JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF TOURISM AND CIVIL AVIATION
KINGDOM OF NEPAL

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR MODERNIZATION
OF
TRIBHUVAN INTERNATIONAL AIRPORT, KATHMANDU
IN
THE KINGDOM OF NEPAL

January 1994

PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In response to a request from the Government of the Kingdom of Nepal, the Government of Japan decided to conduct a Development Study on the Tribhuvan International Airport Modernization Plan. In the process of the study, Urgent Project which is conducted by the requirement of the most urgent improvement in terms of air safety operation in the airport was selected.

In response of the requirement of the project, the Government of Japan has decided to conduct a basic design study and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nepal a study team headed by Mr. Toshiyuki IWAMA, Grant Aid Study and Design Department, JICA and constituted by members of the Pacific Consultants International from 3 November 1993 to 12 November.

The team held discussions with the officials concerned of His Majesty's Government of Nepal and conducted a field study at the study area. After the team returned to Japan, further studies were made 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 His Majesty's Government of Nepal for their close cooperation extended to the team.

January, 1994

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

January 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the project for modernization of Tribhuvan International Airport, Katmandu in the Kingdom of Nepal.

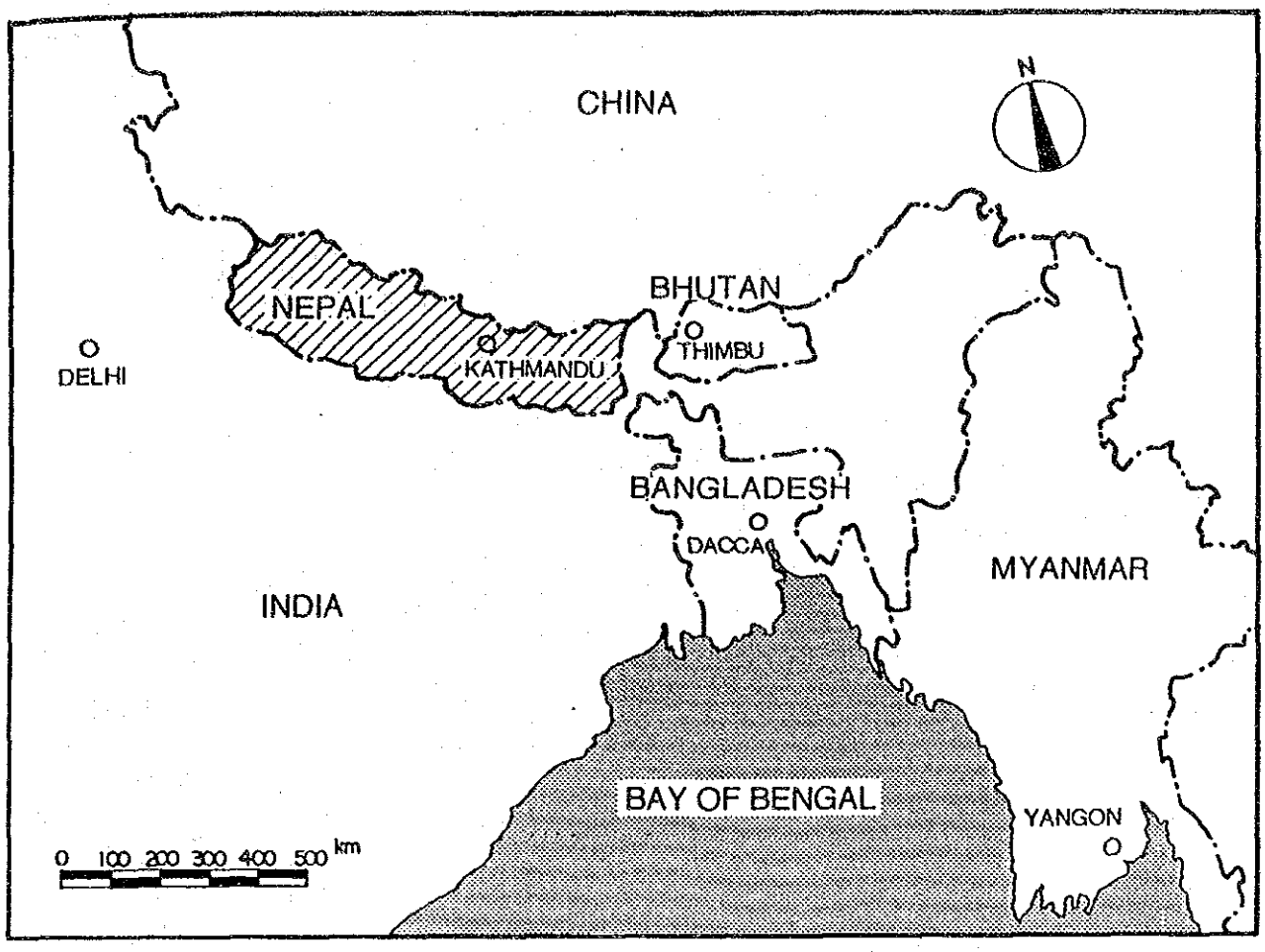
This study was conducted by Pacific Consultants International, under a contract to JICA, during the period November 27, 1993 to January 31, 1994. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Nepal and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

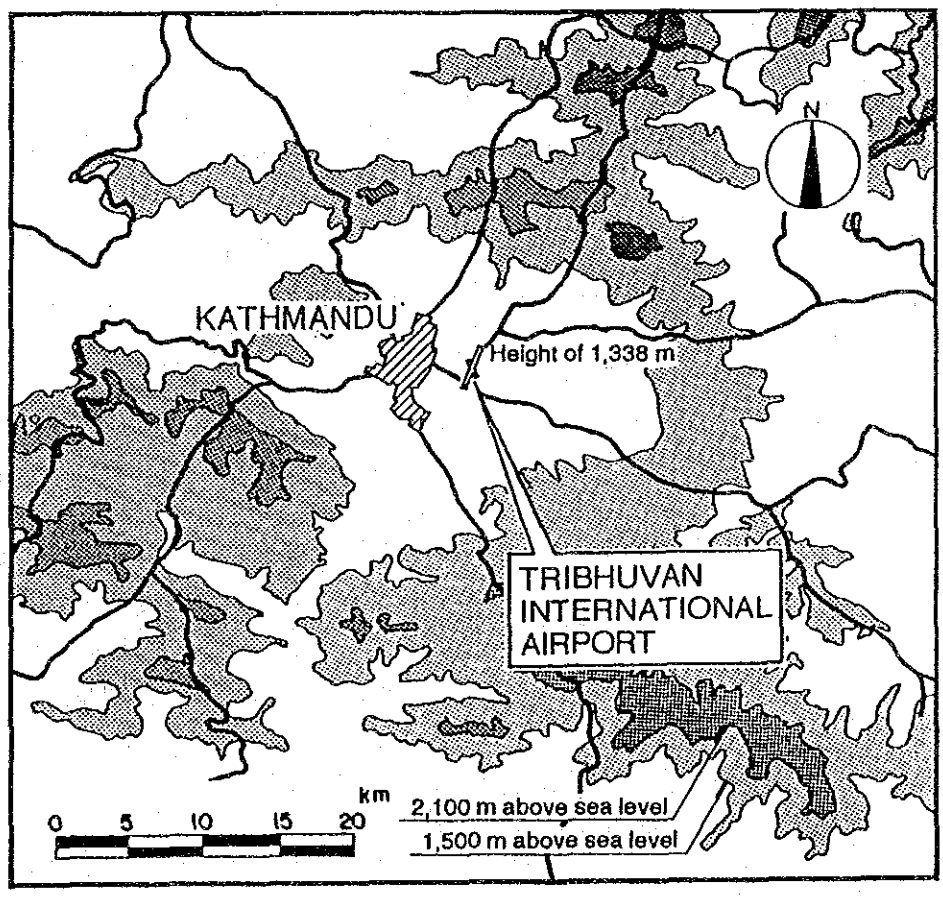
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of Transport. We would also like to express our gratitude to the officials concerned of the Department of Civil Aviation, the JICA Nepal office and the Embassy of Japan in Nepal for their cooperation and assistance throughout our field survey.

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

Very truly yours,

Yoshiya Niinomi
Project manager,
Basic design study team on
the project for modernization of
Tribhuvan International Airport,
Katmandu
Pacific Consultants International





LOCATION MAP

SUMMARY

Summary

The Kingdom of Nepal is an inland country which is bordered by India and the People's Republic of China. The total land area is 140,000 square kilometer, 77% of which are hill or mountain areas. Climate of the country varies in wide range from the semitropics to the arctic of Himalayan ranges.

Due to its steep mountains and deep valleys, the road systems of the total length of 8,300 km are undeveloped and the road network system has not been established. Since development of land transport systems is very difficult in Nepal because of the above-mentioned reasons, air transport plays an important role for transportation of goods, enhancement of public welfare, and earning of foreign money through promotion of the tourism sector. Especially, more than 330 thousand foreigners visit Nepal in a year, and 90% of them entered the country through Kathmandu Airport, which is the one and only international airport in the Kingdom. Kathmandu Airport is also the base of the domestic travel.

Kathmandu Airport is a hub airport of the air transport network in Nepal. However, the airport which is located in the center of the Kathmandu Valley is surrounded by high mountain ranges. Therefore, aircrafts are obliged to operate in a very severe condition which forces aircrafts to maintain a safe altitude at all times and to make steep climbs and descents. Therefore, pilots are under a psychological burden when flying in Nepal. Although, in such a severe situation, it is desirable to control the aircraft by radio navigation aids at the airport, no facilities except VOR/DME are operated due to the constraint of the surrounding terrain.

With these deficiencies in air traffic control, there were two serious aircraft accidents in 1992 which occurred at the Kathmandu Airport, and resulted in fatal loss of life of passengers on the aircrafts. Because of these accidents, improvement of air safety is of the most urgent matter to be implemented.

With these backgrounds, His Majesty's Government of Nepal requested the Government of Japan to provide assistance in formulation of a Master Plan and a Feasibility Study for development of the Air Navigation Systems and other facilities for air safety at Kathmandu Airport. The Government of Japan decided to conduct the Development Study of Tribhuvan International Airport Modernization Plan in Nepal in response to the request, and the Japan International Cooperation Agency dispatched a Study Team. This study was commenced in June 1993 and is expected to be completed in May 1994, and during the process of the study, the matters of air safety related to the improvement of the safe operation of aircraft

were recommended especially as an urgent improvement plan and proposed in the "Air Safety Improvement Plan".

Air Safety Improvement Plan includes evaluation of the present airspace around TIA and improvement of the various fields such as air navigation systems, air traffic control systems, communication systems, organization and institution. Among these fields, Air Safety Improvement Plan recommends implementation of the Urgent Improvement Plan in the early stages which is directly related with human life.

The Urgent Improvement Plan is outlined as follows:

(1) Air traffic control at Kathmandu Airport will be improved from the current visual and ground-to-air communication method to the monitoring and controlling by radar.

(2) Although there is a VOR/DME as the air navigation system for instrument approach, that is not so precise for the final approach guidance system. Therefore, navigation aids for precision approach such as a localizer will be installed in addition to the existing VOR/DME.

(3) Facilities and education material in the training center will be developed so as to improve quality and to secure the required numbers of human resources.

Through the study of implementation schedule of the Urgent Improvement Plan, the items which will take a long lead time for implementation were selected as the Urgent Project, and a technical study (basic design) for that Project was executed.

A general description of the Urgent Project is as follows :

1) Installation of Aerodrome Surveillance Radar.

   To install a radar at Kathmandu Airport to monitor and control aircraft which are in the course of approach, landing, takeoff, and go-around, etc. since they are the most dangerous aircraft operations.

2) Construction of Facilities to House Radar Facilities

   To construct facilities to install and house the radar equipment together with the buildings required to operate and maintain the equipment.

3) Radar Training Facility and Radar Equipment Training Facilities

To construct the training facilities required to operate and maintain the radar equipment which will be the only facility of its kind in Nepal.

Radar coverage is affected by its location due to the characteristics of radio waves. Since topographic constraint at Kathmandu Airport is very severe, several candidate sites were selected through the above technical study.

Consequently, the radar site was selected inside the airport, and it was judged to be appropriate to construct the radar equipment building, the radar operation building, and the power supply station.

The radar at this site covers most of the routes for approach, takeoff, climb, and missed approach, although there are some limitations due to the obstructions such as the surrounding mountains. It is expected to contribute considerably to the safe operation of aircrafts. For construction of the training facilities, the site of previous receiving station was selected which is 3km east of the airport.

The flight procedure established at Kathmandu Airport is of the procedure that the pilot makes judgment by utilizing the air navigation systems on the ground. Operation of the radar will make it possible for air traffic controllers to advise and control the aircraft positively by the information provided from the radar on the aircraft position and altitude. This means that air traffic controllers will, therefore, have the authority for air traffic control. The responsibility of air traffic controllers will become more important, and techniques of air traffic control will affect directly the safety of aircraft operations.

Since technical training of personnel required for radar operation and maintenance is very important in this project, it is necessary to educate the personnel constantly in accordance with the long-term plan. For this purpose, continuous technical cooperation will be required in the field of radar control and radar maintenance.

The present number of personnel for air traffic control and maintenance system will not be sufficient for operation of the planned radar facilities. DCA has, therefore, a plan for reinforcement of those personnel, and it will be carried out in accordance with the training plan for redeployment.

Outline of the facilities in the basic design is summarized as follows:

Items	Description	Type of Structure	Scale
Aerodrome Surveillance Radar	Primary and Secondary Radar		1 set
Construction of Radar Equipment Building and Other Buildings	Radar Equipment Building	RC, single-story	198 sq.m
	Radar Operation Building	RC, two-stories	648 sq.m
	Power Supply Building	RC, single-story	104 sq.m
	Antenna Tower	independent, square	25 m (height)
Radar Training Facilities	Radar Simulator		1 set
	Radar Maintenance Training Equipment		1 set
	Training Building	RC, single-story	690 sq.m

Construction period for this project will be about 4.5 months for the detailed design and 24 months after tender opening for construction.

This project will enhance the safety of aircraft operation at Kathmandu Airport, and will promote the constant development of air transport network in Nepal. It will thereby contribute to the overall political and economic development and promotion of tourism.

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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

Japan International Cooperation Agency (JICA) has been conducting the Development Study on the Tribhuvan International Airport Modernization Plan in Nepal since June 1993 in response to the request of His Majesty's Government of Nepal (hereinafter referred to as "the Government of Nepal") which aims at formulation of a Safety Improvement Plan and Ground Facilities Improvement Plan for the Tribhuvan International Airport.

One purpose of this Study is to formulate a Master Plan for the development of air navigation system, aeronautical telecommunication system, air traffic control system and airport ground facilities, etc. Another purpose of this Study is to evaluate the feasibility of the short-term development plans in the framework of the Master Plan. Furthermore, among the above Safety Improvement Plan, urgent and feasible items of works were selected as the Urgent Project, and the technical study was executed for that Project, since it is most urgent to secure the air safety in comparison with other development works

The Government of Nepal requested the Government of Japan for grant aid to implement this project urgently. Scope of the Urgent Project is as follows:

(1) Installation of a radar.
(2) Construction of a radar operations building.
(3) Construction of a training center and installation of training equipment.

In response to the above request, the Government of Japan has decided to conduct a basic design study. JICA organized a Basic Design Study Team, and formulated the basic design from the results of a technical study for the Urgent Project in the above Study.

In order to explain and to consult the Nepal side on the basic design thereafter, JICA sent to Nepal a study team headed by Mr. Toshiyuki Iwama, Second Basic Design Study Div., Grant Aid and Design Dept., JICA from November 3 to 12, 1993. The Study team explained and consulted on the contents of the basic design with the Nepal side.

The following subject was discussed:

(1) Confirmation scope of the Urgent Project
(2) Requests of the Government of Nepal on the Project
(3) Construction site survey

(4) Operations, maintenance and management plan by the Government of Nepal
(5) Demarcation of construction work, the Government of Japan and of Nepal

The Study team and the Nepalese side exchanged the Minutes of Meeting on November 5, 1993.

The organization of the Study Team, activities in Nepal, the list of the persons concerned of the Government of Nepal, and Minutes of Meeting are attached to this report.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2.1 Background of the Project

Nepal is an inland country with a mountainous terrain and landlocked geographical features, and the road network is still under development due to the lay of the land.

Thus air transportation has an important role in the transportation sector in Nepal.

Tribhuvan International Airport (TIA), taking the central hub of airports in Nepal, is in a severe situation in terms of aircraft operations due to mountainous features around the airport.

Radio Navigation Aids and Communication also are restricted in performance because of the above-mentioned situation.

With this state of matters, two aircraft accidents occurred at the airport in 1992. After these accidents occurred, JICA Study Team has been carrying out their work in respect of air safety improvement and modernization plan of TIA based on the agreement of His Majesty's Government of Nepal (HMG/N) and the Japanese Government (JG).

Although the study is not concluded, the outline of Urgent Improvement Plan is clarified in this study and the most urgent items are selected and identified as an Urgent Project.

The background of Urgent Improvement Plan is as follows:

The air safety improvement plans to be established for the year 2010 consists of a two phased plan, which are the short-term development plan and long-term development plan.

The planned items which requires immediate development from the viewpoint of air safety are selected as the short-term development plan, and some of them are specified as the urgent improvement plan. Thus, the air safety improvement plan is formulated as follows:

- Urgent improvement plan : The plan to be realized as soon as possible.
- Short term development plan : The plan to be improved for the year 2003.
- Long term development plan : The plan to be improved for the year 2010.

The plans are based on the following studies and reports basically:

- ICAO Action Plan of the Civil Aviation Development co-operation in Nepal UNDP/ICAO project NEP/85/028, dated May 1992.

- The recommendations in the press release of the Aviation Accident Report by the Commission for Accident Investigation of HMG/N.

Urgent Improvement Plan

The following items should be improved immediately from the viewpoint of air safety improvement at Tribhuvan International Airport:

(1) Installation and operation of Aerodrome Surveillance Radar (ASR) supported by the Secondary Surveillance Radar (SSR)

The facilities which accommodate the equipment and operation should be provided. Improvement of the communication system for radar operation is required.

(2) Installation of proper instrument guidance system such as Localizer type Directional Aids (LDA) or Localizer including Distance Measure Equipment (DME)

(3) Improvement of CATC training facilities, including building and equipment for practical training.

(4) Establishment of controller's skill evaluation, rating and license in conformity with the ICAO recommendation.

(5) Establishment of maintenance crews technical skill evaluation

2.2 Outline of the Request

This Basic Design is based on the items specified in the above-mentioned study as an urgent project, which is required to be improved as soon as possible for air safety.

The outline of the requests of HMG/N to be implemented as an Urgent Project is as follows:

(1) Installation of Aerodrome Surveillance Radar and Secondary Surveillance Radar (ASR/SSR) System.

(2) Construction of the facilities for accommodation and operation of the equipment.

(3) Construction of training facilities for radar controllers and maintenance technicians including training for radar systems.

2.3 Evaluation of the Existing Airport

2.3.1 Runway

The existing runway is capable of accommodating international long haul aircraft. However, some aircraft are subject to weight restriction when taking off at TIA due to the inadequate runway length of 3,050.

Thus, it is desirable to extend the runway length to accommodate the aircraft of full load. However, the extension will be difficult due to the obstruction on the approach surface of RWY20 and RWY02.

The runway has been operated only one-way direction for landing and take-off in IFR conditions and the complete parallel taxiway is not provided due to the specific topographical condition around TIA. The capacity of the single runway, therefore, will be restricted almost half of the standard capacity in IFR conditions.

2.3.2 Taxiway

The existing partial parallel taxiway of TIA has two points for improvement of the problems. One of them is its extension up to the same length as the runway length and connection to the runway ends. The other one is to shift the parallel taxiway to secure the separation distance with the runway centerline from existing 109m to 182.5m, which is recommended by ICAO. However, they will require large-scale earth work and the relocation of the existing aviation fuel tanks.

2.3.3 Runway Strip

The existing runway strip width of 150m is preferable to be expanded up to 300m which is recommended by ICAO Annex 14 in future. However, this work will not be easy since it will require large-scale earth work and relocation of the some existing airport facilities.

2.3.4 Apron

1) Conversely to the international apron layout, the domestic apron is in a very critical condition, particularly due to the emergence of private airline companies. The increase of many small and medium size aircrafts have caused shortage of parking positions. This will cause insufficient separation required between aircraft and objects (buildings). Particularly after the completion of expansion works at the international apron, it will become possible for large type aircraft to pass in front of the domestic apron. Therefore the capacity of the domestic apron will be decreased in order to secure the minimum separation. This will accelerate the shortage of parking spots.

2) There is no apron service road and arranged GSE (ground support equipment) storage around the domestic apron. This will hamper the smooth and controlled flow of vehicles in the apron.

3) Besides the above-mentioned circumstance, the demand forecast implies that an adequate number of aprons, are to be provided in order to fill up the shortage of parking spots in future and at present, too.

4) As TIA is the main hub airport of the domestic air system, it is necessary to install aprons for aircraft staying at night with the full utilization of loading aprons for international and domestic operations.

2.4 Air Navigation Facilities

2.4.1 Controlled Airspace

Controlled airspace such as Airdrome Traffic Zone, Control Zone and Terminal Control Area have been established at TIA.
ATS routes which are established around TIA are classified into two types, which are inbound and outbound.

All of the approach routes for TIA concentrate to Kathmandu VOR / DME which is provided on the runway 02 extended centerline.

2.4.2 Approach and Departure Procedures

Two instrument approach procedures and six instrument departure routes have been established at TIA at present.

Since the airport is located in the Kathmandu Valley, the aircraft approaching to and departing from the airport strictly requires descend or climb at steep angles.

Only radio communication or sighting are available to control the aircraft, so that it is difficult to recognize exact aircraft position, heading and altitude by controllers.

2.4.3 Air Navigation Aids

A doppler VOR and DME are provided at the extended runway centerline with distance of / Km from the runway threshold. NDBS, locators and a Fan Marker are also provided at the preferable locations around the airport which are contributing as navigation fixes.

Appropriate communication network have been provided for international and domestic point to point communication by means of radio or leased lines.

HF and VHF communication network are also utilized to provided aeronautical mobile services.

Precision instrument guidance system such as ILS or MLS is not provided at the airport.

2.4.4 Air Traffic Control System

Air Traffic Control at TIA is specified to two different functions, such as aerodrome control and ACC. Aerodrome control is in charge of aerodrome control, surface movement control, approach control. Airspace under control of Kathmandu ACC is separated into two subsectors, East and West.

Even if radio communication is established between pilot and controller, approach and en-route control will depend on the pilot position reports in IFR conditions.

Therefore, monitoring and controlling service by airport surveillance radar will be required for air safety at TIA due to the mountainous topographical condition around the approach and the departure courses.

CHAPTER 3 OUTLINE OF THE PROJECT

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3.1 Objective

The objective of the Basic Design Study is to establish the principles for implementation of the project and to formulate an effective system to achieve safe aircraft operations in TIA. Requirements of system operation, maintenance technique and the costs for the maintenance of the equipment will also be studied in this design study.

3.2 Study and Examination of the Request

As a main radio navigation aids, only VOR / DME which installed at the airport are supporting as regard flight in flying instrument flight rule thus, procedures for IFR at TMA are established based on the VOR / DME. Appropriate instrument guidance system such as ILS will be required at the airport, however, installation and operations of the other guidance system have restricted by mountainous features around the airport.

Weather condition in rainy season is fearfully bad particularly in visibility. In such a condition, only ASR /SSR operation can expect as effective aircraft guidance and controlling system for air safety improvement. The radar system operations for the purpose controlling and monitoring aircraft, therefore aimed to control and monitor of the approaching, departing and go-arounding traffic at KTM.

Imediate execution of the Urgent Project which is explained in Chapter 2 is highly expected for enhance air safety and necessity of radar system with supporting facility for radar operation, training have been made clear through the Study of Tribhuvan International Airport Modernization Plan.

3.3 Project Description

Although Urgent Improvement Plan should be implemented immediately, Airport Surveillance Radar, Secondary Surveillance Radar (ASR/SSR) and Training facility related to radar operation and maintenance were selected as the Urgent Project in the Study of Tribhuvan International Modernization Plan in terms of necessity of a long period for equipment manufacturing and system construction.

Therefore, a subject of Basic Design is specified for the radar system and the training facility mentioned above .

3.3.1 Executing Agency and Operational Structure

The executing agency is DCA.

Tribhuvan International Airport (TIA) has the full responsibility on airport operation and maintenance, and the new radar system will be incorporated into the airport organization. Radar controllers and maintenance technicians will also be transferred from their existing positions when radar operations is initiated.

Thus, TIA will be in charge of execution of construction and operation of ASR/SSR from the early stage of the project up to hand over of the radar system.

On the other hand, implementation activity of the training facility for radar operation and maintenance will be carried out by the Civil Aviation Training Center (CATC).

The center will be in charge of project execution, particularly, not only facility construction but also preparation of training curriculum and acquisition of a sufficient number of instructors.

Headquarters of DCA will be expected to support and expedite the project in the field of acquisition of budget for radar operations and maintenance.

Program for radar controllers rating system in Nepal should also be established in the early stage of radar operation .

Executing Agency and Operational Structure are shown in Figure 3.3.1.

3.3.2 Plan of Operation

(1) Human Resources Development

The radar system to be operated by controllers in TIA is the first installation of its kind in Nepal. In spite that the controllers have only non-radar control experience, they have maintain sufficient skill levels in the procedure control in Nepal. Although the new technical operation will be required for the radar, skill level of controllers may be expected to achieve the required technical skill level through adequate training.

Maintenance technical level also can be maintained in sufficient levels even though some of the old equipment has been maintained. Since recent technology will be required for the radar system, technical training for maintenance technicians is essential in order to maintain the system.

Therefore, construction of the radar system training facility for controllers and maintenance technicians will highly be required at the same time.

Arrangement of adequate budget for operations and maintenance shall be set forward.

With initiation of the radar system operations, to keep adequate number of radar controllers, maintenance technicians and instructors with sufficient technical skill level will be required.

In order to obtain human power for radar operations, human resources development plan is studied in Chapter 4. DCA has an improvement program for ATC contralles and technical staff for TIA. Number of total controllers and technical staff including candidates for radar operators and radar maintenance technicians are estimated as follows:

ATC controllers

End of 1993	38 (3 shift work)
End of 1994	50

Radio maintenance, technical

End of 1993	48 (3 shift work)

(2) Running Costs

Since necessary running costs for system are estimated about 13 Million NRs per year, DCA shall arrange enough budget for the operations and maintenance of the system. This running costs will take room about 2% of the total budget as of 1993 / 94 budget bases.

DCA has program to arrange budget in 1995 based on commencement of the radar system and training operations.

3.3.3 On-going relevant Project

The following air navigation facilities have been improved since April 1993 in Air Navigation Project donated by the Australian Government. As the project term, two years duration are expected.

- Replacement Kathmandu DVOR / DME
- UHF radio link between TIA and NTC (Nepal Telecommunication Corporation)
- RVR
- Ceilometer
- Maintenance Center regarding the DVOR / DME, including training facility

The other project has been promoted such as runway and taxiway pavement overlay, apron expansion, runway shoulder expansion and car parking for domestic terminal building under ADB loans. however, there are not any conflict or competition among the projects.

3.3.4 Location and Conditions of Project Site

Site locations selected for the radar facilities to be planned in the project are the inside of the airport, previous receiver site at Thimi and Phulchouki radio relay station.

(1) Airport Site

A radar equipment building, an antenna tower and a power supply station will be located at the radar site where is planned at the east side of the runway. A radar operation building will be planned to be collocated with the existing operation building and control tower, so as to keep easy access each other. Construction of access road which to be connected with the radar site and the existing perimeter road will be required.

Although there are no high structures around the proposed radar antenna currently, it is expected that the high structure will be constructed in future such as aircraft maintenance hangar. Thus, height of the radar antenna has been designed to keep at least 25m height above the ground level.

A bright display console and communication console switches are provided at the control tower cabin and the existing operation building.

(2) Previous Receiver Site at Thimi

Some of receiver equipment and radio antenna towers have been maintained at previous receiver building and inside of the site. Radar training facility which will be controlled by CATC are planned in the site. Some area of the site has been cultivated on one year contract with DCA.

DCA is considering that there are not any problems of the landspace for construction of the training building on these conditions.

DCA has maintained access road and electric cable to the site and it will be usable for he new training facility although some modification may be required.

Although small size of public water supply pipe has been installed under the main road in front of the site, capacity of the pipe will not be adequate to provide the water to the site. Therefore the project will provide water supply take at the site and Nepalese side will supply water.

(3) Phulchauki Radio Relay Station

DCA has maintained the radio relay station at the Mountain Phulchauki so as to ensure VHF air to ground radio coverage, due to restriction of the coverage at the airport.

Radio frequency for radar control will be allocated and the equipment for the new frequency will be provided at the relay station, and the airport. Access road and electric lines have been provided at the station and adequate floor space is available to install the equipment.

Details of the location and conditions are described in Chapter 4.

3.3.5 Outline of Facility and Equipment

Radar operation building plays an important role as the center of radar operation. On the other hand, receiving signals of ASR/SSR are processed by processing equipment which is installed in this building. Processed radar signal is provided to the radar operation room and control tower display. Simulation target generating function is provided for OJT.

Pulse radar transmitter and receiver which are accommodated in the Radar Equipment Building have the function of radio frequency generating and receiving. The equipment of the building is supported by emergency engine generator and uninterrupted power supply system. The power supply facility is located independently so as to avoid noise and electrical interference.

Both equipment, which will be installed in the radar operation building and radar equipment building will be connected with optical fiber cable in order to control and monitor the signals.

Radar training facility, which consists of a radar simulator equipment, for radar controllers training and radar transmitter / receiver for maintenance technicians training will be provided.

The components installed in the each building are as follows:

(1) Radar Operation Building

- Radar Display Console
- Radar Data Processor
- Communication Control System

(2) Radar Equipment Building

- ASR/SSR transmitter/receiver
- Signal Processor

(3) Power Supply Station

- Engine Generator
- UPS

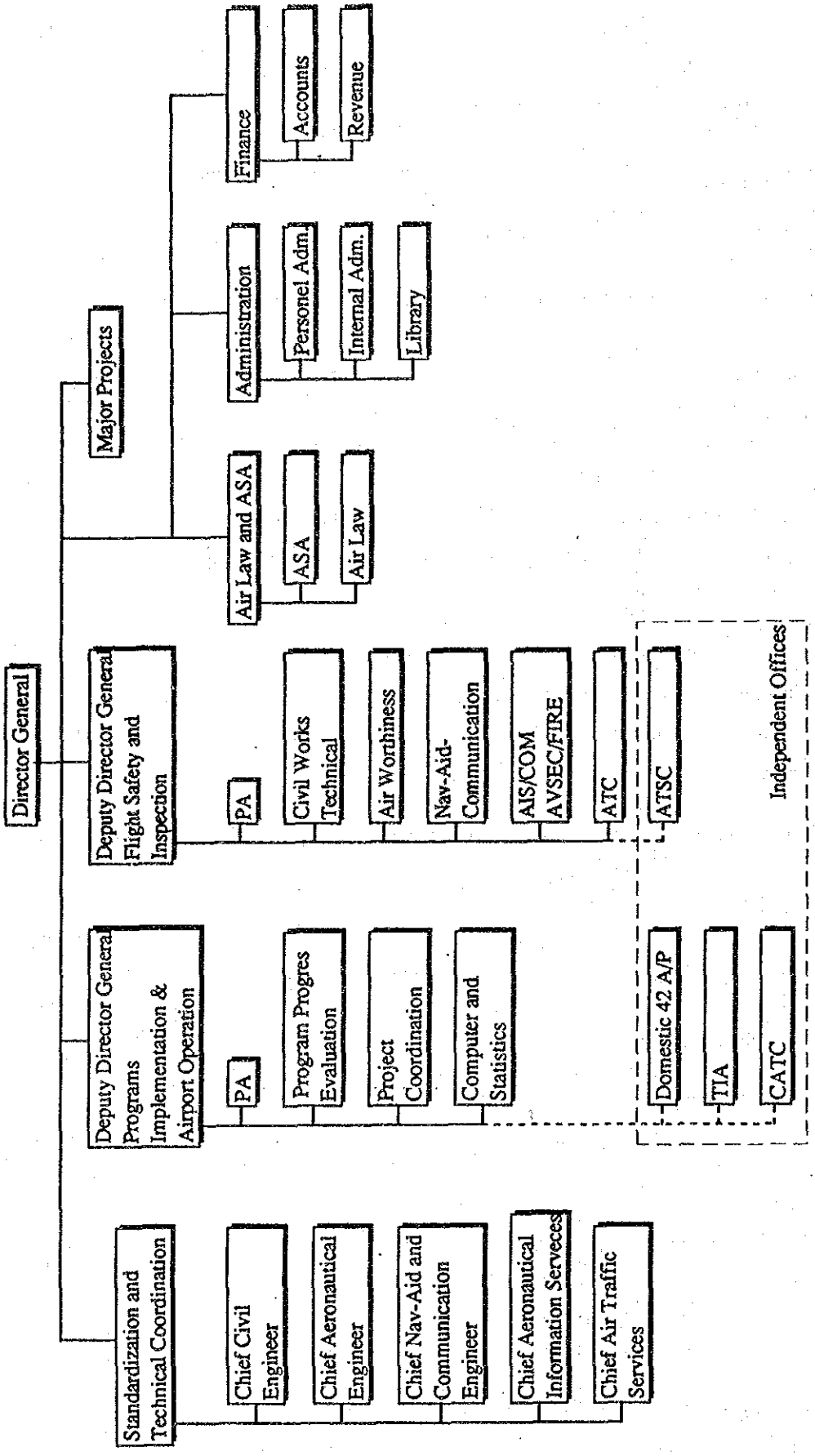


Figure 3.3.1 Overall DCA Organizational Structure

(4) Training Building

- Radar Simulator
- ASR/SSR transmitter/receiver
- Data Digital Laboratory

In addition to the above, VHF air to ground radio sets and radar display console will be provided to the existing facilities.

3.3.6 Operation and Maintenance Plan

(1) Human Resource Development

Required man power by commencement of operation of the radar system is estimated as follows:

- Radar Controllers: 16
- Maintenance Technicians: 20

DCA has a program for augmentation of controllers and maintenance technicians. Total number of the augmentations up to 1994 is estimated for 12 controllers and maintenance technicians respectively.

In spite of increase in the number, more than 2 controllers and 20 maintenance technicians are required for the radar system operation and maintenance.

Therefore, DCA shall arrange a program to human resource development.

Its detail is explained in Chapter 4.5.

(2) Running Costs

Required budget for radar operation and maintenance is estimated as follows:

Cost of the training facility is included in these costs.

Table 3.3.1 Running Costs Estimation of the Radar System

(Million NRs)

	1997	1998	1999	2000	2001
Labor Costs	0.8	1.7	1.9	2.0	2.3
Consumables for Equipment Maintenance	1.8	9.8	9.0	8.5	8.0
Facility Maintenance	0.7	1.4	1.4	1.4	1.4
Electricity and Water Rate	1.0	2.0	2.0	2.0	2.0
Total	4.3	14.9	14.3	13.9	13.7

Note: 1. Temporary maintenance fee is not included
2. Estimation period of year is from January to December
3. Labor Costs includes 10 % cost incrusing rate Per year

3.4 Technical Cooperation

3.4.1 Necessity for Technical Cooperation

No one has the experience for radar operation and maintenance because of first installation in Nepal. Aircraft control by using radar system requires a quite different technical level from the existing systems. On the other hand, high maintenance skill level will also be required due to apply modern technology in this system.

Since high technical ability to operate and maintain the radar system is required, no instructors or technicians can be found in Nepal. Therefore, dispatching experts to Nepal for technology transfer is highly expected. Overseas training should also be considered.

3.4.2 Requirement for Technology Transfer

Long training periods will be required for technology transfer on radar control, and technical skill level of the controllers will affect air safety. For the above reasons, technical transfer should be programmed conforming to the controller's technical level.

In the early stages of the radar operation, controllers who were trained outside Nepal will be in operation of the equipment with advise of experts. Although only monitoring operations will be expected in this stage, radar control of aircraft will be required in future operations.

Continuous training and technology transfer should be maintained in order to achieve sufficient technical skill levels.

Transfer of Technology should be able to make the Nepalese maintenance technicians self dependent on Radar System maintenance. In order to achieve this objective the curriculum of the training courses should be developed based on the level of skill of the DCA maintenance technician.

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4.1 Design Principle

4.1.1 Basic Concept

This facility shall be completed in a short period to allow the immediate operation in consideration of the importance and urgency of the project. On the system design, therefore, simple configuration of the system shall be considered as much as possible, and new development factors of system and equipment shall be avoided. For the design and construction of the building of radar equipment, the environmental impact for natural circumstances must be minimized by avoiding large-scale earthworks.

4.1.2 Design Policy

The subject of the design will be selected from the agreed items between the Nepal Government and the Study Team as the urgent project in "the Study of Tribhuvan International Airport Modernization Plan in Nepal" as described in Chapter 2. The actual subject of design are the airport surveillance radar system and training facility for the operation and maintenance of this system.

The following points are to be considered in the Basic Design.

- System performance and configuration of radar system must comply with the operational requirements.
- The airport surveillance radar system and its training facility must be coordinated with the current airport function and its future plans.
- The radar facility can be constructed within a short duration and easy construction, operation and maintenance are the desirable features.
- The equipment's of the radar system must consist of simple components as much as possible. Easy maintenance, low operation and maintenance costs are also required.

4.1.3 Design Condition for the Radar System

In the site selection process, a number of factors should be considered. Siting requirement for ASR/SSR facilities are identified for the following categories:

(1) Specific Coverage Requirement

- Navigation fixes

  All of the navigational fixes and air routes within the terminal area are desirable to be located within the line of sight (LOS) from the selected radar site.

- Runway Approach/Departure Coverage

  Coverage on final approach should be provided up to the missed approach point, and departure aircraft should be picked up at least 1 nm from the exiting runway edge (probably 300 feet above the extended runway surface).

(2) Requirements for Facilities Construction

The following items should be considered in terms of the construction costs and maintainability:

- Extensive and/or unusual road construction or improvements
- Special installation of water and/or electrical power
- Requirements for remote control and monitoring cable or microwave link
- Grading, landscaping or other property improvements
- Drainage
- Road access

(3) Technical Requirements

It is desirable to keep the minimum separation between the ASR/SSR antenna and any above ground structures and radio generating equipment such as radio navigation aids, communication facilities.

Ground clutter effect, lobbing, large reflection objects which may cause false targets should be analyzed.

4.1.4 Design Condition for Buildings Construction

(1) Natural Conditions

Monthly average temperature in the Kathmandu Basin is between 10 to 24 degrees C. and there are big differences with the seasons. Rainy and dry seasons are clearly divided and most of the annual precipitation is concentrated in the rainy season between May and September. Accordingly, the natural conditions for the design are settled as follows:

- The adequate measure for hot and cold weather for the design of buildings shall be considered for the prevailing weather conditions at the site.
- The condition of the drainage system in the rainy season, and soil improvement shall be considered for designing of the type for foundations of buildings and facilities.
- Maximum wind velocity for the design of the tower and building shall be 30 m/sec based on the past meteorological data.
- External finishing material for buildings shall be brick in consideration of standard construction materials in Nepal and for harmonization with the surroundings.

The normal operating condition of the equipment shall be as follows:

Ambient temperature :	Indoor equipment	: 0°C to 45 °C
	Outdoor Equipment	: -10°C to 60°C
Relative humidity :	Indoor equipment	: 90% at 40°C
	Outdoor Equipment	: 95% at 40°C
Duty		: 24 hours continuous operation

All equipment shall have electromagnetic compatibility and anti-electrostatics features.

(2) Consideration for Social Circumstances

The measure against the instruction by domestic animals shall be taken because there is cattle grazing around the radar site. The protection of cables by field mice also shall be considered.

As a special consideration for the construction schedule control, there are many national holidays and festivals in Nepal, especially in October and November should be made.

(3) Construction

The Japanese architectural standard shall be referred to the technical decision on building works in cooperation with local conditions because there are no regulations or standards for architectural works established in Nepal.

The technical capability and ability of local contractors are not expected to be of high level, but there will be no difficulties or troubles under good construction management inferred from the last terminal building construction works.

The common laborers can be obtained easily, but skilled laborers and technicians must be arranged in advance. It is necessary to recognize the difficulties of implementation of outdoor works during the rainy season. Local contractors may join the limited field of works in consideration of components of the project. Most of the construction materials and equipment should be obtained from Japan or other countries.

Heavy construction equipment for civil and architectural works and erection tower can be obtained from local contractors, except for some special kind of machines.

Most of the construction materials, excluding aggregate, timber, cement and bricks, must be arranged in advance since they will depend on imports from India or other countries. The material produced in the country also will be required to be arranged in advance because supplied volumes are not stable.

4.1.5 Governability of Executing Agency

As for the Executing Agency, the airport surveillance radar and the training facility will be the full responsibility of DCA.

After completion of the facilities, they will be handed over to Tribhuvan International Airport and Civil Aviation Training Center respectively.

The airport authority of Tribhuvan International Airport seems to have a high ability for management inferring from the operation and maintenance activities of the current systems and equipment, and they can arrange a budget for operation and maintenance for the radar system which will be provided by this project. However, the maintenance capability for the radar system must be trained in advance because special techniques are required.

Since the radar system and the training facility will require high technical level to maintain the equipment in good condition, it is essential to arrange a sufficient budget and to provide technical stuff for the system management and operation.

Necessary expendable materials and important spare parts for the operation and maintenance will be provided at the handing over time with the new equipment, but the budget arrangement to supply parts after some parts are consumed is also very important.

(1) Construction Period

The equipment of the system provided by the project will be custom-made and require long periods manufacturing. Thus, it will take a major portion of the total construction period, and special consideration will be required in the implementation program control of the project.

Implementation phase will be specified into the following stages:

- System and equipment design
- Manufacturing and inspection
- Installation, adjustment and commissioning test.

The standard period of each phase is estimated as follows which does not include any requirement of new design or development time:

- Design : about 1 month
- Manufacturing and inspection : about 10 months
- Installation, adjustment and testing : between 3 ~ 6 months

The construction period of the building to accommodate the equipment will require about 10 months, and ancillary facilities such as air conditioning plant or electric voltage transformer, etc. should be manufactured and transported in advance of the installation of equipment. However, they are easy to adjust on the construction schedule due to the shorter period than the radar equipment protection. The details will be explained in "4.4 Execution Program".

4.1.6 Under-taking by the Nepal Side

The following works shall be executed as the undertaking works by the Nepal side in cooperation with the construction schedule of the project.

(1) Radar Site

- The power supply shall be fed from the existing Main Substation by 3 phase 11 KV. Nepal side shall prepare floor space for installation of high tension voltage switching gear in the main substation.
- Branching work of the existing water distribution line.
- Preparation for the new telephone trunk lines at the existing PABX.

(2) Operations Building

- Preparation to supply low tension voltage electric power for essential load.
- Branching work of the existing water distribution line.
- Preparation for the new telephone truck lines at the existing PABX.

(3) Training Center

- The extension works from the existing 11KV high tension voltage line to the site.
- The extension works public telephone line to the telephone terminal box at the training center building.
- Improvement of the existing access road to the site.

(4) Testing

- Flight Inspection

4.2 Basic Design

4.2.1 Siting of Facility

The airport surveillance radar consists of two major functions, transmitter/receiving equipment installed at the radar equipment building, signal processing and display unit installed at the radar operations building.

Radar operation building is preferable to be located near the current operating facilities, but the location of the transmitter and receiver facility shall be decided in consideration of radar coverage, siting conditions and construction conditions.

Department of Civil Aviation has plans to relocate the existing Aviation Training Center (CTAC) to the previous receiving station site in the near future. Then, the new radar training facility provided by the project is preferable to be constructed at the previous receiving station so as to coordinate with the future plan. The construction site of the radar equipment building was studied on some selected alternative sites based on the design criteria. The studied results are shown as follows. The most suitable site was selected in the airport site. The location of alternative sites are shown in Figure 4.2.1.

(1) Mt.Phulchauki Site

The low angle area is not covered due to the characteristics of the radar antenna. This means that a departing or arriving aircraft with low flying level can nor be detected.

(2) Mt. Nagarkot Site

Horizontal coverage is insufficient due to the shadow of Mt. Phulchauki. Then, the lacked coverage is overlapping with the Shara approach which is the main approach route from the south.

The coverage chart is shown in Figure 4.2.2.

(3) Changunarayan Site

Near screened obstruction is anticipated on this site. Therefore more than 25 m height of antenna tower will be required to clear this obstacle. Improvement of access road and installation of radio link between the airport and the site will be required.

The coverage chart is shown in Figure 4.2.3.

(4) Torebhir Site

The site survey was not carried out because of difficulty for access due to road conditions. Judging from the actual conditions, large scale construction works for the access road will be required.

The coverage chart is shown in Figure 4.2.4.

(5) Airport Site

Some parts of the radar coverage is screened by Mts. Phulchauki and Chandragili, but the surveillance for approaching from the south is possible.

The coverage chart is shown in Figure 4.2.5.

4.2.2 Facility Layout Plan

Facility layout plan of the radar operations building, radar equipment building and training facility at Tribhuvan International Airport was studied as shown in Figure 4.2.6 to Figure 4.2.10 in consideration of easy construction, short construction period, and coordination with the future plan.

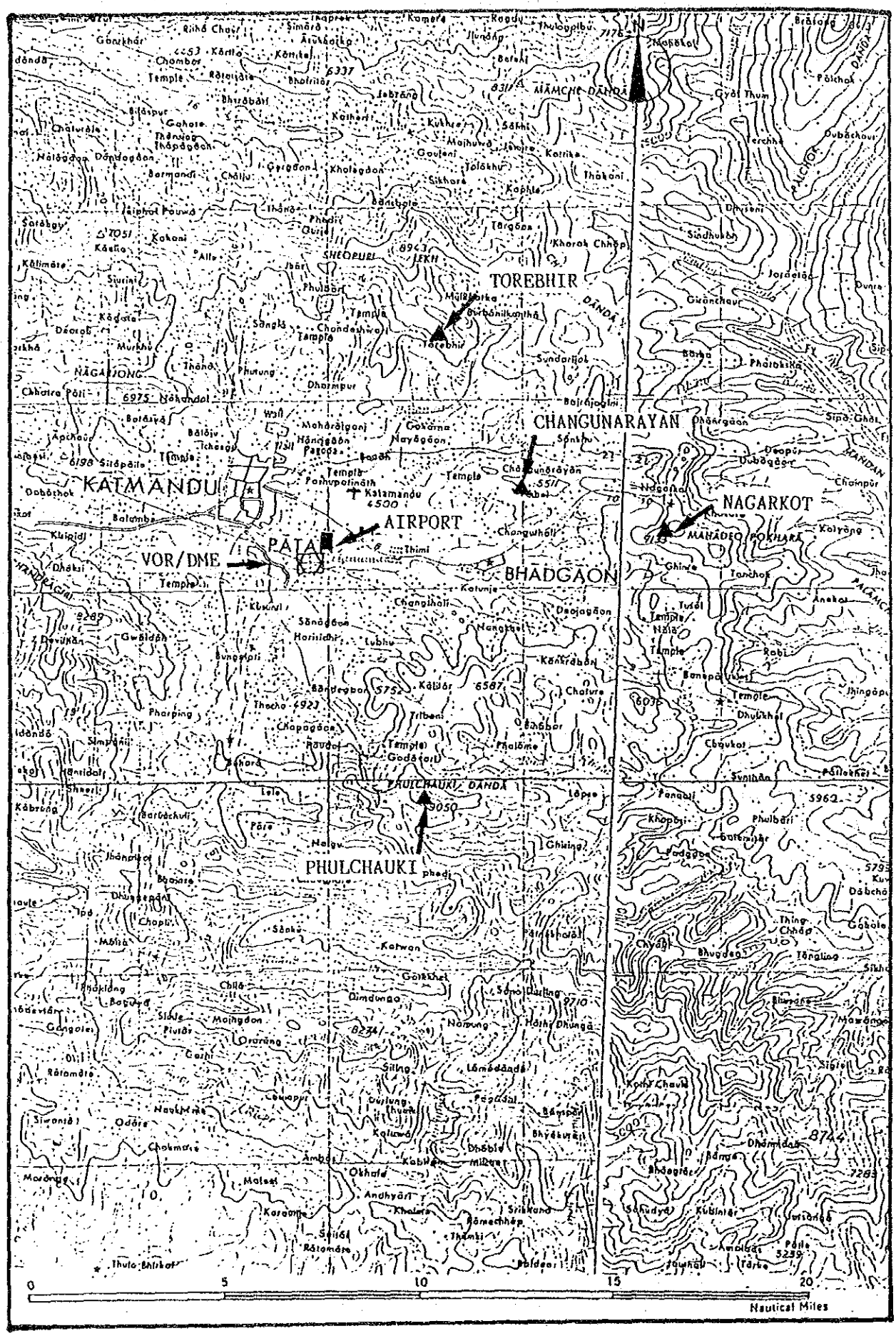


Figure 4.2.1 Alternate Radar Site Locations

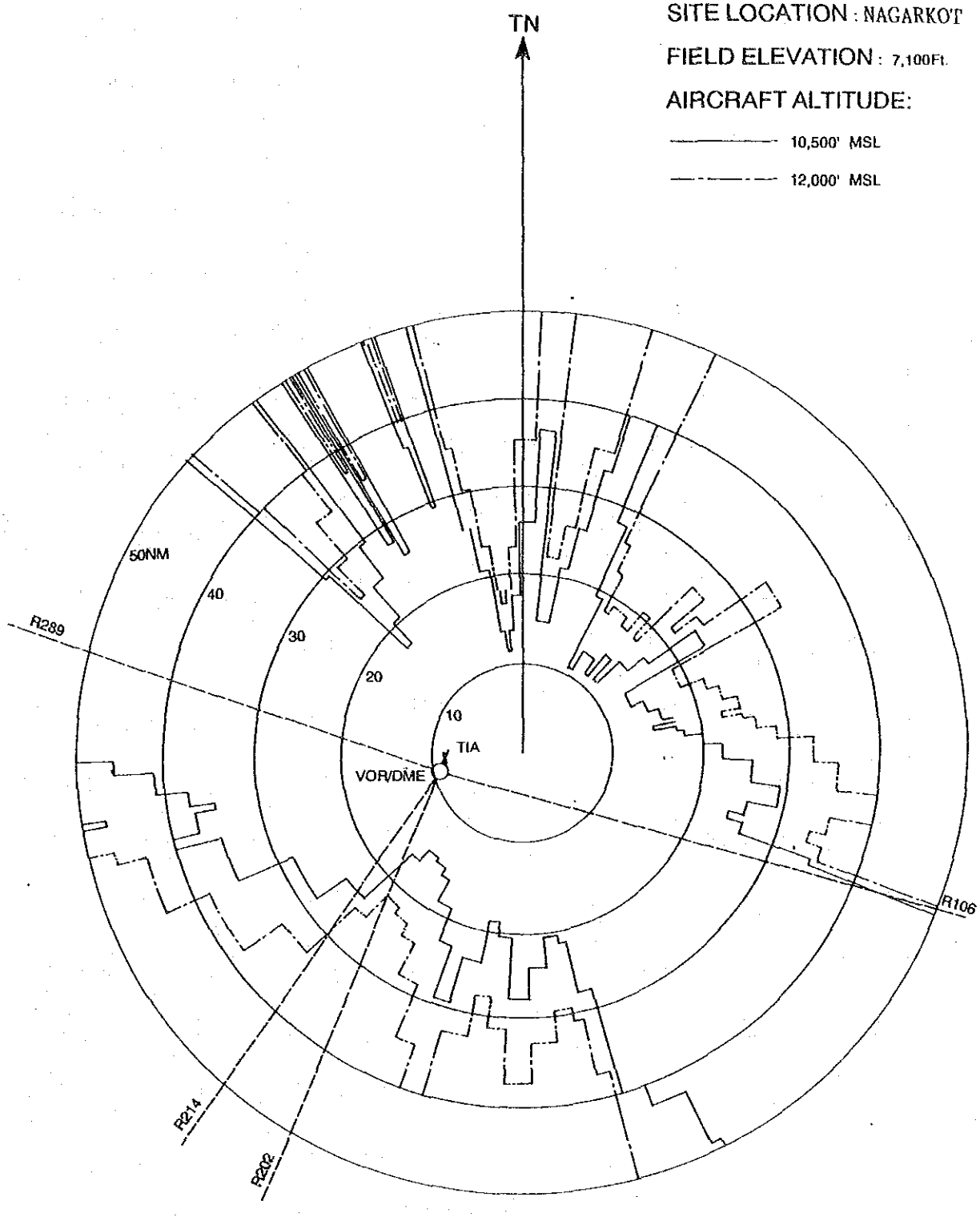


Figure 4.2.2 Coverage Chart of Mt. Nagarkot Site

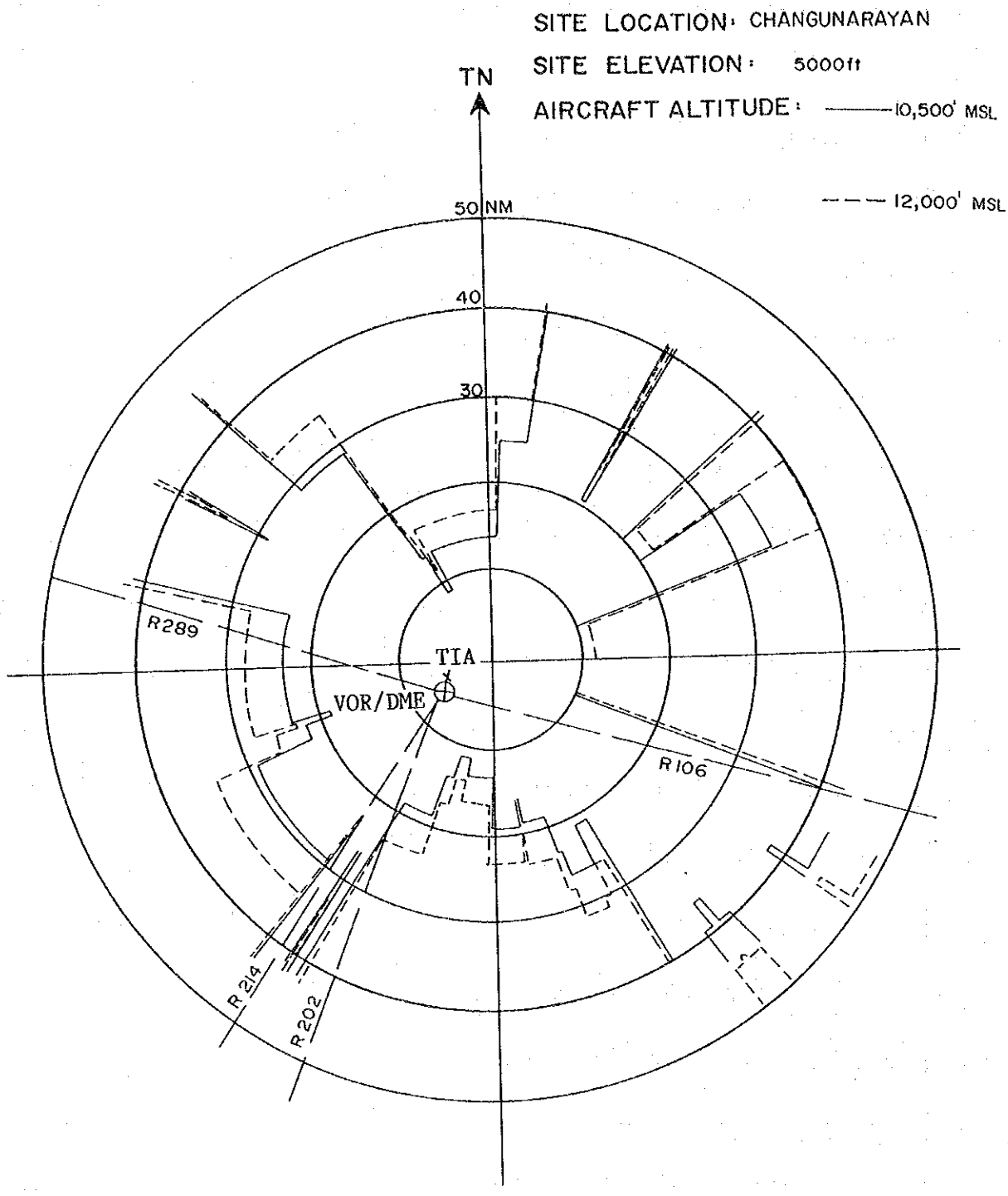


Figure 4.2.3 Coverage Chart of Changunarayan Site

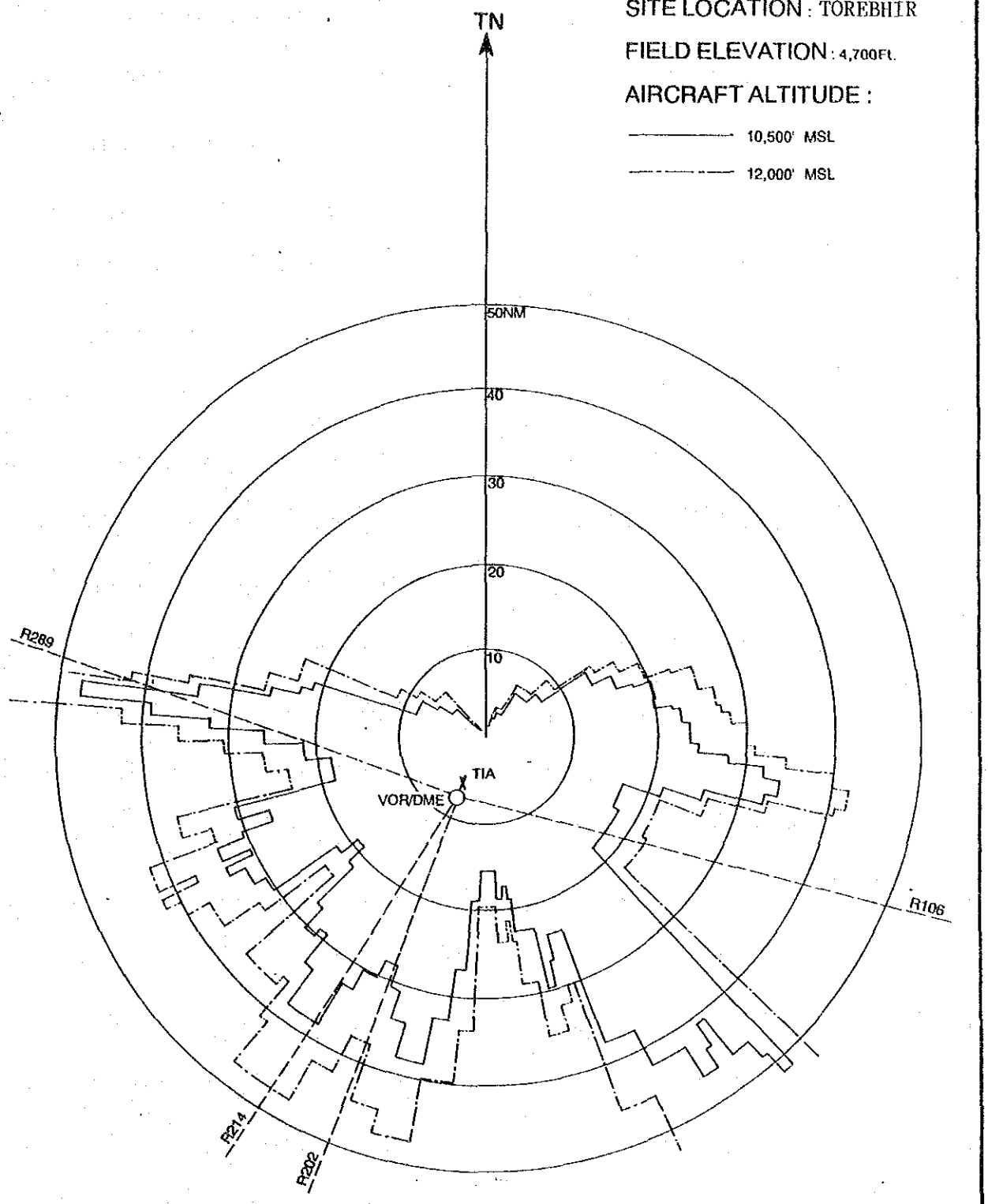


Figure 4.2.4 Coverage Chart of Torebhir Site

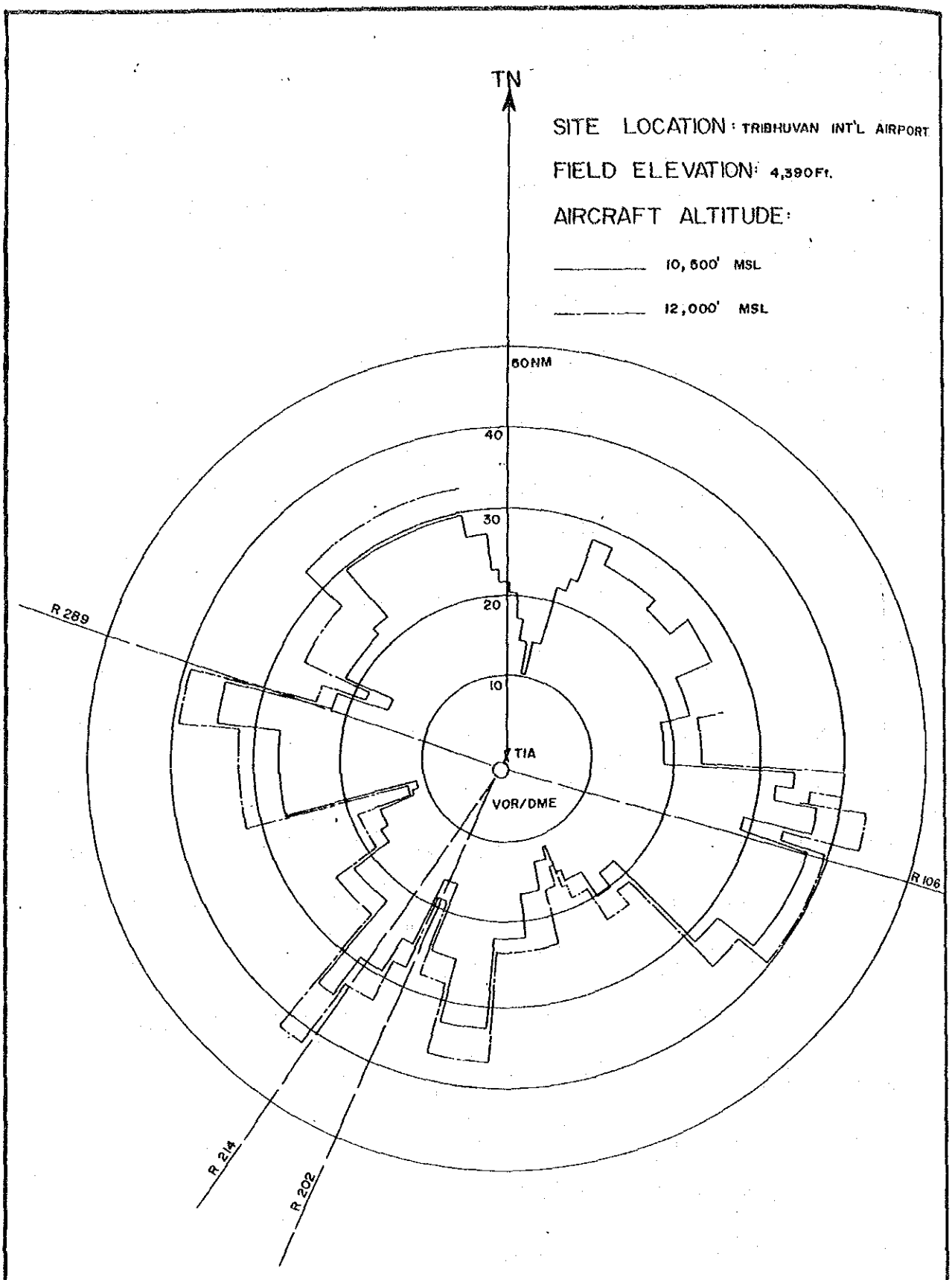


Figure 4.2.5 Coverage Chart of Airport Site

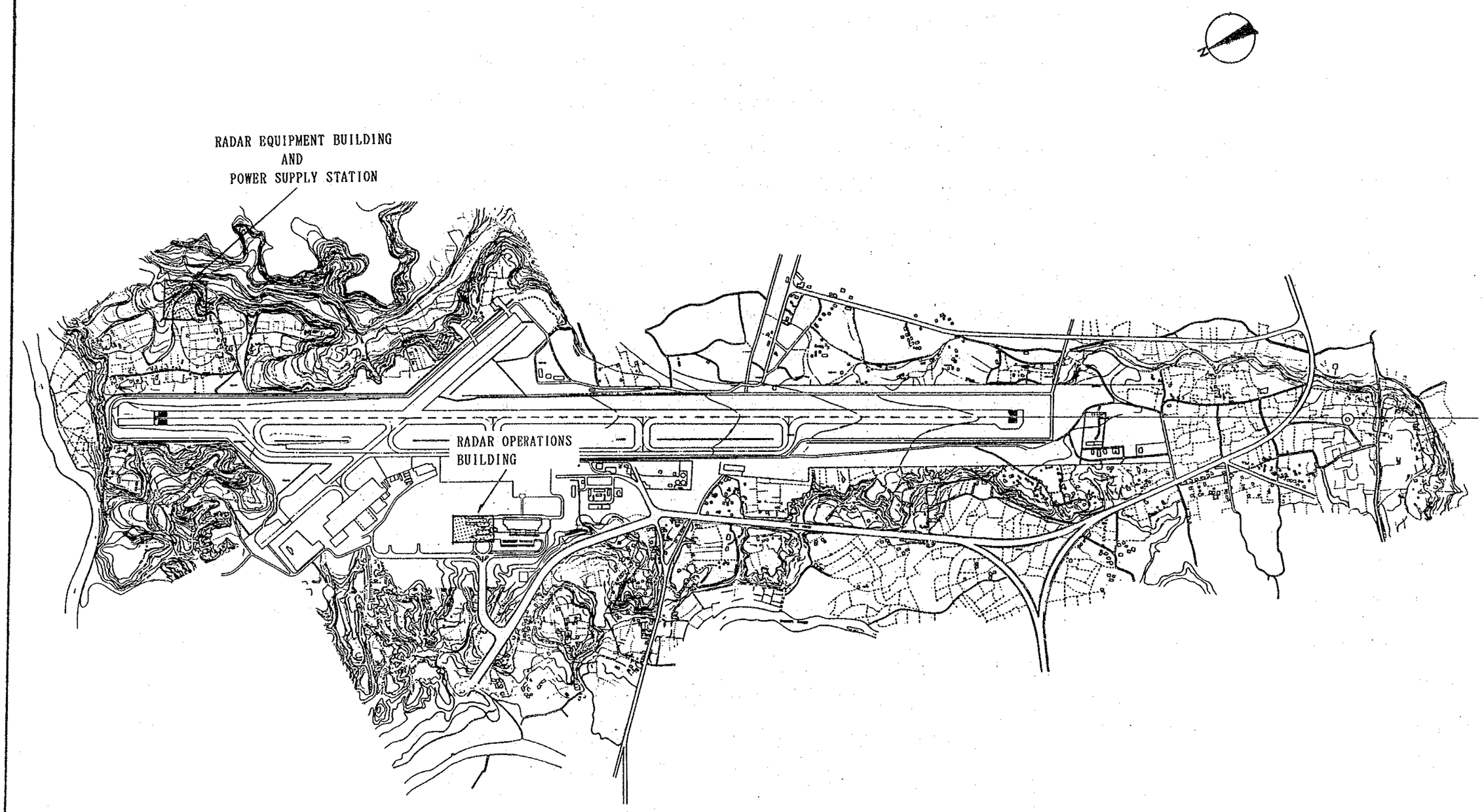


Figure 4.2.6 Radar Facilities Location Map

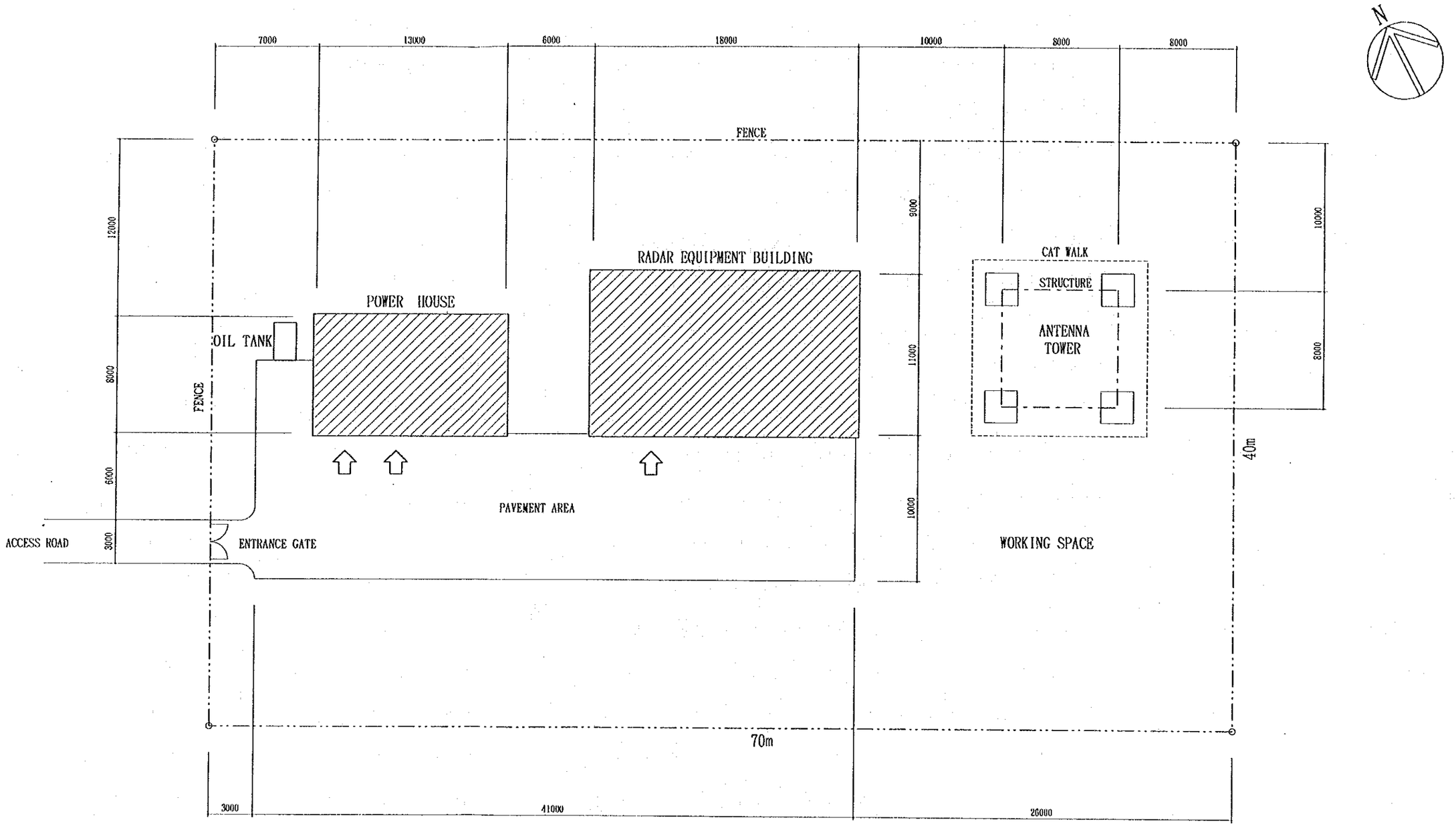


Figure 4.2.7 Radar Site Layout Plan

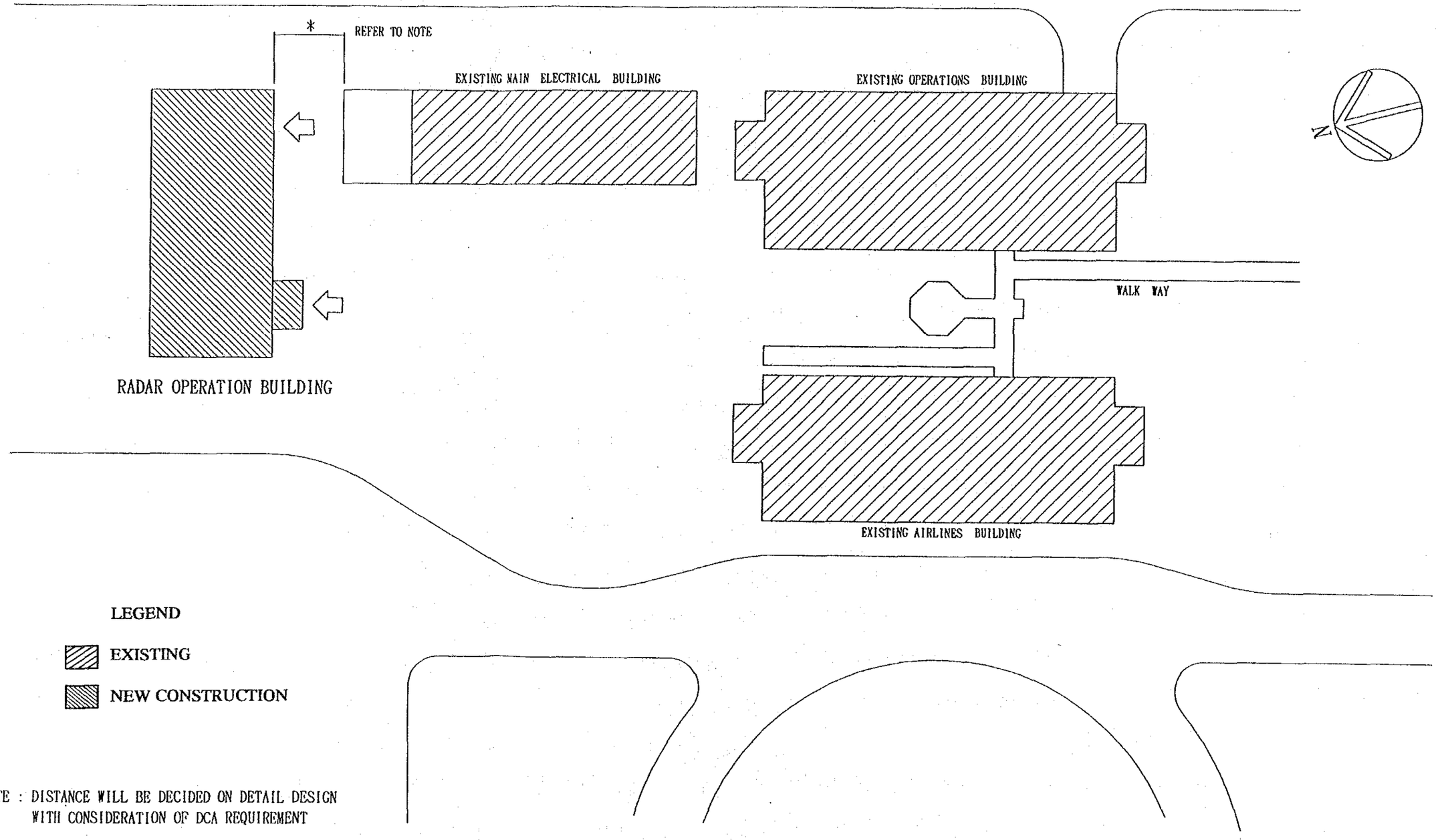


Figure 4.2.8 Radar Operations Building Site Layout Plan

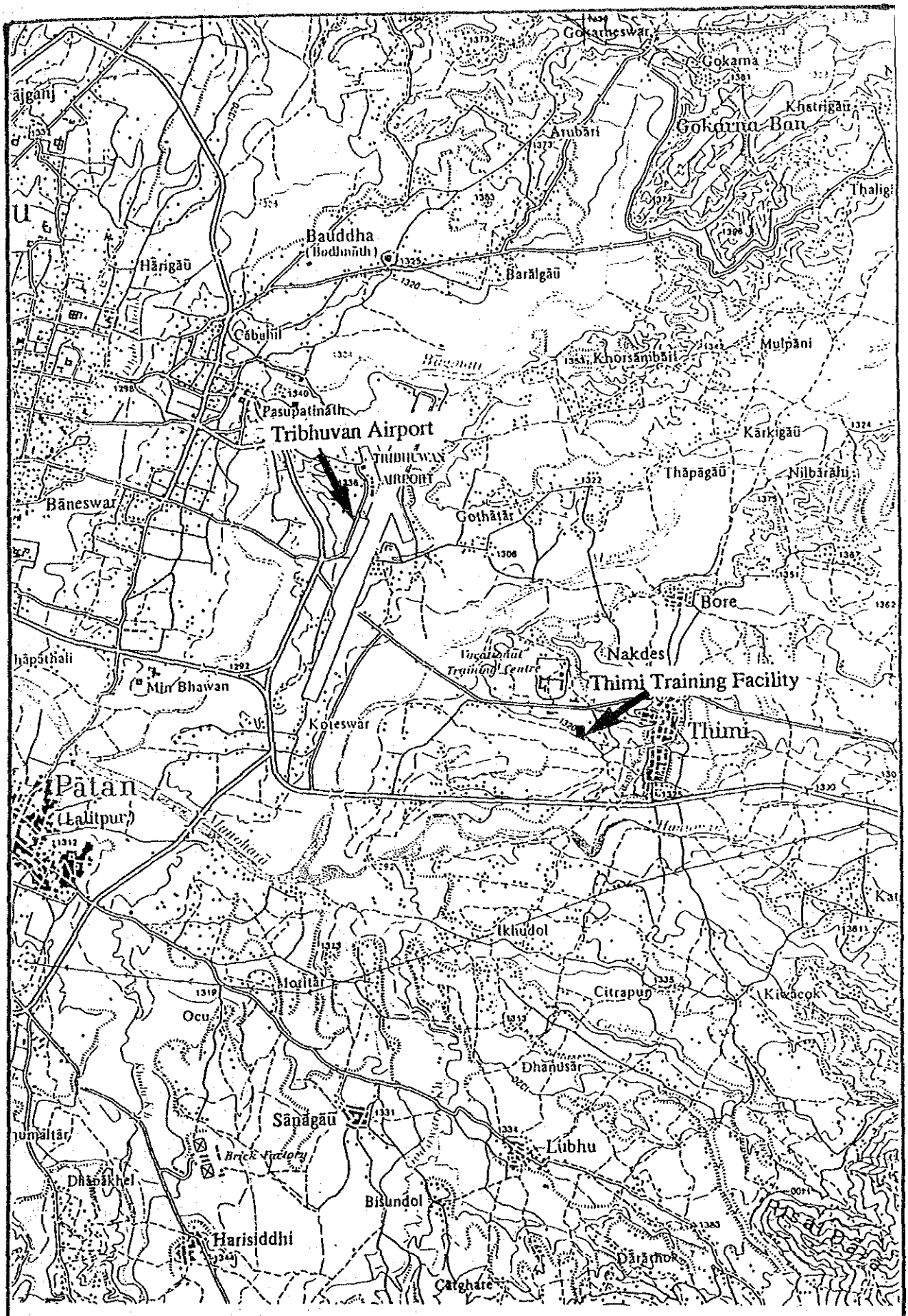


Figure 4.2.9 Radar Training Building Location Map

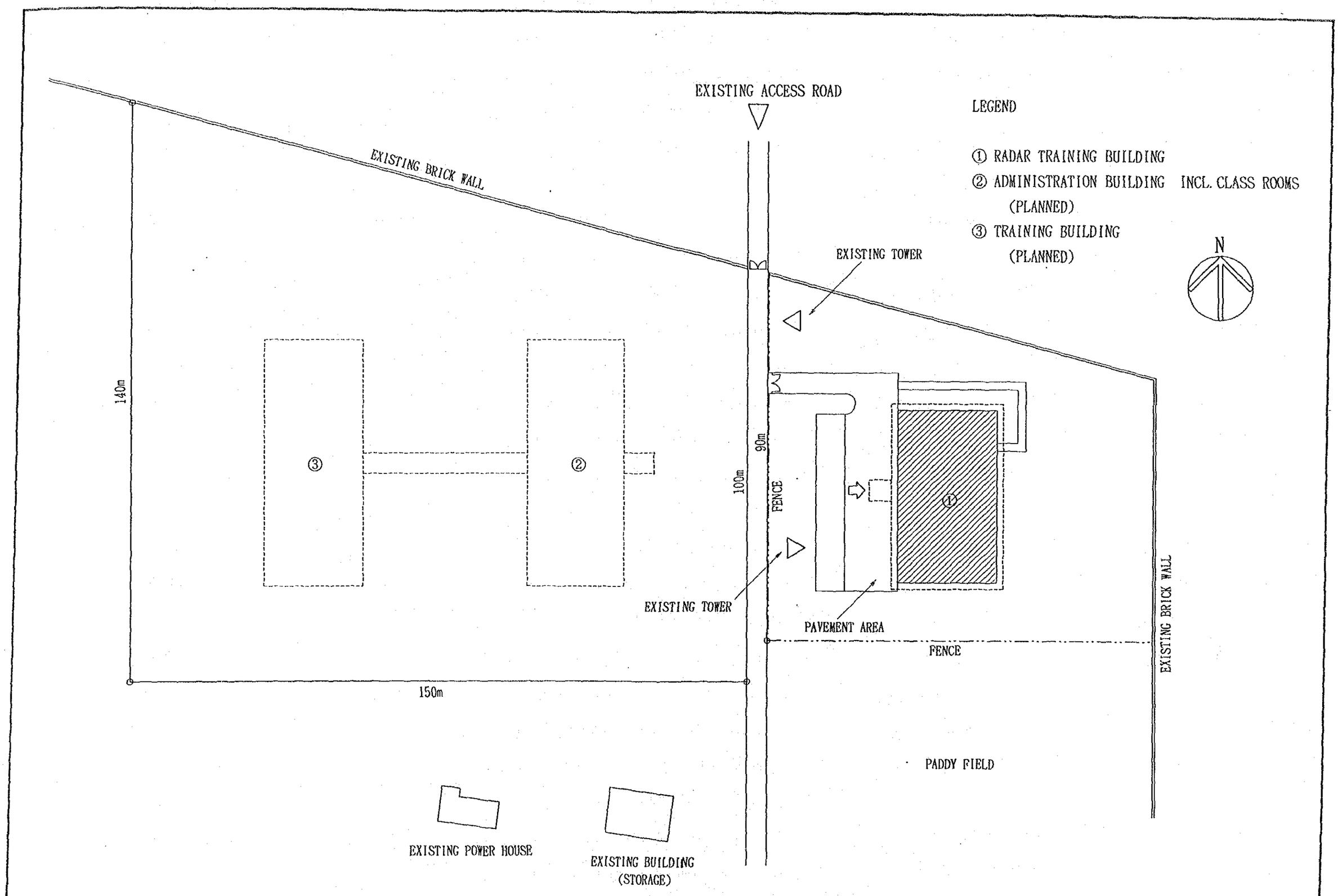


Figure 4.2.10 Radar Training Building Layout Plan

4.3 Facility Plan

4.3.1 Basic Function of Airport Surveillance Radar

Airport Surveillance Radar (ASR) system which consists of a primary radar and a secondary beacon radar, and it will be divided into two parts; one is the radar head for the transmitting and receiving of radar signals and beacon signals. Another one is the operation unit with signal analyzing, processing and display for the operation.

The components of radar head and antenna will be installed in the radar equipment building at the radar site, and the signal analyzing, processing and display unit will be in the operations building.

These two units are connected with the communication and control cable for signal transmitting and remote monitoring and controlling.

The following performance shall be considered for the system design.

(1) Radar Coverage

Requirement of radar coverage shall be satisfied with the following conditions at 25,000 feet vertical coverage and 60 nautical mile in the azimuth range.

- Target Reflection Area : 2 m^2
- Detection Probability : more than 80 %
- False Alarm Rate : 10^{-6}

(2) Measures for Clutter

The special measures for the occurrence of ground clutter shall be considered due to the topographical conditions of Kathmandu Valley. The following measures shall be studied.

- application of MTD (moving target detection) based on the I.Q. logic.
- elimination of reflection by ground obstacles by STC.

(3) Warning by Secondary Radar Signal

The following warning functions shall be provided by the processing signal data of the secondary radar.

- MSAW (Minimum Safe Altitude Warning)
- CN (Conflict Alert)

The allocation of VHF radio frequency for air to ground communication is required with providing suitable equipment for the radar operation. This communication equipment will be installed at Mt. Phulchauki to maintain sufficient coverage. Stand-by equipment will be installed at the existing operations office.

Other than the above communication system, inter-communication circuits between the radar consoles and ACC consoles, control tower consoles are indispensable for the effective operation of the radar system.

System Concept is shown in Figure 4.3.1.

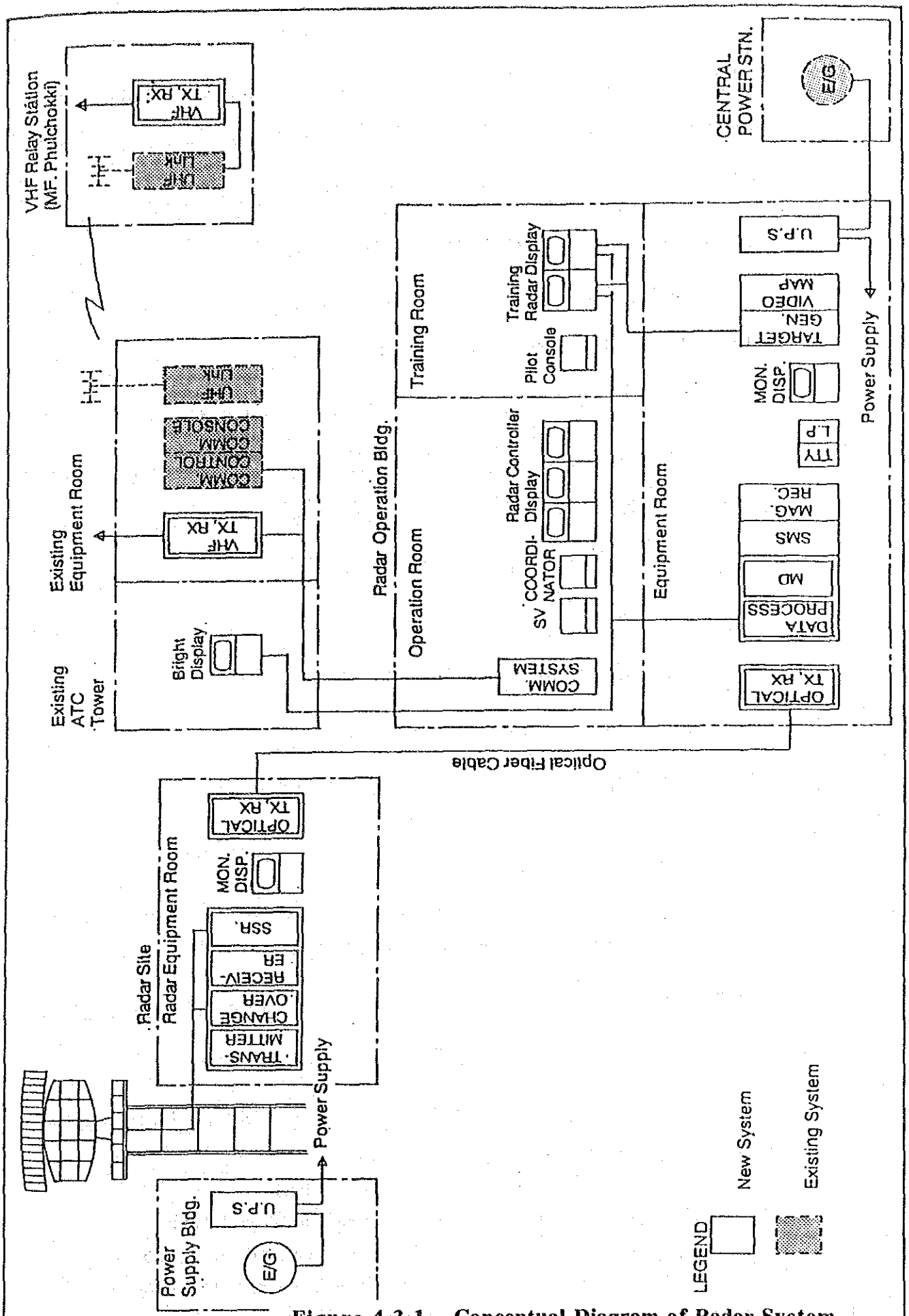


Figure 4.3.1 Conceptual Diagram of Radar System

4.3.2 Facility Layout Plan

A radar equipment room, a power supply building and a radar operations building for the accommodation of the new radar system shall be constructed newly in the airport property because of the lack of space at the current airport buildings.

The facility for the training of radar controllers, and maintenance technicians shall be provided in the Chimi at the previous receiving site.

(1) Outline of Facility

1) Radar Equipment Room and Power Supply Building

- Floor area
  - Radar equipment room : 198 m^2
  - Power supply building : 104 m^2
  - Height of antenna tower : 25 m
- Single-story building

2) Radar Operations Building

- Total floor area : 648 m^2
- Two-stories building

3) Training Center

- Total floor area : 690 m^2
- Single-story building

(2) Main Equipment

The main equipment in each building is shown in Table 4.3.1, and shall include necessary spare parts, test equipment and special tools.

(3) Outline Specifications

1) ASR

Output power	:	500 Kw
Frequency	:	S band (2,700 ~ 2,900 MHz)
Type of Amplifier Tube	:	Klystron
Noise Figure	:	Ress than 4.0 dB
Range Resolution	:	Not more than 200m at 25NM
Azimuth Resolution	:	Not more than 1.5 degrees at 25NM
Accuracy	:	Not more than 50m and 0.5 degrees

2) SSR

Interrogation modes (ground-to-air)

Mode A - to elicit transponder replies for identify and surveillance. (8±0.2 microseconds)

Mode C - to elicit transponder replies for automatic Pressure - altitude transmission and surveillance. (21±0.2 microseconds)

Performance and characteristics shall conform with ICAO, Annex 10 specification.

3) Signal Processing

1. Range	about 60 NM
2. Radar Processing Data	Primary Surveillance Radar Data Secondary Surveillance Radar Data
3. Number of Displays	max. 6 displays
4. Processing Capacity	120 Aircraft (Number of Tracks)
5. Response Time (sec.)	within 1.5
6. Display of Data Block	Beacon Code Aircraft Identification Altitude / Coast / Hand off Symbol / Speed / Aircraft Type / Emergency Indication
7. Display of List	26 lines (maximum)
8. RDP Interface	Option
9. Operation	Dual

The radar system should have compatibility with the other SSRs which may be located outside of the airport.

(3) Power Supply System

The electric power supply to the radar operations building and radar equipment building shall be fed from the main power substation of the airport. Low tension voltage supply to radar operations building and high tension voltage supply to radar equipment building shall be designed taking cable losses into consideration. Load of the system shall be backed up by the central engine generator of the airport or local engine generator. The essential load should also be supported by uninterrupted power supply system (U.P.S).

Performance of Power Supply System

- Radar Site	:	UPS: 50 KVA	15 minutes support
		Emergency Generator: 120 KVA	
- Operations Building	:	UPS: 30 KVA	15 minutes support

Remote Monitoring of Power Supply

The following items shall be monitored by an alarm and indication panel in the radar operation building;

a. Trip of 11 kV main circuit breaker of the radar site substation

b. Operation mode of emergency generator of the radar site substation

The power supply system of the training center shall be by high tension voltage from main cable and stepped down by the transformer.

(4) Training System

- Controller Simulator

Scale of Simulation	More than 10 training area setting More than 20 training program available
Training Condition	Wind Direction 360 degrees Wind Velocity up to 200 knots Ground Clutter Equipment Failure
Aircraft Movement Control	Flight Plan setting; more than100 tracks Presetting track number; more than 20 tracks Controlled track number; more than 10 tracks

- Maintenance Training Equipment

ASR (Single Configuration) Same as airport ASR radar
SSR (Single Configuration) Ditto
Training kits for practice

Table 4.3.1 Equipment List

Building	Room Name	Equipment	Q'ty
Radar Operations Building	Radar Operations Room	Radar Display Console	3
		Coordinator Console	1
		Supervisor Console	1
		DEDS/TTY Terminal	1
	Simulator Training Room	Radar Display Console	2
		Pilot Console	2
	Equipment Room	Radar Data Processor	1
		Video Recorder	1
		Reproducer	1
		Monitor Display	1
		System Management Console, DEDS, TTY	1
		Comm. Control System	1
		Optical Control	1
	Power Supply Room	U.P.S.	1
		Battery	1
Radar Head Equipment Building	Radar Head Equipment Room	ASR TX/RX	2
		SSR TX/RX	2
		Signal Processor	2
		Change Over Unit	1
		Monitor Display	1
		Optical System Terminal	1
	Power Supply Room	U.P.S.	1
		Battery	1
		Generator	1
CATC Building	Simulator Room	Radar Display Console	3
		Comm. Console	3
		Pilot Console	3
	Simulator Computer Room	Computer System	1
		Video Generator	1
		Comm. Control System	1
		Video Recorder	1
		Video Reproducer	1
		System Management Console, VDU/TTY	1
		Power Supply	1
	Radar Laboratory	ASR TX/RX	1
		SSR TX/RX	1
		Monitor Display	1
	Data Digital Laboratory	Digital Circuit	1
		Trainer set	3
		Personal Computer	

(5) Building Construction

Building facilities design will be carried out based on the following design plans:

1) Site Layout Plan

- Radar Site

Radar equipment building, local power station and radar antenna tower will be provided at the radar site. The distance between the equipment building and the antenna tower should be close to each other in order to minimize feeder line losses of RF. Working area should be provided around the tower.

Carpark and turning area for vehicles will be required in front of the building. Fencing around the site and outdoor lighting facility should be provided. Layout of the equipment building and the local power station should be designed in consideration of accessibility.

- Radar Operations Building

The radar operations building will be located near the existing airport operations building and both buildings will be connected by a walking path. Carpark in front of the building, and access road to the airport main road also shall be provided.

- Training Facility

Location of the training building will be planned at the previous radio receiver site close to the access road. Landscaping should be considered around the building.

2) Layout Plan

- Radar Site

Radar equipment building and local power station will be designed individually, and the entrance for the each building shall be planned to have adequate space to carry in/out of the equipment. Radar equipment room, maintenance office, toilet and serving room will be provided in the equipment building. Engine with a fuel tank generator with a fuel tank uninterruptible power supply (U.P.S) with battery will be accommodated in the local power station building. On the antenna tower, working space will be provided with a ladder.

- Radar Operations Building

Radar operations building, shall be planned for a two-story configuration consisting of radar operations room on the first floor and the equipment room on the ground floor. Heavy-weight equipment such as radar equipment, U.P.S and lead acid batteries will be installed on the ground floor. Toilet and serving room will also be provided. Radar operations room and On-the-Job Training room located close by the operations room will be provided on the first floor in consideration of the flow of traffic. An office room on each floor of the building, which has a relation with the room functions shall be provided.

- Training Building

Training building, with a detached single-story configuration, specified in two functions, with an area for radar controller training and for radar maintenance technician training. The building space is divided into two areas, the left side and right side roughly, and each function will be provided in the zoning plan.

Practice training room and class rooms are located closely to each other to maintain a short traffic line. Additionally cafeteria, conference room, library, chief of training center room, administration room, watch man room and storage shall be provided. Adequate space will be provided for toilets, and entrance to the building based on the requirement of training facilities generally.

The floor area of the training center should be sufficient so that training can be conducted at least for 12 trainees of the radar operations and maintenance respectively, at the same time.

Inner court and corridor are provided at the center of the building.

3) Sectional Plan

- Radar Equipment Building

On the assumption that the maximum height of the equipment will be 2,500 mm, the clear space between the ceiling and top surface of the equipment will be 1,000 mm, and space for maintenance of 1,000 mm, a total clear height above the floor level at 4,500 mm will be required for the equipment installation.

- Local Power Station Building

In the same manner, maximum height of 1,800 mm for the engine generator will be required. So the exhaust muffler of the engine will be suspended from the ceiling slab, and effective height of 2,700 mm will be required. In this height, the U.P.S. may be installed as the maximum height of the U.P.S. which will be assumed to be 2,300 mm.

- Operations Building Ground Floor

Maximum height of the equipment is assumed to be 2,000 mm. Since more than 500 mm clear space is required above the equipment, 2,500 mm height above floor level will be required. All of the necessary cables will be installed in floor pits or floor ducts and it will not be considered for cable ladder access.

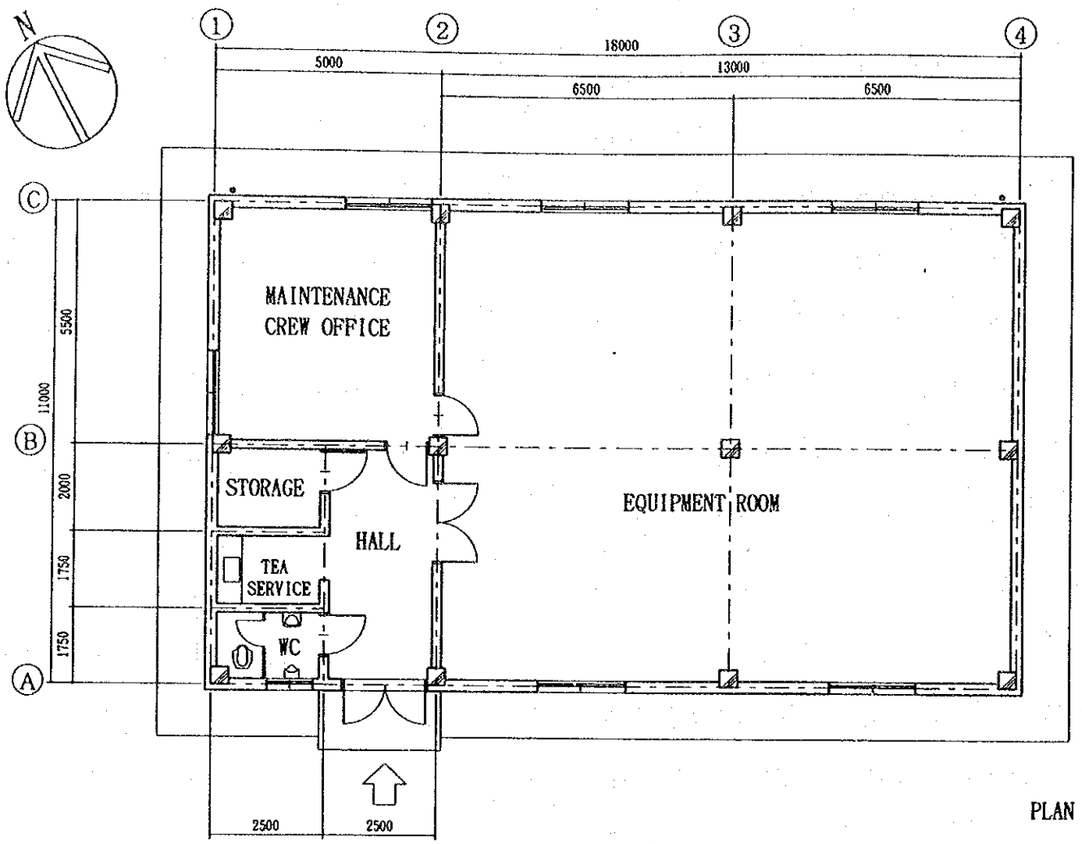
- Operations Building First Floor

No tall equipment will be installed in this room and cable access will be planned by using floor pits in floor ducts. Thus, the height above floor level will be determined to be 2,500 mm.

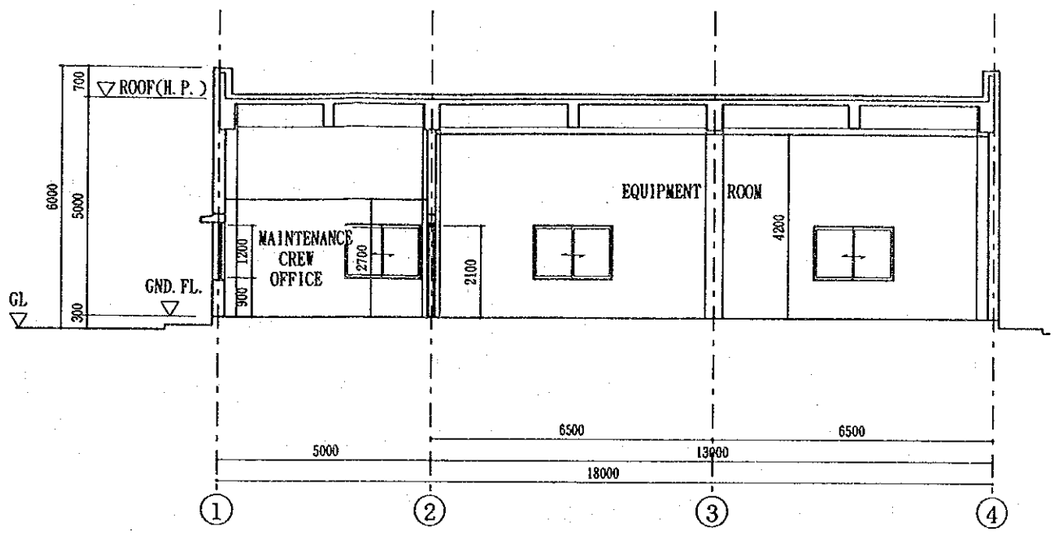
- Training Building

The equipment installed in the building will be same as the equipment which is installed in the radar equipment building and radar operations building. Although the maximum height of the equipment is assumed to be 2,500 mm, dummy load installation space above the equipment top surface will be required instead of wave guide and cable ladder space. Thus, a maximum height of 3,500 mm above the floor will be required.

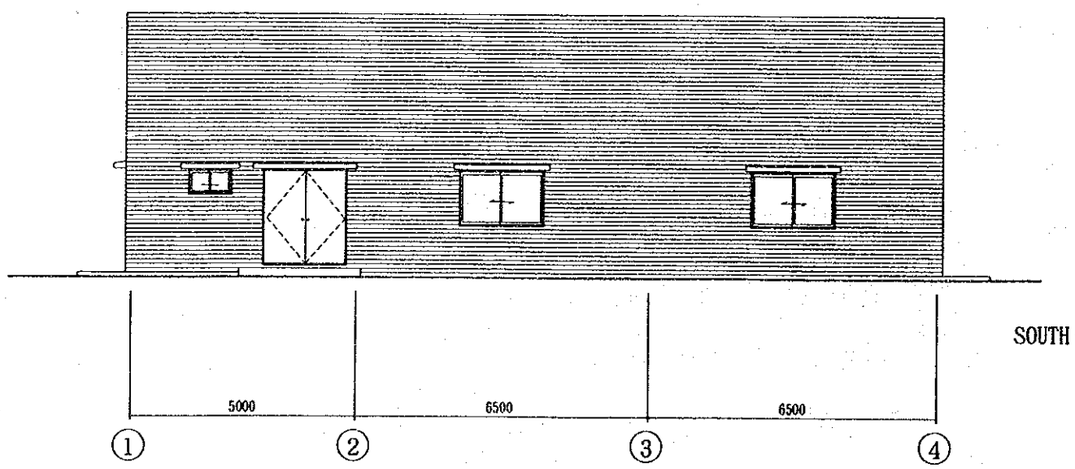
Since the necessary space between the bottom of the room beam and floor surface of the room is depending on the requirement of equipment installation and maintenance, the sectional plan of the building should be reviewed at the detailed design phase. Layout plan and section / elevation of the buildings are shown in Figure 4.3.2 to Figure 4.3.9.



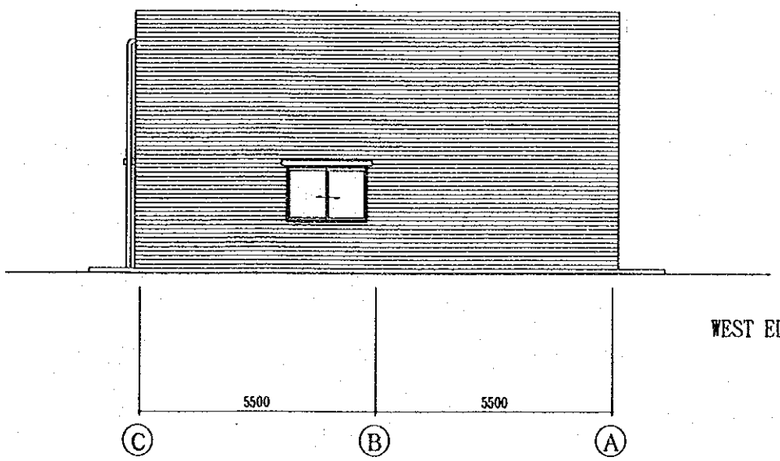
PLAN



SECTION

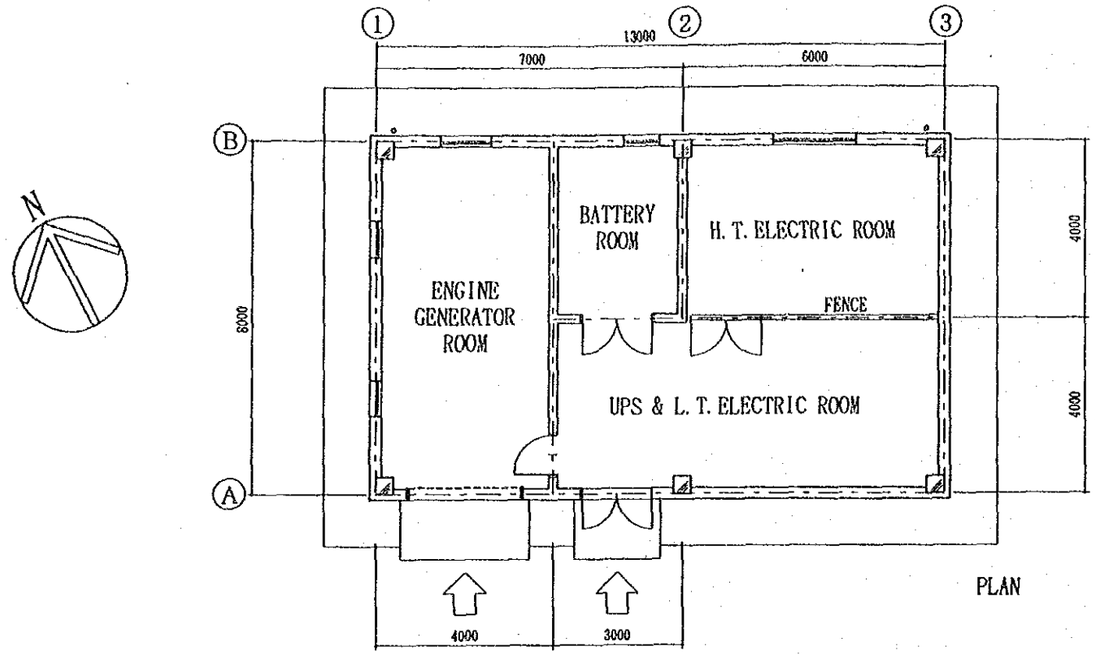


SOUTH ELEVATION



WEST ELEVATION

Figure 4.3.2 Radar Equipment Building
Layout Plan and Section/Elevation



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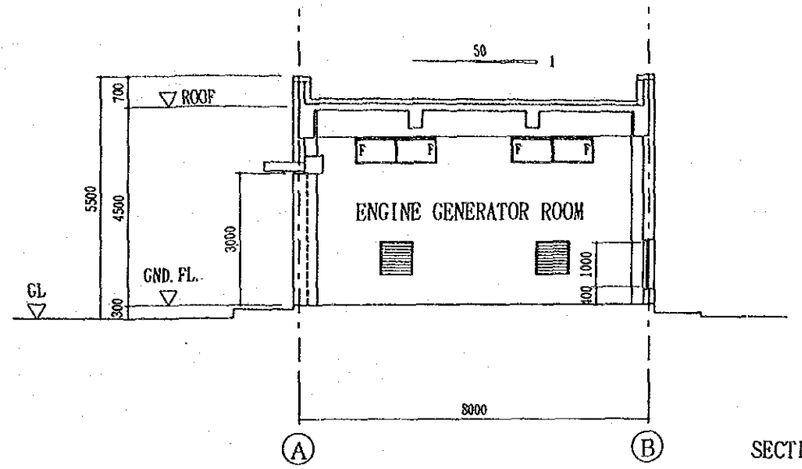
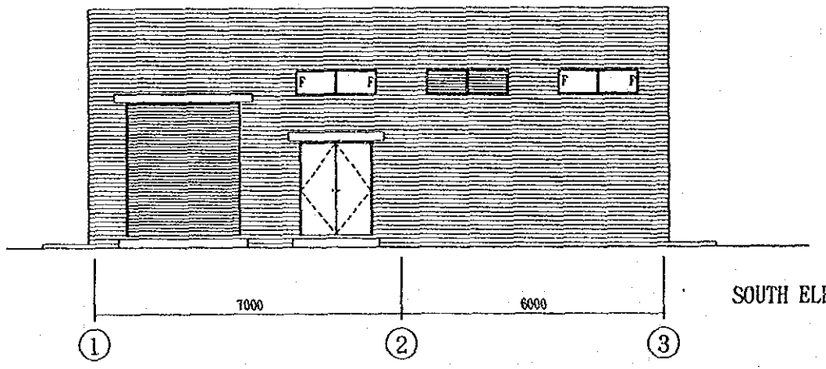
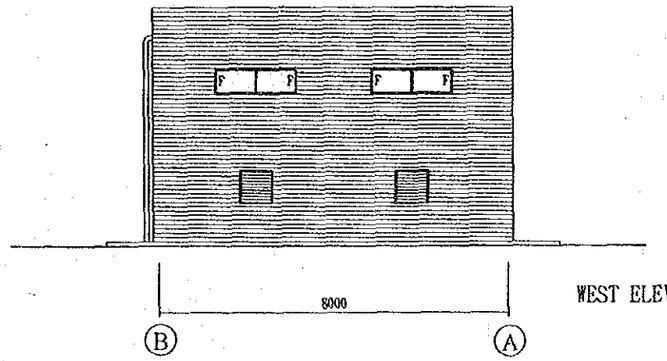


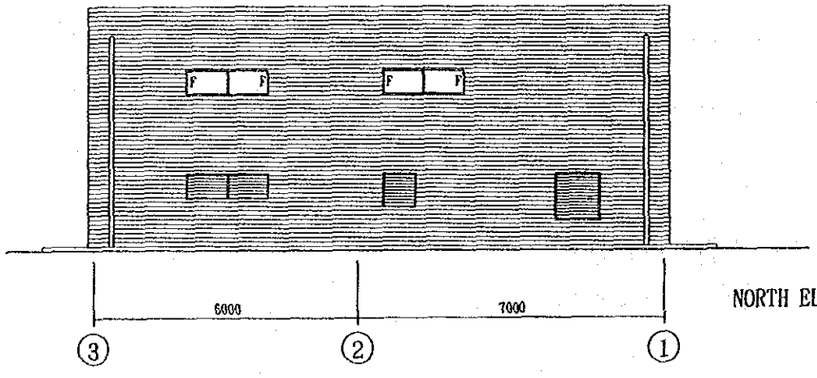
SECTION



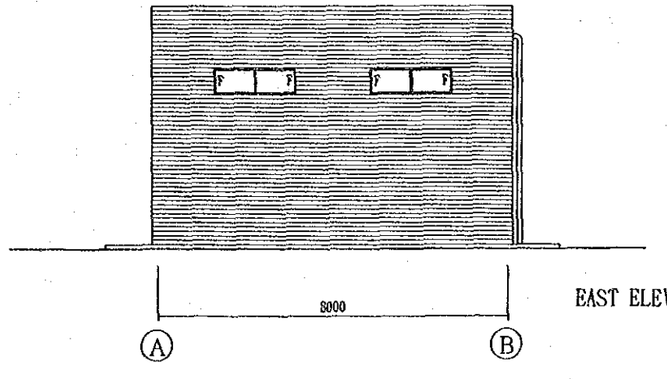
SOUTH ELEVATION



WEST ELEVATION

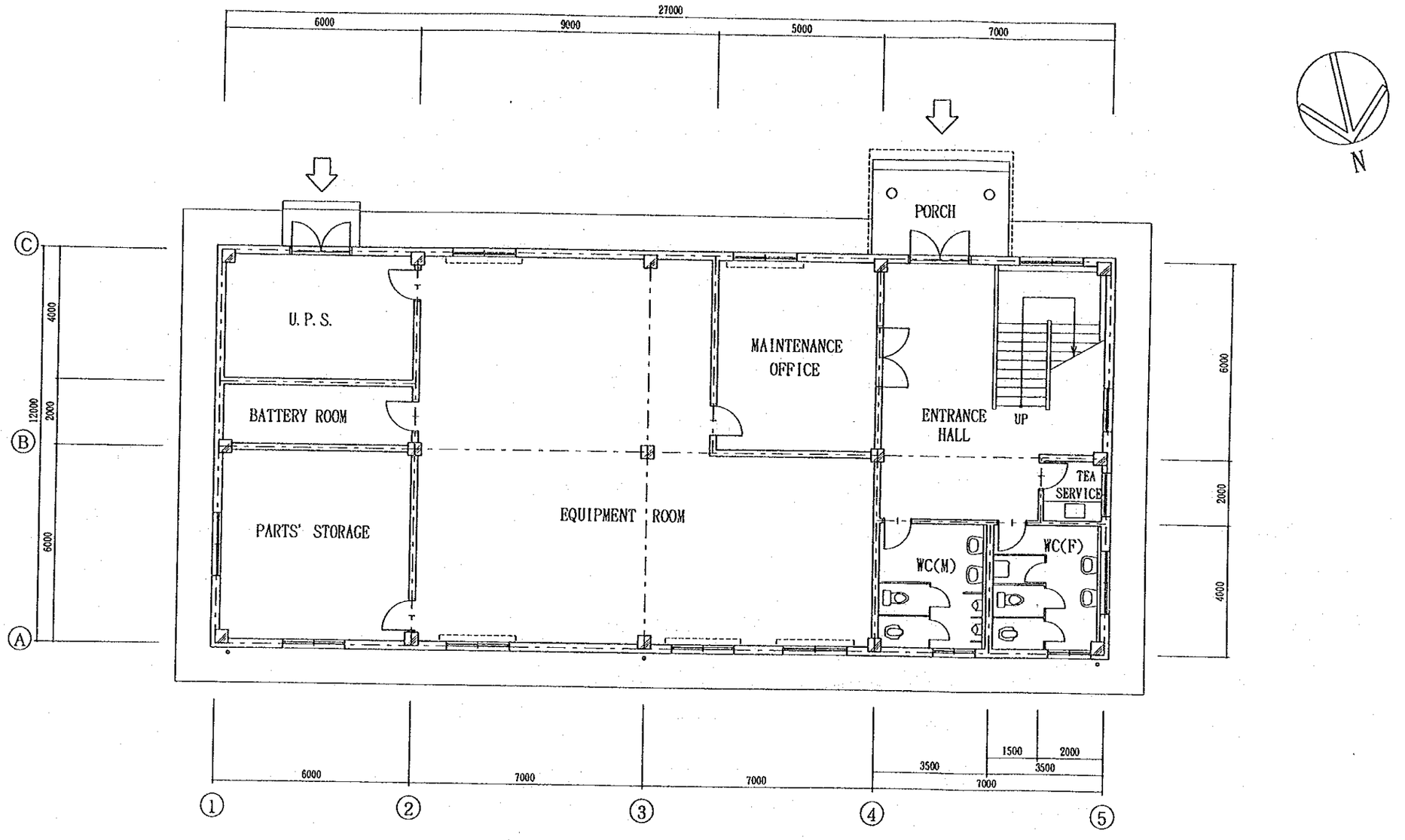


NORTH ELEVATION



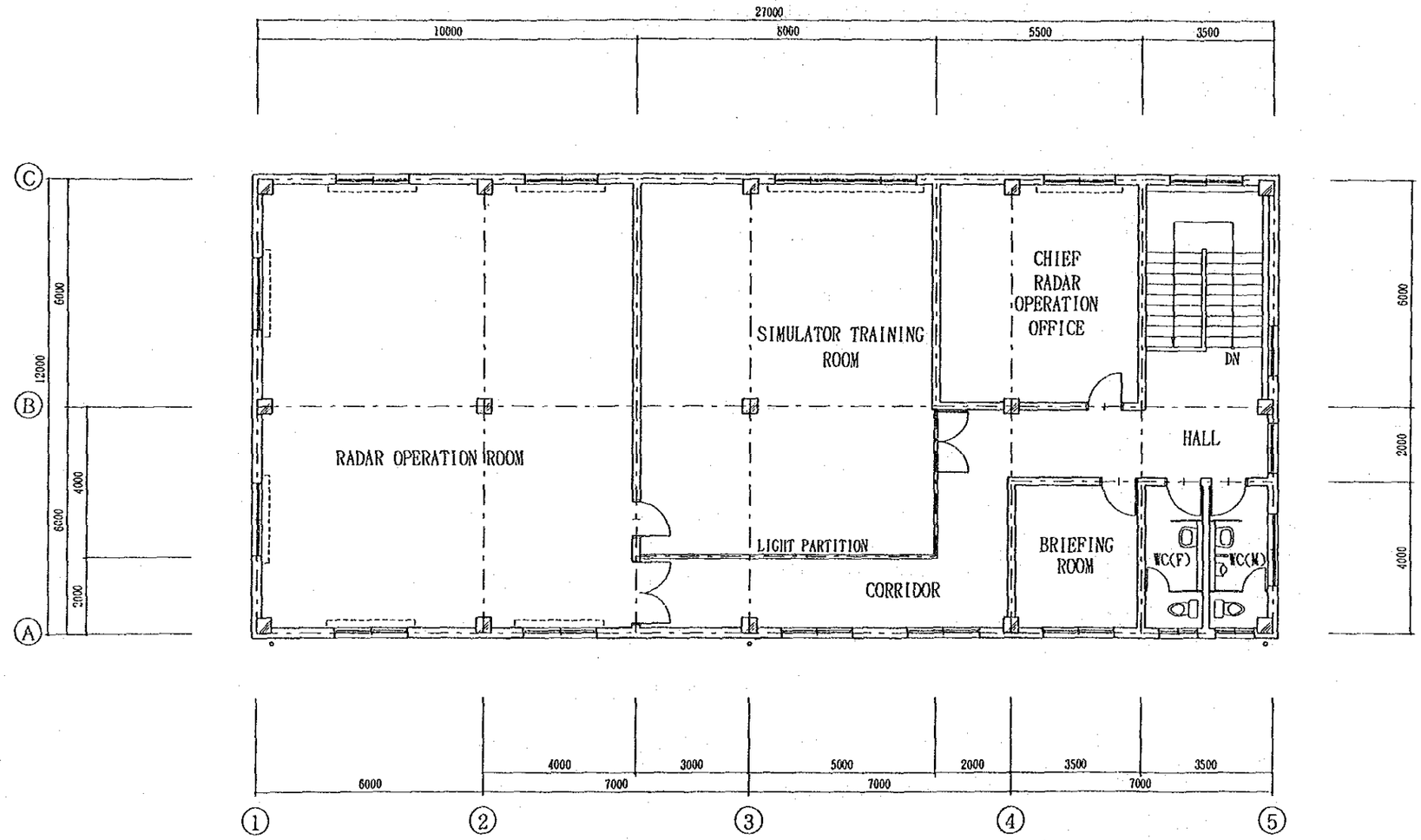
EAST ELEVATION

Figure 4.3.3 Power House Layout Plan and Section / Elevation



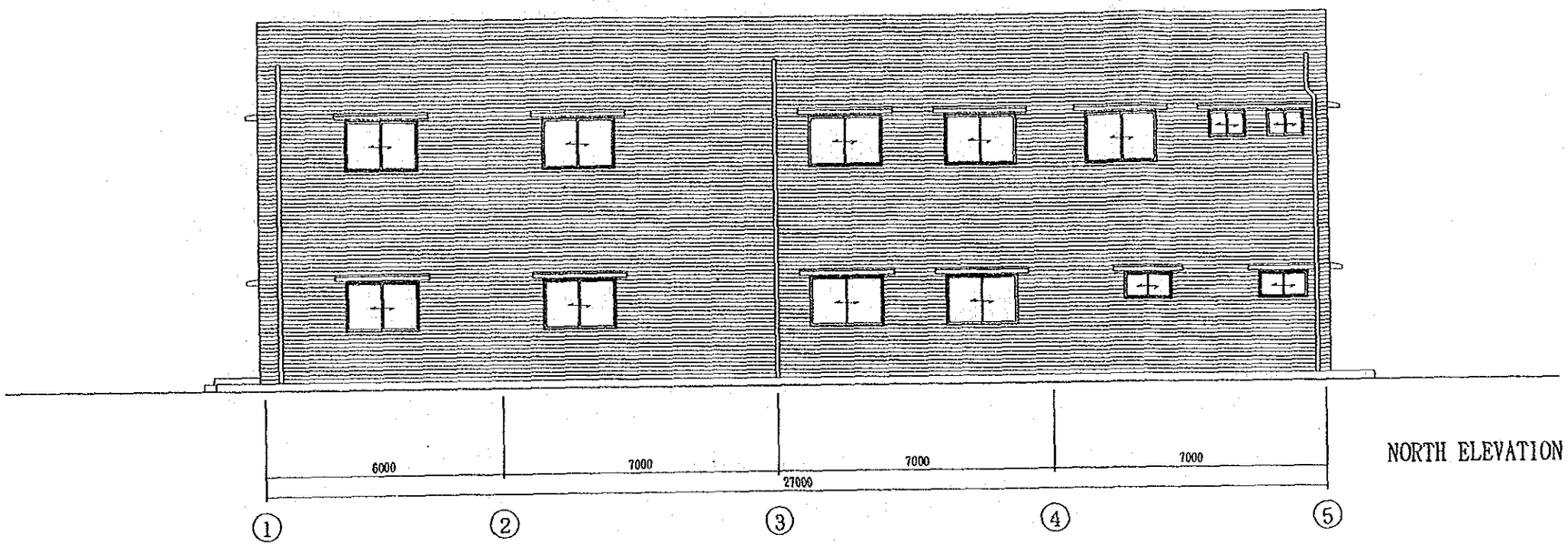
GROUND FLOOR PLAN

Figure 4.3.4 Radar Operations Building Ground Floor Plan

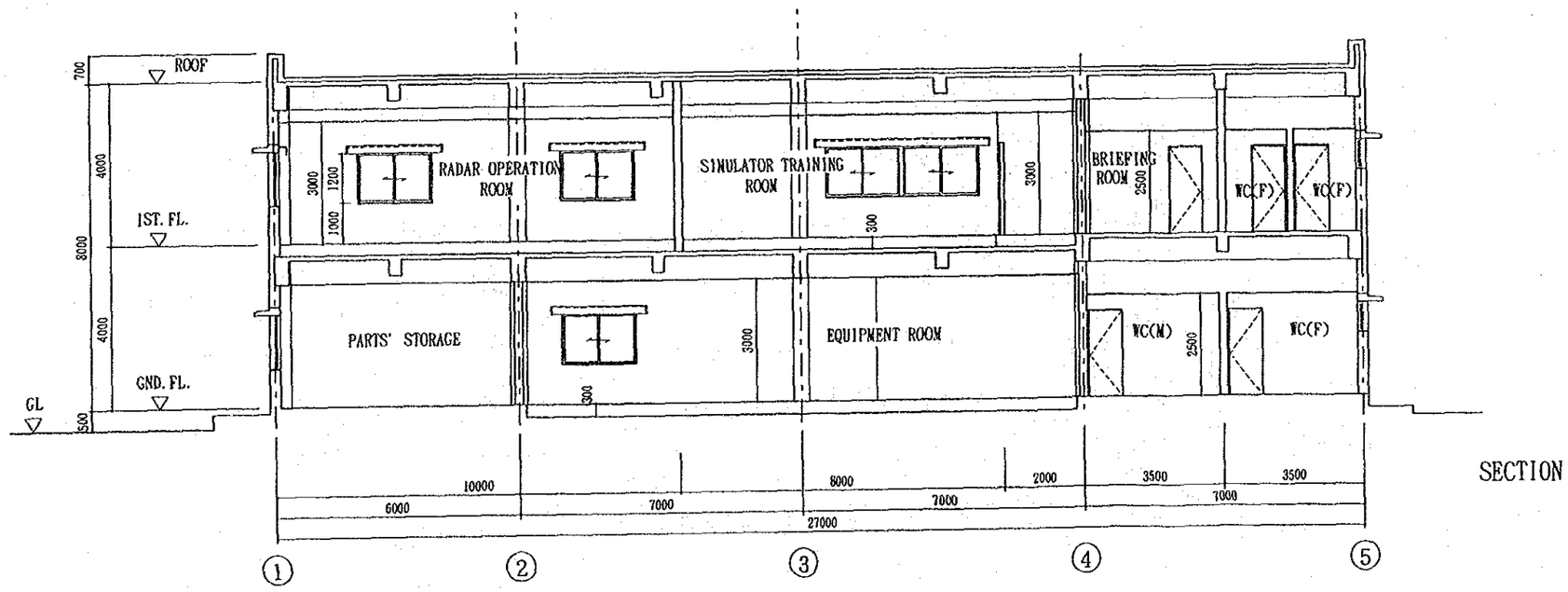


FIRST FLOOR PLAN

Figure 4.3.5 Radar Operations Building First Floor Plan

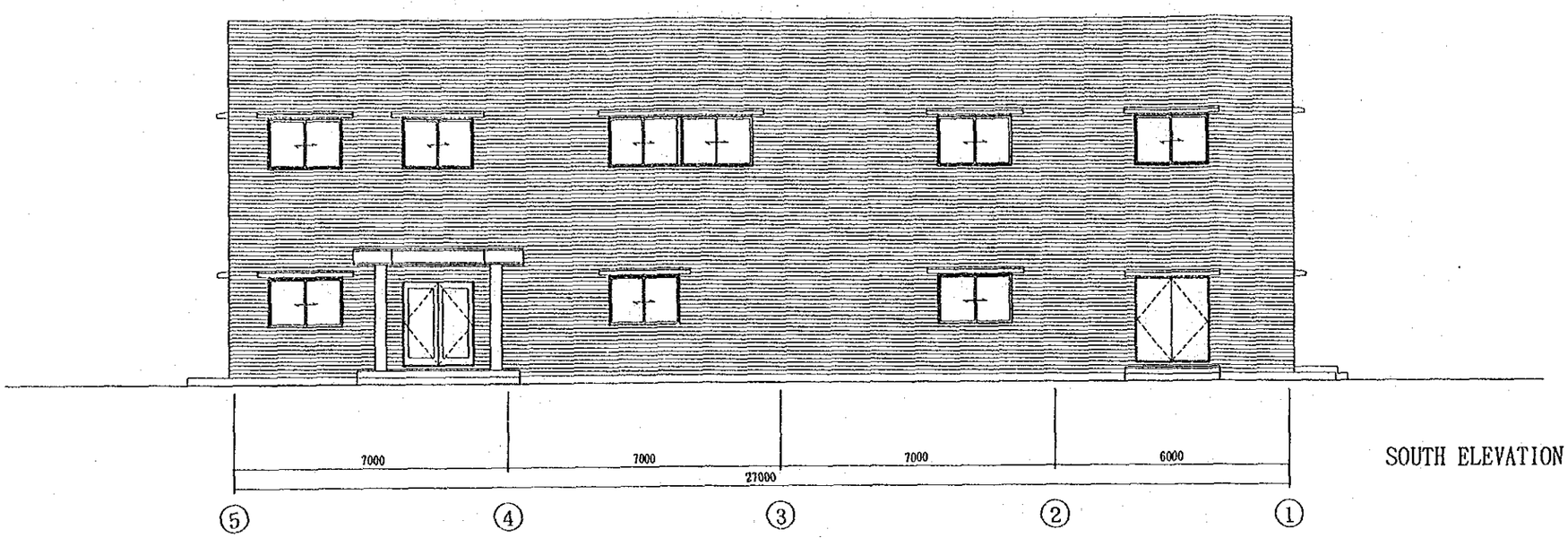


NORTH ELEVATION

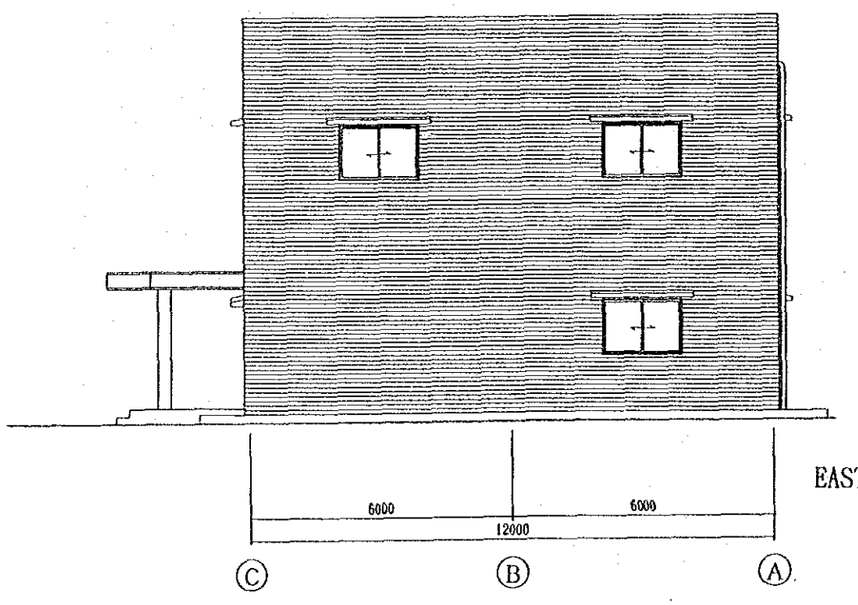


SECTION

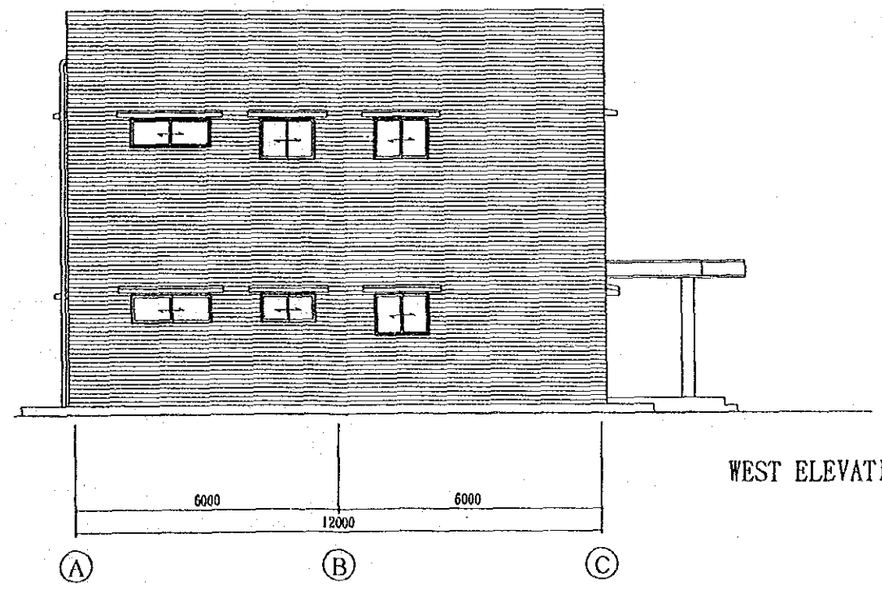
Figure 4.3.6 Radar Operations Building Section / Elevation (1)



SOUTH ELEVATION



EAST ELEVATION



WEST ELEVATION

Figure 4.3.7 Radar Operations Building Section / Elevation (2)

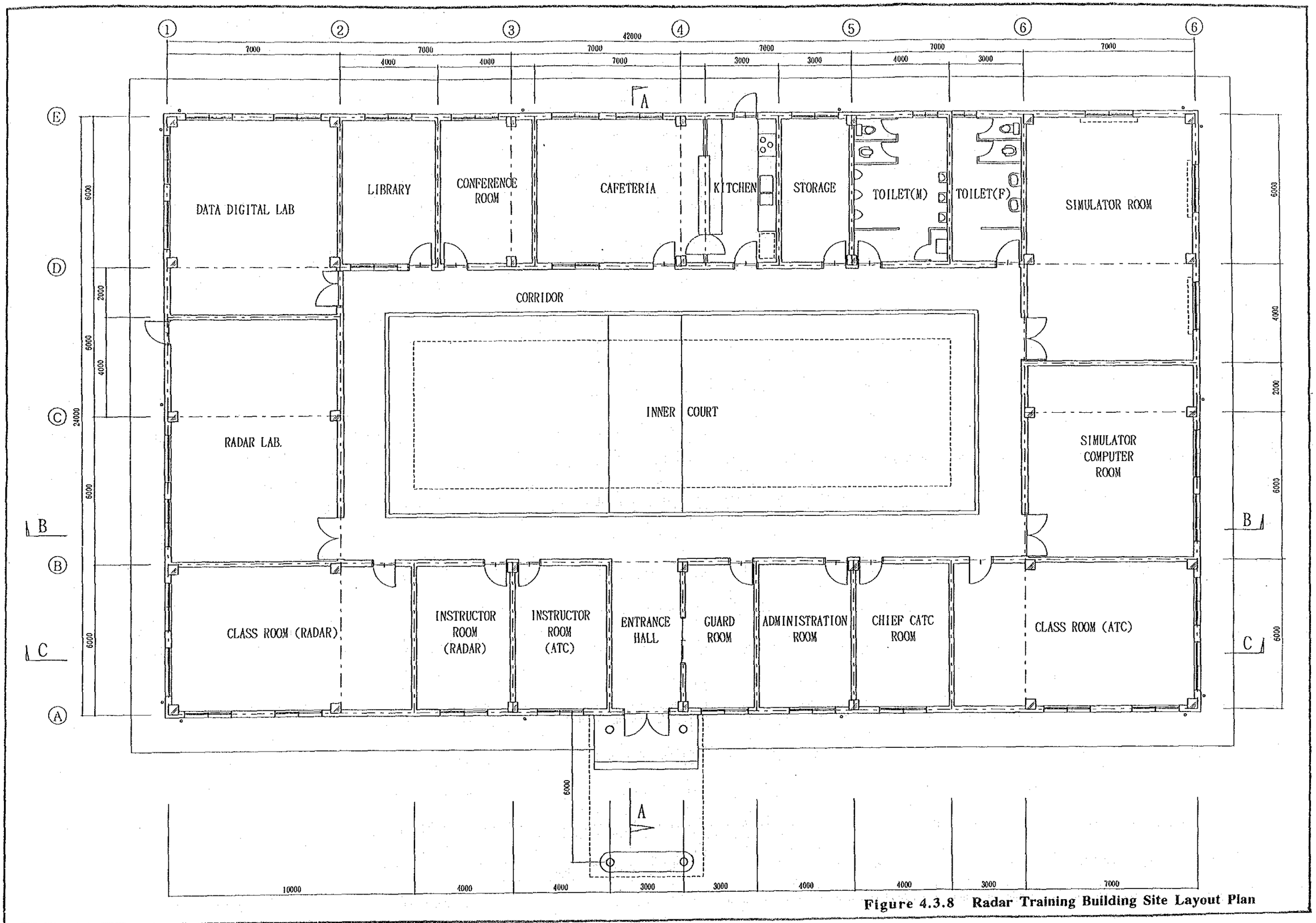
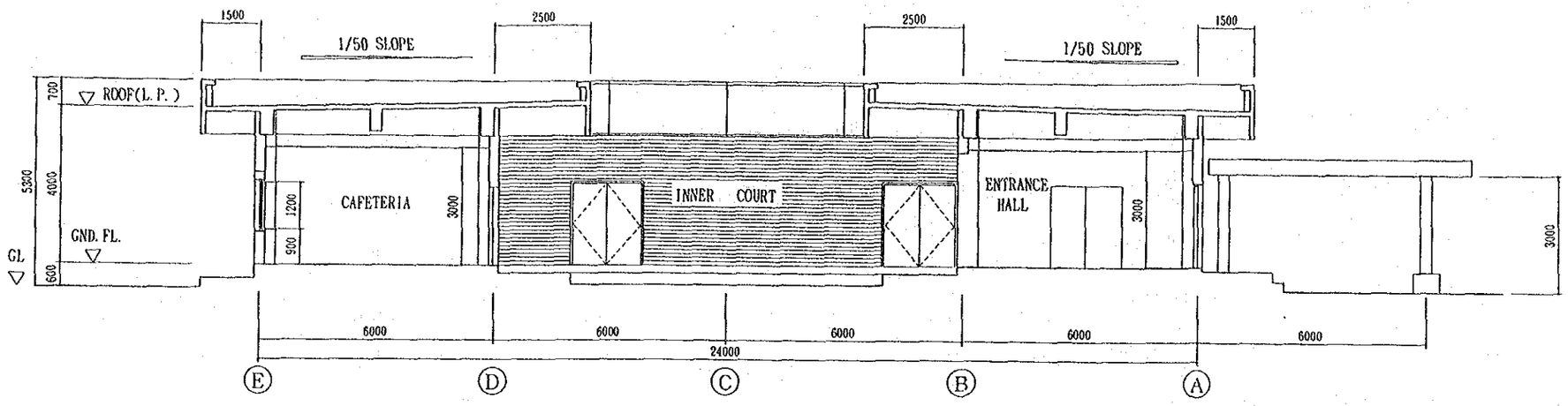
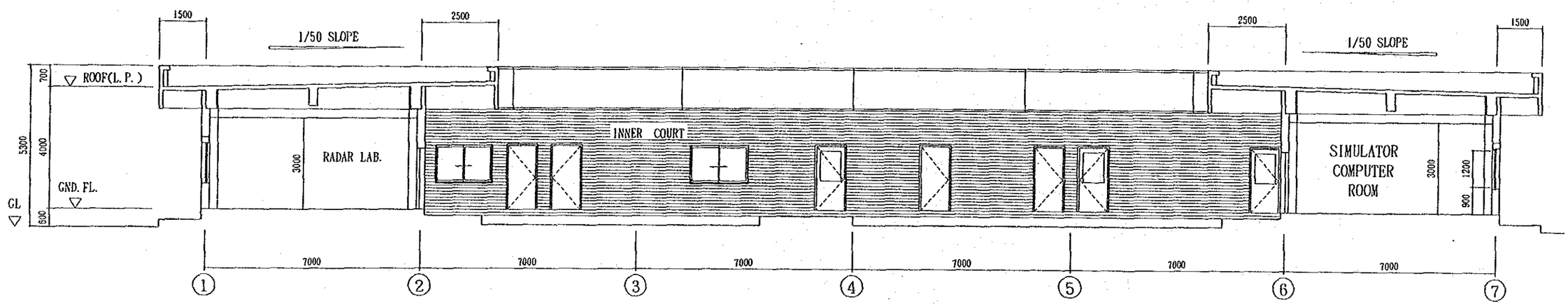


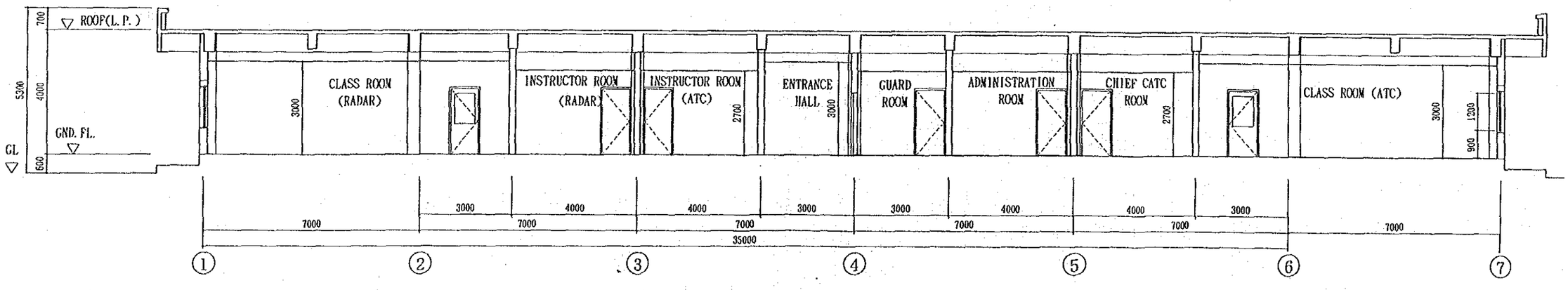
Figure 4.3.8 Radar Training Building Site Layout Plan



A-A SECTION



B-B SECTION



C-C SECTION

Figure 4.3.9 Radar Training Building Section / Elevation

4) Architectural Design

The building should be designed for application of fair-faced brick to exterior finishes with simple design.

Particularly, the design of radar operations building will be in harmony with the existing surrounding buildings.

5) Structural Design

All of the buildings should be designed in accordance with AIJ Code (Architectural Institute of Japan code) and shall be of R.C. (Reinforced Concrete) rigid frame structure with fair-faced brick walls produced locally.

Foundations for the buildings will be designed based on the soil boring test on standard penetration tests etc. RC roof structure should be flat roof with 1/50 pitch roof.

- Natural Conditions

Soil Bearing Capacity	10~20 t/m² (Depending on soil investigation results)
Wind Velocity	30 m/sec. max.
Seismic Load	Seismic Factor for earthquake K=0.15

- Material Condition

Reinforced concrete	Fc=210 kg/m²
Leveling concrete and non-structural slabs	Fc=135 kg/m²
Reinforcing Bar	SD30/JIS

6) Utility Plan

- Air-conditioning

Room temperature of radar equipment room, simulator room, operations room and U.P.S. room will be controlled by packaged type air-conditioners. Ventilation fan of the explosion proof type will be provided for the battery room.

No louvers should be provided where the building faces outdoors for dust proof and corrosion control.

- Water Supply, Waste Water and Plumbing

All of the buildings should be provided with toilets and water service except the local power station building. Soiled water and waste water are conducted to a septic tank to be installed on discharged to the existing drainage pipes installed by plumbing.

Soil pipe for the operations building should be connected to soil main trunk line of the airport. Storm water for the operations building should be conducted to the storm drains of the airport.

Interior finish is shown in Table 4.3.10.

Table 4.3.10 Interior Finishing Schedule (1)

Radar equipment building

Room	Equipment	Floor	Ceiling	Baseboard	Wall	Door	Lighting	Special Installation
Equipment room	Radar transmitter, receiver, change-over unit Optical cable Monitor display	Vinyl tile	Concrete slab Emulsion paint spray Insert plug in ceiling slab to pull down cable ladder H=2,800	Vinyl H=100	Mortar Plaster +Emulsion paint Insert plug for fix W/G and cable ladder	Double glazed Wood door	Ceiling suspender type Office standard	Air conditioning Switch board Terminal box Telephone cable Elect. cable
Maintenance room		Plastic tile	Suspended ceiling Plaster board H=2,500	Vinyl H=100	Mortar Plaster +Emulsion paint	Wood door with fixed glass	Office standard	Telephone Air conditioning Bookshelf
Toilet		Ceramic tile	Flexible board Suspended ceiling +Vinyl paint H=2,500		Ceramic tile H=1.5M Mortar Plaster +Vinyl paint	Wood door	About 300 LX	Water closet: Nepal Style Sewerage system 2 persons
Service room		Ceramic tile	Ditto		Ditto		About 200 LX	Water supply Sewerage
Store		Mortar trowel	Mortar	Mortar trowel H=100	Mortar	Wood door	Ditto	
Entrance		Terrazzo	Plaster board Suspended ceiling +Emulsion paint H=2,700	Terrazo H=100	Mortar Plaster +Emulsion paint	Steel locked door	Ditto	Portable fire extinguisher Elect. cleaner

Table 4.3.10 Interior Finishing Schedule (2)

Power Statiion Building

Room	Equipment	Floor	Ceiling	Baseboard	Wall	Door	Lighting	Special installation
Generator roon	Generator Service tank Automatic switch board	Concrete, Steel trowel, Dust-proof paint	Concrete slab, Engine muffler Effective height H=2,700 Engine muffler suspender from slab, Vinyl paint spray	Mortar, Steel trowel H=100 Dust proof paint	Mortar plaster, +Vinyl paint	Steel door	about 200 lx	Outdoor oil tank (1kl) Man hole 1,000x1,500 Terminal box
UPS room	UPS	Concrete, Steel trowel, Dust-proof paint	Concrete slab, Vinyl paint spray	Mortar, Steel trowel H=100 Dust proof paint	Mortar plaster, +Vinyl paint	Steel door	about 200 lx	Air conditioned
Battery room	Battery	Concrete, Steel trowel,	Concrete slab, Vinyl paint spray	Mortar, Steel trowel H=100 Dust proof paint	Mortar plaster, Acid proof paint	Wood door	about 200 lx	Ventilator (Explosion proof) Portable fire extinguisher (2)

Table 4.3.10 Interior Finishing Schedule (3)

Radar operation building(Ground Floor)

Room	Equipment	Floor	Ceiling	Baseboard	Wall	Door	Lighting	Special Installation
Equipment room	Radar data recorder Radar data processing unit	Vinyl tile Anti-static processing Floor pit (300W x 250D)	Suspended ceiling Plaster board Ceiling height 2,700	Vinyl H=100	Mortar Plaster Emulsion Paint	Glass wood door : double Wood door : single	Office standard No fixed equipment above	Air conditioner Cables for radar and communication Switch Board Book Shelf
Maintenance office		Vinyl tile	Suspended ceiling Plaster board Ceiling height 2,500	Ditto	Ditto	Wood door	Ditto	Telephone duct Air conditioner
U.P.S.	U.P.S.	Concrete with steel trowel Dust proof paint	Concrete slab Vinyl paint spray	Mortar with steel trowel H=100	Mortar plaster vinyl paint	Outside:Locked steel double door Inside:wood door	Approx. 200lx	Air conditioner
Battery room	Battery	Ditto Acid proof paint	Ditto	Ditto Acid proof paint	Ditto Acid proof paint	Wood door with louver	Ditto	Explosion proof ventilator
Storage		Concrete with steel trowel	Ditto	Mortar with steel trowel H=100	Mortar	Steel door	Ditto	Central Power Distribution Board Outdoor Cooling Condenser
Toilet		Ceramic tile	Suspended flexible ceiling board Vinyl paint Ceiling height 2,500		Mortar Plaster Emulsion Paint	Wood door	Approx. 300lx	Western/Nepal style water closet Male/female:8/2
Entrance		Terrazzo	Plaster board Emulsion paint	Terrazzo H=100	Plaster board Emulsion paint	Steel frame wire glass Double door		Other facilities Emergency light Portable fire extinguisher Elect. cleaner

Table 4.3.10 Interior Finishing Schedule (4)

Radar operation building (First Floor)

Room	Equipment	Floor	Ceiling	Baseboard	Wall	Door	Lighting	Special Installation
Simulator room	Radar console	Carpet tile	Suspended ceiling plaster board	Wood H=100	Mortar acoustic board	Wood	Standard;Office lighting control	Air-conditioned Telephone A.C.
Radar operations room	Radar console, Comm. console	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	A.C
Operations office room		Vinyl tile	Ditto	Vinyl base board H=100	Mortar plaster +E.P	Ditto	Stndard:Office	Telephone, A.C.
Briefing room		Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Toilet (F)		Ceramic tile	Flexible board +V.P.		Plaster + Vinyl P.	Ditto	Approx. 300lx	Toilet (F) Western, Nepal style, mirror
Corridor & stair-case		Terrazzon	Plaster board suspended ceiling +E.P.	Terrazzon H=100	Plaster +E.P.		Approx. 200lx	Space under stair is storage portable fire extinguisher Notice board (2) Emergency light Elect. cleaner Water supply direct connection from main pipe Sewerage:Connect to collective pipe

Table 4.3.10 Interior Finishing Schedule (5)

Radar Training Building

Room	Equipment	Floor	Baseboard	Wall	Ceiling	Door	Lighting	Remarks
Data-digital lab		Vinyl tile	Vinyl H=100	Mortar-plaster +Emulsion paint (EP)	Acoustic board H=2,700	Wood		
Storage		Ditto	Ditto	Ditto	Asbestors cement board +EP H=2,500	Ditto		
Instructor room (1) (2)		Ditto	Ditto	Ditto	Acoustic board H=2,700	Ditto		
Class room (1) (2)		Ditto	Ditto	Ditto	Ditto H=3,000	Ditto		
Simulator room		Carpet Tile, Anti-static	Wood H=100	Mortar, Acoustic panel	Ditto	Ditto		
Simulator computer room		Ditto	Ditto	Ditto	Ditto	Ditto		
W.C (M&F)		Mortar, Ceramic tile 200x200		Mortar-plaster Vinyl paint (VP) Ceramic tile, 100x100 H=1,500	Asbestors cement board +EP H=2,500	Ditto		
Entrance Hall		Terrazzo tile	Terrazzo H=100	Mortar-plaster +EP	Acoustic board H=3,000	Steel frame glazed		
Radar lab		Vinyl tile	Vinyl H=100	Mortar-plaster +EP	Ditto	Wood, steel		
Kitchen		Terrazzo tile	Terrazzo H=100	Mortar-plaster +VP	Asbestors cement board +VP H=3,000	Ditto		
Cafeteria		Ditto	Ditto	Ditto	Acoustic board H=3,000	Wood		
Chief CATC		Vinyl tile	Vinyl H=100	Mortar-plaster +EP	Ditto H=2,700	Ditto		
Conference		Ditto	Ditto	Ditto	Ditto H=2,700	Ditto		
Library		Ditto	Ditto	Ditto	Ditto H=2,700	Ditto		
Guard room		Terrazzo tile	Terrazzo	Ditto	Ditto H=2,700	Ditto		