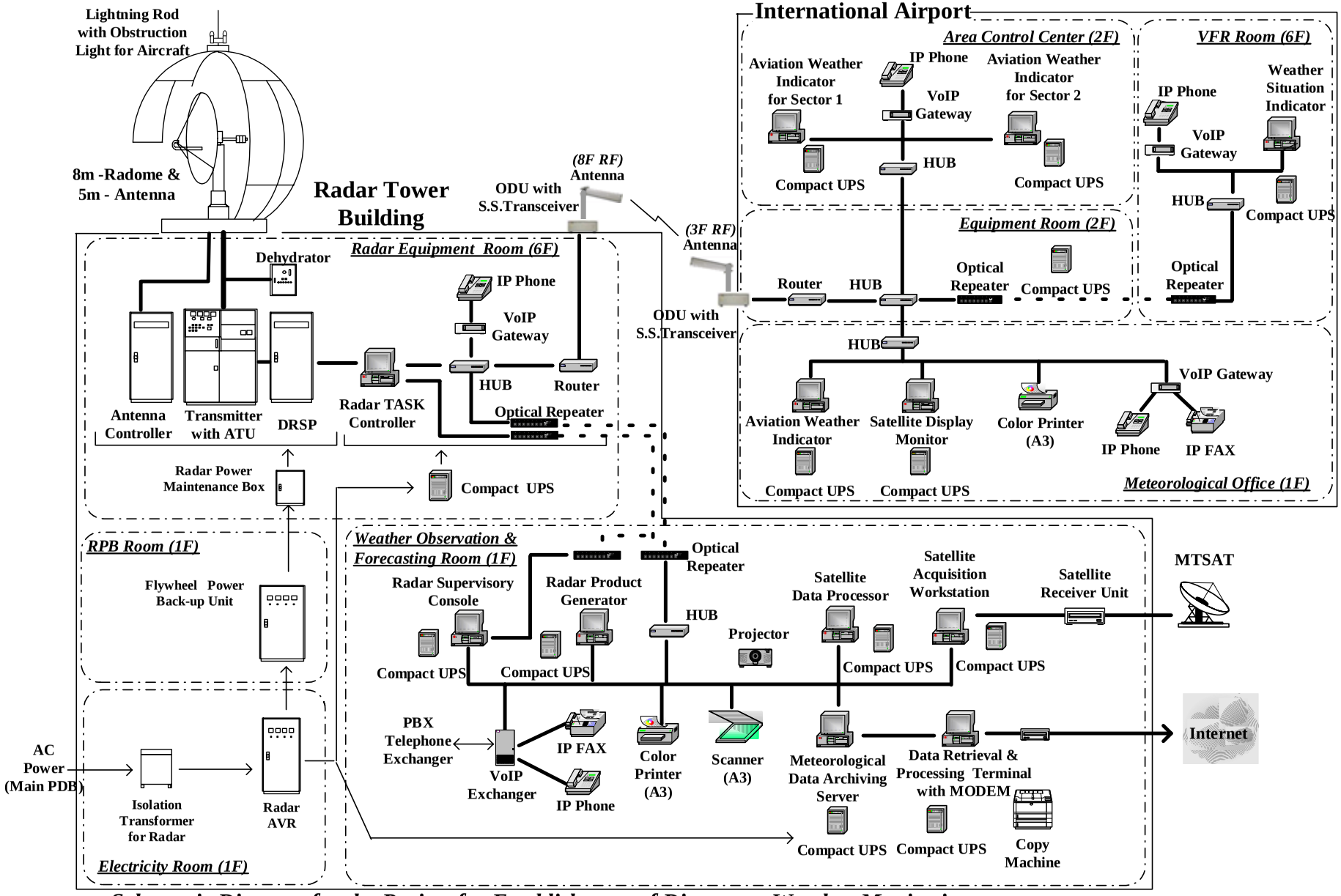
4) Meteorological Radar & Meteorological Satellite Data Display System

Considering the DMH's forecasters, DMH's personnel making a briefing for an aircraft pilot in the meteorological office and the air-traffic controllers in the Vientiane International Airport optimize their use of the meteorological products of the radar system and the satellite data receiving system, it is necessary for them having a lot of work to obtain the required products at their working spaces promptly. Due to such consideration, installation of the meteorological radar & meteorological satellite data display system at the following rooms is designed. The system must have a function to receive and display all the meteorological products in real time for the routine works of weather forecasting & warning and air-traffic control in the Airport.

a) Weather Observation and Forecasting Room in the Radar Tower Building to be constructed in the Project
b) Control Tower Building of Vientiane International Airport
   - Meteorological Office
   - Area Control Center
   - Flight Control Room

For installation of the system, suitable environment and enough space for installation of the system are already available at each room equipped with air-conditioning system in the Control Tower Building described above.

"Schematic Diagram for the Project for Establishment of Disastrous Weather Monitoring" showing the total system configuration of the Project is attached hereto.



Schematic Diagram for the Project for Establishment of Disastrous Weather Monitoring

Equipment List for Planned Major Components

Equipment List – Meteorological Radar System

Name of Site: Radar Tower Building (8F)			
Equipment	Specification	Quantity	Purpose
Radome	Type: Sandwich Type Dimension: Approx. 8m diameter Allowable wind speed: max 70m/s in gust, max 50m/s in average Suitable Frequency: 5,300MHz Transmission loss: <0.5dB or less on one way path in dry Lightning rod: Protecting angles of 60degree for the radar system Lightning rod, obstruction light, base ring	1	For protecting the radar antenna assembly (a parabolic dish reflector) and maintenance personnel from severe weather conditions and lightning attacks.
Antenna	Type: Horn feed parabolic antenna Reflector: approx. 5m diameter Suitable Frequency: 5,300MHz Beam width: not wider than 0.9 degree with radome Antenna gain: >44dB or more Polarization: Linear, horizontal Side lobe level: less than –29dB Driving range: Azimuth 360 degree, elevation –2 to +90 degree Optical connection box	1	For radiating radar beam into the atmosphere and receiving scatter waves while rotating the parabola antenna as azimuth and elevation direction.

Name of Site: Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
Antenna Controller	Control mode: Programming and manual control system Driving range: Azimuth 360 degree, elevation –2 to +90 degree Rotation speed Azimuth: 0.5 to 6 rpm (6 rpm in operation) Elevation: not more than 17 second for each way scan between –2 and 60 degree Accuracy of specified angle: Azimuth: less than +/–0.1 degree Elevation: less than +/–0.1 degree	1	For rotating a parabolic dish reflector and for controlling azimuth and elevation antenna by horizontal and vertical drive motor unit.
Transmitter	Transmitting frequency: 5,300MHz band Transmitting power: >250kW peak, –10% to +10% Modulator: Solid state type Nose figure: Better than 3dB Pulse repetition frequency: [Doppler Mode: Dual PRF] From 500Hz to 2000Hz, 2 pulse selectable (Pulse width: 1.0 μs) [Intensity Mode: Single PRF] From 200 Hz to 300Hz, 1 pulse selectable (Pulse width: 2.0 μs) Pulse width: from 0.4 μs to 3.0 μs (2 pulses selectable by users between 0.4 μs to 3.0 μs)	1	For generating and emitting stable pulse frequency and transmitting the pulse to the antenna.
Amplifier Tube Unit (ATU)	Focus coil unit and cooling system (oil tank) Triple transmitting tube: klystron type	1	For generating stable pulse frequency and supply the pulse signal to Transmitter.

Digital Receiver and Signal Processor (DRSP)	Receiver type: Coherent IF digitizer Sensitivity: Better than –110dBm at the input terminal of low noise amplifier Dynamic range: >80dB (depending on matched filter bandwidth) Intermediate frequency: 30MHz +/–7MHz Quantization: 14 bits Processing area: throughout 0 km to 400 km in range and 0 to 360 degree in azimuth Area: 600km×600km (Intensity Mode) 100km×100km (Doppler Mode) Data grid: 2.5km×2.5km (Intensity Mode) : 1.0km×2.5km (Doppler Mode) Intensity mode Ground clutter suppression: Chebyshev IIR digital high pass filter Velocity mode Processing type: Pulse Pair, FFT and Random Phase Resolution: Velocity 1.0 m/s, Spectrum width 1.0 m/s Accuracy: Velocity 1.0 m/s, Spectrum width 1.0 m/s Velocity De-arising: Real-time processing by Dual-PRF Output data: Reflectivity(Z), Doppler velocity(V), Spectrum width(W) Output data resolution: 8bit or 16bit Time adjustment: By GPS time server with antenna and ntp (network time adjustment protocol) feature	1	For receiving and processing video echo signal from the transmitter. For suppressing unnecessary echo such as ground clutter signal. For sending ingest data to radar TASK controller.
Dehydrator	Capability of ventilation pressure: 3+/－1 liter/min, Upper limit: 300 +/－30 gf/cm2 Lower limit: 70+/－30 gf/cm2	1	For supplying dried and pressurized air into the wave-guide to reduce wave propagation loss.
Wave-guide Configuration	Wave-guide Type: C band wave-guide Circulator Power ration: at least 350 kW TR limiter Type: Solid state type	1	For connecting between the antenna and TX/RX for the wave propagation.
Radar TASK Controller	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk(1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2)ports or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX or LINUX-based Application software: [Radar local control and monitoring] [Observation scheduling] [Radar echo display] [Radar data generation and dissemination]	1	For operating the radar system, monitoring condition of the radar system and generating raw product data. Monitoring items: Radiate control/status Azimuth/elevation position control/status TX standby status Pulse width control/status Antenna local/maintenance mode status
Peripherals	Compact UPS -Capacity: 500VA or more -Input power: 220V AC ±15%, single phase, 50Hz -Output power: 220V AC ±5%, single phase, 50Hz -Operation time: at least 5 minutes	1	For supplying back-up AC power to computing equipment in case of power stoppage for shutdown the system.
	Radar Power Maintenance Box -Circuit breaker: no-fuse-breaker type -Input power: 220V AC, single phase, 50Hz -Output power: 220V AC, single phase, 50Hz	1	For distributing and supplying AC power to radar system.

Name of Site: Radar Tower Building (Electricity Room)			
Equipment	Specification	Quantity	Purpose
Isolation Transformer	-Capacity: 35kVA or more -Input Power: 220V AC, single phase, 50Hz -Output Power: 220V AC, single phase, 50Hz -Insulation: Class B -Surge voltage: 30kV	1	For protecting each equipment from surge voltage.
Radar AVR	-Capacity: 30kVA or more -Input Power: 220V AC ±15%, single phase, 50Hz -Output Power: 220V AC ±5%, single phase, 50Hz	1	For supplying the constant voltage to radar system.

Name of Site: Radar Tower Building (Radar Power Backup Room)			
Equipment	Specification	Quantity	Purpose
Fly Wheel Power Back Up Unit	Back up period: more than 90 sec Input voltage: 220V AC(single phase 50Hz) Energy: without Battery	1	For supplying the uninterrupted power by flywheel energy when power failure.

Name of Site: Radar Tower Building (Maintenance Room)			
Equipment	Specification	Quantity	Purpose
Test Instruments and Materials	Test signal card Power meter Power sensor Frequency counter Detector Attenuator set with terminator Terminator for detector Oscilloscope Digital multi meter CW Converter Tool Set Extension code Level checker Step ladder Grease for Antenna Timing belt for Antenna	1	For maintenance of radar system.

Equipment List – Meteorological Radar Data Display System

Name of Site: Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
Peripherals	Optical Repeater -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, one (1)port Optical fiber interface one(1)set Multi-mode (100Mbps) -Input power: 220V AC, single phase, 50Hz	2	For converting electrical signal and optical signal on LAN.
	Switching HUB -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, sixteen (16)ports -Input power: 220V AC, single phase, 50Hz	1	For connecting all the computing equipment on LAN.

Name of Site: Radar Tower Building (Weather Observation & Forecasting Room)			
Equipment	Specification	Quantity	Purpose
Radar Supervisory Console	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk(1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2)ports or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX or LINUX-based Application software: [Data collection] [Data monitoring by PPI real time display] [Radar remote control and supervising] [Radar network monitoring]	1	For controlling and monitoring the radar equipment via local area network remotely.
Radar Product Generator	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX, LINUX or Windows-based Application software: [Raw data receiving, extract, dissemination] [Weather product processing] [Map projection] [Product display & retrieval]	1	For generating and monitoring doppler weather radar product such as rainfall, wind direction and each product.
Data Retrieval & Processing Terminal (with Modem)	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-ROM drive: one (1) drive Modem: for analog line, Max 56kbps Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2) ports or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX, LINUX or Windows-based Application software: [Data communication] [Product display & retrieval] [Radar image delivery]	1	For radar product retrieving at an operator's command.

Meteorological Data Archiving Server	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk(1.44Mbytes) CD-RW drive: one (1) drive Tape Drive: One (1) drive (4mm DAT) Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, two (2) ports or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX, LINUX or Windows-based Application software: [Data communication] [Product display & retrieval] [Data storing to external storage]	1	For data storing and retrieving between hard disk and external storage.
Peripherals	Color printer -Color inkjet type, A3 size -At least 1200dpi resolution, 7ppm of faster printing speed -Interface USB, SCSI or LAN	1	For printing radar products.
	Scanner -Size: A3 -At least 1200 dpi resolution -Interface USB and/or SCSI	1	Convert from paper document to electrical image file for meteorological services.
	Projector -Projection System: DLP™ -Video port: XGA -Brightness: 1500lm -Keystone correction feature	1	Use for meeting and discussion of meteorological services.
	Copy Machine -Paper: A3, A4 -Black and white laser type -Speed: 20 ppm or more	1	For coping each document.
	Optical Repeater -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, one (1)port Optical fiber interface one(1)set Multi-mode (100Mbps) -Input power: 220V AC, single phase, 50Hz	2	For converting electrical signal and optical signal on LAN
	Switching HUB -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, sixteen (16)ports -Input power: 220V AC, single phase, 50Hz	1	For connecting all the computing equipment on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: 220V AC ±15%, single phase, 50Hz -Output power: 220V AC ±5%, single phase, 50Hz -Operation time: at least 5 minutes	4	For supplying back-up AC power to computing equipment in case of power stoppage for shutdown the system.

Name of Site: Vientiane International Airport (Meteorological Office)			
Equipment	Specification	Quantity	Purpose
Aviation Weather Indicator	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX, LINUX or Windows-based Application software: [Raw data receiving, extract, dissemination] [Weather data management & product control]	1	For monitoring and forecasting severe weather conditions.
Peripherals	Color printer -Color inkjet type, A3 size -At least 1200 dpi resolution, 7ppm of faster printing speed -Interface USB, SCSI or LAN	1	For printing radar products.
	Switching HUB -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, eight (8)ports -Input power: 220V AC, single phase, 50Hz	1	For connecting all the computing equipment on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: 220V AC ±15%, single phase, 50Hz -Output power: 220V AC ±5%, single phase, 50Hz -Operation time: at least 5 minutes	1	For supplying back-up AC power to computing equipment in case of power stoppage for shutdown the system.

Name of Site: Vientiane International Airport (Equipment Room)			
Equipment	Specification	Quantity	Purpose
Peripherals	Optical Repeater -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, one (1)port Optical fiber interface one(1)set Multi-mode (100Mbps) -Input power: 220V AC, single phase, 50Hz	1	For converting electrical signal and optical signal on LAN.
	Switching HUB -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, eight (8)ports -Input power: 220V AC, single phase, 50Hz	1	For connecting all the computing equipment on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: 220V AC ±15%, single phase, 50Hz -Output power: 220V AC ±5%, single phase, 50Hz -Operation time: at least 5 minutes	1	For supplying back-up AC power to computing equipment in case of power stoppage for shutdown the system.

Name of Site: International Airport (Area Control Center)			
Equipment	Specification	Quantity	Purpose
Aviation Weather Indicator (For each sector)	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk(1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX, LINUX or Windows-based Application software: [Data communication] [Product display & retrieval]	2	For monitoring and forecasting severe weather conditions.
Peripherals	Switching HUB -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, eight (8)ports -Input power: 220V AC, single phase, 50Hz	1	For connecting all the computing equipment on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: 220V AC ±15%, single phase, 50Hz -Output power: 220V AC ±5%, single phase, 50Hz -Operation time: at least 5 minutes	2	For supplying back-up AC power to computing equipment in case of power stoppage for shutdown the system.

Name of Site: Vientiane International Airport (Flight Control Room)			
Equipment	Specification	Quantity	Purpose
Weather Situation Indicator	CPU: Intel Pentium 4, 2.8GHz or equivalent Main memory(RAM): 1024Mbytes or more Hard disk unit: 80Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk(1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T,TCP/IP, one (1) port or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, 50Hz, single phase Software Operation system: UNIX, LINUX or Windows-based Application software: [Data communication] [Product display & retrieval]	1	For monitoring and forecasting severe weather conditions
Peripherals	Switching HUB -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, eight (8)ports -Input power: 220V AC, single phase, 50Hz	1	For connecting all the computing equipment on LAN.
	Optical Repeater -LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, one (1)port Optical fiber interface one(1)set Multi-mode (100Mbps) -Input power: 220V AC, single phase, 50Hz	1	For converting electrical signal and optical signal on LAN.
	Compact UPS -Capacity: 500VA or more -Input power: 220V AC ±15%, single phase, 50Hz -Output power: 220V AC ±5%, single phase, 50Hz -Operation time: at least 5 minutes	1	For supplying back-up AC power to computing equipment in case of power stoppage for shutdown the system.

Equipment List – Meteorological Data Communication System

Name of Site: Radar Tower Building (Radar Equipment Room)			
Equipment	Specification	Quantity	Purpose
VoIP Gateway	-Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: phone-line (telephone, fax, etc.) port -WAN interface: 10/100BASE-T	1	For converting voice packet signal. And exchange dial signal for telephone.
Telephone	-Type: Analog 2wire, DTMF	1	For voice communication
Spread Spectrum Transceiver with ODU	-Frequency: 2.4GHz ISM band -Radio Standard: IEEE802.11g -Output Power: Less than 3mW/MHz -Wire Interface: 10/100BASE-T -Data Rate: 54Mbps -Modulation: Direct sequence -Output Door standard: IP43 -LAN Arrester: For surge protection, RJ45 interface	1	High data rate transmission using radio.
Antenna	-Frequency: 2.4GHz ISM Band -Type: Yagi Antenna -Gain: 19dBi -Polarization: Vertical	1	Combination use with Spread Spectrum Transceiver.
Router	-LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, two (2)ports -Routing: IP routing -Input power: 220V AC, single phase, 50Hz	1	For connecting and routing all the computing equipment on LAN.

Name of Site: Radar Tower Building (Weather Observation and Forecasting Room)			
Equipment	Specification	Quantity	Purpose
VoIP Exchanger	-Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: FXS, FXO or OD -External link port: 2 lines -WAN interface: 10/100BASE-T	1	For converting voice packet signal. And exchange dial signal for telephone.
Telephone	-Type: Analog 2wire, DTMF	1	For voice communication.
FAX	-Type: Analog 2wire, DTMF -Communication Speed: G.3FAX 4800bps	1	For disseminating meteorological information.

Name of Site: Vientiane International Airport (Meteorological Office)			
Equipment	Specification	Quantity	Purpose
VoIP Gateway	-Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: phone-line (telephone, fax, etc.) port -WAN interface: 10/100BASE-T	1	For converting voice packet signal. And exchange dial signal for telephone.
Telephone	-Type: Analog 2wire, DTMF	1	For voice communication
FAX	-Type: Analog 2wire, DTMF -Communication Speed: G.3FAX 4800bps	1	For disseminating meteorological information.

Name of Site: Vientiane International Airport (Equipment Room)			
Equipment	Specification	Quantity	Purpose
Spread Spectrum Transceiver with ODU	-Frequency: 2.4GHz ISM band -Radio Standard: IEEE802.11g -Output Power: Less than 3mW/MHz -Wire Interface: 10/100BASE-T -Data Rate: 54Mbps -Modulation: Direct sequence -Output Door standard: IP43 - LAN Arrester: For surge protection, RJ45 interface	1	High data rate transmission using radio.
Antenna	-Frequency: 2.4GHz ISM Band -Type: Yagi Antenna -Gain: 19dBi -Polarization: Vertical	1	Combination use with Spread Spectrum Transceiver.
Router	-LAN interface: IEEE 802.3 Ethernet -Connections: 100BASE-T, two (2)ports -Routing: IP routing -Input power: 220V AC, single phase, 50Hz	1	For connecting and routing all the computing equipment on LAN.

Name of Site: Vientiane International Airport (Area Control Center)			
Equipment	Specification	Quantity	Purpose
VoIP Gateway	-Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: phone-line (telephone, fax, etc.) port -WAN interface: 10/100BASE-T	1	For converting voice packet signal. And exchange dial signal for telephone
Telephone	-Type: Analog 2wire, DTMF	1	For voice communication

Name of Site: Vientiane International Airport (Flight Control Room)			
Equipment	Specification	Quantity	Purpose
VoIP Gateway	-Type: H323 or SIP -Decoding method: G.723, G.729 or G.711 -VoIP Interface: phone-line (telephone, fax, etc.) port -WAN interface: 10/100BASE-T	1	For converting voice packet signal. And exchange dial signal for telephone.
Telephone	-Type: Analog 2wire, DTMF	1	For using voice communication.

Equipment List – Meteorological Satellite Data Receiving System

Name of Site: Radar Tower Building (2F)			
Equipment	Specification	Quantity	Purpose
Antenna	-3.7m dish precision spun Aluminium parabolic antenna -Fixed mount -L-band feed	1	For reception of radio waves from meteorological satellite.
Low noise amplifier (LNA) and down-converter	LNA: Gain: 45dB (nominal) Downconverter: Input frequency: 1650 – 1750 MHz Output frequency: 140.000MHz at 1687.1MHz in	1	For Amplifying low level signals from antenna feed and downcoverting signal frequency to a frequency suitable for the Satellite Receiver Unit.
Lightning suppression	In-line RF suppressors shall be applied at both ends of the RF cables from antenna to the receiver	1	For protecting the system from power surges due to lightning.

Name of Site: Radar Tower Building (Weather Observation and Forecasting Room)			
Equipment	Specification	Quantity	Purpose
Satellite Receiver Unit	Input frequency: 140MHz Demodulation modes: MTSAT HiRID, HRIT, LRIT Output: High speed computer interface (USB, 10-Base or backplane)	1	For receiving signal from antenna and modulating it into data for ingest into the Acquisition Workstation.
Satellite Acquisition Workstation	Hardware Main processor: Intel Pentium4, 2.8GHz or better Main memory (RAM): 1024 Mbytes or more Hard disk unit: 160 Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-RW drive: >=32x, one (1) drive Monitor display: Color LCD type, 17 inches or more LAN interface: IEEE802.3, 10/100BASE-T, TCP/IP, one(1) port or more LAN Arrester: For surge protection, RJ45 interface Interface for Satellite Receiver Unit: one (1) port Input power: 220V AC, single phase, 50Hz Software Operating system: LINUX-based or Microsoft Windows Application software - Receive data from the receiver - Monitoring and control of the antenna and reception process	1	For processing raw data from the receiver and prepares it for processing by the Data Processor. It also provides an archive for raw data, allows users to monitor the system, and logs system operation.
Satellite Data Processor	Hardware Main processor: Intel Pentium4, 3GHz or better Main memory (RAM): 1024 Mbytes or more Hard disk unit: 250Gbytes, 7200 rpm Floppy disk unit: one (1) drive for 3.5 inches disk(1.44Mbytes) CD-RW drive: 48x32x48x, one (1) drive Monitor display: Color LCD type, 19 inches or more, supporting 1280x1024 resolution LAN interface: IEEE802.3, 10/100BASE-T, TCP/IP, one (1) port or more LAN Arrester: For surge protection, RJ45 interface Input power: 220V AC, single phase, 50Hz Software Operating system: LINUX-based or Microsoft Windows Application software [Data processing] [Data display]	1	For operators and forecasters to process and analyze the formatted data, producing high level meteorological output suitable for weather forecasting, dissemination to other sites, and research.
Peripherals	Compact UPS - Capacity: 500VA or more - Input power: 220V AC ±15%, single phase, 50Hz - Output power: 220V AC ±5%, single phase, 50Hz - Operation time: at least 20 minutes	2	For power back-up to computers.

Equipment List – Meteorological Satellite Data Receiving System

Name of Site: Vientiane International Airport (Meteorological Office)			
Equipment	Specification	Quantity	Purpose
Satellite Display Monitor	Hardware Main processor: Intel Pentium4, 2.8GHz or better Main memory (RAM): 1024 Mbytes or more Hard disk unit: 160 Gbytes or more Floppy disk unit: one (1) drive for 3.5 inches disk (1.44Mbytes) CD-ROM drive: one (1) drive Monitor display: Color LCD type, 19 inches or more, supporting 1280x1024 resolution LAN interface: IEEE802.3, 10/100BASE-T, TCP/IP, one (1) port or more Input power: 220V AC, single phase, 50Hz Software Operating system: LINUX-based or Microsoft Windows Application software - Output: geo-referenced, calibrated imageries (channels: VIS, IR, WV) - Zooming of imagery - Animation	1	For data reception and display of the satellite imagery and derived products.
Peripherals	Compact UPS - Capacity: 500VA or more - Input power: 220V AC ±15%, single phase, 50Hz - Output power: 220V AC ±5%, single phase, 50Hz - Operation time: at least 20 minutes	1	For power back-up to computer.

(2) Basic Plan of the Facility

1) Site and Facility Layout Plan

The site for construction of the radar tower building is located in the premises of DMH Head Office. The site is sufficiently large to accommodate the radar tower building and located next to the existing Head Office building performing for 24 hours in round-the-clock operation. In addition, the premises of DMH Head Office is adjacent to residential areas and its main entrance located to the north side faces the national road route 1 and also the south side faces the Mekong River.

Regarding the site infrastructure, power supply, water supply and telephone line are available, however, there is no drainage and sewerage facilities.

In the premises of DMH Head Office, there is a very significant facility which is the synoptic observation station registered at WMO for hourly transmitting the observed data through GTS to the whole world, therefore, a special consideration should be given to layout of the radar tower building for not exercising any influence to it.

<Site Conditions>

Construction Site	: sufficient and flat
Power Supply	: AC 380V, 3 phases and 4 wires, 50Hz is available
Water Supply	: the existing facility is usable
Sewerage	: not available (a septic tank and a seepage pit are required according to the regulation of VUDAA)
Telephone	: the existing lines or new lines are usable

In the radar tower buildings, when radar observers and forecasters work at the display monitors and radar operating consoles, they typically face north, since this direction is considered optimum in terms of operating efficiency and directional sense. This direction clearly facilitates the efficient conduct of radar operations, since the screen surface on which radar images are displayed on monitors and consoles is oriented to the north, which coincides with the facing direction preferred by operators and forecasters. Accordingly, the layout plans for the radar tower buildings will have the backs of the radar display monitors and operating consoles facing north as much as possible.

2) Architectural Design

[1] Floor Plan

The floor plan is virtually symmetrical, making possible a structural design that is safe and avoids eccentricity. The floor plan for the central portion of the radar tower buildings allows the various rooms to be arranged more flexibility, since all structures such as

columns and beams are not protrude into the internal staircase, which is also to serve as evacuation routes. Construction methods and materials have been employed in common local use and the building is of standard grade in Laos.

Floor area of each room, number of working staff, room's function and calculation base for each room area are indicated in the following table.

Name of Room	Floor Area (m^2)	Number of Working Staff	Room Function	Calculation Base
Radome Room	30.17	—	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	32.04	—	Installation space for antenna controller, transmitter, amplifier tube unit, digital receiver and signal processor, dehydrator, wave-guide configuration, radar task controller, power distribution box, maintenance box, maintenance cabinet, measuring instrument cabinet, air-conditioning units, etc.	Operation and maintenance space for all the apparatuses described in the left column. For installation of all the required equipment, at least $30m^2$ required.
Weather Observation and Forecasting Room	75.27	Shift Schedule Daytime: 8 Night Time: 5 Daily Briefing: 12 Mass Media Briefing DMH: 12 Mass Media: 9-18	For weather observation & forecasting terminals: 6 Existing terminals: 4 VoIP exchange: 1 Optical repeater: 2 Printer, scanner, projector, photocopy machine, IP telephone, IP FAX, UPS for PCs, filing cabinets, screen, white board, etc.	For Weather observation and forecasting space and also installation space for all the equipment described in the left column, 7-8 m^2/person is required. In daytime always 8 person in operation, approx. $60m^2$ is required. For mass media briefing, approx. $15m^2$ required. However, personnel of mass media receive a briefing standing up.
Maintenance Room	24.70	Daytime: 4 Night Time: 2	For maintenance instruments, measuring equipment, cabinets for operation & maintenance manuals and spare parts & consumables.	Maintenance space for various type of the equipment: $16m^2$ m^2($4m^2$/person). Keeping space for maintenance instruments, measuring equipment: at least $20m^2$. Cabinets for operation & maintenance manuals and spare parts & consumables: 4-5 m^2.
Data Room	10.09	—	For keeping observed data, files of forecast products, radar and satellite digital data. Data storage cabinets (high type: 2 low type: 5).	Necessary space for keeping all data secured.
Toilet (Man & Woman)	12.61	—	For Man: 1 closet bow and 1urinal For Woman: 1 closet bowl	Room area includes areas of anti-space and slop sink.
Engine Generator Room	19.61	—	For engine generator, service tank, accessories.	Approx. $20m^2$ required including installation, operation and maintenance space for 75kVA engine generator with 600 liter service tank and automatic change-over switch.
Electricity Room (including 2 EPSs)	9.25	—	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. $10m^2$ required.
Radar Power Backup Room	8.16	—	For radar power back-up unit and control rack.	Installation, operation and maintenance space for all the apparatuses described in the left column: at least $8m^2$ required.
Storage	2.40	—	Storage space for spare materials of the radar tower building and miscellaneous goods.	Approx. $2m^2$ secured as a storage space for the building.

[2] Sectional Plan

I. Height of the Radar Tower Building

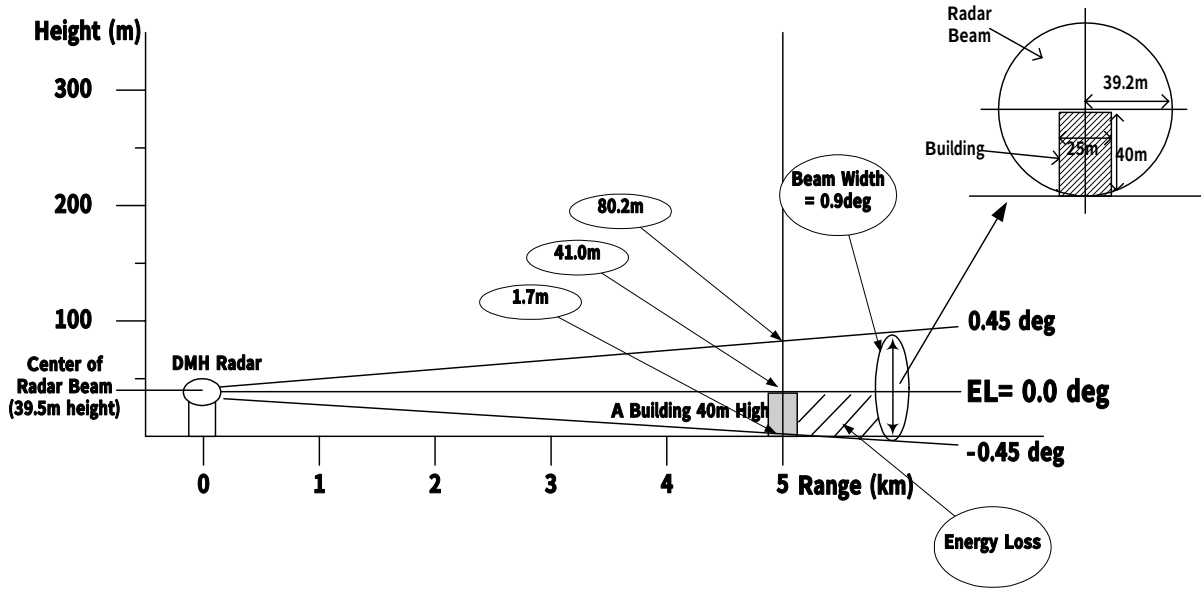
The construction site of the radar tower building in the premises of DMH Head Office is located under the obstacle limitation surface prescribed by ICAO. The obstacle limitation of ICAO only allows constructing any facility maximum 45m high. In addition to this, due to the site located in Vientiane city that is a flat land, in case that the radar system is operated from the radar beam angle: 0 degree, the radar beam hits the ground, so that the radar beam angle: 0 degree is not suitable for appropriate and effective radar observation. The most recommendable and operational radar beam angle for observation is from +0.5 degree being put into general use in.

In Vientiane city, there are two areas in which construction of a maximum 40m high facility (building) can be permitted by VUDAA. One is approxmatelly 8km away and the other is a bank along Mekong Rever approxmatelly 5km away from the site in a crow line. In order that the radar beam streaks over a 40m high building, 39.5m is required for a height of an antenna center from the ground level. Thereby, the antenna center of the meteorological radar system must be 39.5m and top of the lightening rod must be 45m to keep the obstacle limitation.

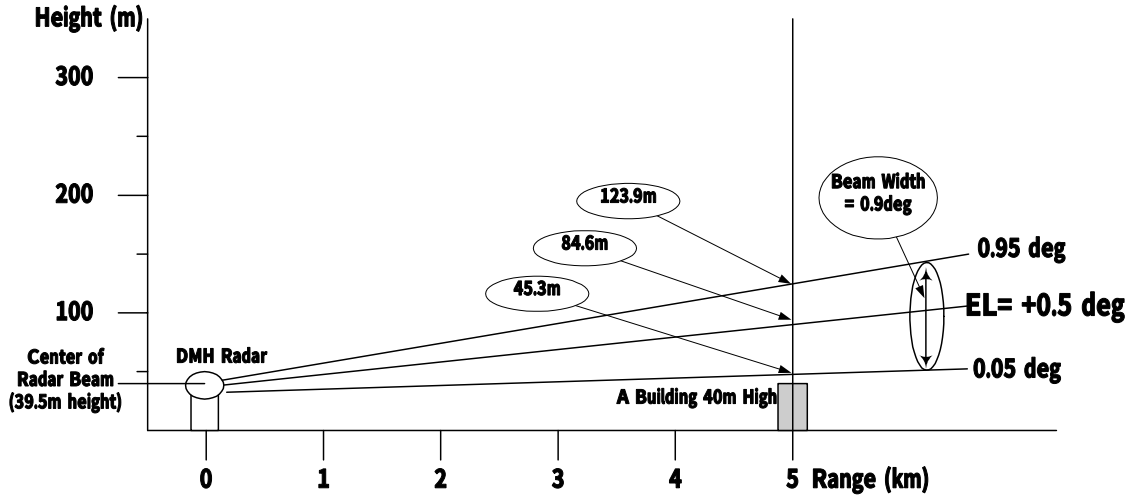
The previous flood disaster record indicates that the maximum flooded water level of Mekong River in Vientiane was 1.1-1.2m from the ground level. For avoiding any serious affection from a bad flood, the first floor concrete slab of the radar tower building has been designed as 1.5m from the ground level.

The following diagrams indicate the expectable influence in case that the antenna center of the radar system is designed as 39.5m high and a building 40m high constructed at a place that is 5km away from the site in a crow line. In accordance with the diagrams, the radar system operated from the radar beam angle of +0.5 degree is not affected by a building 40m high. As indicated in the diagram of radar beam angle of +0.5 degrees, in case that the antenna center of the radar system is 39.5m high, approximately 5m clearance can be secured from the top of a building 40m high.

<Radar Beam Angle of 0 degrees>



<Radar Beam Angle of +0.5 degrees>



II. Ceiling

In the radar equipment room and the weather observation and forecasting room as the major rooms of the radar tower building, the radar equipment must be protected against dust collecting above the cable rack. In addition, so as to improve the airtight-ness of these rooms as well as to reduce the equipment noise, the ceilings will be finished with acoustical boards. And, since both of these rooms are to be air-conditioned, the use of ceiling boards will be also be effective in terms of raising the efficiency of cooling operations. The ceiling height has, accordingly, been set at about 2.7m, based on the dimensions of the intended equipment.

III. External Wall

For circumventing the effect of the outside temperature and humidity for the radar equipment room, external walls of the radar equipment room are designed as cavity walls in which glass wool is sandwiched for heat insulating. Due to enhancing cooling efficiency of the room, the recurrent cost of DMH after the completion of the Project can be minimized by economizing power consumption of air-conditioning systems.

IV. Access Floor

Access floor of 15cm height is adopted for floors of the radar equipment room and the weather observation and forecasting room for easy wiring of power and signal cables, easy maintenance and easy future expansion. Antistatic and heavy-duty access floor has been selected for radar equipment room in which a high power radar transmitter weighting about 1 ton is planed to install.

V. Equipment Carry-in Method

In order to install all the equipment directly from outside into the radar equipment room, a large opening is necessary for carrying the equipment in from outside. 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 at the adjacent staircase room. For lifting the equipment, 2-tons lifting hook will set at the upper part of this balcony.

[3] Elevation Plan

The columns and beans will protrude to the outside, with an appealing elevation plan that enhances the structural design. In this way, since columns and beams will not protrude into the staircase, therefore, the staircase will be able to comfortably handle traffic in both directions.

[4] Material Plan

Materials specified for both exterior and interior finishing are all available locally. They have been selected with a view to ease maintenance by DMH as follows.

		Material and method of finishing
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
	Walls	Cement Sand mortal base, Vinyl paint finish Glazed ceramic tiles Glass wool with glass cloth
	Ceilings	Acoustic panels (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 Steel doors
	Interior	Wooden doors Steel doors

		Bases for adoption of materials	Procurement
Exterior Finishing	**Roof Floor**	Due to external temperatures are high, reaching over 35 degrees, 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. 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, acoustic mineral boards will be used. Other rooms which will not require any ceiling board will be directly applied emulsion paint finish on cement and sand mortal.	To be procured locally
Windows and Door	**Exterior**	Aluminum and steel will be chosen 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

Since its design standard for building structures has not been firmly established yet in Laos, it has been approved by MCTPC and VUDAA that a structural design is implemented to

follow the relevant standards in the major industrial countries. Based on the UBC (United Building Code) which is commonly used in Asian countries, the structural design of the radar tower building is implemented in conformity with Thai and Japanese standards.

II. Structure Type

Reinforced concrete has been nominated as structure type for the radar tower building because reinforced concrete construction is the most typical structural type in Laos. The floor slabs are to be reinforced concrete while exterior walls and partition walls are local made concrete blocks.

III. Foundation

As a consequence of the boring test at the site, the most suitable bearing layer for the building construction (N value: 70) has been confirmed at approximately 20m in depth from the ground level. For securing the radar observation accuracy, building stiffness is quite significant and allowable horizontal distortion angle of the building must be not more than 0.07 degree. Therefore, cast-in-place concrete piles constructed into the bearing layer at least 0.5-1m will be required to satisfy the allowable horizontal distortion angle.

The site is located in the premises of DMH Head Office being adjacent to residential areas and located next to the Head Office building performing for 24 hours in round-the-clock operation. Furthermore, in the premises, the synoptic observation station registered with WMO is available. In Laos, ready-made concrete piles are generally used for a building construction. However, driving ready-made concrete piles are not adoptable for the Project for avoiding any impediment to the meteorological routine work and observation, devastating impact to the existing facilities, hideous din, thumping vibration, etc. In addition, soil heaving will provably occur due to driving ready-made concrete piles at the site. There is high possibility that all the existing facilities available near the site may be greatly affected by soil heaving. Since these seasons described above, adoption of cast-in-place concrete piles for construction of the radar tower building is indispensable.

[6] Design Load

I. Dead load

Weight of all the structural and finishing materials has been included in dead load calculation for the radar tower building. The estimated combined weight of the radome and radar antenna to be mounted on the top of the radar tower building is approximately 4.5 tons as a special dead load.

II. Live load

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

III. Wind load

Since occurrence of strong wind with thundercloud has been observed in Laos, the following wind load has been calculated in accordance with “Recommendations for Loads on Building” published by the Architectural Institute of Japan, referring to the standards adopted in Thailand.

Velocity Pressure for Building Design = 200kgf/m^2 (approx. 2000N/m^2)

IV. Seismic load

No earthquake affecting buildings has been recorded in either Vientiane or its surrounding areas. The seismic force is not considered in the building design.

V. Materials for building structural

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

- Concrete : conventional concrete
  specified concrete strength Fc= 21N/mm^2
- Cement : TIS, JIS or equivalent
- Deformed reinforcing bars : TIS, JIS or equivalent

TIS: Thai Industrial Standard

JIS: Japan Industrial Standard

[7] Electrical Facility Design

I. Power intake facility

The required commercial power for the radar tower building will be step-down to low-voltage by the existing transformer available alongside of the national road route 1 and will be connected through the existing power meter of DMH to the radar tower building. The power intake up to the radar tower building including wiring and power connection to a low-voltage switchboard through a hand-hole to be installed under the Project is one of major scope of works to be taken by DMH at his own expense. The required power for the radar tower building is 380V, 3-phase, 4-wire, 50 Hz.

II. Power generating facility

To ensure uninterrupted operation of the meteorological radar system and the other equipment, an engine generator with the following capacity is required for the radar tower building as a back-up power source during the commercial power supply failure. For supporting the radar system on more than 12 hours continuous operation, a service tank of 600 liters will be supplied.

Capacity : 75 KVA (3 phase 4 wire, 380V, 50 Hz)

III. Trunk line and power facility

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

- Trunk line foe lighting and power : 3 phase 4 wire, 380/220V
- Branch power circuits : 3 phase 4 wire, 380V
- Branch lighting circuits : single phase 2 wire, 220V
- Branch equipment circuits : single phase 2 wire, 220V

IV. Lighting and plug outlet

Using voltage for lightings and sockets is single-phase 220V and all the fixings must be grounded. For piping for wiring, steel pipes generally used in Laos will be adopted. 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 application.

The illuminance standard in the various rooms will be approximately as shown below.

Radome Room:	200 Lx	Engine Generator Room	200 Lx
Radar Equipment Room:	300 Lx	Electricity Room:	200 Lx
Weather Observation and Forecasting Room:	300 Lx	Radar Power Backup Room:	200 Lx
Data Room:	300 Lx	Entrance Room:	200 Lx
Maintenance Room:	300 Lx	Other Rooms:	200 Lx

General-purpose plug outlets will be equipped with switches and also setting exclusive plug outlets at the radar equipment room, the weather observation and forecasting room,

the maintenance room and the data room for the computing equipment of the Project will be required.

V. Telephone system

From the existing overhead telephone line running along the national road route 1, the required lines will be extended to the site through the overhead cable lines available in the premises of DMH Head Office. 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. The cabling work to the service terminal box will be conducted by DMH at his own expense. A private branch exchange (PBX) will be installed in the weather observation and forecasting room and four telephone lines including two existing lines will be required for the building.

VI. Intercom system

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

VII. Alarm system

An alarm panel will be installed at the weather observation and forecasting room. The following warnings of the building equipment will be indicated.

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

VIII. Grounding system

Grounding cables for the equipment installed on 1st and 6th floors will be connected to the terminal box for earthing. All the equipment to be installed in the electricity room and the radar power backup 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 lightening rod on the top of radome (the equipment portion of the Project) and roof conductors on concrete handrails of parapets at the observation deck on 7th floor and the roof top of 8th floor will be installed for protecting all the equipment and the radar tower building. A connection box will be placed at the radome room for the lightening 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

Two power distribution boards at 1st floor and 6th floors and an automatic blinking switch at 1st floor will be installed for two obstruction lights on the top of radome (equipment portion of the Project) to be connected to a connection box placed at the radome room and four obstruction lights (building portion of the Project) to be installed at the observation deck on 7th floor. All the aviation obstruction lights will be furnished with surge arresters. Connecting work between the obstruction lights on the top of radome and a connection box placed at the radome will be included in equipment portion of the Project.

XI. Fire detection and alarm system

Fire detections will be installed at the radar equipment room, the electricity room, the radar power backup room and the engine generator room and an alarm system will be installed at the weather observation and forecasting room.

[8] Water Supply, Drainage and Sanitary Fixture Design

I. Water supply system

In the premises of DMH Head Office, water supply system has already existed and the existing water supply pipe is available a few meters away from the site. A gate valve for water supply for the radar tower building will be laid in a berm of the building. DMH will be responsible for the intake works up to a gate valve in the inside berm.

II. Drainage system

Drainage will be divided into 2 systems as sewage and miscellaneous drainage. Sewage will primarily be treated in a septic tank and then 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 designed and constructed in accordance with the regulation of VUDAA and the required capacity of a septic tank and a seepage pit for the radar tower building has been designed for 12 who are DMH personnel in operation and visitors.

III. Sanitary fixture

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

IV. Fire extinguisher

In the following rooms, fire extinguishers will be supplied.

Radome Room:	CO2 type	Maintenance Room:	CO2 type
Radar Equipment Room:	CO2 type	Engine Generator Room:	ABC type
Weather Observation and Forecasting Room:	CO2 type	Electricity Room:	CO2 type
Data Room:	CO2 type	Radar Power Backup Room:	CO2 type
		Tea Kitchen:	ABC type

[9] Air-conditioning and Ventilation System Design

In the following rooms, air-conditioning systems will be installed. Especially for all the equipment in the radar equipment room and the weather observation and forecasting room, multiple units of air-conditioning systems are indispensable to continuously keep appropriate environment. In addition, a package type air-conditioning system has been selected for minimizing any influence to operation of the radar system in case that an air-conditioning system failure occurs.

- Radar Equipment Room
- Weather Observation and Forecasting Room
- Data Room
- Maintenance Room

In the tea kitchen and the toilets, ceiling fan as forced ventilation will be installed. Due to the equipment generating heat in the radar equipment room, the engine generator room, the radar power backup room and the electricity room, forced ventilation system will be adopted. Furthermore, the other rooms requiring a ventilation to keep the following conditions, suitable ventilation will be installed.

<Environmental conditions>

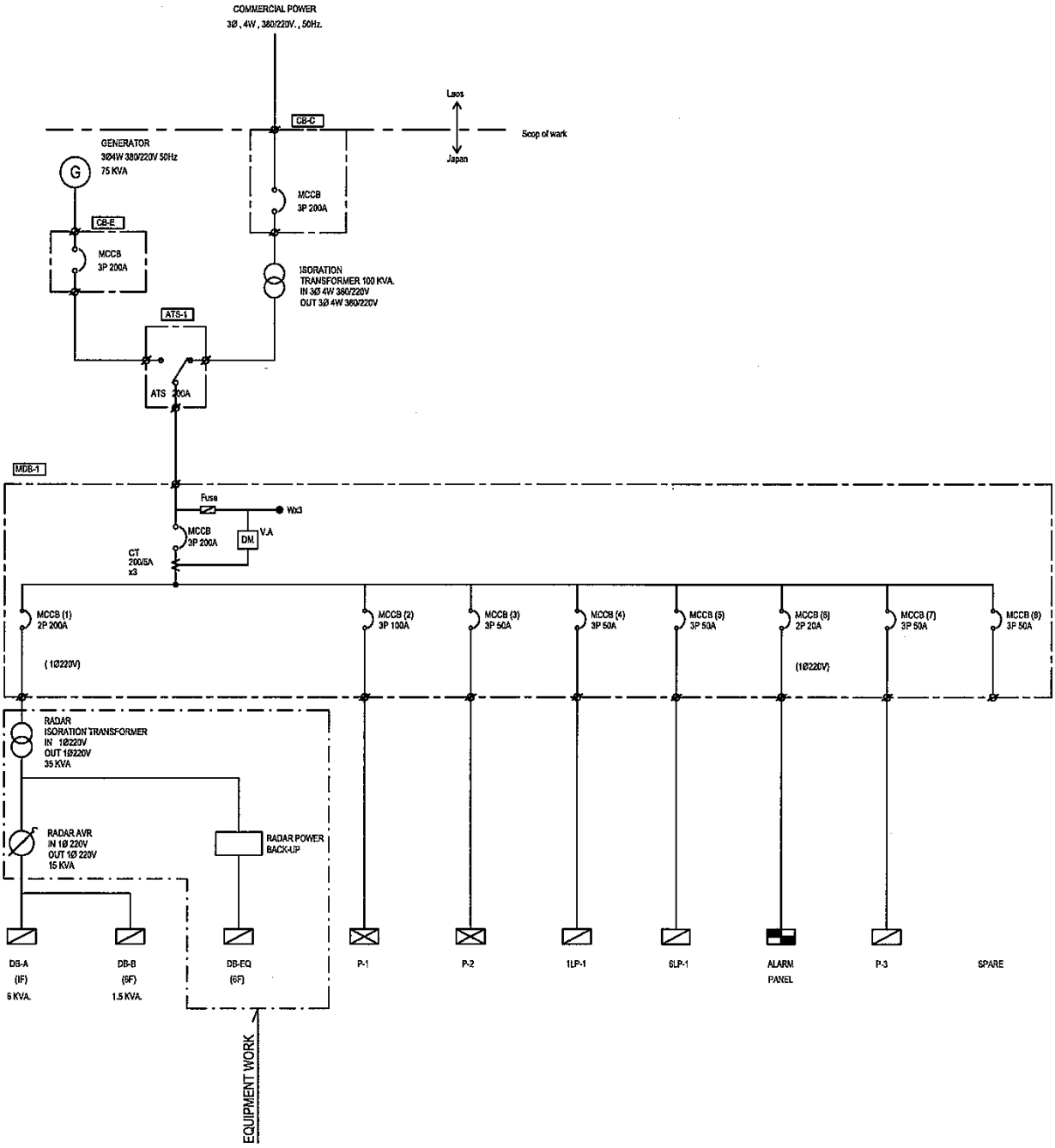
- Outside condition: 35°C (maximum temperature)

- Indoor condition: temperature 26°C humidity 40-60%
  In the radar equipment room: 25°C humidity 40-60%

The following diagrams of the building equipment plan for the radar tower building are attached from the next page.

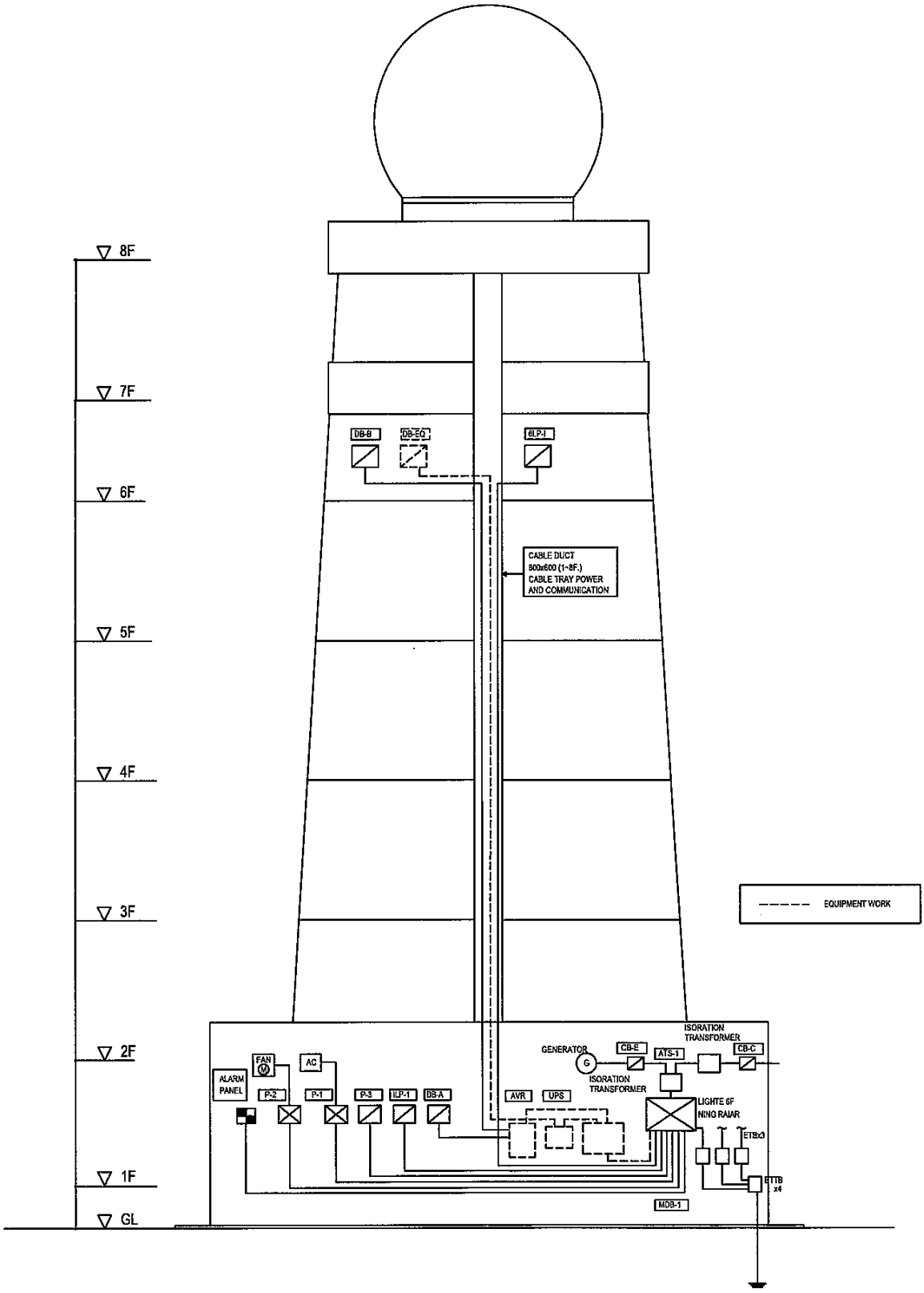
- Power Receiving System Diagram Diagram 1
- Feeder & Power System Diagram Diagram 2
- Telephone & Intercom System Diagram Diagram 3
- Fire Detection System Diagram Diagram 4
- Alarm System Diagram Diagram 5
- Lightning Protection & Grounding System Diagram Diagram 6
- Obstruction Light System Diagram Diagram 7
- Water Supply & Sewage System Diagram Diagram 8
- Air-conditioning & Ventilation System Diagram Diagram 9

Diagram 1



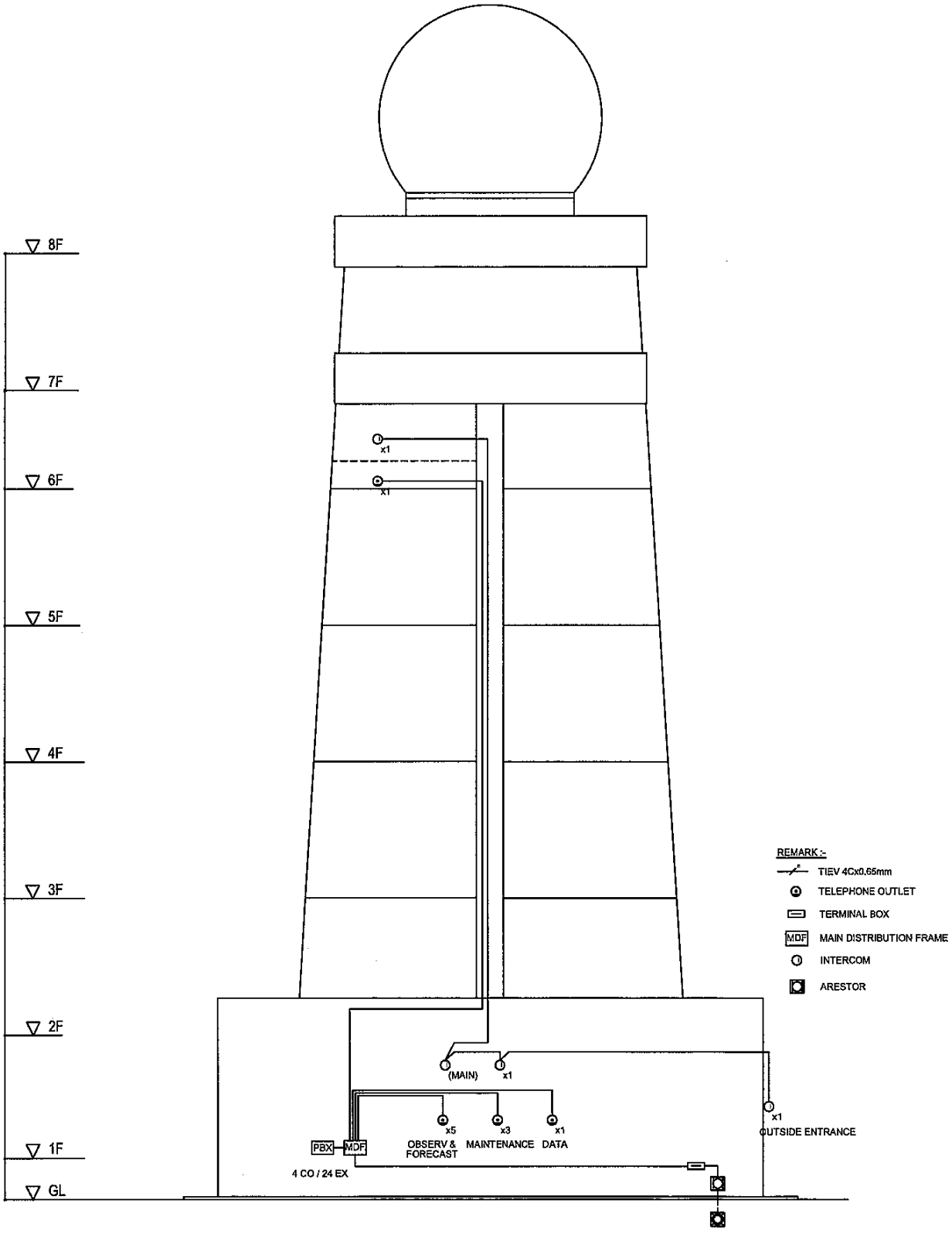
Power Intake System Diagram

Diagram 2



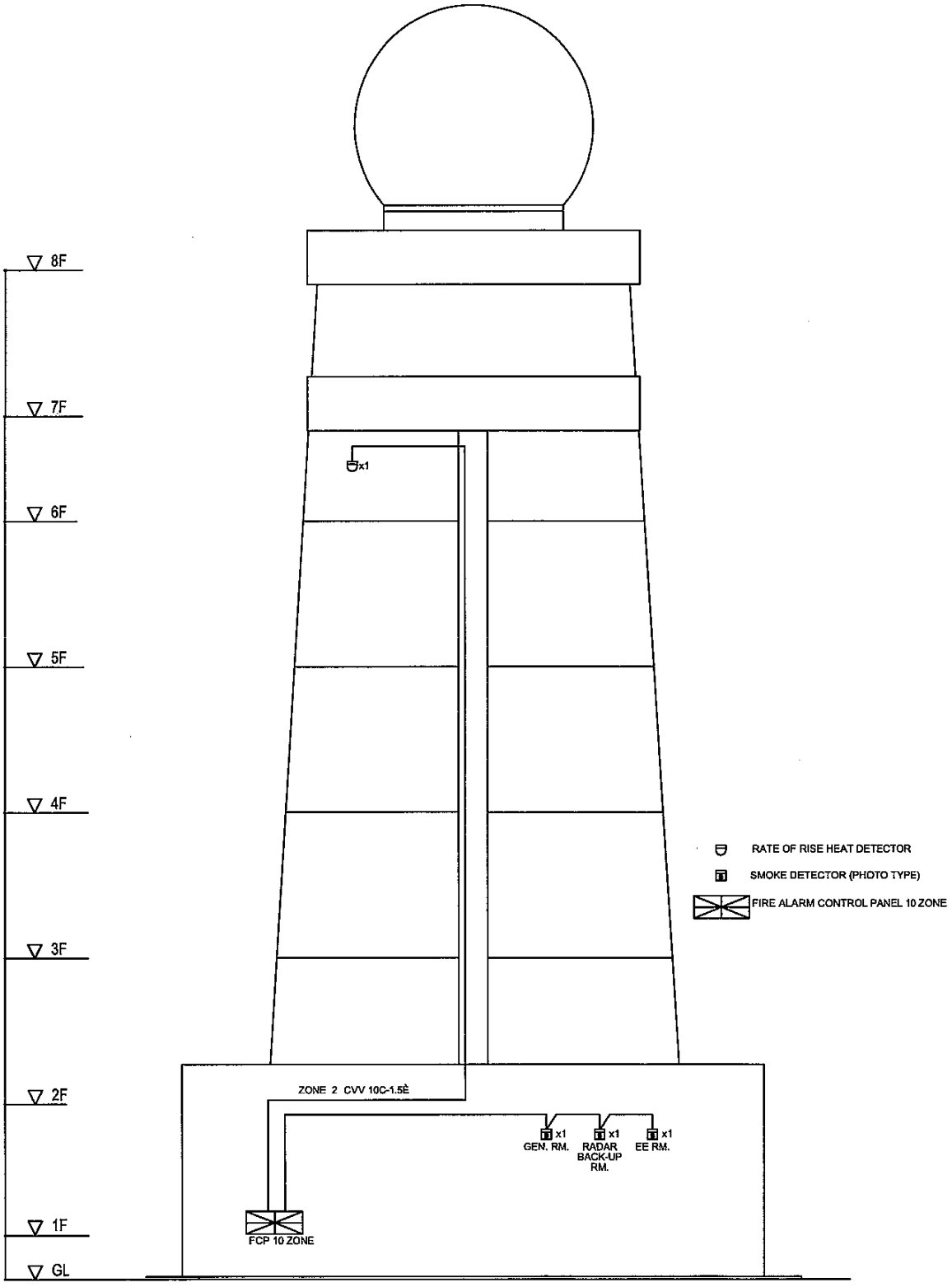
Feeder & Power System Diagram

Diagram 3



Telephone & Intercom System Diagram

Diagram 4

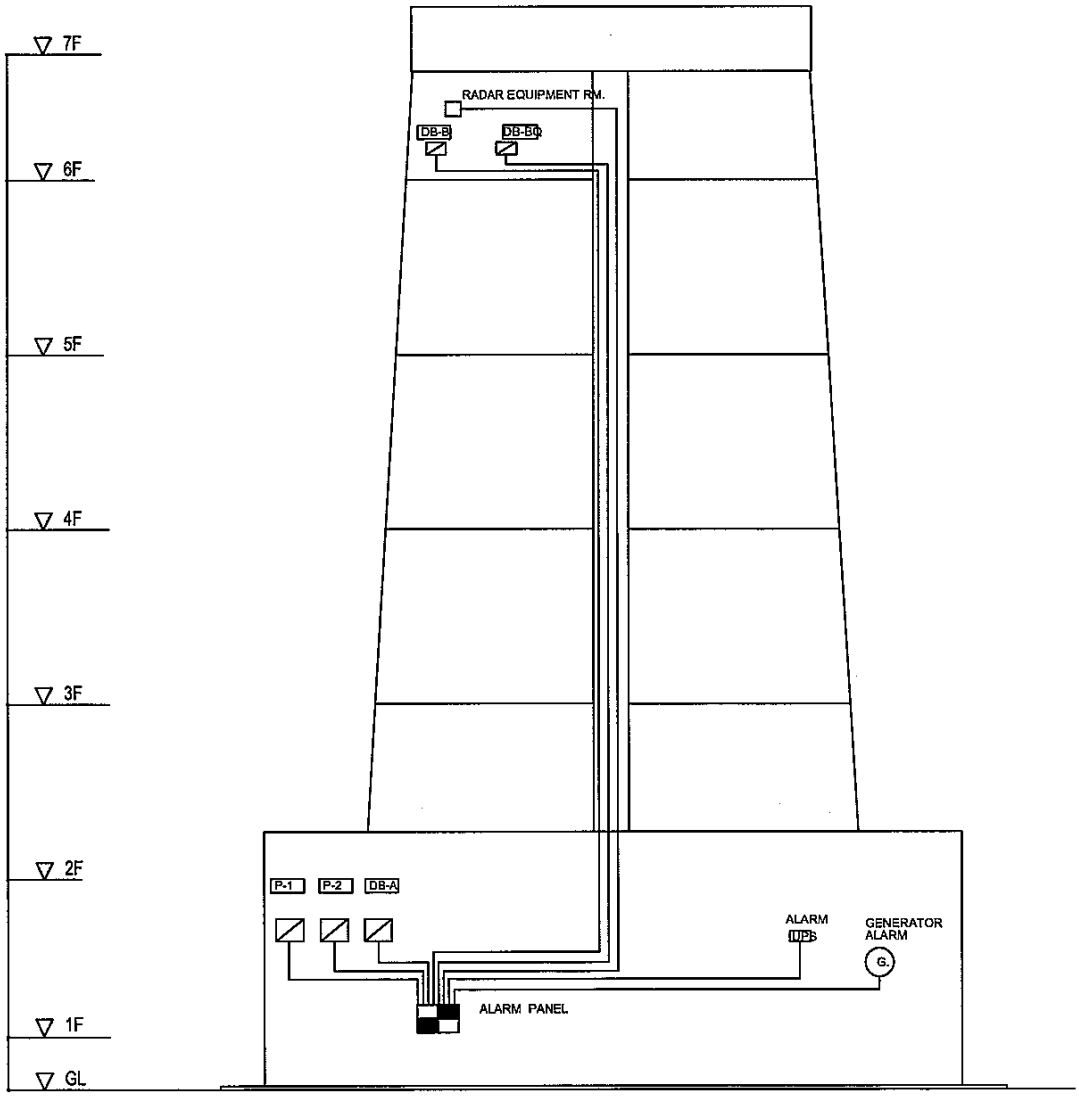


Fire Detection System Diagram

Diagram 5

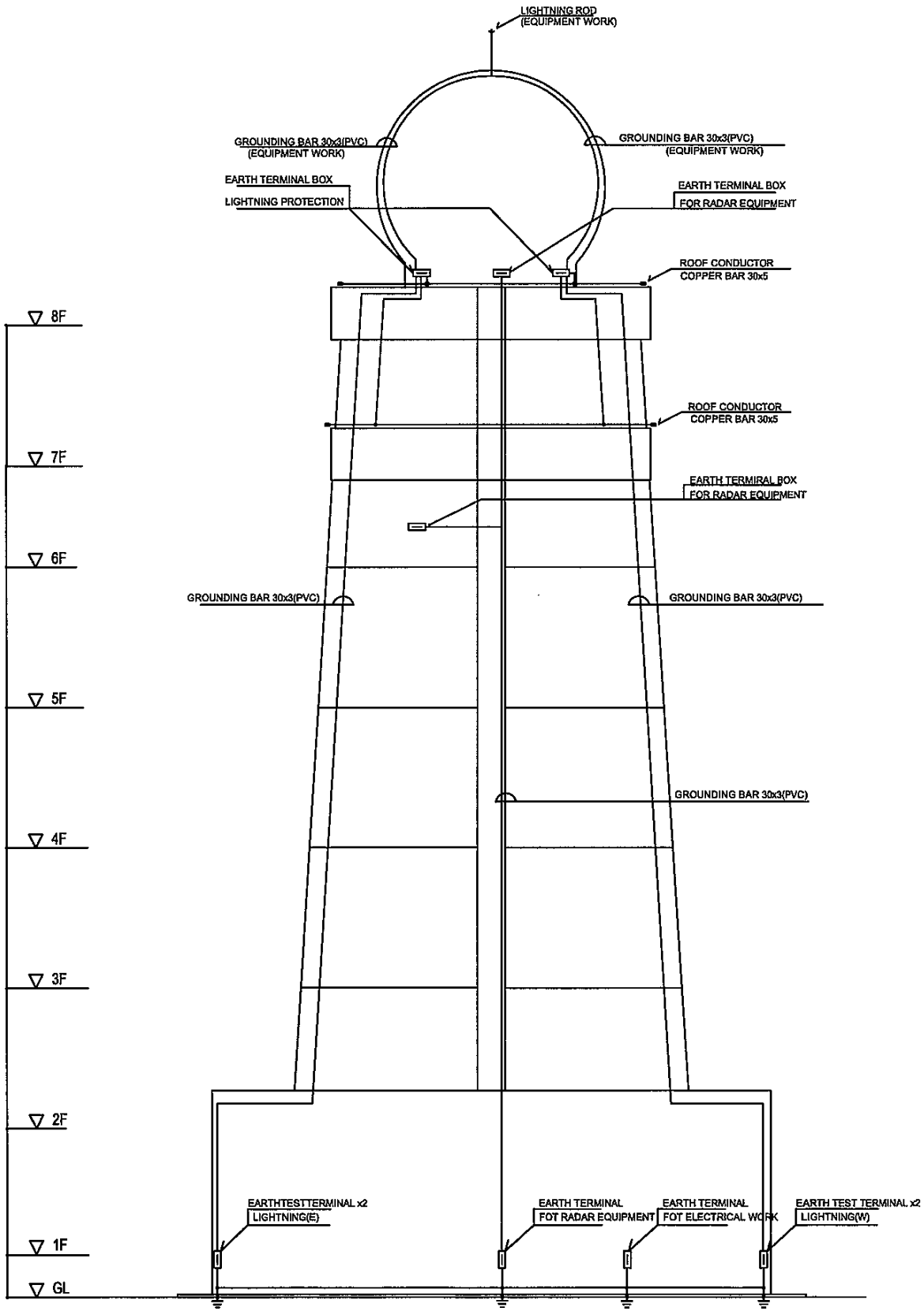
ALARM LIST

SYSTEM	ALARM
GENERTOR	ALARM
RADAR TOWER BACKUP UNIT	ALARM
DB-A	COMMON ALARM
P-1	COMMON ALARM
AIR-CON 6F RADAR EQUIPMENT ROOM	AIR CON. ALARM
P-2	COMMON ALARM
DB-B	COMMON ALARM
DB-EQ	COMMON ALARM



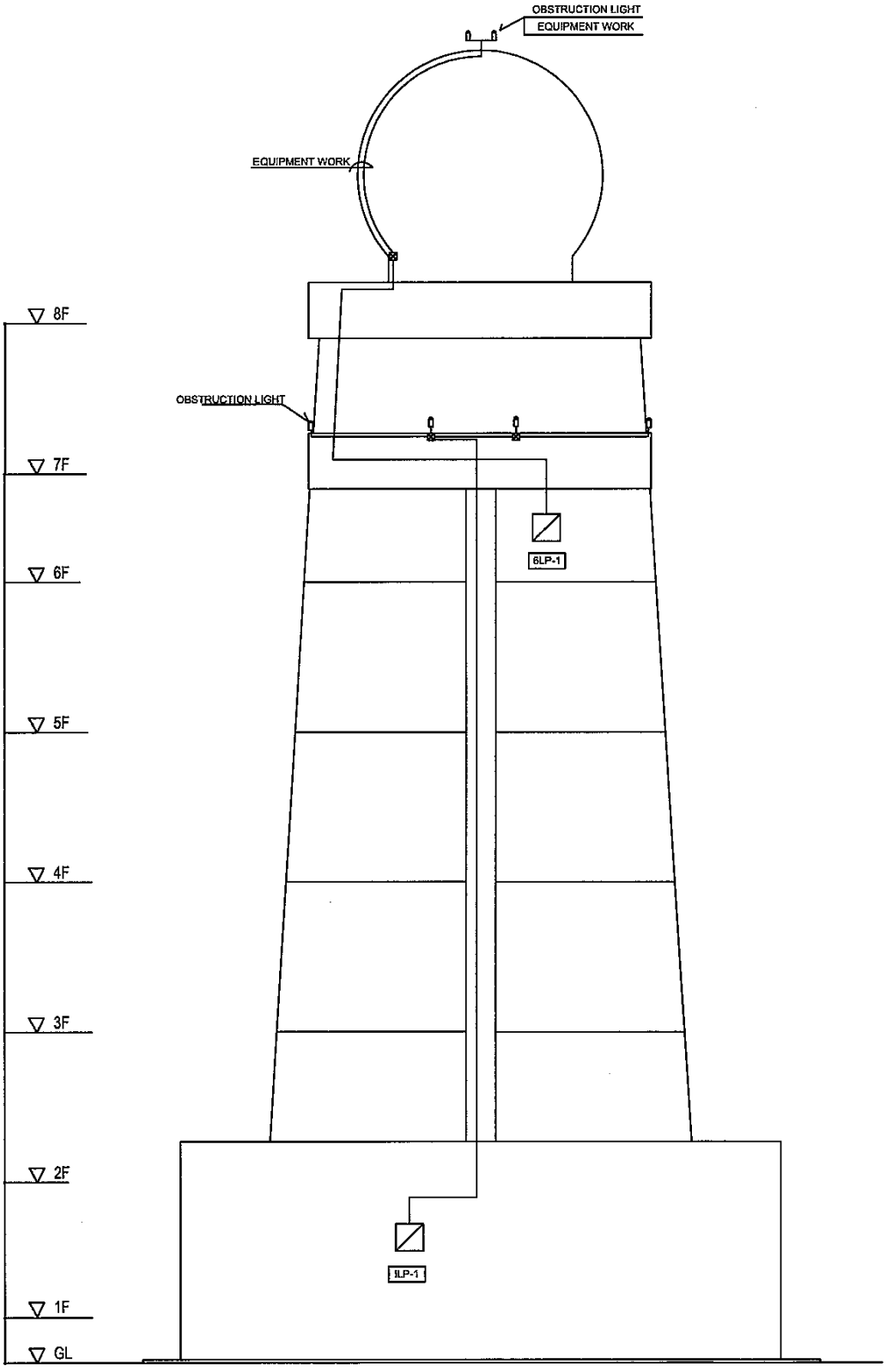
Alarm System Diagram

Diagram 6



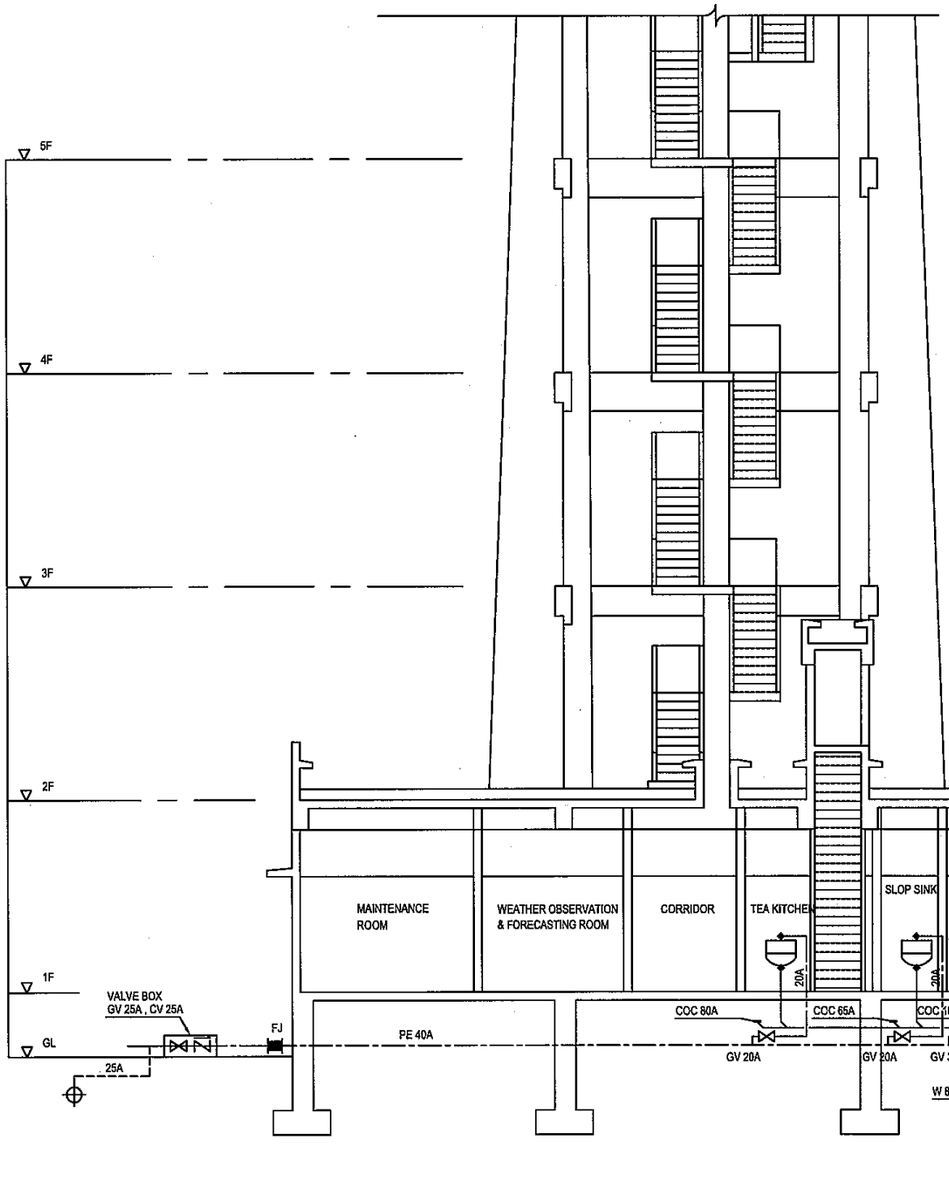
Lightning Protection & Grounding System Diagram

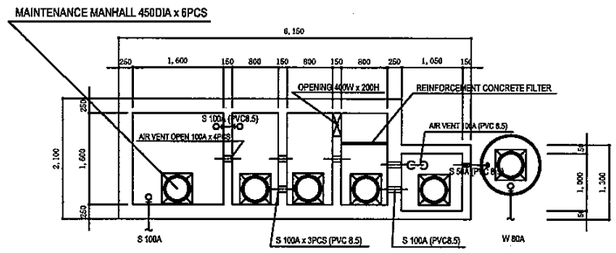
Diagram 7



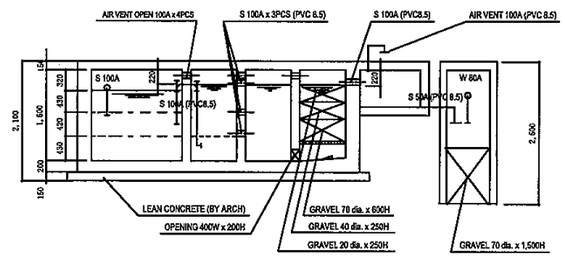
Obstruction Light System Diagram

Diagram 8

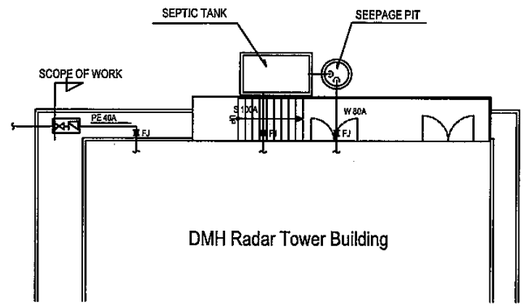




SEPTIC TANK & SEEPAGE PIT PLAN

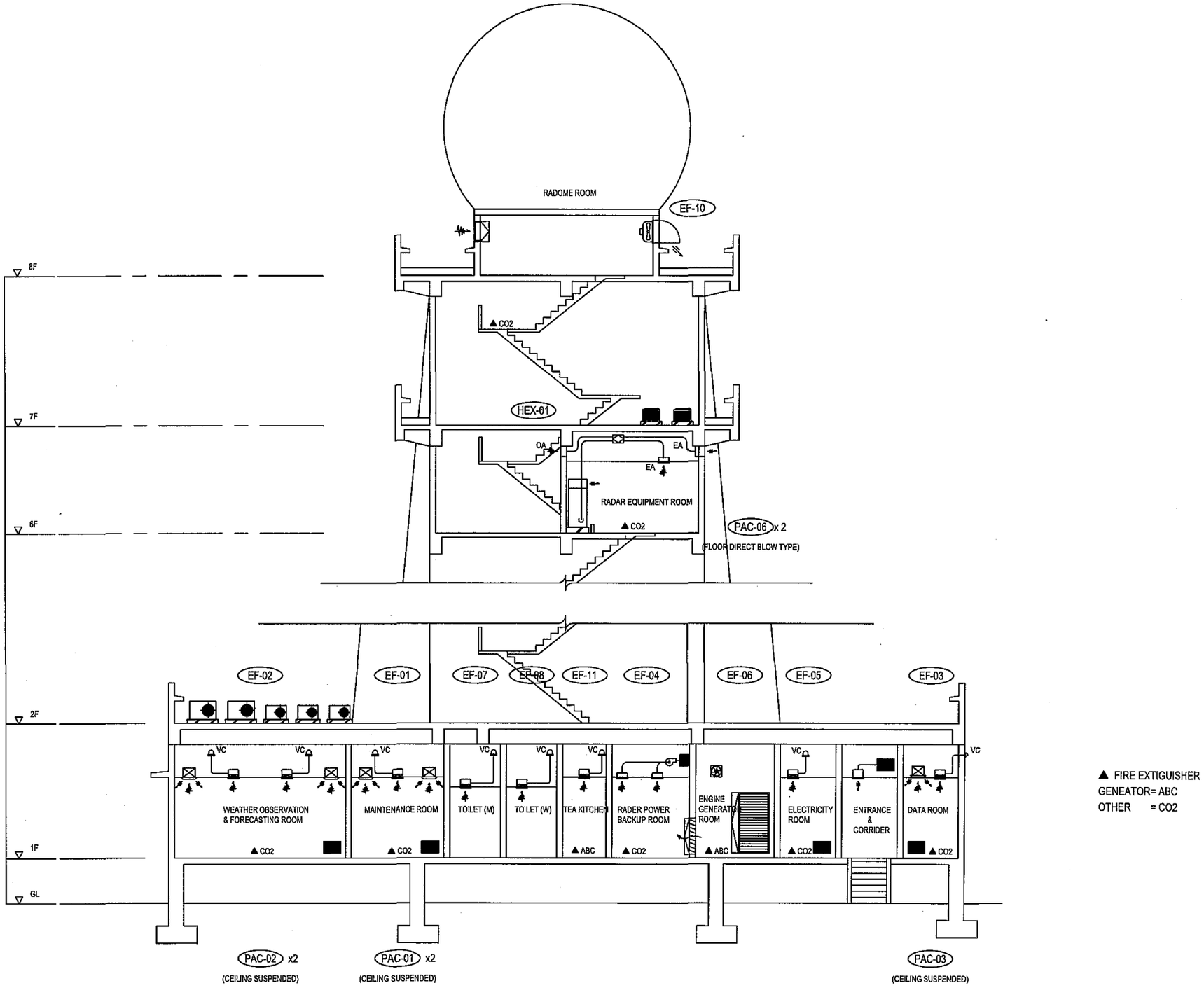


SEPTIC TANK & SEEPAGE PIT SECTION



Water Supply & Sewage System Diagram

Diagram 9



▲ FIRE EXTIGUISHER
GENEATOR= ABC
OTHER = CO2

Air-conditioning & Ventilation System Diagram