MONGOLIA MINISTRY OF NATURE AND ENVIRONMENT
NATIONALAGENCY FOR METEOROLOGY,
HYDROLOGY AND ENVIRONMENT MONITORING

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR NATURAL DISASTER REDUCTION IN MONGOLIA

JANUARY, 1998

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN WEATHER ASSOCIATION

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PREFACE

In response to a request from the Government of Mongolia the Government of Japan decided to conduct a basic design study on the Project for Natural Disaster Reduction in Mongolia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from 9th of August to 30th of August, 1997.

The team held discussions with the officials concerned of the Government of Mongolia, 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 Mongolia 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 Mongolia for their close cooperation extended to the teams.

January 1998

Kimiaki Fujita

President

Japan International Cooperation Agency

January, 1998

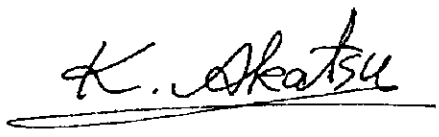
Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Natural Disaster Reduction in Mongolia.

This study was conducted by Japan Weather Association, under a contract to JICA, during the period from July 31, 1997 to January 16, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mongolia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

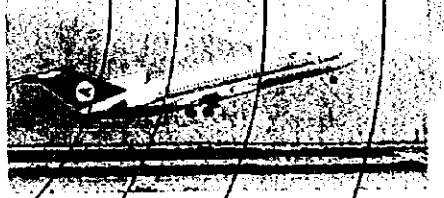
Finally, we hope that this report will contribute to further promotion of the project.

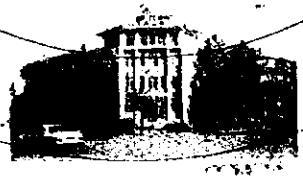
Very truly yours,

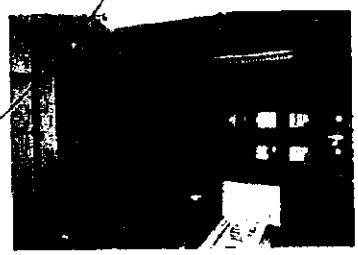


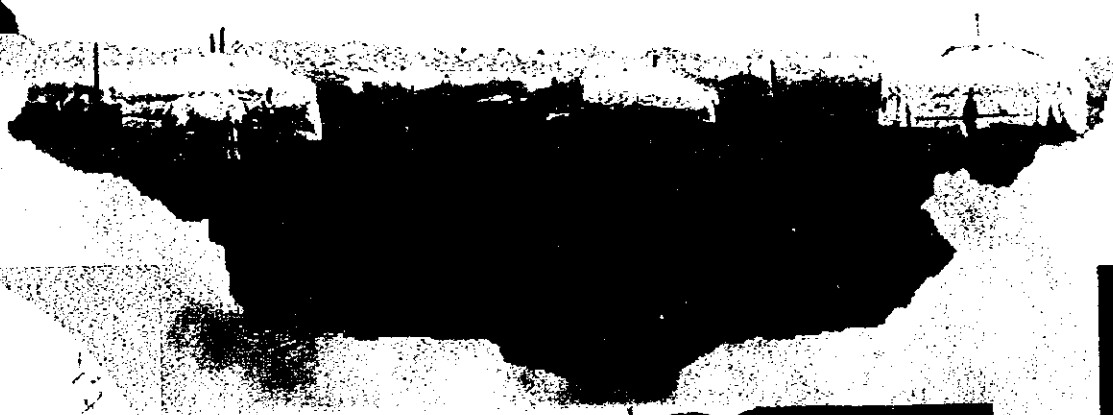
Kunio Akatsu
Project manager,
Basic design study team on the Project for
Natural Disaster Reduction in Mongolia
Japan Weather Association

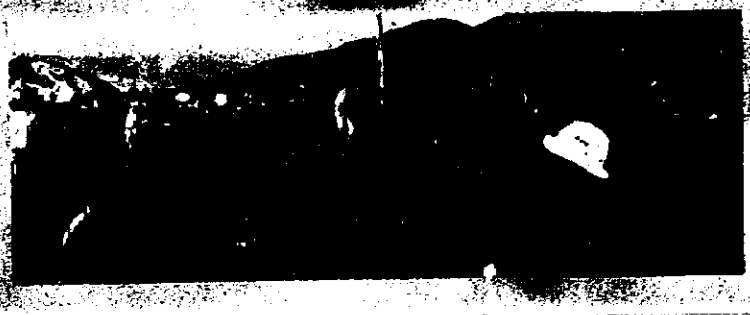
THE PROJECT FOR NATURAL DISASTER REDUCTION IN MONGOLIA

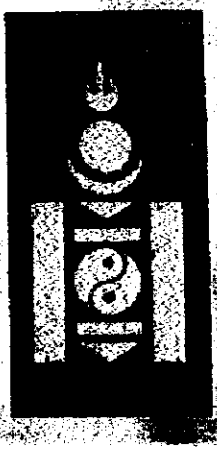


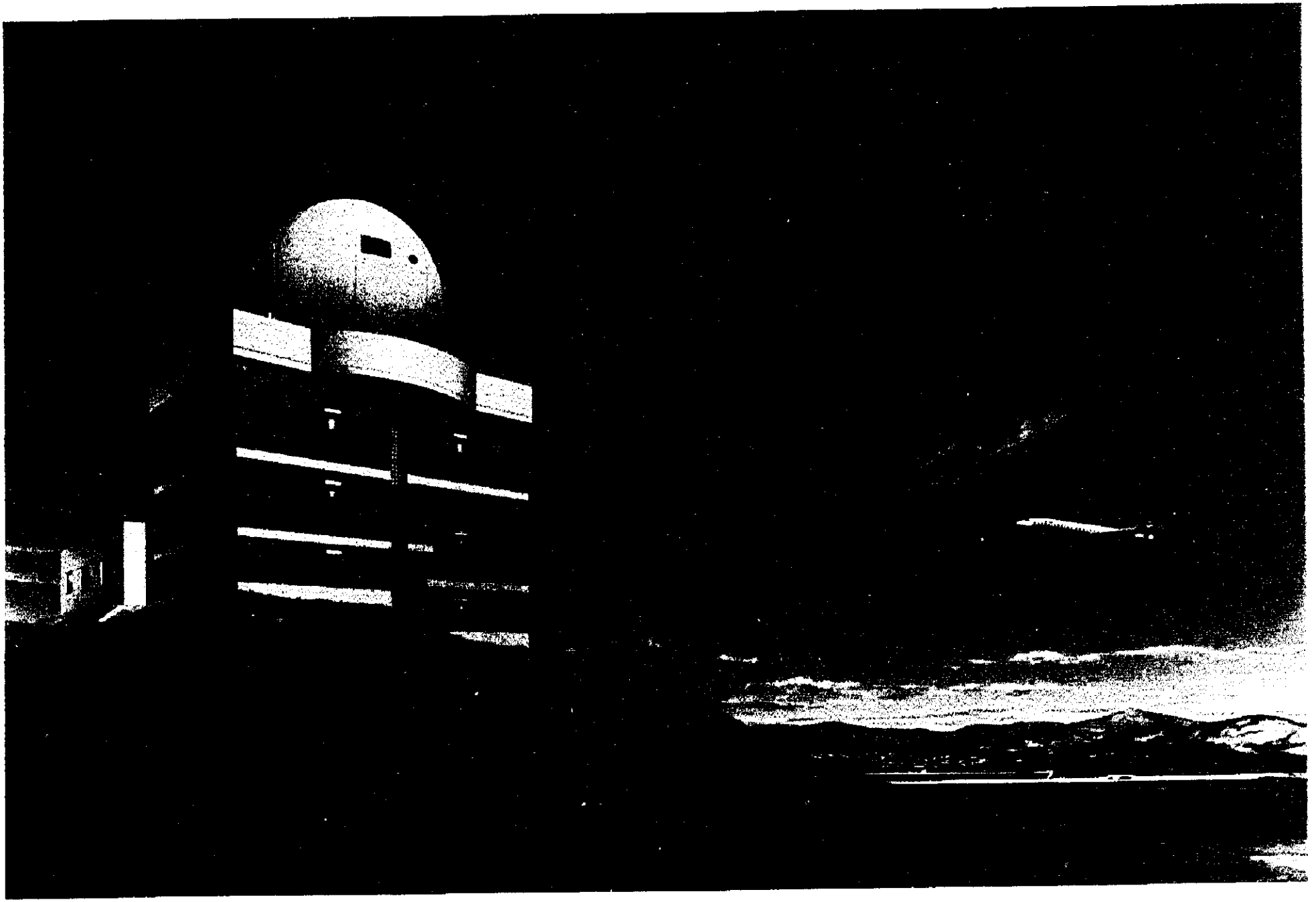






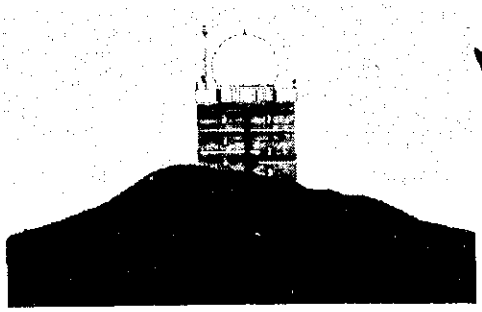






Morin-Uul Radar Tower Building

The Project for Natural Disaster Reduction in Mongolia

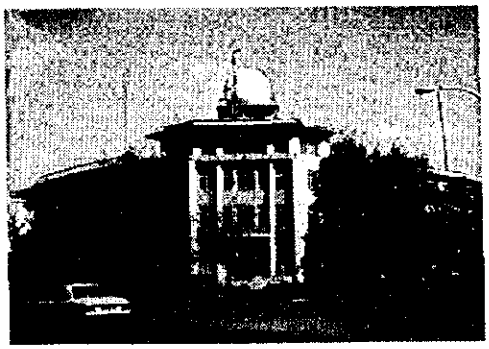


Meteorological Radar & Automatic Weather Observation Station at Morin-Uul

Microwave Link

Ulaanbaatar International Airport

Microwave Link

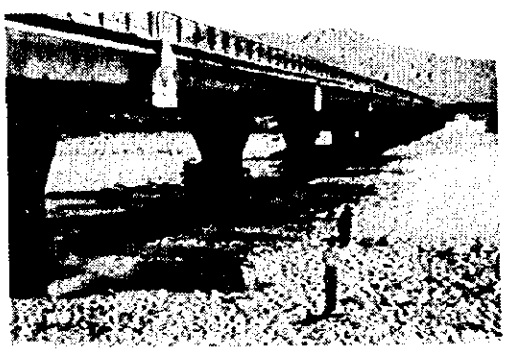


NAMHEM

UHF Link

Microwave Link

Radio & TV Center



Tuul River Water Level Monitoring Station

Contents

Appendices

Chapter 1
Background of the Project

Chapter 1 Background of the Project

- Climate Features -

Mongolia is a landlocked country sandwiched between Russia and China and it has several mountain ranges, the highest being the Altai mountains, located in the far west. Much of southern and eastern Mongolia is occupied by a vast plain or grassland. The so-called Gobi region, Mongolia's semi-desert, lies in the south. The high Central Asian mountain ranges surrounding Mongolia on practically all sides form a formidable barrier against the humid masses of air moving from the Atlantic and the Pacific, thus establishing the dominance of a continental climate in Mongolia. The climate is continental with sharply defined seasons, extreme annual diurnal temperature fluctuations and low rainfall. Because of the high altitude, Mongolia's climate is generally colder than that of countries at the same latitude.

The typical climatic features are sharp temperature fluctuations with the maximum annual amplitudes reaching 90° in Ulaanbaatar. Even the daily temperature may fluctuate by 20°~30°C. The coldest month is January and the hottest month is July . In some regions, for instance in the northern part of the Khuvsgul Aimak, the temperature drops to between 45° and 52° below zero.

- Economy -

Mongolia is taking first steps towards grater diversification of its external trade with free market economies and the establishment of market-oriented economic systems. The country is experiencing economic failure and other difficulties during this transition period even now. After, Perestroika in the former Soviet Union and democratic changes in Eastern Europe to create a favorable external environment, in the year 1990, Mongolia held the first free elections in its eighty years of modern history and has taken important steps toward pluralistic and democratic society and the path of democratization of the political system of the country and of transition to a market economy had been chosen by Mongolia. At present the national economy of the country is experiencing a crisis. The economic crisis started in 1990 and reached its peak during 1991 and 1992. The Major causes for such a great decline are as follows. Firstly, the fact that the assistance and credits which were rendered by the former Soviet Union ceased, the terms and character of the cooperation and foreign trade had changed radically, secondly, the process of introducing a new system of macro-economic management has been stretched out.

Mongolia's severe climate, geographical spread and limited physical infrastructure make delivery of basic social services a daunting task. While the Government of Mongolia has focused on

stabilization of the economy, control of inflation, administrative reform and economic restructuring. Efforts to alleviate poverty are necessary to ensure macro-economic stability and sustained growth with equity.

- Natural Disaster -

Mongolia is frequently exposed to different types of natural disaster, such as snow and dust storm, drought, zud, flood, flash flood, wildfire, heavy snow, plant diseases, and etc. and it is obvious that the natural disasters carry the highest potential for loss of life and property, and severely affect the agricultural sector, specially livestock breeding, the basic economic sector of the country. Regrettably, the extensive damage from natural disasters is the determining factor for significant set-back of national economy and development activities of Mongolia. The Government of Mongolia is continuing to raw the attention to natural disaster reduction related issues as before although the country is in deep economic crisis, now.

The Government of Mongolia is responsible for all activities (planning and implementation) related to prevention and mitigation of, and combat to, all types of natural disaster, and relief. In 1990, the Government of Mongolia established the State Permanent Emergency Commission (SPEC) by its resolution No.276 in order to introduce coordinated activities among the government agencies against any type of natural disaster.

Measure to combat natural disasters are organized jointly or separately by "Civil Defence Board", "Ministry of Nature and Environment", "Ministry of Defence", "Ministry of Trade & Industry", "Ministry of Health, Ministry of Food & Agriculture", "National Agency for Meteorology, Hydrology & Environment Monitoring (hereinafter referred to as NAMHEM)" and others under the guidance of SPEC.

The SPEC has the following functions :

- Preparation of a National Disaster and Calamities Preparedness Plan ;
- Organization of disaster coordinating down to the ministerial and local governmental level ;
- Coordination of relief activities and taking measures to reduce consequences ;
- Organization of reconstruction or rehabilitation measures ;
- Disaster mitigation activities.

As regards hydrometeorological services, Mongolia is still at its early stage of development, and hence National Agency for Meteorology, Hydrology & Environment Monitoring (NAMHEM) is expected to continuously play the leading role in providing more accurate

forecasts and authentic warnings for the reduction of natural disasters in the county. NAMHEM is mainly responsible for national meteorological and hydrological services in Mongolia. Its main duties are recording meteorologicl observation round the clock and providing weather information necessary for mitigation and prevention of the natural disasters and development of the socio-economic activities of Mongolia. NAMHEM also provides meteorological information for unirrigated agriculture, pasture animal husbandry, mining and manufacturing industries, aviation as scheduled, and daily weather forecasts to the general public on radio and television. Concerning impending natural disaster in the area, NAMHEM provides warnings and advisories to as many as all administrative divisions, concerned agencies and mass media, and is now striving for the improvement of its capabilities for natural disaster warning service in order to meet the increasing national and regional demand for natural disaster prevention. This situation urgently requires that NAMHEM should upgrade the weather observation, forecasting and warning facilities and also weather information dissemination system to the general public to match with people's demand and to meet the function and responsibility as the national meteorological organization in Mongolia under World Meteorological Organization (WMO).

- Necessity of Improvement for Meteorological Services in Mongolia -

Sustainable and suitable development of the country, it depends on very close links between the weather condition and economy due to physiography, economic structure and climatic specific condition. NAMHEM provides various kinds of weather information through mass communication to the nation as the national hydrometeorological organization in the country and is always trying to improve the reliability of the forecasting and warnings in order to prevent and reduce natural disasters. However, the improvement of the meteorological facilities has not yet been achieved mainly because of budgetary problems.

The existing radar system made in Soviet (Russia) was established in 1978. It was already been passed approximately 20 years and time has now come to initiate necessary action for its replacement. Due to collapse of the Union of Soviet Socialist Republics, production of radar system has been discontinued and there is no possibility for procurement of the spare parts and consumables from Russia, thereby, the existing radar system will stop in the very near future. The existing radar system does not have the function of atmospheric turbulence surveillance. It is located at the top of mountain approximately 200m higher than the runway just behind Ulaanbaatar International Airport.

For safety operation of aviation and reduction & prevention of natural disasters, replacement of the existing radar system is required. The proposed meteorological radar system must have

the functions of rain & hail surveillance and atmospheric turbulence surveillance, because there were domestic airplane crash in the recent years and weather condition such as snow storm, atmospheric turbulence, etc. was surely one of the causes of such airplane crash. In the other hand, the airport complex of Ulaanbaatar International Airport has been extended to meet the future requirement as an international airport.

For expediting the national economy and development activities of Mongolia and for safety operation of civil aviation, it is necessary to protect Ulaanbaatar, the capital city of Mongolia and the International Airport, the entrance gate of Mongolia from the natural disasters which carry the highest potential for loss of life & property and the great damage to socio-economy. The air transport services are expected to play a very important role in the implementation of the Government's plans for economic recovery through an expansion of trade and tourism with inclusion of overseas partners. In this way the objective of economic and social development in Mongolia will be furthered.

After the implementation of the Project, the weather monitoring system of NAMHEM will be strengthened, the position and intensity of severe meteorological phenomena will be determined more accurately and timely. Besides, the accuracy and the reliability of meteorological warnings related to natural disasters will be improved. And it is expected that overall standard of meteorological information will be in better position, and NAMHEM will thus be able to contribute in a greater perspective to reduction of the natural disasters. Further, the improvement of observing, forecasting & disseminating systems as the result of this Project will highly enhance NAMHEM's activities and will put NAMHEM in a position to play its due role in the economic development of Mongolia.

Chapter 2
Contents of the Project

Chapter 2 Contents of the Project

2 - 1 Objectives of the Project

The objective of the Project is to contribute to;

i) the prevention and reduction of natural disasters in Mongolia, especially in and around Ulaanbaatar by improving and strengthening capability for weather observation and forecasting of disastrous meteorological phenomena, and

ii) the improvement of the safety of civil aviation operation and of people's life & property by providing more accurate weather forecasts and warnings.

Because it is necessary to protect Ulaanbaatar, the capital city of Mongolia and the International Airport, the entrance gate of Mongolia from the natural disasters which carry the highest potential for loss of life & property and the great damage to agriculture, pasture animal husbandry, mining and manufacturing industries and aviation. Regrettably, the extensive damage from natural disasters is the determining factor for significant set-back of the national economy and development activities of Mongolia.

For safety operation of civil aviation and reduction & prevention of natural disasters and also for expediting the national economy and development activities of Mongolia, it is indispensable to improve observing, forecasting & disseminating activities and facilities of National Agency for Meteorology, Hydrology and Environment Monitoring (NAMHEM) through the introduction of;

i) advanced meteorological surveillance radar and automatic weather observation system to be located at Morin-Uul, Ulaanbaatar for observing weather conditions and monitoring hazardous weather phenomenon,

ii) meteorological data transmission systems for data transmission,

iii) water level telemeter system at Tuul river for flood monitoring,

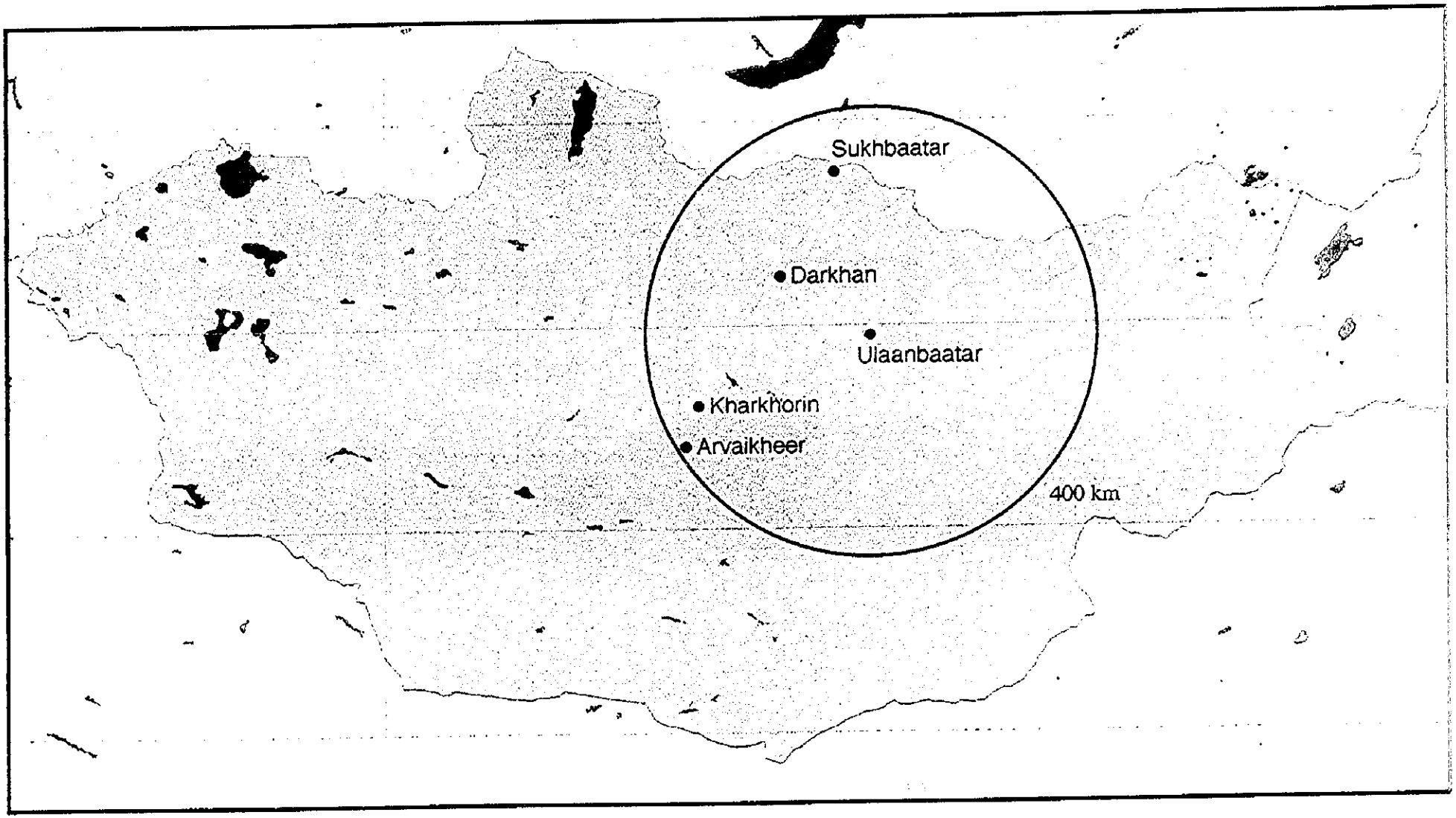
iv) weather warning siren system in Ulaanbaatar and

v) broadcasting equipment for disseminating meteorological information to general public under the Project.

Since the facilities of NAMHEM are likely to be improved greatly by the Project, NAMHEM will be capable of contributing effectively to the mitigation and prevention of damages and

losses by natural calamities like prolonged snowfall, snow storm, hail, heavy rain, flash flood, thunderstorm, strong wind, etc. in Mongolia. Further, the improvement of observing, forecasting and disseminating system as a result of the Project will highly enhance the NAMHEM's activities and will put the NAMHEM in a position to play its due role in the economic development of Mongolia.

"Covering Range of Morin-Uul Radar Network" is shown hereunder.



COVERING RANGE OF MORIN-UUL WEATHER SURVEILLANCE RADAR

2 - 2 Basic Concept of the Project

The Government of Mongolia has officially requested the following systems for implementation of the Project.

(1) Construction of a radar tower building for a new radar system at the Morin-Uul radar site.
(2) Replacement of the existing radar system made in Russia at Morin-Uul Radar site and provision of a new meteorological surveillance radar system which has two functions of rain surveillance and atmospheric turbulence surveillance.
(3) Installation of automatic weather observation system at the Morin-Uul radar site.
(4) Establishment of water level telemeter system at Tuul river for water level surveillance.
(5) Establishment of radio data transmission systems between National Agency for Meteorology, Hydrology and Environmental Monitoring (NAMHEM) and the following sites.
    a. Morin-Uul radar site
    b. Ulaanbaatar International Airport
    c. Radio & TV Center
    d. Water Level Telemeter Station
(6) Provision of equipment of weather information broadcasting through Radio and TV.
(7) Installation of weather warning siren system for the general public.
(8) Provision of meteorological training equipment.

In connection with all the systems as described above, the study and investigation have been held in Mongolia and Japan. In accordance with the result of the study, the basic concepts of the Project are as follows.

(1) Construction of a radar tower building

In accordance with the structural strength confirmation giving consideration of dead load and wind load, the existing tower building is not suitable for a new radar system, because of weight of a radar antenna (1.5 tons) and a radome (3 tons) (total weight : 4.5 tons). Thereby, it is necessary to construct a new radar tower building to be adjacent to the existing building for installation of the following weather surveillance radar system at Morin-Uul radar site.

Main required rooms are as follows.

① Radar equipment room	② Radar observation room	③ Analysis room
④ Maintenance room	⑤ Spare parts room	⑥ Operation room
⑦ Electricity room	⑧ Water & septic tanks room	⑨ Engine generator room
⑩ Store room		

(2) Replacement of the existing meteorological surveillance radar system at Morin-Uul

The existing radar system made in Soviet (Russia) was established in 1978. It has already been passed more than 19 years and time has now come to initiate necessary action for its replacement. Due to collapse of the Union of Soviet Socialist Republics, production of radar system has been discontinued and there is no possibility for procurement of the spare parts and consumables from Russia. Thereby, the existing radar system will stop in the very near future and it is sure that replacement of the existing radar system is necessary.

The existing radar system does not have the function of atmospheric turbulence surveillance. It is located at the top of Morin-Uul mountain approximately 200m higher than the runway just behind Ulaanbaatar International Airport. For more accurate and speedy surveillance of hazardous weather phenomenon within a circle area of 400 km radius at the center as Ulaanbaatar and for safety operation of civil aviation and reduction & prevention of natural disasters in and around Ulaanbaatar, replacement of the existing radar system is surely and timely required and the new meteorological radar system must have two functions of rain & hail surveillance and atmospheric turbulence surveillance. In consequence of discussion with NAMHEM, C band (wave length : approx. 5cm) radar system has nominated for the Morin-Uul radar site due to suitability on the local meteorological condition.

(3) Installation of automatic weather observation system

Ulaanbaatar International Airport is surrounded by hills (mountains) on three sides. At the present, there is an automatic weather observation system at the runway touch point for observation of weather condition of the airport. However, due to the above said geographical condition and inconvenient location, there is great anxiety about an occurrence of wind shear (a variation in wind velocity at right angles to the wind's direction). Because, during landing and take-off, an air craft is in instability position and it is very delicate for wind shear and other hazardous weather condition.

Therefore, it is required to install an automatic weather observation system at Morin-Uul radar site under the Project for making comparative observation between the existing automatic weather observation system and new one to be located at Morin-Uul radar site for surveillance of wind shear and other hazardous weather condition for safety operation of air-traffics, and also all necessary observation elements (wind speed, wind direction, temperature, humidity, precipitation and pressure) shall be observed by this system. For receiving all necessary data from this system at the airport meteorological office, airport control tower, area control room and NAMHEM, meteorological telecommunication network will be established under the Project together with optical fiber cable network in the airport of Civil Aviation Authority.

(4) Establishment of meteorological telecommunication links

1) Necessary meteoroological telecommunication links

For transmitting weather information, data and radar imagery, establishment of the following four telecommunication links are required for the Project.

① Morin-Uul radar site ⇆ Ulaanbaatar International Airport
② Morin-Uul radar site ⇆ NAMHEM
③ NAMHEM ⇆ Radio & TV Center
④ NAMHEM ← Tuul River Water Level Monitoring Station

For establishing telecommunication links of ①, ② and ③, microwave link (2Mbps) will be required for transmitting weather information, data and radar imagery.

For receiving water level of Tuul River at Ikh Tenger Bridge, UHF telecommunication system for ④ link will be established under the Project.

2) Frequency of meteorological telecommunication system

In consequence of the discussion with Ministry of Infrastructure Development, Communication Department and the basic design study in Mongolia, there are sufficient vacant frequencies in Mongolia, therefore, 2GHz band for digital microwave links and 400MHz band for UHF link to be established under the Project will probably be allocated.

(5) Provision of weather information broadcasting system at Radio & TV Center, Ulaanbaatar

At present, weather information program on TV in Mongolia is neither so attractive nor enough to meet the people's demands.
In order to prepare an attractive weather program by Mongolian Radio & TV Center, visible images such as radar images and other weather information will be required. Using the weather information broadcasting system, Mongolian Radio & TV Center will be able to provide understandable and attractive weather program for the people of Mongolia. After completion of the Project, it is expected that it will efficiently make appropriate benefit to the people of Mongolia.

(6) Establishment of water level monitoring system at Tuul river for water level surveillance

For monitoring water level of Tuul river and provision of timely and accurate water level information to NAMHEM for flood and a water shortage forecasts & warnings, establishment of a water level monitoring system with UHF telecommunication system at Ikh Tenger Bridge, Ulaanbaatar, will be necessary for the safety of people's lives and properties.

(7) Installation of weather warning siren system at NAMHEM

For detecting and monitoring natural calamities at frequent intervals to forecast their intensity and land-fall more accurately, the meteorological radar system will be able to ensure continuous supply of rainfall distribution, intensity and movement, cloud echoes, atmospheric turbulence and other necessary information to NAMHEM and also the water level monitoring system will be able to provide movement of water level of Tuul river. In case of emergency and an evacuation warning of a flash flood due to a heavy rain is required to the general public, NAMHEM can switch on the weather warning siren system.

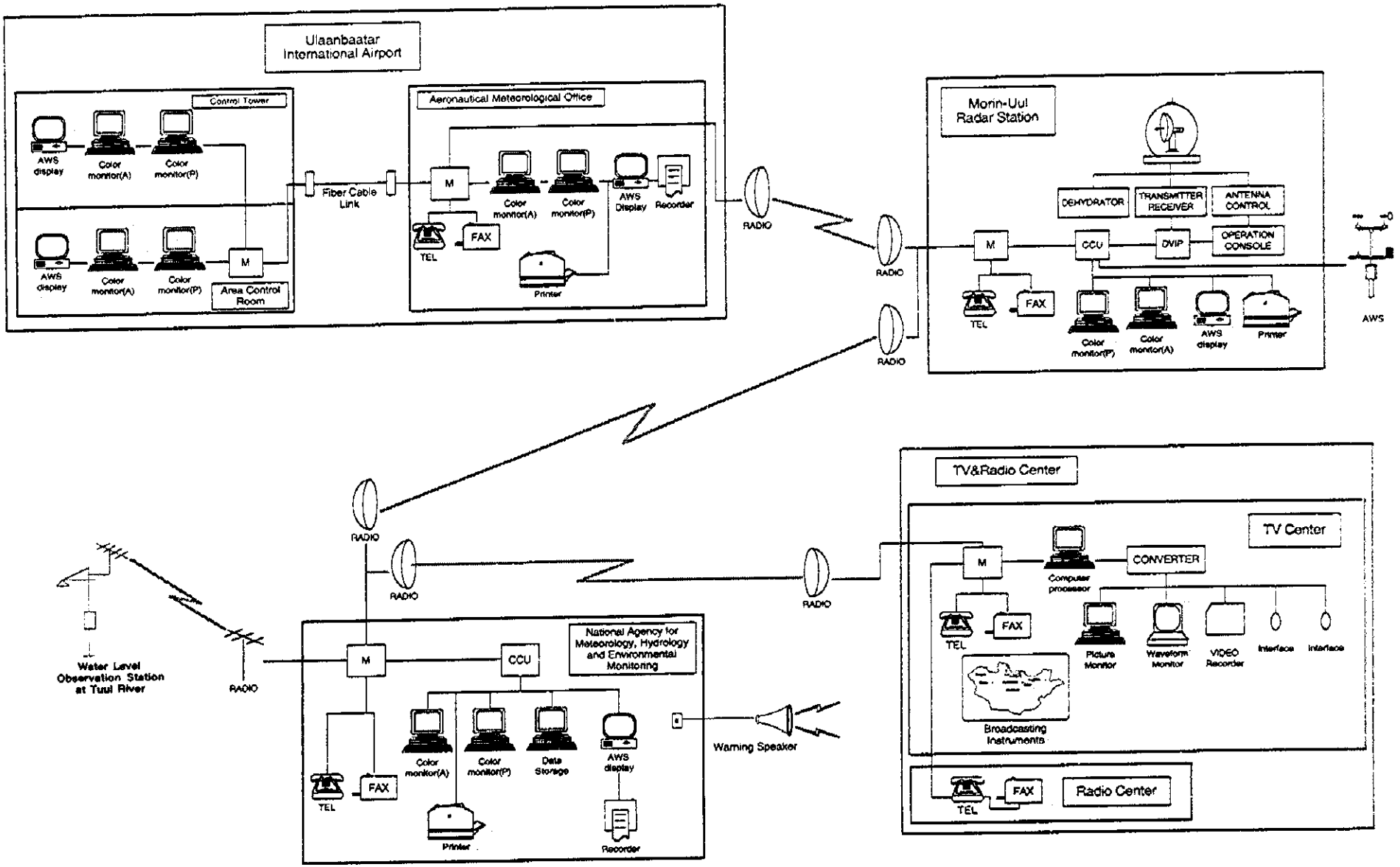
(8) Provision of meteorological training equipment

Meteorological Department, National State University, Ulaanbaatar has a total enrollment of between approximately sixty and seventy students and almost of graduates enter into NAMHEM. For acquiring skills and measures of operation and maintenance for the automatic weather observation system to be installed at Morin-Uul radar site under the Project, the same system should be supplied to the Meteorological Department, National State University under the Project

as meteorological educational equipment. In addition, the Meteorological Department is used for providing a training to the staff of NAMHEM. Therefore, this educational automatic weather observation system will be very useful for upgrading of technical level of meteorology in Mongolia.

If this Project is implemented, the facilities of NAMHEM will greatly be improved and thus NAMHEM will be capable of contributing effectively to the mitigation and prevention of natural disasters, damages and losses by natural calamities like prolonged snowfall, snow storm, hail, heavy rain, flash flood, thunderstorm, strong wind, sand storm, drought, etc. in Mongolia. Further, the improvement of observing, forecasting and disseminating system as a result of the Project will highly enhance the NAMHEM's activities and will put NAMHEM in a position to play its due role in the economic development of Mongolia.

"Project Configuration" is attached on next page.



Project Configuration

2 - 3 Basic Design

2 - 3 - 1 Design Concept

1. Design Concept of the Equipment

The basic design concept of all the systems to be installed under the Project are as follows.

a. To design all equipment to conform operation and maintenance systems and technical capabilities of NAMHEM.

b. To attempt to make appropriate compatibility and suitability between the equipment to be supplied under this Project and the technical requirements of World Meteorological Organization (WMO).

c. To apply, whenever possible, digital communication system as the meteorological telecommunication links for transmitting radar imagery to minimize a loss of radar imagery quality as much as possible.

d. To consider NAMHEM's technical level and structure of operation & maintenance for the systems.

e. To minimize recurrent costs of operation and maintenance for the equipment at NAMHEM.

2. Design Concept of the Buildings

1) Building Plan : "Radar Tower Building"

Based on the future plans of the NAMHEM, the design concept is to make building and facility plans for achieving duties as meteorological radar facility which are to become operating bases for weather radar observation.
The Plan is to construct meteorological radar tower building at Morin-Uul that will ensure appropriate and effective operations and accommodate the required systems, equipment and manpower.

The basic concept is to design the meteorological radar tower building incorporating with the following eight functions.

a. To be capable of carrying out various meteorological services as the "Meteorological Radar Tower Building."

b. To provide necessary environment where services to be performed effectively and efficiently in accordance with the flow of the meteorological services.

c. To be capable of responding to the service curriculum, with forecasting and observation sections on 24 hour shifts.

d. To be furnished with suitable equipment (Uninterrupted Power Supply system and Auto Voltage Regulator, etc.) for performing the meteorological services of 24 hours a day, 365 days a year, in round-the-clock operation.

e. Having the mission of supplying uninterrupted radar observation and weather forecast & warning even during heavy rain, flooding, etc., the radar tower building is to be sufficiently robust with adequate countermeasures taken against natural disasters.

f. To be capable of adapting to the meteorological radar system and other related equipment to be supplied under the Project.

g. To be capable of adapting to the meteorological services as duties of the national meteorological organization and the staff members.

2) Structural Plan

In order to withstanding natural disasters (especially strong wind, heavy rain and flooding), the safe and economical structural design is to be applied, and local structural materials are selected wherever possible. For design and selection of the foundation structure, the results of accurate soil investigations at the Project site of Morin-Uul are applied and also adhesion measures must be taken against a bedrock.

3) Building Equipment Plan

Building equipment required for the round-the-clock operation throughout the year, and the implementation of uninterrupted radar observation and forecasting & warning even during heavy raining and snowing, are to be planned. The equipment is to be selected from the viewpoint of easy operation and maintenance, taking safety and economy into consideration. In addition, special consideration to sever cold weather will be required for building heating and air-conditioning systems.

4) Construction Plan

By using the materials available in the local markets in Mongolia and applying local construction methods, an appropriate and economical construction plan is to be established.

5) Reduction of Operation, Maintenance and Administration Cost

The size and grade of the building is to be appropriately decided so as to avoid imposing any undue technical or financial burdens on the NAMHEM with respect to ongoing operations and maintenance after completion of the building construction. Therefore, reliable and economical construction materials should be selected for the building and also easy local procurement of the materials should be considered for the future maintenance.

3. Design Concept for Implementation Schedule

For smooth implementation of the Project to be carried out by Japan's Grant Aid Assistance, the Client, NAMHEM should be fully conversant with the required procedures. This Project will be first project of NAMHEM under Japan's Grant Aid Assistance, therefore, for smooth implementation of the Project under Japan's Grant Aid Assistance, NAMHEM must has a good understanding on all the necessary procedures.
Regarding the implementation schedule of the Project, actually, there is no sufficient time spare. Because the construction period is supposed to be totally 8 months, however, in the winter season of Mongolia, it is impossible to implement any construction and civil work due to Mongolia is located in the sever cold area in the world. Since a part of the building construction work period may fall within the winter season, therefore, the construction schedule must be split into 2 stages as described in the implementation schedule for avoiding such situation. The dead

line of the Project implementation period is supposed to be by March, 2,000. To avoid the Project delay and to keep the time schedule, the cooperation of both countries, accordingly, is essential to smooth Project implementation and the Consultant should then coordinate closely in connection with advance procedures and preparations together with the Client.

4. Design Conditions

1) Meteorological Equipment System

a. Meteorological Radar System

i) The detecting capability of meteorological radar is determined by such factors as height of installed radar antenna, angle of radar beam transmitted from the antenna (radar beam angle), curvature of the earth and height of meteorological phenomena bearing precipitation (height of cumulonimbus cloud normally is 6 ~ 12 km). For surveillance and monitoring of hazardous meteorological phenomena, the meteorological radar will be designed to have 400 Km radius observation range.

ii) The meteorological radar system is designed to have two functions of rain & hail surveillance and atmospheric turbulence surveillance, individually. Due to suitability on the local meteorological condition, C band (wave length : approx. 5cm) radar system has nominated for the Morin-Uul radar site and also for more accurate observation and monitoring of precipitation and atmospheric turbulence, 5m diameter antenna is selected to make narrow radar beam angle, approximatly 1 degree.

b. Automatic Weather Observation System

Automatic weather observation system to be installed at Morin-Uul radar site for surveillance of wind shear and other hazardous weather condition for safety operation of air-traffics, which will consist of the following equipment. For receiving all necessary data from this system at the airport meteorological office, airport control tower, area control room and NAMHEM, microwave telecommunication link will be established under the Project.
The functions of all the necessary equipment shall meet the following requirements as described below.

- To meet the standards of World Meteorological Organization and International Civil Aviation Organization (ICAO)

- To receive the following data of observation elements.
  - Wind speed & direction
  - Temperature
  - Humidity
  - Precipitation
  - Pressure

c. Meteorological Telecommunication System

The meteorological telecommunication systems to be established under the Project must meet the ITU-R recommendations of International Telecommunication Union (ITU).

① Circuit quality

Circuit quality of the digital radio link must conform to the ITU-R recommendation of F.556 (7/86), while bit error rates (hereinafter referred to as "BER") must satisfy the following conditions.

i) The number of duration when the BER exceeds 10^{-3} not exceed 0.054% in any month.
ii) The number of duration when the BER exceeds 10^{-6} not exceed 0.4 % in any month.
iii) The error duration in any month not exceed 0.32%.

② Radio frequency

The radio frequency shall be in the 2 GHz and 400MHz band and also shall meet the ITU-R recommendation of F.283-5 (6/90).

③ Height of Antenna

The height of the antenna shall be considered, in so far as possible, an effective earth radius coefficient of K= 4/3 and the clearance coefficient which shall be at least 1.0.

④ Design Specifications

	Transmission links to be established	Distance of the links
i)	Morin-Uul radar site ~ Ulaanbaatar International Airport	3.9km
ii)	Morin-Uul radar site ~ NAMHEM	17.3km
iii)	NAMHEM ~ Radio & TV Center	2.1km
iv)	NAMHEM ~ Tuul River Water Level Monitoring Station	4.2km

Transmission links of " i, ii. and iii." as described above shall meet the following requirements.

- Radio frequency : 2GHz
- Transmission capacity : 2 Mbps
- Modulation method : 4 PSK
- Transmitter output : + 27 dBm
- Minimum receiving input (10^{-3} BER) : - 93.5 dBm
- Antenna
  - Diameter : 0.9 m ~ 1.2 m (i & iii), 1.2 m ~ 1.8 m (ii)
  - Gain : 22.5 dB, 25.3 dB or 28.5 dB

Transmission link of " iv " as described above shall meet the following requirements.

- Radio frequency : 400MHz
- Transmission capacity : 6 Ch
- Modulation method : FM
- Transmitter output : + 30 dBm
- Minimum receiving input (10^{-3} BER) : - 80 dBm

The antenna gain shows a standard value, as determined in accordance with the diameter and radio frequency. Minimum receiving input shows an average value.

DC power supply is intended to furnish power from a storage battery to prevent interruptions in power supply to the newly installed digital radio equipment in case of commercial power failure. Accordingly, the storage battery will be capable of supplying the power for 4 hours.

The Project sites include Ulaanbaatar International Airport, where establishment of meteorological telecommunication links will be held under the Project and so serious consideration must be given to achieving mutual accommodation between the equipment to be installed and the existing facilities, particularly as regards the airport facilities, control tower, internal-airport communication, radio facilities and underground lines, as well as aircraft landing, takeoff, and taxiing patterns.

d. Weather Information Broadcasting System

In order to broadcast meteorological information to the general public as weather information program for reduction of natural disasters, weather information broadcasting system will be installed at Mongolian Radio & TV Center. The weather information broadcasting system will convert digital signal of radar imagery & weather information to be received by the meteorological telecommunication system to video signal for broadcasting as a weather program.

e. Water Level Monitoring System

Tuul river is frozen over in every winter season. For monitoring water level of Tuul river and provision of accurate water level information to NAMHEM, the water level monitoring system using an ultrasonic water level sensor with UHF telecommunication system will be established at Ikh Tenger Bridge, Ulaanbaatar. The ultrasonic water level sensor is very suitable for a sever cold area, because it can be keeping out of touch with river water.

f. Weather Warning Siren System

Whenever it is required to disseminate a warning to the general public in Ulaanbaatar, the weather warning siren system is utilized. In case of emergency and an evacuation warning of a flash flood due to a heavy rain is required to the general public, NAMHEM can switch on the weather warning siren system with a directivity.

g. Meteorological Training Equipment

For acquiring skills and measures of operation and maintenance for the automatic weather observation system to be installed at Morin-Uul radar site, the same system as the meteorological training system will be supplied to the Meteorological Department, National State University under the Project. The functions of the equipment shall meet the following requirements as described below.

- To meet the standards of World Meteorological Organization and International Civil Aviation Organization (ICAO)

- To receive the following data of observation elements.
  - Wind speed & direction
  - Temperature
  - Humidity
  - Precipitation
  - Pressure

- Data storage computer system and display monitor.
  The data storage computer system will be useful for meteorological data processing & analysis educational program and radar meteorological educational program using radar imagery of Morin-Uul radar system to be supplied under the Project. And also in the near future, it will be able to connected to the Internet.

2) Design Conditions for the Radar Tower Building

The following design conditions will be considered in connection with the facility and equipment plans.

a. Facility Plan

In connection with the meteorological radar building plan, sufficient space must be provided to allow NAMHEM staff for working efficiently and also to appropriately accommodate and utilize the systems and equipment at both the new and existing facilities.

The appropriate size and scale of radar tower building is determined on the basis of the staff, system and equipment required to carry out the functions, role and operations of a meteorological radar system for accurate weather observation.

The number of rooms and floor areas of the radar tower building is designed on the basis of the administration structure, personnel requirements, systems, equipment, and operating space established under this Project, taking into account the present conditions of NAMHEM (i.e., in terms of the existing systems, equipment, and operating space).

b. Building Equipment Plan

The power supply requirements for the building must be sufficient to support the systems and equipment needs established under the Project, along with general lighting, air-conditioning systems, heating systems and other necessary equipment for the building.

In assessing the capacity of air-conditioning systems, the heating values of the personnel using the space, the newly established systems and equipment, lighting and other heat-generating items and thereby determine the methods and types of air-conditioning systems and also in assessing the capacity of heating systems, outside temperature, freezing and condensation in the winter season must deeply be considered to determine the methods and types of heating systems.

With regard to the power supply systems, 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 natural disasters, the power supply system must include an uninterrupted power supply system and engine generator system to ensure proper operation of the meteorological systems and equipment.

2 - 3 - 2 Basic Design

1. Equipment Plan

The objectives of the project are to improve the observing, forecasting and disseminating system of NAMHEM through the introduction of latest meteorological surveillance radar (observation range : 400km) with 2 functions of rain & hail surveillance and atmospheric turbulence surveillance and automatic weather observation system at Morin-Uul for observation and surveillance of weather conditions and hazardous weather phenomenon, meteorological data transmission systems, water level monitoring system at Tuul river for flood monitoring and also weather information broadcasting system at Radio & TV Center & weather warning siren system for disseminating meteorological information & warning to general public.

In addition, in order to disseminate the Project effect and benefit to the Mongolia nation as soon as possible through improvement of NAMHEM's capability of meteorological observation and data ingestion and also strengthening the meteorological forecasting and warning for reduction of natural disasters, it is necessary to provide the following systems under the Project.

1) Meteorological surveillance radar system at Morin-Uul
2) Automatic weather observation system at Morin-Uul
3) Meteorological telecommunication links
4) Weather information broadcasting system at Radio & TV Center, Ulaanbaatar

5) Water level monitoring system at Tuul river
6) Weather warning siren system at NAMHEM
7) Meteorological training equipment

Regarding the equipment designation, specifications, quantity and purpose of all the meteorological equipment to be supplied under the Project are described in "Major Equipment Lists" attached hereunder.

Table2 - 8 Major Equipment List (1/2)

(1) Weather Surveillance Radar (Radar Equipment will be installed at Morin-Uul Radar Site, monitoring systems will be installed at International Airport, NAMHEM, TV Center)

Equipment Designation	Specifications	Quantity	Purpose
(a) Weather Surveillance Radar System			
Radome	Diameter: about 9m, Spherical shape , Maximum wind speed resistance: 70m/s Base ring, lightning arrester attached	1	To protect the radar antenna assembly and shelter maintenance personnel from severe weather conditions. A lightning arrester will be attached to the top of the radome for protection from lightning.
Antenna Assembly	Diameter about 5m Parabolic antenna Beam width: Less than 1. 2 Gain: 42 dB or more Equipped heating system	1	The parabolic antenna will rotate over an azimuth of 360° and at an angle of elevation of 0~45° in either direction. The waves transmitted from the transmitter/receiver will be radiated in pencil-beam form into the atmosphere, receive the scattered waves returning from the precipitation particles, and return these waves back to the transmitter/receiver unit.
Antenna Control Unit	Dual-axis scan (rotation in azimuth) Horizontal scan : 360°, 4 rpm Vertical scan : -2 ~ 60°, about 15 seconds Angle precision (accuracy) :0. 3° or less	1	Based on an antenna control signal pursuant to the radar observation mode, this unit drives the horizontal and vertical antenna motors, controlling the azimuth and elevation of the antenna.
Transmitter / Receiver	Transmitting frequency: C- band Transmitting power : 250 kW Pulse repetition frequency : 260 Hz Minimum detectable signal : 110 dBm or less Dynamic range : 60 dB or more Phase Detector	1	The microwave power emitted at the transmitter section is sent to the antenna as the transmitting wave, while a video signal is obtained in response to the strength of the receiver wave. After being converted to a digital value, the video signal is outputted to the signal processor (digital video integrator and processor).
Digital Video Integrator and Processor	Digital video input : 12 bits Ground clutter rejection : 40 dB or more Range correction : 4 ~ 175 Km Averaging over range / polar coordinate / address calculation on Cartesian coordinate (using range and azimuth angle on the polar) Input data: 8 bits, 400 km range	1	After converting the video signal from the receiver into a digital value, ground echo rejection, averaging of the received signal echo intensity correction for distance, and other processing is performed, yielding 8-bit video data, which is then inputted into the data transmission apparatus.
PPI Indicator (Radar control and monitoring display)	Scan Converter Method Other superimposed display of map and range marks Automatic / manual observation controls	1	PPI Indicator indicates positions and intensity of rain echoes on the monitor display by using the signal data from T/R. Operator can monitor the appropriateness of the signal processing system between an antenna and T/R.
Operation Monitoring Unit	Color CRT, 20 " or over Automatic observation capability Switchover capability to existing radar units (dual control) CPU: EWS Hard Disk: 2 Gbyte RAM: 64 MB or more Network : Ethernet and TCP/IP support	1	After conversion of 8 bit video data from polar to Cartesian coordinates, based on the angular values for the existing antennas, displays are shown freely over the subject range. Scheduled observations are performed automatically to compose the data observed at radar station. In order to realize the functions of existing data equipment, the equipment will have switchover capability between the scheduled observation mode and the application mode for the existing radar installations

Table2 - 8 Major Equipment List (2/2)

(1) Weather Surveillance Radar (Radar Equipment will be installed at Morin-Uul Radar Site, monitoring systems will be installed at International Airport, NAMHEM, TV Center)

Equipment Designation	Specifications	Quantity	Purpose
Dehydrator	Normal pressure level : 195 hPa Upper level of pressure for wave guide : 295 hPa Lower level of pressure for wave guide : 70 hPa Air provision ability : 2 liter/min. or more	1	The wave guide, connecting the antenna and the transmitter receiver, is filled with drop and pressurized air so as to reduce and stabilize the wave propagation loss
Connection Wave Guide	WR159	1	Connection Wave Guide connects between an antenna and T/R for the propagation of radio with minimum loss.
Automatic Voltage Regulator	Capacity : about 7.5 kVA Input : AC 230V ± 20%, single-phase, 50 Hz Output : AC 200V ± 3 %, single-phase, 50Hz	1	This item will be used to stabilize power supply voltage to insure stable operation of the radar assembly
Uninterrupted Power Supply	Capacity : about 15 kVA Input : AC 200V ± 10%, single phase, 50 Hz Output : AC 100V ± 2 %, single-phase, 50Hz Backup time: at least 10 minutes at full load	1	Short-term power backup will be provided to prevent operating errors or damage to the radar facilities as a consequence of brief interruptions in the commercial power supply.

(b) Radar Image Monitoring System			
Color Monitoring Display	Color CRT, 20 " or over Automatic observation capability Switchover capability to existing radar units (dual control) CPU: EWS Hard Disk: 2 Gbyte RAM: 64 MB or more Network : Ethernet and TCP/IP support	8	These equipment will receive the image data observed at radar station and will superimpose and display this data, together with the map displays and range marks. It will also accumulate, play back, and print the received imagery. It will display intensity of rain and turbulence separately. These equipment will be installed at the radar site, the international airport, NAMHEM and TV Radio Centre.
Data Converter	Digital sampling : 12 bits Distance intervals for digital sampling : 250 m equivalent Equal echo processing range: 4 ~ 256 km Address calculations on polar / Cartesian coordinates Output data : 8 bit, 400 km range	1	Data Converter installed at radar site will received the data from DVIP. It will process and analyze data for producing the image of intensity of rain and turbulence of atmosphere and then will pass them to Color Monitor Displays through network system.
(c) Network System			
Computer Network System	LAN Network : Ethernet Router Modem Printer	1	Each system will be connected each other by Ethernet LAN. Computer Network system will be installed at the radar site, the international airport, NAMHEM and TV Radio Centre.
UPS	Capacity : 1kVA Input : AC 220 V ± 10 %, single-phase, 50 Hz	1	To protect computer equipment, fitted with a hard disk, from total blackout or short interruptions in the commercial power supply.

Table2 - 8 Major Equipment List (1/1)

(2) Communication System

(Communication system will be installed at Morin-Uul Radar Site, International Airport, NAMHEM, TV Center)

Equipment Designation	Specifications	Quantity	Purpose
Multiplex Radio Equipment	Frequency range : 2 GHz band Line capacity : 2 Mbps Transmitting power (output) : 1W Antenna: Grid Parabolic Antenna	1	To link up the following stations by microwave radio link; 1.Morin-Uul Radar Site～NAMHEM 2.Morin-Uul Radar Site ～Ulaanbaatar International Airport 3.NAMHEM～TV Radio Centre
Multiplex Carrier Terminal Equipment	Power input and output capacity for at least 4 transmission lines in 1st group (equivalent to 30 CH converted at 64 Kbps/s) Digital interface (64 Kbps / s) Digital interface (V. 24) 4W analog interface	1	This equipment will convert the data and audio signals to PCM symbols and multiplex them to 2,048 Mb / s.
DC Power Supply	AC Input : 220V± 10% Frequency : 50Hz Efficiency : 80% Output power should be enough for installed equipment	1	The UPS is as a backup for the equipment during power stoppage.
Storage Battery	Noise level : 100mVp-p or less		At normal times, it will furnish DC power to the load at the rectifier while also recharging the battery. During power stoppage, power will be supplied to the load from the storage battery.
Isolation Transformer	Voltage: 220V, 50Hz Maximum Voltage: AC10kV, 1min.		The isolation transformer will prevent movement of the induced lightning surge to the communication equipment, thereby preventing accidental interference with this equipment.

Table2 - 8 Major Equipment List (1/1)

(3) Automatic Weather Observation System (Morin-Uul Radar site, International Airport, NAMHEM)

Equipment	Specifications	Quantity	Purpose
Automatic Meteorological Observation System	•Observation items : atmospheric pressure, temperature, humidity, wind direction & speed and precipitation •Observation method : Comfort to standard of WMO & ICAO.	1	This system will be installed beside Morin-Uul Radar site and observes left mentioned items automatically.
Data Processor Unit	Serial port : Supporting Ethernet CPU performance : Pentium : 166 MHz or more Hard disk : 1GB or more Memory : 64 Mbyte or more Data recorder should be included.	1	This unit will be installed in Morin-Uul Radar site. This unit will receive the observed data of AWS and processes, replays, archives, transmit those data.
Meteorological Information Display Unit	Serial port : Supporting Ethernet CPU performance : Pentium : 150 MHz or more Hard disk : 1GB or more Memory : 64 Mbyte or more Data recorder should be included.	1	This unit will be installed in Met office of airport and NAMHEM. This unit will receive the observed data of AWS from Data Processor Unit and processes, replays, archives, transmit those data
UPS	Capacity : 1kVA Input : AC 220 V ± 10 %, single-phase, 50 Hz	1	To protect computer equipment, fitted with a hard disk, from total blackout or short interruptions in the commercial power supply.

(4) Water Level Telemeter Station at Tuul River

Equipment	Specifications	Quantity	Purpose
Water Level Gauge	Ultra sonic type	1	Water Level Gauge measures the water level of Tuul River by using ultra sonic sound.
UHF Data Link Equipment	Frequency range : 400MHz band Line capacity: Telephone 6CH Output :1W Antenna : Yagi Antenna Feeding Line : Low Loss type Coaxial Arrester	1	To link up between Water Level Gauge at Tuul River and NAMHEM
Data Processing Unit	Serial port : Supporting Ethernet CPU performance :Pentium 166 MHz or more Hard disk : 2GB or more Memory : 32 Mbyte or more a data recorder and a printer should be included.	1	Data Processing Unit processes the observing data of Water Level Gauge for displaying and archiving those data.
UPS	Capacity : 1kVA Input : AC 220 V ± 10 %, single-phase, 50 Hz	1	To protect computer equipment, fitted with a hard disk, from total blackout or short interruptions in the commercial power supply.

Table2 - 8 Major Equipment List (1/1)

(5) Video Signal Converting System (Radio TV Centre, Ulaanbaatar)

Equipment Designation	Specifications	Quantity	Purpose
Weather Data Receiving Editing Processor	Microwave link modem: PCI type	1	To receive the weather data transmitted from NAMHEM, and superimpose them on the map for editing broadcasting image.
On-Air Radar Image Editing Processor	Chromaky Method	1	To composite the weather data superimposed on the map and a weather caster in the studio for preparing the weather forecasting programme on TV.
Scan Converter	RGB --> PAL Conversion Input : RGB Signal (VGA) Output : PAL-b 625/50, CCVS(BPP) Input terminal : 2 port or more Output terminal : 5 port or more	1	To convert the RGB video signal from PC to PAL video signal for TV broadcasting.
UPS	Capacity : 1kVA Input : AC 220 V ± 10 %, single-phase, 50 Hz	1	To protect computer equipment, fitted with a hard disk, from total blackout or short interruptions in the commercial power supply.

(6) Weather Warning System

NAMHEM (National Agency for Meteorology, Hydrology and Environment Monitoring)

Equipment Designation	Specifications	Quantity	Purpose
Weather Warning System	Interface: Serial Communication: Line Transmitting Speed: 2400 bps Applied line: Dedicated Siren: Speaker System	1	Weather Warning System informs the people of a submission of flood warning by sounding sirens when the precipitation exceeds the criteria.

7) Automatic Weather Observation System (National State University)

Equipment	Specifications	Quantity	Purpose
Automatic Meteorological Observation System	•Observation items : atmospheric pressure, temperature, humidity, wind direction & speed and precipitation •Observation method : Comfort to standard of WMO & ICAO.	1	This system will be installed in National State University and observes left mentioned items automatically.
Data Processor Unit	Serial port : Supporting Ethernet CPU performance : Pentium : 166 MHz or more Hard disk : 1GB or more Memory : 64 Mbyte or more Data recorder should be included.	1	This unit will be installed in National State University This unit will receive the observed data of AWS and processes, replays, archives, transmit those data to Meteorological Information Display Unit
Meteorological Information Display Unit	Serial port : Supporting Ethernet CPU performance : Pentium : 150 MHz or more Hard disk : 1GB or more Memory : 64 Mbyte or more Data recorder should be included.	1	This unit will receive the observed data of AWS from Data Processor Unit and processes, replays, archives, transmit those data

2. Basic Facility Plan

1) Site Layout Plan

The proposed Project site is located in the premissies of Morin-Uul radar station of NAMHEM at the top of Morin-Uul mountain, however, for constraction of a radar tower building, there is not very sufficient space. At east side area of the existing building, the new radar tower building will be constructed and also it will be faced to Ulaanbaatar International Airport.

• Morin-Uul Site

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

a. For obtaining necessary commercial power supply (380V, 50Hz, 3 Phases, 4 wires) for the radar system and the building to be established under the Project, the existing transformer will be utilized for the Project, which is located at 200m going down the top of the mountain.
b. As to drinking water supply for the new radar tower building, portable water plastic tanks will be used to water supply equipment and water will be transported from NAMHEM head office. For lavatory, rain water and transported water will be kept to a water tank and utilized for washing.
c. With regard to drainage (rain water) and sewage disposal in the Project site, rain water will directly be sunk from drainage pit into the ground and also the sewage primarily treated by septic tank will pass into the ground.

2) Architectural Design

a. Floor Plan

The floor plan will be virtually symmetrical, making possible a structural design that is safe and avoids eccentricity. The floor plan for the central portion of the tower building will allow the various rooms to be arranged more flexibility, since all structures such as columns and beams will 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 buildings will be of standard grade in Mongolia.

In the radar tower building, 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 building at Morin-Uul will have the backs of the radar display monitors and operating consoles facing north.

Floor Area of the Radar Tower Building

Floor		Area (m^2)
2nd. F	12.9×8.0	103.2
M2nd.F	7.9×8.0	63.2
G. F	12.9×8.0	103.2
B1F	12.9×8.0	103.2
Total		372.8

- Outline of the Rooms and Equipment Layout for the Radar Tower Building

Name of Room	Floor Area (m^2)	No. of staff	Equipment and room function
Roof floor	118.76	—	Antenna of microwave system, radar antenna and radome to be installed Outside unit for AC system (Concrete foundations) Automatic weather observation system
Radar equipment room	40.00	Daytime:5 Night:3	2 AC (10,000 Kcal), radar transmitter/receiver, AVR, UPS, signal processing equipment
Radar observation room	40.00	—	2 AC (10,000 Kcal), radar operating console & display monitor, telecommunication equipment, UPS
Maintenance room	25.00	—	For repairing works of the equipment
Spare parts room	15.00	—	For keeping spare parts, measuring equipment and maintenance tools
Operation room	17.50	—	Operation for radar tower building
Electricity room	22.55	—	Main power board, distribution board and cable racks
Analysis room	25.00	3	Analysis of radar echo sketches, analyzed data and floppy disk & magnet optical disk storage
Water tank room	8.40	—	Water tank for lavatory, pumps and maintenance space
Septic tank room	15.00	—	Septic tank and maintenance space
Store room	25.00	—	For storage of oil, grease, other consumables, cleaning gear and spare parts for the building
Generator room	62.40	—	Standby generators, peripheral devices and service tank
Tea kitchen	6.52	1~2	Portable water supply & kitchen facilities and cupboard
Lavatory	3.30	—	————
Common area	67.13	—	Corridor, Staircase, P.S
TOTAL	**491.56**		

- Calculating Bases for Determining Room Area

Name of room	Room Area (m^2)	Calculation Bases for Room Area
Roof floor	118.76	For installation of radar antenna and radome and also for maintenance For installation of outside unit for AC system (Concrete foundation) and outside stairs
Radar equipment room	40.00	Installation space for radar transmitter/receiver of the radar system and working space.
Radar observation room	40.00	Space for installation of radar operating console & display monitor and telecommunication equipment and working space.
Maintenance room	22.50	Mechanical repairing space : ($10m^2$/person ×2 persons=20 m^2).
Spare parts room	15.00	Storage space for spare parts, special tools, etc. : 15 m^2
Operation room	17.50	Operational work space for radar tower building
Electricity room	22.55	Installation space for power distribution boards, cable racks, etc.
Analysis room	22.50	Working space ($7m^2$/person ×3 persons≒20 m^2)
Water tank room	8.40	Installation and maintenance space for pumps, switches, and FRP water tank (0.5 m^3).
Septic tank room	15.00	Installation and maintenance space for septic tank
Store room	25.00	Storage space for spare parts for radar tower building, cleaning things, oil, etc.
Generator room	62.40	Installation space for engine generators×2, 2 reserve tanks for 12 hours
Tea kitchen	6.52	Space for kitchen sink and shelf and preparation of drinks≒7.0m^2
Lavatory	3.30	———
Common area	67.13	Corridor, Staircase, P.S

b) Sectional Plan:

① Height of Tower Building and Floors

In Morin-Uul radar site, the existing radar tower building of 10.6m is available. The height of a radar tower building to be constructed under the Project, therefore, must be sufficient to clear the tops of the existing radar tower building. Since the above conditions, for making a clearance of radar antenna, and so at least the same height of the existing building will be necessary to the height of the radar antenna foundation from the ground level. Regarding calculation of standard height between structural slabs, taking into consideration on proper height and dimensions of each equipment of radar system, wiring and cabling space behind the ceiling, thickness of heat insulating materials, etc., the radar equipment room and observation room should be 4m.

② Ceilings

In the radar equipment and observation rooms, the equipment must be protected against dust collecting above the cable rack. In addition, so as to reduce condensation of these rooms, the ceilings will be finished with suspended welded wire mesh ceiling. Ceiling height has been set at about 2.5 m, based on the dimensions of the intended equipment.

③ Radome and Rooms for Radar Equipment

Foundation of radome and radar antenna will be made a part of the slab of roof floor, so that the weight of the radar antenna will be borne by the beam located at mid-portion of the slab. For access to inside of the radome, internal stairs will be provided form the 1st floor.

④ Equipment Installation Method

In order to install all the equipment directly from outside into the radar equipment and observation rooms, a large opening will be necessary for bringing the equipment from outside.

However, the large opening would be undesirable from the standpoint of airtightness and dust proofing. The equipment will, therefore, be brought in via an unloading balcony at the

adjacent staircase landing. For lifting the equipment, 2-tons lifting hook will set at the upper part of this balcony.

c) Elevation Plan

For against sever cold temperature in the winter season, all the building structure will be covered by and also the external walls will be made of local made bricks. Therefore, the columns and beans will not protrude to the outside with an appealing elevation plan because the building will be faced to Ulaanbaatar International Airport. Since columns and beams will not protrude into the staircase, therefore, the staircase will be able to comfortably handle traffic in both directions.

d) Material Plan

Materials specified for both exterior and interior finishing, they have been selected with a view to ease maintenance by NAMHEM.

Exterior	
Roofs	Waterproof mortar t=30mm, Asphalt waterproofing, Insulation boards t=200mm, Protection concrete and Cement tiles
Exterior walls	Burnt clay bricks ALC panel t=125mm Skirtings : Concrete base, cement sand mortar t=20mm
Interior	
Floors	Porcelain tile Epoxy resin paint (dust-proof) Vinyl tile
Walls	ALC panel t=125mm Cement sand mortar base vinyl paint 100 square glazed tiles
Ceilings	Mended fair faced concrete, vinyl paint Weld wire mesh, oil paint (suspended ceiling system)
Windows and Doors	
Exterior	Aluminum double glazing glass (outside:wire glass t=6.8, inside:float glass t=5.0) Aluminum & Steel door (heat insulation board)
Interior	Wooden

In consideration of maintenance by NAMHEM for the radar tower building at Morin-Uul, all the necessary materials for construction of the building will locally procured as much as possible.

External Finish

Roofs : Due to external temperature is very low, reaching -32° C, insulation boards t=200 mm are required.
Asphalt waterproofing is the most reliable waterproofing material which will be protected by protection concrete, mortar and cement tiles.

Exterior walls : Walls will be made of structural bricks and colored cement splay finish. All materials are generally used locally, they are considered highly reliable in terms of this construction ease and accuracy.

Interior Finish

Floors : Materials have been selected on the basis of superior durability and ease of maintenance.
Porcelain tiles around the entrance hall and vinyl tiles in the other rooms have been selected. In rooms where dust must be avoided, a dust-proof paint finish has been specified.

Walls : Mortar (trowel-coated) has been chosen primarily for its durability. Vinyl paint will be applied for higher wall surfaces. 100 square glazed ceramic tiles will be laid in the lavatory (1.5 m high from floor level).

Ceilings : In order to enhance the environment in rooms and to reduce condensation due to sever cold, suspended weld wire mesh ceiling will be used and other rooms which will not require any ceiling board will be directly applied vinyl paint finish.

Windows and Doors

External : Steel and aluminum has been chosen throughout for reasons of durability. However, aluminum double glazing glass windows will be required for keeping a good temperature of each room, which is not available in the local market.

Interior : Wooden with synthetic oil resin paint will be employed throughout for its handling ease during construction and from a maintenance standpoint.

3) Structural Design

a) Structural Design Standards

Constructions codes in Mongolia have been determined in conformity with Russia, but independent structural standards have not yet been completed. Accordingly, for the structural design of the radar tower building, wind pressure and seismic force, exterior force and other considerable force will be determined on the basis of actual records. Moreover, reference has been made, as required, to the Japanese Construction Code as well as the standards of the Architectural Institute of Japan (AIJ).

b) Structural Type

Reinforced concrete has been nominated as structural type for the radar tower building, because locally reinforced concrete is most typical structural type in Mongolia. The floor slabs are to be reinforced concrete while exterior walls and partition walls are to be burnt clay bricks and autoclaved light weight concrete panels (ALC).

c) Foundations

Based on excavation and geological survey at the proposed site in Morin-Uul, a suitable foundation bed as a lock stratum for this radar tower building is available 3m in depth form the ground level. Since above these reasons, the lock stratum adhesive concrete foundation will be applied to support the building.

d) Structural design standards

- Stress calculations

Calculated based on an elasticity analysis

- Section design

The reinforced concrete structural design has been based on the calculation standards established by the Architects Institute of Japan (AIJ), applying the elastic design method.

e) Design loads and external pressure

・Dead load

Dead load calculation will include all of the structural and finishing materials. The estimated combined weight of the radome and radar antenna, which are to be mounted on the roof floor of the radar tower building as a special dead load, is approximately 4.5 tons.

・Live loads

Since virtually all the rooms in the radar tower building will have a storage function, either as equipment room or store room, live loads, with the exception of live loads of the roof, will all be uniform. These loads, which are deemed to be identical to those for telecommunication equipment rooms in Japan, have been applied as follows.

Floor slab and small beams	:	500 kg / m^2
Other structure	:	400 kg / m^2
Foe seismic	:	300 kg / m^2

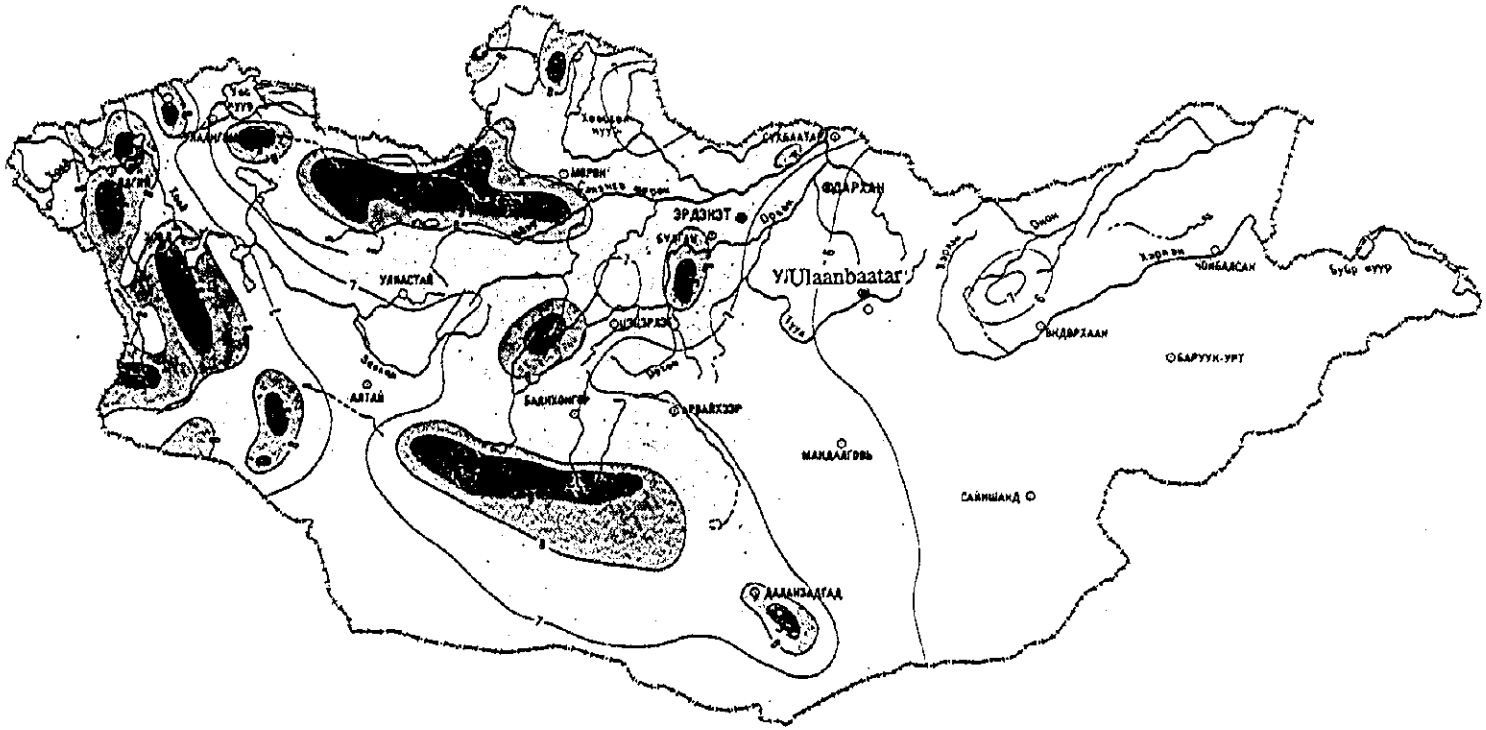
In estimating loads of the radar observation deck, an allowance has been made for the moving space of the maintenance workers servicing the radar radome. Based on the Building Standard Law of Japan, the above values have been reduced to 180, 130, and 60kg / m^2, respectively for these roof surfaces.

・Wind load

At the top of Morin-Uul mountain, previously, the highest velocity of 52m/s was recorded. For appropriate and economical structural design, wind speed of the highest velocity will be applied as the design wind velocity for the structural design of the radar tower building and radar antenna & radome. In addition, appropriate safety factor 1.5 times shall be added to the structural design.

・Seismic force

Seismic force calculations have been based on American UBC design standards. A chart of the seismic zones of Mongolia is attached hereunder. Morin-Uul Project site belongs to the same area of the maximum intensity of 4 ~5 on Japanese seven-stage scale. Therefore, Zonal Factor of Z = 1 as the seismic force calculation standard and a basic seismic coefficient of Co = 0.08 will be applied for Morin-Uul radar tower building to be constructed under the Project.



Seismic Intensity Comparative Table

Mongolia Standard	1	2	3	4	5	6	7	8	9	10	11	12

Japanese Standard	1	2	3	4	5	6	7

Ижил доргиллын шуган (MSK -64 шатлалын баллаар)

Доргиллын эрчим (баллаар)

доош 6 7 8 9 дээш

Seismic Intensity Map of Mongolia

・Soil bearing capacity

Due to the results of excavation and geological survey at the proposed site in Morin-Uul, a suitable foundation bed as a lock stratum for this radar tower building is available 3m in depth from the ground level. For construction of the radar tower building, it is very much sufficient to support the building.

f) Structural materials and strength

・Concrete

Ordinary concrete will be used, with a design strength of c = 210kg/cm^2 (with a 28-day compression strength).

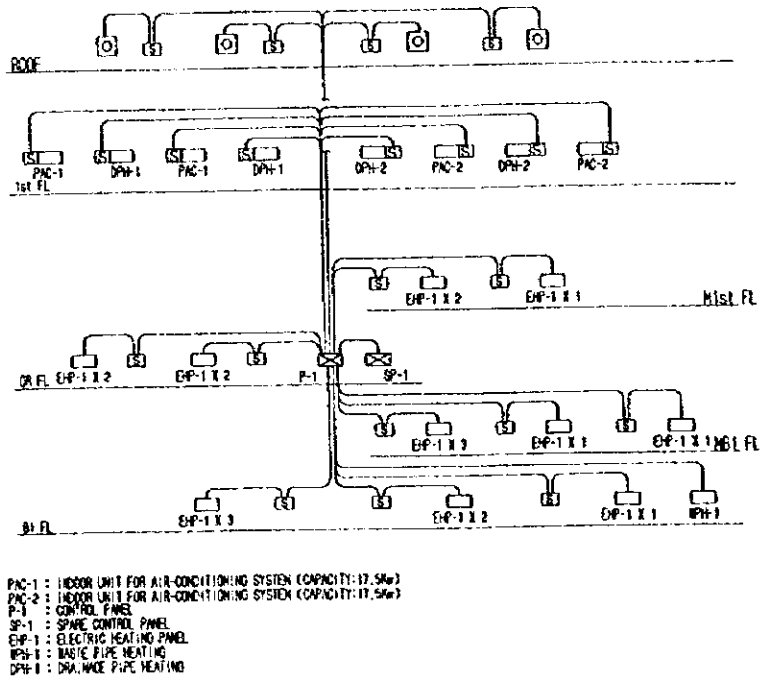
・Reinforced concrete

Reinforcing bars	Standard	Yield strength (MPa)
Deformed bars	Grade 235	235 MPa
	Grade 275	275 MPa

4) Electrical Facilities Design

a) Power intake facility

Power intake up to the Project site including wiring and power connection to a low-voltage switch board are major scope of works to be taken by the Government of Mongolia on his responsibility. In connection with the 380V and 50Hz low-voltage facilities, a hand-hole will be installed at the site, with a 150 mm underground pipe to be laid from this hand-hole to the low-voltage switchboard on the ground floor of the radar tower building.
The required power will be 2 circuit, 3-phase, 4-line, 50 Hz.



POWER WIRING DIAGRAM

b) Generating facility

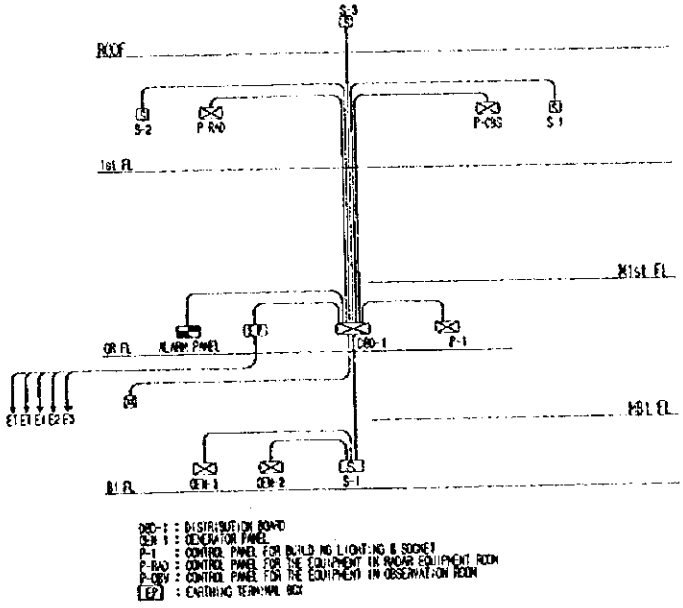
To ensure uninterrupted operation of the radar system, an engine generator will be installed at the site, as follows, as a back-up power source during the commercial power supply failure. For supporting the radar system on 24 hours operation, two service tanks of 400 liters will be supplied at the Morin-Uul project site

Capacity : 80 KVA

Voltage : 3 PH 4 W, 380V and 50 Hz

c) Trunk line and power facility

Both the exterior and underground pipes will be of polyethylene pipes against saline rot. Inside the building, steel piping will be employed. Air conditioning units will be individually controlled, while ceiling and ventilating fans will be manually operated.



POWER FEEDER DIAGRAM

d) Lighting and wall sockets

Wiring work will conform to the Mongolia technical standards for electrical facilities and using voltage will be single-phase 220V, with all the equipment to be grounded. Steel pipes will be specified, as generally used in Mongolia. 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. Obstruction lighting system for aviation will be placed on the top of radome.

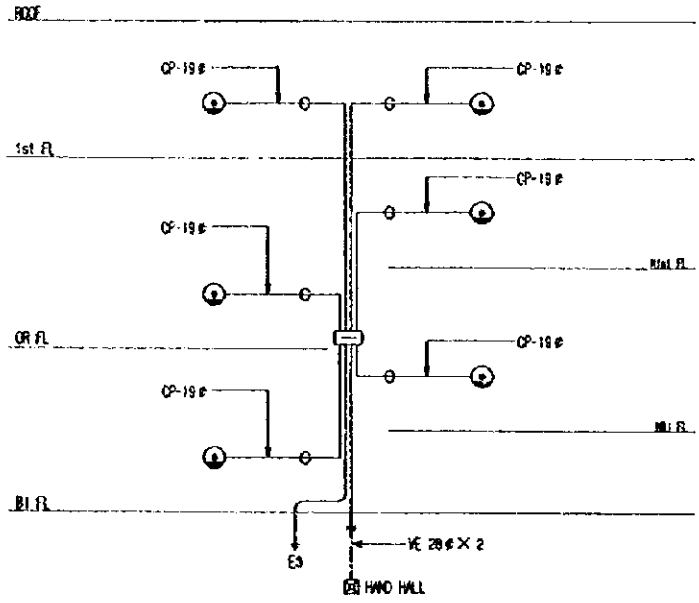
The illuminance standard in the various rooms will be approximately as shown below.

Radar equipment room:		400 lx
Observation room	:	400 lx
Operation room	:	350 lx
Analysis room	:	350 lx
Generator room	:	250 lx
Pump room	:	300 lx
Electricity room	:	250 lx
Maintenance room	:	350 lx
Other rooms	:	200 lx

General-purpose sockets will be equipped with switches, with a 2-pronged socket to be placed at 5 m ~ 8 m intervals and also a separate socket will be provided for the wall ventilating fan.

e) Hollow pipes for telephone lines:

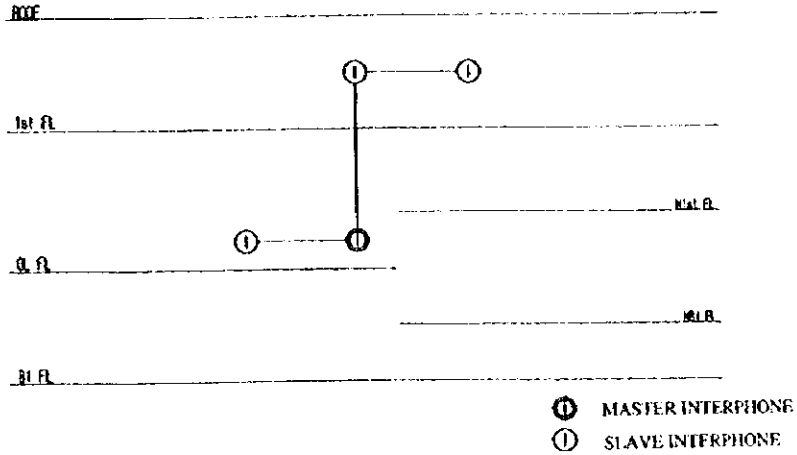
Hollow vinyl piping, with a diameter of at least 28 mm$^{\phi}$, will be installed from the hand-hole to be provided in the project site to the terminal board installed at the building. Hollow steel pipes will be laid between the terminal board and the various telephone outlets, with lead wires to be installed in the pipes. The wirings and related works will be borne by the Government of Mongolia.



TELEPHONE DIAGRAM

f) Interphone equipment

Interphone equipment will be installed at the ground floor, outside entrance and in the various meteorological operating rooms (radar equipment, observation, etc.) as a security measure to permit night personnel to screen visitors.



INTERPHONE DIAGRAM

g) Alarm facilities

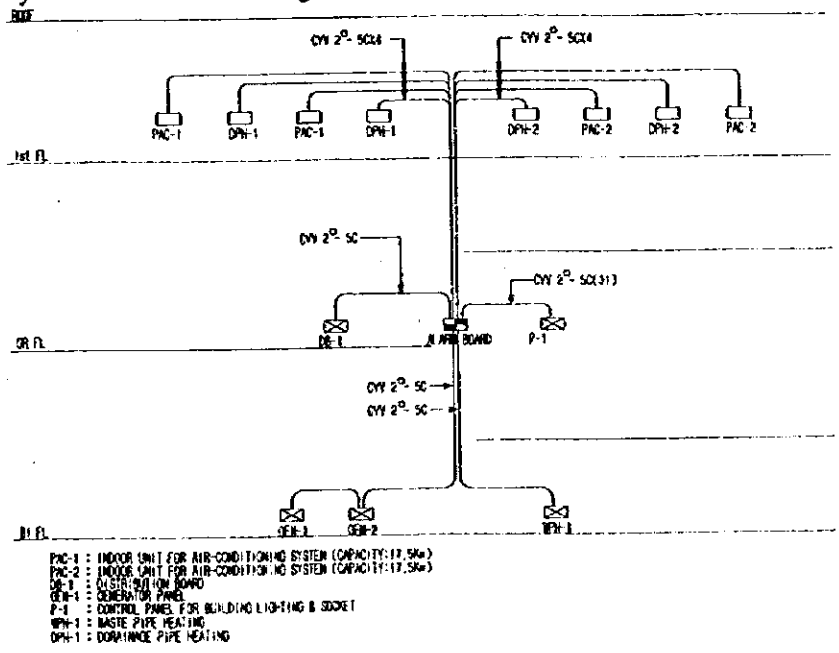
Alarms will be equipped with 20 terminals, the following warnings of the building equipment will be indicated.

No. 1 System failure and overheating of air-conditioning units.

No. 2 System failure and overheating of engine generator facilities.

No.3 System failure and overheating of the low voltage switch boards.

No.4 System failure of heating units for water supply pipes and drainage pipes.



ALARM SYSTEM DIAGRAM

h) Grounding facilities

Due to the rock stratum at the Project site, sufficient measures for grounding resistance must be taken for protection of all the equipment to be supplied under the Project from lightning damage. Since this reason, at least two groundings will be required. Grounding facility terminals for the equipment will be installed on each floor. Grounding wires of at least 5.5 sq. will be connected to the terminal board located on the ground floor.
The equipment in the electricity room will be grounded via the terminal board, while the telephone equipment will be grounded by erecting a grounding pole and running a wire from there to the terminal board.

i) Lightning rod facilities

A connection box will be placed on the roof. Inside the building, copper wire 2.6mm$^{\phi}$ × 17 will be laid in a vinyl pipe VE 28mm$^{\phi}$ and grounded via the test terminal board. The connection from the lightning rod on top of the radome to the grounding box on the radome foundation will be portion of the equipment installation work.

5) Water Supply, Drainage and Sanitary Fixture Design

a) Water supply system

As to drinking water supply for the new radar tower building, portable water plastic tanks will be used to water supply equipment and water will be transported from NAMHEM head office. For lavatory, rain water and transported water will be kept to a water tank and utilized for washing.

b) Drainage system

Drainage will be divided into 2 systems as sewage and miscellaneous drainage. With regard to drainage (rain water) and sewage disposal in the Project site, rain water will directly be sunk from drainage pit into the ground and also the sewage primarily treated by septic tank will pass into the ground.

c) Sanitary fixtures

Toilet seats, washbasins, and other types of sanitary fixtures will be installed where required.

d) Fire extinguishers will be installed as required

6) Air-conditioning, Heating and Ventilation Facility Design

Large size of air-conditioners will be installed in the radar equipment and radar observation rooms. Heating system will also be provided in the maintenance, data and analysis rooms.

a) Environmental conditions

- Exterior condition

Summer season	30 °C	(Maximum)
Winter season	-33 °C	(Minimum)

- Interior condition

Summer season	25 °C (Temperature)	30 ~ 50% (Humidity)
Winter season	18 °C (Temperature)	30 ~ 50% (Humidity)

b) Air-conditioning equipment

The air conditioning equipment to be installed in the radar tower building will be package systems. They can be separately controlled due to the interest of energy conservation and from the standpoint of their intended use. The outside units for the air-conditioning systems will be installed on the roof of the building.

c) Heating equipment

Electrical radiant heating equipment will be installed at each room as main heating system and as a spare heating system, panel heating equipment will be supplied.

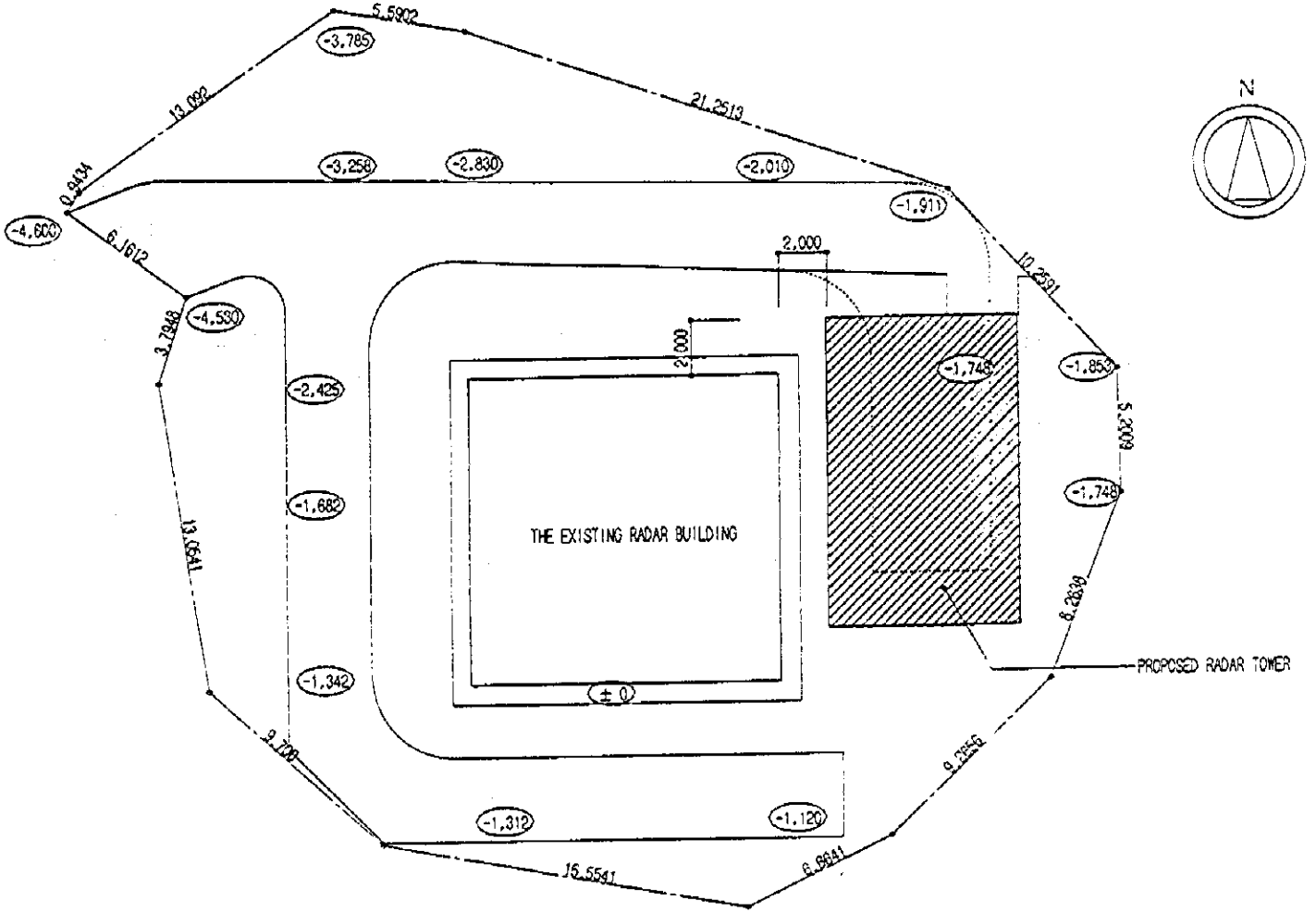
d) Ventilating equipment

Ventilating fans providing forced ventilation will be installed in tea-kitchen, lavatory and other rooms emitting offensive odors. Ventilation systems will also be installed in other rooms where it is deemed necessary to maintain an appropriate environment. In the winter season, for reduction of condensation due to sever cold temperature, air intake will be from the staircase as an air-chamber.

d) Basic Design Drawing

The basic design drawings are as follows.

SITE LAYOUT PLAN	A-01
FLOOR PLAN	A-02
SECTION & ELEVATION	A-03



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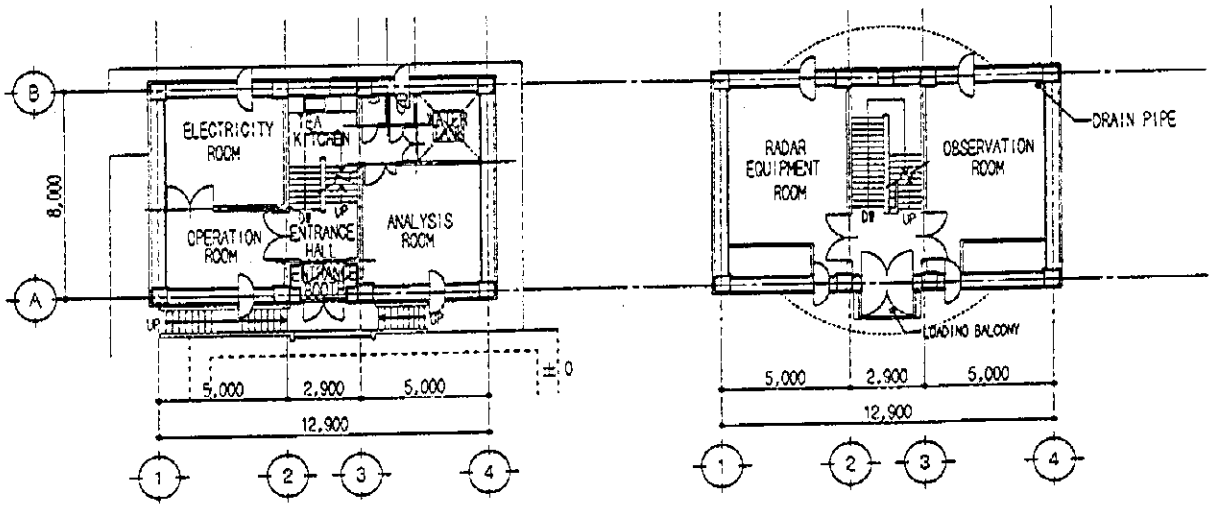
PROJECT:
Morin-Uul Radar Tower Building

DRAWING TITLE:
SITE-LAYOUT PLAN

SCALE:

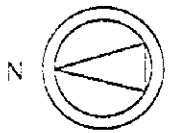
DRAWING No.
A-01

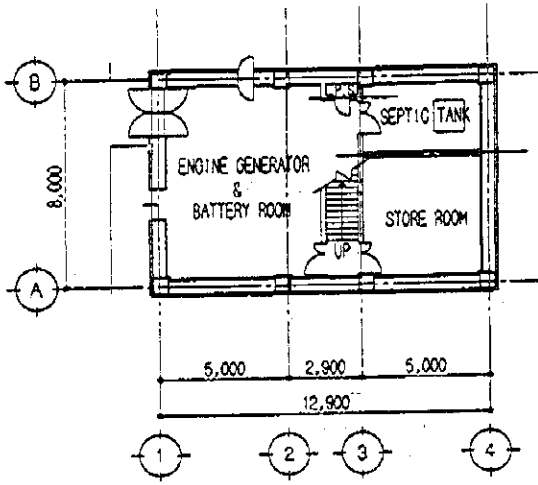


GF PLAN

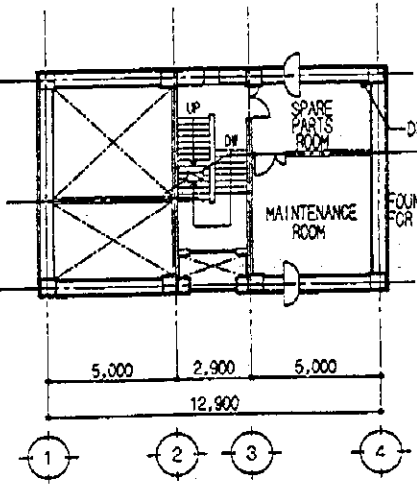
1st PLAN

FLOOR		
1F	12.9 x 8.0	103.2
M1F	7.9 x 8.0	63.2
GF	12.9 x 8.0	103.2
2F	12.9 x 8.0	103.2
TOTAL		372.8

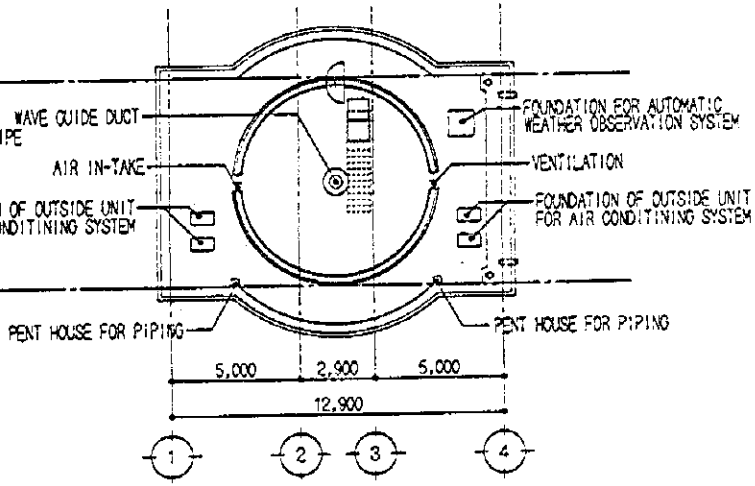




B1F PLAN



M1F PLAN



ROOF PLAN

0 1 2 3 4 5m

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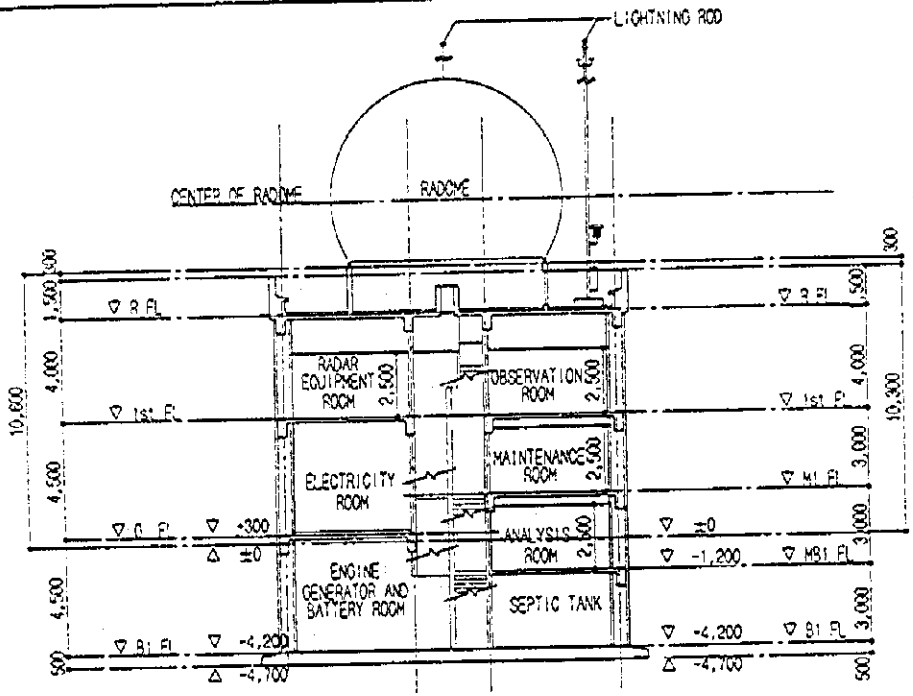
PROJECT: Morin-Uul Radar Tower Building

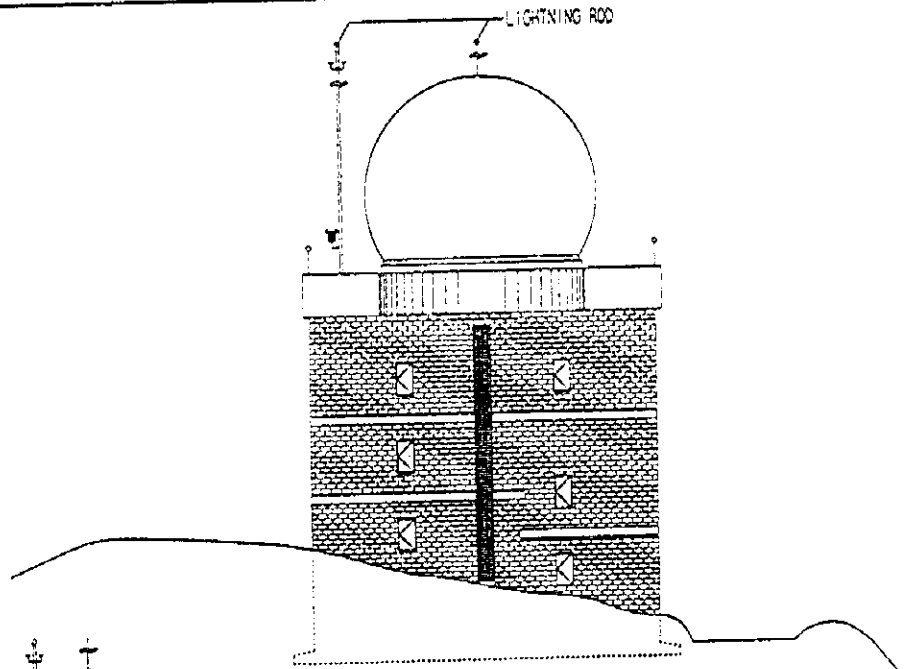
DRAWING TITLE: PLAN

SCALE:

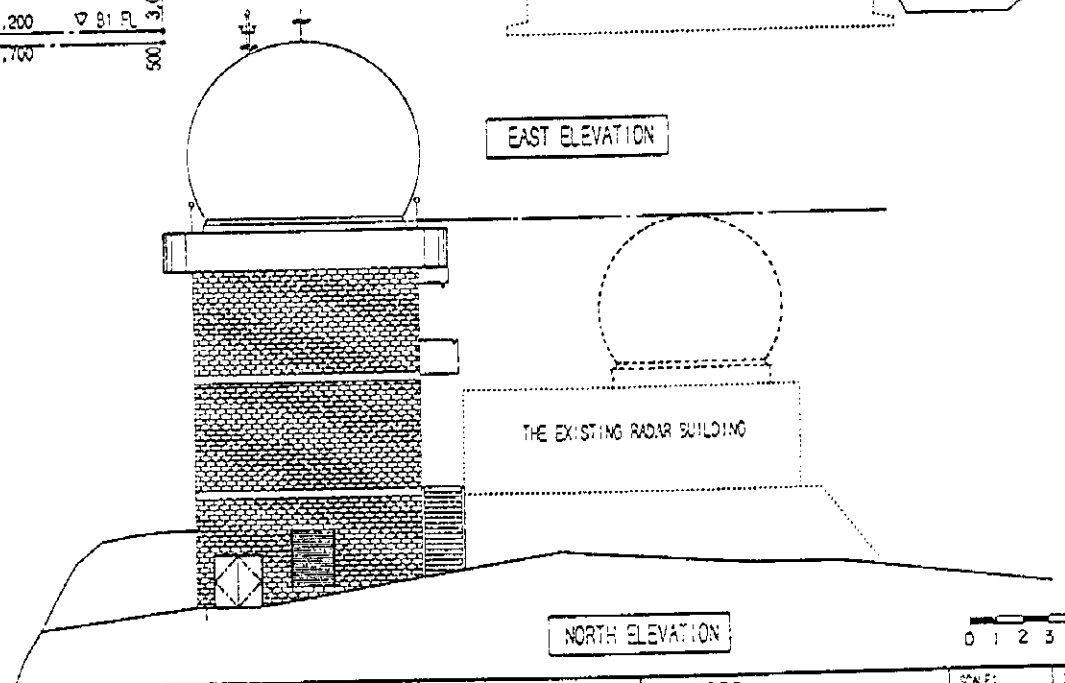
DRAWING No. A-02



SECTION



EAST ELEVATION



NORTH ELEVATION

JWA Japan Weather Association
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PROJECT:	DRAWING TITLE:	SCALE:	DRAWING No.
Morin-Uul Radar Tower Building	SECTION & ELEVATION		A-03

Chapter 3
Implementation Plan

Chapter 3 Implementation Plan

3 - 1 Implementation Plan

3 - 1 - 1 Implementation Concept

The coordination among related implementation works for completion of the Project shall be required, because the Project concerns systematically many engineering fields such as meteorology, communication, architecture, civil engineering, etc. In this Project, there is meteorological equipment work portion which refers to manufacturing, shipment, local installation, adjustment and commissioning.

For smooth implementing of the Project and avoiding delays and misunderstanding, communicating with the responsible organization (NAMHEM), Embassy of Japan, JICA Mongolia Office and concerned government authorities will be required.

1. Executing agency of the Project

The responsible governmental agency of Mongoliaia for the implementation of this Project is NAMHEM under supervision of Ministry of Nature and the Environment and it will be a signer of Consultant Agreement and Contract as the Client.

2. Implementation Plan

As for the implementation plan, it is necessary to discuss in detail and confirm the following points between NAMHEM and the Consultant during the implementation period of the detailed design.

1) Securing and clearing the Project site, distribution of electricity, telephone other incidental facilities to the Project site and also taking all necessary procedures shall be completed by Mongolia side prior to the commencement of the Project.

2) The construction period is supposed to be approximately and totally 8 months, however, in the winter season of Mongolia, it is impossible to implement any construction work. Since part of the building construction works period may fall within the winter season, the construction schedule must be split into 2 stages as described in the implementation schedule and must be well planned.

3) Ulaanbaatar International Airport is one of the Project sites. For avoiding obstruction of the international airport operations, adequate attention and careful consideration will be required.

4) For procurement of the equipment and materials for this Project to be financed by Japan's Grant Aid Assistance, careful liaison and coordination must be maintained with the concerned governmental agencies of Mongolia. All necessary procedures for importing limited items and tax exemption procedures must be promptly completed in cooperation with the implementing organization, NAMHEM.

5) With regard to the installation works for the meteorological telecommunication system, the equipment to be supplied under the Project will be installed at the existing facilities of NAMHEM Head Office, Ulaanbaatar International Airport, etc. Therefore, elaborate precautions will have to be taken to ensure safety of these existing facilities.

6) The materials will be procured as much as possible in Mongolia local market. However, in case procurement of the equipment and materials from Japan or third countries will be required, the Mongolia side shall take necessary measures for customs clearance and shall bear all the expenses.

7) At the time of the detailed design, the confirmation of the budgetary allocation will be necessary for the procurement of furniture, fixtures, etc., and also external work and removal and setting of the existing equipment, furniture and fixtures to be borne by Mongolia side.

3 - 1 - 2 Implementation Conditions

1. Construction Conditions

1) Local Sub-contractors

Generally in Mongolia, the technical levels of the major construction firms are relatively sufficient. Therefore, construction method & grade and also structural design should be suitable for the local contractor's level. In addition, with respect to the equipment installation works, the technical levels of private local contractors, who will be undertaking this work together with Japanese engineers of the main contractor, will be adequate.

2) Labour Condition

Labourers are not generally classified by their skills. Common labourers are not classified into special fields and are employed when necessary. The skills of labourers are much varied and truly skilled labourers are quite few.

3) Quality and progress control

Concrete aggregate, cement, lumber, and other primary products as construction materials are produced in Mongolia. Moreover, special machinery and equipment will be imported from Japan and neighboring countries, so that reasonable level of quality will be expected.

2. Special Project Considerations

The construction work can be adequately carried out by the local construction firms. The materials to be procured from Japan or the other countries would not pose any substantial problems, providing these materials are appropriate for the construction standards in Mongolia. Weather radar system, meteorological telecommunication system and other sophisticated equipment will be installed in the Morin-Uul radar tower building. Thus, it would be no exaggeration to say that the electrical power supply equipment for these systems are indispensable for the weather radar tower building for uninterrupted operation, and also power supply systems are very significant for heating systems of the building specially in the winter season of sever cold. In accordance with the construction schedule, an electrical engineer will be dispatched at the time of the installation, adjustment and wiring for the electrical power supply equipment and the power supply back-up system. A building equipment engineer will also be dispatched

for adjustment and confirmation of air-conditioning and heating performance at the time of the installation of such systems. During the construction period, procurement of the materials and securing of the skilled labourers will be necessary to be performed in accordance with the construction schedule.

As to the procurement and installation of the system and equipment, an engineer will be required to be dispatched for on-the-job training at each site for operation and maintenance of all the systems, in view of specific works and precision of installation works. After installation work, more further discussion with NAMHEM will be necessary for smooth and appropriate maintenance of all the systems.

The dispatch of the following engineers of the contractor during each implementation period will be required.

<Building construction>

·Resident Engineer (Architect) :	1 person
·Building facilities engineer :	1 person
·Administrative officer :	1 person
·Electrical engineer :	1 person
·Plumbing & Air-conditioning engineer :	1 person

<Equipment installation and adjustment>

·Total system integrator :	1 person
·Weather radar system engineer :	2 persons
·Automatic weather observation system engineer :	1 person
·Antenna engineer :	2 persons
·Radio engineer :	2 persons
·Transmission engineer :	1 person
·Water level monitoring system engineer :	1 person
·Meteorological Airport facilities engineer :	1 person
·Meteorological warning siren system engineer :	1 person

3 - 1 - 3 Scope of Works

(1) Construction of Weather Radar Tower Building

• Portions to be undertaken by the Japan side :

1) Architectural and civil works for radar tower building
2) Electrical works for radar tower building
3) Air-conditioning works for radar tower building
4) Plumbing works for radar tower building

• Portions to be undertaken by the Mongolia side :

1) Securing the Project site
2) External work
3) Fencing work
4) Power supply intake work (including power meter)
5) Telephone line intake work
6) Purchase of furniture
7) Movement and relocation of the existing objections on the Project sites

(2) Installation Work for the Equipment:

• Portions to be undertaken by Japan

1) Procurement of all the necessary equipment and materials
2) Transport of the equipment to the various project sites.
3) Installation work for the equipment.
4) Adjustment work for the equipment.
5) Commissioning for the total system.

• Portion's to be undertaken by Mongolia :

1) Removal and relocation of the existing facilities in the Project site, if any.

3 - 1 - 4 Consultant Supervision

In accordance with the guidelines of Japan's Grant Aid Assistance and the basic design, the Consultant will be responsible for expeditious project implementation, forming project teams of detailed design and supervision for the implementation of the Project.

The Consultant is to dispatch one resident engineer to Mongolia for the construction of the radar tower building at Morin-Uul. This resident engineer of the Consultant will provide appropriate advise and direction to personnel of the contractor and will maintain close liaison with the NAMHEM, Civil Aviation Authority, National Air Traffic Services, Radio & TV Center, the Embassy of Japan in Mongolia, the JICA Mongolia office and concerned government authorities. With the progress of the construction work, the Consultant's engineer in charge of structures and facilities will be dispatched, as required, to conduct inspections and provide construction guidance on site.

With respect to installation and adjustment works of the system, engineers of the Consultant will be dispatched to Mongolia timely for installation guidance, inspection, etc. for each system. In connection with the weather radar system, performance test at a factory and also adjustments, inspections, commissioning of the equipment and data reception and transmission conditions in Mongolia will especially be required.

1. Principal Guidelines for Supervisory Plan of the Consultant

1) Closely to communicate with responsible organizations and personnel of both countries, and complete the Project in time in accordance with the implementation schedule.

2) In order to carry out the construction and equipment installation work in accordance with the technical specifications and drawings, direction and advice will be given to contractor personnel without delay.

3) Local construction methods will be adopted, and to the maximum possible extent, locally available materials will be procured.

4) Instruction for construction and installation methods and technique will be provided to a local contractors as technical transfer so as to maximize the Project effect.

5) Upon the Project completion, the contractors will be obliged to submit the maintenance manuals and provide appropriate guidance to the NAMHEM to ensure smooth operation

and maintenance of all the systems.

2. Construction Supervision Work of the Consultant

1) Construction supervision

The Consultant will prepare the form of the Contract in accordance with JICA standard and select a Japanese prime contractor through tendering with NAMHEM, and also recommend the Contractor to the Government of Mongolia.

2) Confirmation of the drawings, materials and equipment

The Consultant will inspect and confirm shop-drawings, system drawings & diagrams and material samples submitted by the Contractor as well as performance of all the equipment.

3) Direction for Construction

Based on a review of the construction schedule, the Consultant will provide instructions to the Contractor and submit progress reports on the construction work to NAMHEM, Civil Aviation Authority, National Air Traffic Services, Radio & TV Center, Embassy of Japan in Mongolia, JICA's Mongolia office, etc.

4) Approval procedure for payment

The Consultant will cooperate in certification for payment, such as meticulous examination of notice of approval and invoices in connection with implementation cost to be disbursed during the implementation period and upon completion of the Project.

5) Attendance for inspection

As required during the implementation period, the Consultant will perform inspections at each stage of the work based on confirmation of completion and fulfillment of the contract conditions. The Consultant will be present at the handing over of the facilities and equipment, at which point its tasks will be completed, with the approval of the Client. Reports will also be made to concerned personnel in the Government of Japan on all required items, such as progress reports during the implementation period, payment procedures, completion and handing over.

3. Dispatch of Engineers

A meteorological planning engineer will be dispatched to Mongolia as the general project supervisor.

<Building Construction>

Accurate quality control and supervision of construction progress will be required throughout the construction period. With regard to quality control, it should be observed that, whether the construction materials are sourced within Mongolia or brought in from Japan or third countries, quality and construction methods may differ even for the same material, so that, in most cases, swift assessments must be made, owing to the severe time restraints of the Project. In case of the absence, precious time would be required to reach decisions.
In addition, the construction period is supposed to be totally 8 months, however, in the winter season of Mongolia, it is impossible to implement any construction work. Since a part of the building construction work period may fall within the winter season, therefore, the construction schedule must be split into 2 stages as described in the implementation schedule for avoiding such situation.

Furthermore, as radar tower building is to be constructed at the Morin-Uul site, the supervisory service is likely to be quite complex. Based on the above considerations, in case of spot supervision, serious problems could be expected in both quality and progress control. Therefore, it is deemed that a resident engineer will be dispatched for the project. Accordingly, architectural engineer-B will totally be sent to Mongolia for 8 months under construction period.

During the construction period, the Consultant's engineers will provide supporting services on construction drawings, methods as well as inspections of the equipment in Japan. In addition, these engineers will be dispatched to Mongolia, as required, for supervision on installation and adjustment stages.

a) Architectural Engineer-A
b) Architectural Engineer-B
c) Structural Engineer
d) Electrical Engineer
e) Air-conditioning & Plumbing Engineer
f) Quantity Surveyor

<Equipment Work>

The various equipment differs on function and performance. Thus, in order to combine each equipment organically into a single meteorological system, and integrate these separate systems into one total system, based on the specifications, it is vital that such overall integration be made the corner-stone of the schedule. To support the resident engineer, each engineer in meteorological communication, radio, transmission, etc. will be dispatched to supervise the meteorological communication system, along with radar engineers to oversee the weather radar system, and a meteorological planning engineer to provide general supervision for all the system. Moreover, these supervisory services will be performed from the standpoint of the user, the NAMHEM.

In connection with the supervision of the equipment installations, most suitable engineers will be dispatched timely to carefully supervise installations in their respective areas of expertise. During the implementation period, these engineers will also perform checks on system drawings and installation methods along with the equipment inspections in Japan and will be dispatched, as needed, to Mongolia for installation, adjustment and commissioning works.

a) Meteorological Service Planner
b) Meteorological Telecommunication Engineer
c) Telecommunication Radio & Transmission Engineer A
d) Telecommunication Radio & Transmission Engineer B
e) Meteorological Radar Engineer
f) Meteorological Radar Imagery Analysis Engineer
g) Meteorological Data Transmission Engineer
h) Water Level Monitoring System Engineer
i) Meteorological Observation System Engineer
j) Meteorological Software Engineer

3 - 1 - 5 Procurement Plan

The procurement plan for materials and equipment is oriented to local maintenance level and structure for the meteorological systems and equipment, and radar tower building and building equipment. The plan is deemed to be appropriate, in that recurrent costs have been estimated on the basis of NAMHEM's probable financial capabilities after completion of the Project.
The procurement plan has been designed, with full awareness of the current situation at NAMHEM, on the basis of the estimated useful life of each item, a regular maintenance cycle for the systems and equipment, a proper supply of spare parts for maintenance use, and procurement methods. Consideration has also been given to the preparation of operating and maintenance manuals, related guidance, as well as training programs for NAMHEM.

1. Equipment

The most considerable factors in supplying equipment is maintenance method of the equipment and availability of the necessary parts and consumables in Mongolia. The equipment procurement must take account of ongoing maintenance requirements after completion of the Project. Careful consideration should be given in making maximum use of the local agent when problems occurred with a particular item of the equipment.

The weather radar system, weather radar image composition system and other systems, many of which will be difficult to procure locally. Thus, in connection with quality and maintaining levels of sophisticated systems, it will be absolutely essential to procure such components from Japan and/or third countries. At these days, equipment prices are almost identical in Japan and third countries. For quality control of each system, procurement of the equipment from Japan will be easier than third countries. It is sure that procurement from Japan would surely be advantageous to NAMHEM in consideration of durability & reliability of the systems and easy procurement of spare parts, operating procedures and maintenance techniques of the equipment.

The most considerable points on supply of the equipment are regarding operation and maintenance methods and also procurement of necessary spare parts after completion of the Project for long time. This will surely be a vital factor which is determining the success of the Project.
As might be expected, major concern from a maintenance standpoint relates to all the sophisticated system such as weather radar, weather radar imagery display systems, etc., with being essentially computer systems. As activities of the private sector related to computer systems, there are several agents of the computer equipment in Mongolia.

The activities of the private sector in Mongolia will be useful for the computer systems and other sophisticated systems to be introduced under the Project.

Based on the above considerations, the procurement plan for the Project equipment should be designed with a view to achieving the maximum possible degree of standardization as well as ease of obtaining spare parts and selecting equipment with which NAMHEM is already familiar and which can be maintained locally.

2. Construction Materials

The basic construction materials such as concrete aggregate, cement, lumber, etc. can be obtainable in Mongolia. On the other hand, almost of the building equipment is, at present, largely imported. Only the materials difficult to obtain in Mongolia and those specially required to achieve the quality of the facility of the Project shall be procured from Japan and/or the other countries.

1) Cement

Supply is relatively stable. However, careful quality checks will be required during construction work.

2) Concrete aggregate

Concrete aggregate uses mainly either crushed or natural stone. Local supplies are stable and able to meet current demand in terms of both quantity and quality. For obtaining 210kg/m^2 of concrete strength for construction of a radar tower building, the local concrete aggregate is suitable for the Project.

3) Concrete products

In the absence of ready-mixed concrete, all concrete must be made at a site, requiring careful quality and strength checks. Concrete should be test-mixed at the site, after which an optimum mixture can be determined.

4) Reinforcing bars

Reinforcing bars, as required for the production of reinforced concrete, can be locally sourced, and a reliable intensity value can be confirmed from the mill sheet obtained of the reinforcing bars.

5) Timber and Plywood

Plywood both for indoor and exterior, as well as for use in concrete forms can be procured locally.

6) Door and window products

Various types of wooden windows and doors produced in Mongolia, however, they are not suitable for a radar tower building due to less airtightness. For this Project, therefore, all windows and doors will be procured in Japan or third countries besides wooden doors to be fixed into the building.

7) Paint

The paints both for indoor and exterior are available in terms of quantity, color, and base (oil, emulsion, epoxy).

As noted above, only basic construction materials are available in Mongolia, with quality presenting no particular problem. In connection with the radar tower building construction period, since certain materials for special building equipment such as a power-supply equipment, as needed to install the weather radar system, cannot be locally sourced. Such items will have to be brought in from Japan or third countries.

3. Transport Routing for Materials

The equipment and materials shipped by sea to Mongolia from Japan or third countries will be unloaded at Tianjin seaport and will be railroaded to Ulaanbaatar Internal Container Depot (UICD). At the Depot, necessary measures for custom clearance will be held. After the custom clearance, the equipment and materials will be roaded to each site.

1) Air service

MIAT Mongolian Airline operates direct flight between Kansai and Ulaanbaatar International Airports. This airline also have many domestic flights.

2) Shipping service

There are scheduled shippings between Tianjin and Japanese ports (primarily Kobe, Nagoya, and Yokohama).

3) Domestic transport

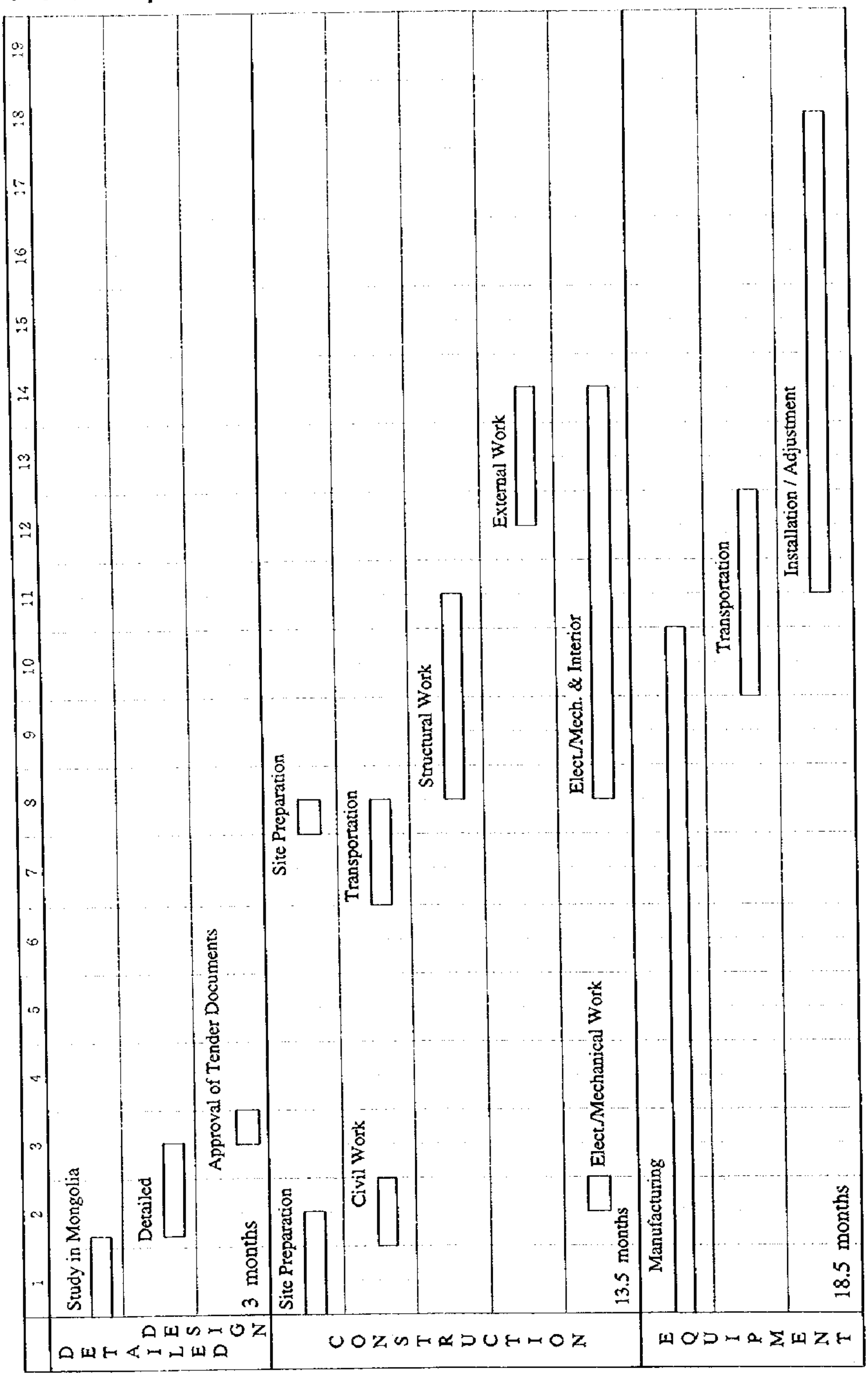
From Tianjin seaport, the equipment and materials will be railroaded to Ulaanbaatar Internal Container Depot (UICD) by China and Mongolia railways and from the Depot, they will be roaded to each site.

4. Implementation Schedule

The Project involves the construction of weather radar tower building at Morin-Uul together with the manufacturing, installation, adjustment and commissioning of the equipment for weather radar, weather radar imagery display systems, meteorological telecommunication and other sophisticated systems. The entire implementation of the Project is expected to require some 17.5 months in all.

The building construction work will consume about totally 8 months from preparation work to completion, while some 10 months will be needed to manufacture all the equipment. The equipment introduced under this Project will be of a specialized and used exclusively for meteorological purposes. Therefore, the production cycle will necessarily be longer than for conventional equipment.

3 - 1 - 6 Implementation Schedule



3 - 1 - 7 Obligation of recipient country

Undertakings required of the Government of Mongolia

In the implementation of the Project under Japan's Grant Aid Assistance, the Government of Mongolia is required to undertake such necessary measures as the following:

(1) General requirements

1) To take all necessary procedures in Mongolia.
2) To open an account in the name of the Government of Mongolia in an authorized foreign exchange bank in Japan and to bear commissions to the Japanese foreign exchange bank for the banking services based upon Banking Arrangement.
3) To exempt taxes and to take necessary measures for customs clearance of the materials and equipment brought for the Project at the port of disembarkation.
4) To accord Japanese nationals whose services may be required in connection with the supply of products and the services under the verified contracts such facilities as may be necessary for their entry into Mongolia and stay therein for the performance of their work.

(2) Requirements for the Equipment

1) To provide appropriate frequencies for radar systems and microwave & UHF links to be established.
2) To secure effective spaces at the existing facilities for installation of the equipment to be supplied.
3) To maintain and use properly and effectively that the equipment purchased under the Grant Aid.

(3) Requirements for Construction of Radar Tower Building

1) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction.
2) To provide facilities for distribution of electricity, telephone and other incidental facilities to the Project sites.
3) To undertake incidental outdoor works such as fencing, gates and exterior lighting in

and around the site, if necessary.

4) To provide temporary facilities for distribution of electricity, water supply, telephone, and other incidental facilities for construction of the building.
5) To secure effective spaces at the Project sites for temporary facilities such as a contractor's office, workshop, building materials storage, etc. for construction of the building.
6) To bear all the expenses other than those to be borne by the Grant Aid, necessary for the transportation and construction of the building.
7) To maintain and use properly and effectively that the building constructed and the equipment supplied under the Grant Aid.

3 - 2 Project Cost Estimation

Cost estimation for major undertaking to be borne by Mongolia side (Capital Budget).

At the time of implementation of the Project under Japan's Grant Aid Assistance, the estimated cost for the major undertaking of the Government of Mongolia will be necessary as described in the following table.

Item	
Clear of obstacle	US$ 100.-
Power meter cost	US$ 200.-
Telephone line intake cost	US$ 800.-
Furniture cost	US$ 500.-
Total	US$1,600.-

However, due to the local regulation, commissions to the Japanese foreign exchange bank through the Bank of Trade and Development nominated by the Government of Mongolia for the banking services based upon Banking Arrangement will be 0.035% of the total project cost and it shall additionally be borne by the Government of Mongolia.

3 - 3 Operation and Maintenance Costs

1. Staff Requirements for Implementation of the Project

After completion of the Project, the following staff assignments will be required at the Morin-Uul radar site for appropriate and effective operation and maintenance of the radar system to be supplied under the Project. These following staff are already available in NAMHEM.

	No. of Post
1. Meteorological Engineer	1
2. Electrical Engineer	1
3. Mechanical Engineer	1
4. Technician	2
5. Assistant	2
Total :	7

2. Operation and Maintenance Plan of Facilities

After completion of the Project, NAMHEM will play a role in operating and maintaining the weather radar tower building at Morin-Uul, in conjunction with other government agencies.

<Maintenance Cost for Facilities>
After completion of the Project, NAMHEM will take care of expenditure for operation of the radar tower building at Morin-Uul at his expense. The necessary expenditure for electricity, telephone, etc. are calculated on bases of the present rate as follows.

1) Electricity charge : Tg 850,000 / year
Electricity charges at the existing radar site is approximately Tg 570,000/year. Based on the expenditure of the existing radar sites, new radar site of Morin-Uul can be expected as the most likely the power consumption one and a half times as high as the power consumption of the existing radar site.

2) Telephone charge : Tg 227,000 / year
Telephone calls : 10 calls / day for 5 minutes (Tg 6/min)
Telephone : 10 calls / day x Tg 30 x 30 days x 12 months = Tg 108,000 / year
Facsimile : 5 calls / day x Tg 30 x 30 days x 12 months = Tg 54,000 / year
Tg 5,400 (Line charge) x 12 months = Tg 64,800 / year
Tg 108,000 + Tg 54,000 + Tg 64,800 = Tg 226,800 / year ≒ Tg 227,000 / year

3. Operation and Maintenance Plan of Equipment

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

- Staff training
- Operation and maintenance structure of NAMHEM
- System failure incidence
- Frequency of scheduled parts & consumables replacement and overhauls

Many electronic parts are used in the electronic equipment in these days. When they have developed a failure internally, only replacement of a part is useful to solve this failure. Therefore, the following methods will have to be applied to minimize the occurrence of failures and maintenance cost to be borne by NAMHEM.

- The power supply to a radar system should be provided through uninterrupted power supply (UPS) and auto voltage regulator (AVR).
- At the time of installation work of the equipment, effective operation and maintenance method and technique should be provided through on-the-job training by a consultant and a contractor.
- Consideration for selection and procurement of the equipment will be necessary for utilization of local activities in the occurrence of a failure.
- Unification of spare parts and consumables between the existing equipment and the equipment to be supplied under the Project.
- For procurement of the equipment, operation and maintenance procedures should be resembled as closely as possible to the existing equipment.

In order for each responsible person to be able to appropriately and effectively perform his duty to avoid any failure, provision of operation and maintenance manuals are indispensable. In addition, on-the-job training through actual use of the equipment should be conducted to as many staff as possible in accordance with these manuals.

After expiry of the warranty period for 1 year from completion of the Project, NAMHEM will maintain all the equipment himself, thus NAMHEM should recognize necessity of some special expenditures at a time of problem occurred. However, for minimization of expenditures to be taken by NAMHEM for operation and maintenance of the equipment, as much as possible,

standardization and unification of spare parts & consumables and selection of the most durable & reliable equipment of NAMHEM are indispensable. Such a policy will be able to contribute positively to reducing financial burden of future procurement of spare parts and consumables as well as overall maintenance expenditures.

<Maintenance Cost for the Equipment>

Future maintenance costs for the equipment have been calculated on the basis of the following conditions. The systems to be supplied under the Project will be installed at the rooms fully equipped with power backup systems, such as uninterrupted power supply, automatic voltage regulator, and air-conditioning systems. Therefore, the whole equipment will be installed in a suitable and effective environmental condition. In case of normal operation of the equipment under the above said conditions, the annual maintenance cost for the equipment can be estimated on the basis of Japanese experience.

1) Realistically expecting maintenance cost for the equipment

After completion of the Project, for the first year, all the equipment are still under warranty by the contractor, no problems should be encountered. Spare parts for 2 years normal operation to be supplied under the Project should be adequate for the third and fourth year, and it is probably not expecting any major equipment failure because the whole system is still new. During these early years, therefore, maintenance expenses should be modest.
From the fifth year, practical maintenance cost will be required and the following expense may be anticipated.

- Major expensive items -
For operating a radar system, the following essential parts, in particular, will have to be procured by NAMHEM on a continuing basis.

- Magnetron (pulse radar transmission tube)
  Life time : approximately 8,000 ~ 10,000 hours
- Transmitting/receiving limiter (switching equipment between radar beam transmission & receiving)
  Life time : approximately 10,000 hours
- Batteries for uninterrupted power supply equipment
  Service life : approximately 5 ~ 6 years

The systems to be supplied under the Project can be expected to operate for approximately 3,000 hours per year. On this basis, for appropriate operation of a radar system to be installed in Mongolia, replacement of a magnetron, transmitting/receiving limiter, etc. would be required approximately every 3 years or 4 years.

To new radar systems to be installed at Morin-Uul, 3 magnetrons and 3 transmitting/receiving limiters will be attached to the radar system. Thus, for 9 ~ 10 years operation with them will most provably be possible. However, a magnetron is a pulse radar transmission tube, certain parts will wear out before the end of the magnetron's life time, so NAMHEM must obtain an annual maintenance appropriation at an early stage to be absolutely sure of its ability to procure these essential parts for a radar system, as required.

The NAMHEM's maintenance capabilities have been amply confirmed on the basis of the more than 19 years' experience it has had with the existing radar system made in Russian. The technical skill levels of radar engineers and technicians in NAMHEM are quite enough for maintenance of a radar system.
Minimization of an annual operation and maintenance cost of NAMHEM has been considered in the basic design study, nevertheless the operation and maintenance cost for the radar tower building at Morin-Uul to be constructed and the equipment to be installed under the Project will be required.
In order to minimize the operation and maintenance cost, it is necessary that NAMHEM must have the spacial consideration on execution of a appropriate maintenance & operation, minimization of consumption and must achieve economizing. It is the best method for minimization of expenditure of NAMHEM.

・Operation and Maintenance Cost due to the Project

In consequence of the above conditions, the annual operation and maintenance cost for the Project as described in the below table will be needed.

	1st year	2nd year	3rd year	from 4th year
Repairing cost	Tg0.	Tg0.	Tg0.	Tg200,000.
Consumables	Tg0.	Tg0.	Tg0.	Tg100,000.
Electricity charge	Tg850,000.	Tg850,000.	Tg850,000.	Tg850,000.
Telephone charge	Tg227,000.	Tg227,000.	Tg227,000.	Tg227,000.
Total	Tg1,077,000.	Tg1,077,000.	Tg1,077,000.	Tg1,377,000.