6.8 Car Park and Roadway

(1) There is very little car parking at the domestic terminal. However, a new car park will be constructed by the on-going project at the site north of the international passenger terminal.

(2) There is a car park located in front of the new international passenger building. It is fully occupied by cars at the time of passenger arrivals and does not provide its function at times of need.

(3) In front of the Operation and Airlines office building, there is a bus stop for regular services. Also there are some unauthorized cars parked here which hamper the smooth flow of traffic. It is expected to be re-arranged to cope with the present circumstances and the future demand.

6.9 Aircraft Maintenance Hangar

(1) There are hangars belonging to RNAC which accommodate small aircraft up to HS-748. However most aircraft maintenance work there is conducted in the open air. It may be the basis of safe aircraft operations to conduct maintenance work under cover.

(2) RNAC now has B-757 type and A-310 type aircraft. RNAC has requested to the Nepalese government to build hangars for these type of aircraft. Other private airlines companies have no maintenance facilities, because there is no adequate land area in the present condition of TIA. They have requested to DCA to lease land for their own hangars. It is required to provide an area for aircraft maintenance and hangars in the airport planning.

6.10 Fuel Supply System

The existing fuel storage tanks are so close from the parallel taxiway that there is a possibility of damage to aircraft running on the parallel taxiway in case of a breakout of fire in the tanks. Therefore it is required to relocate the storage tanks. Also in order to meet the ICAO requirements, the separation distance between the parallel taxiway and the runway at present is recommended to be wider.

It will be possible to conform to the requirements by relocating the existing facilities alongside the parallel taxiway.

6.11 Airport Perimeter Fence

There are villagers who cross the aircraft operation area even in the daytime and also there are dogs loitering in the runway strip. They should not be allowed in the airport area to secure the safe operation of aircraft.

Therefore it is urgently required to construct a perimeter fence to completely encircle the entire aircraft operational area.

6.12 Airport Perimeter Road

There is an unpaved perimeter road in the northern part of the airport, but it becomes so muddy in the rainy season that vehicles cannot run easily. On the other hand there is no road in the southern part. These conditions makes airport maintenance work and security patrol work difficult. Therefore, it is required to construct a paved perimeter road in order to access any portion of the airport easily and quickly to enhance airport activities.

6.13 Rescue and Fire Fighting

6.13.1 Fire Station

The present site of the rescue and fire fighting station cannot meet the ICAO requirement of response time of "two minutes" (and not exceeding three minutes) to the end of RWY 02. Therefore it is expected to be relocated to a more appropriate location for easy access to the runway.

6.13.2 Rescue and Fire Fighting Vehicle

(1) Category of Services

The classification of the crash protection category of the airport by AIP Nepal is Category 5.

The airport category is, in general, determined by the overall length of the longest airplane and their maximum fuselage normally using the airport. Movements in the busiest consecutive three months of the year shall also be considered in compliance with the ICAO recommendation.

At Tribhuvan International Airport, the actual traffic volume by major aircraft types in 1991 are summarized as follows:

A300, B757, B727	(Category 7) :	3,640 movements/year
A320	(Category 6) :	390 "
HS748	(Category 4) :	730 "
DHC6, Do228	(Category 3) :	3,250 "

According to these figures, the movements of the highest category (Category 7) during the three consecutive busiest months are more than 700. Therefore, the actual airport category for the service is estimated to be Category 7.

(2) Capacity of Existing Service

The type and number of existing fire fighting vehicles at the airport are as follows:

Medium foam tender, 4,100 liters (1975):	2 Nos.
Medium foam tender, 6,000 liters (1993):	1 No.
Water tender, 16,000 liters (1993):	1 No.
Ambulance (1983):	1 No.

The capacity of extinguishing agents for AFFF (Aqueous Film Forming Foam) is 14,200 liters in total at present.

(3) Evaluation

The minimum number and types of rescue and fire fighting vehicles, the minimum usable amounts of extinguishing agents for AFFF, and amount of dry chemical as complementary agents for each airport category are described in the Airport Service Manual of ICAO as follows:

	Category 5	Category 7
Rapid intervention vehicle	1	1
Major vehicle	1	2
Extinguishing agents (liters)	5,400	12,100
Dry chemical (kg)	180	225

The amount of extinguishing agents are sufficient for both Category 5 and 7 in comparison with ICAO requirements at present. However, the following items are pointed out as existing problems of the rescue and fire fighting services of the airport.

i) A rapid intervention vehicle is not provided but is required according to the Airport Service Manual of ICAO.

ii) Two existing medium foam tenders are of the old type which were manufactured eighteen years ago.

6.14 Slope Protection

TIA is situated on a horseback topography. Particularly in the northern half of the airport is surrounded by steep cliff. The cliff at the end of RWY 20 collapses repeatedly due to rain every year. Therefore it is recommended to stabilize the surrounding slopes in order to protect airport facilities and airport property by constructing retaining walls and storm water drainage facilities.

6.15 Land Use surrounding the Airport

In this region, there are no preserved zones such as national parks, wildlife parks, natural forest, etc. The region under reference mainly practices agricultural and commercial activities, and is inhabited by a significant number of people. Therefore the control of land use will have to be treated quite seriously in order for TIA to get along with surrounding areas.

6.16 Environmental Conditions

6.16.1 Social Environment

As a future plan, it will be necessary to prepare a land use plan so that problems due to aircraft noise will not be encountered.

6.16.2 Natural Environment

Topographically, it is anticipated that significant slope faces will be further exposed, with the expansion of the airport. Without any slope protection, during the period of heavy rains, it is possible that sediment flow could occur.

Meteorologically, no big problem is expected to occur since it is a partial expansion of the present airport.

As regards the color adjustment of airport structures in the plan, it will be expected to maintain harmony with the existing airport and the surrounding conditions.

Since this region is mainly comprised of agricultural paddy land, it does not have an impact on rare animals and vegetation.

6.16.3 Pollution

Once the construction works is commenced, the volume of traffic may increase on account of material transportation, but it is not expected to be so high. It is anticipated that aircraft operations will not be so high that it will cause problems of high atmospheric pollution. However, periodic investigations must be carried out to check the air quality.

There is the possibility of muddy water being generated during the construction period in the monsoon season, but it will be able to be treated technically. Once the airport has been completed, waste water will be flowing out of the airport facilities, but it will not be a problem as it is presently well controlled.

As regards the problem of aircraft noise, it is certain that the magnitude of aircraft noise will increase on account of the demand growth. Therefore the noise problem must be investigated periodically for the future control.

It is anticipated that noise and vibration will occur on account of the large dump trucks and construction equipment used during the period of construction. But, since the number of vehicles is not expected to be that high, it may not be a problem.

CHAPTER 7

GROUND FACILITIES IMPROVEMENT PLAN

CHAPTER 7 GROUND FACILITIES IMPROVEMENT PLAN

7.1 GENERAL

7.1.1 Objectives of the Airport Master Plan

This chapter describes the airport master plan for Tribhuvan International Airport by studying the development policy for the future through the comparison study. The Airport master plan was prepared for the long-term development based on the airport facility requirement analysis described in Chapter 5, the evaluation of the existing airport facility in Chapter 6 and the environmental considerations. The phased development plan was studied in line with this airport master plan.

The main objective of the airport master plan was to provide guidelines for the future development which will satisfy traffic demand and will be compatible with the community development and environmental conditions of the surrounding areas. For this purpose, development alternatives were prepared and carefully studied in order to find the most appropriate development plan for the Tribhuvan International Airport.

(Note) According to the composition of this report, aircraft operation and air navigation system are described in Part C "AIR SAFETY IMPROVEMENT PLAN".

7.1.2 Basic Concept of the Airport Improvement Plan

(1) Concept of the Plan

" Improvements for modern TIA "

- improvement of safety
- improvement of level of service

(2) Basic Policy in Planning

According to the specific circumstances around TIA, the following were considered as the basic policy in the planning.

a) Topographical condition

Because of the rough mountainous terrain around the existing airport, it is not easy to obtain a flat area for the future development. In order to expand required facilities to modernize TIA, a large amount of earth borrow work will be required for the fill. This means a higher project cost.

Therefore it will be considered to utilize the available terrace as much as possible.

b) Staged implementation

Taking into consideration the present progress of the projects around the terminal, it will be considered to utilize the newly-built facilities as much as possible.

For the development process, it will be considered to apply a staged implementation such as staged expansion and or modular construction.

Attention will be paid to the process of project development to maintain the present airport activity as much as possible.

c) Financial circumstance

It will require a large amount of cost and a long time to complete the modernization project. Under the financial constraints it will be taken into account to utilize the existing facilities as much as possible. It will be considered to set up a priority for each facility improvement based on necessity and urgency, and then to allocate them a proportion of the total cost so as to ease the financial burden.

(3) Phased Development Program

In order to implement the long-term Modernization Plan for the target year 2010 effectively and efficiently, particularly under the above-mentioned circumstances, it will be desirable to make use of phased development.

After deciding the priority of each facility improvement by examining the necessity and urgency, they will be allocated into the following programs.

a) Short-term Modernization Plan

Improvement plan consisting of higher necessity and urgency program, aiming at the year 2003.

This plan is the first stage of the Modernization Plan and will primarily consist of the programs of improving present safety and congestion. Urgent projects, expected to be implemented immediately, will be selected from programs of the short-term plan.

b) Long-term Modernization Plan

This is the second stage of the Modernization plan aiming at the year 2010, primarily consisting of programs of keeping the service level of the target year and or with lower urgency.

c) Ultimate Modernization Plan

This is the third and final stage of the Modernization Plan, for continuous development beyond the year 2010.

7.2 Airport Development Alternatives

7.2.1 Terminal Area Development

(1) Site Considerations for the Terminal Area

a) It is a basic concept of airport terminal design to concentrate the passenger terminal buildings, cargo terminal buildings and other facilities together in the same area so as to secure functions of the airport and be of convenience to the users.

As a master plan defines the planner's concept of the ultimate development of the airport not only until the planning year but also beyond it, the terminal layout should be established from the viewpoint of maintaining the functions and convenience as much and far as possible into the future.

b) However there may be exceptions under certain conditions. There is an idea to disperse the domestic terminal or cargo complex to the south-eastern part of the airport within the present airport boundary, apart from the existing terminal. This idea has the specific merit that the development here does not need any adjustment with offices, companies and people concerned, because there are no existing facilities there. This site is now easy to secure and free for development. However, there will be many problems in airport activities in the long-run; such as the convenience for users, congestion caused by mixed flow of vehicles, ease of airport administration, duplication of facilities, equipment and personnel, etc..

Therefore this idea will serve as a temporary measure.

c) To cope with the larger type of aircraft planned such as Boeing B-747s, it will be necessary to provide longer depths of aprons to satisfy the ICAO requirements and their maneuvering. In order to fully use the existing new facilities in the planning, particularly the international passenger terminal building(Int'l PTB) and the apron, there are two directions, north or south, for the development as shown in Figure 7.2.1.

If the development is to the south, it will be necessary to move the "Ring Road" and acquire the surrounding areas to expand the airport territory. Also because of the topography, it will be necessary for land fill to construct a flat area for the terminal expansion.

On the other hand, it will be easier to develop the facilities to the north, because the site for the expansion is presently used as the domestic terminal and maintenance and military hangars. These sites are on terraces with wide depths and are within the present airport boundary. The construction costs can be reduced because of a smaller volume of earthwork than for the development to the south.

This development case requires the removal of the above-mentioned facilities; the domestic terminal passenger building, and the maintenance area and hangars. However this removal is considered easier, because 1) offices concerned are members of the TIA operation and activities, 2) there is space available for them to relocate within the airport, and 3) some of them (private airline companies) wish to rearrange their offices and aircraft maintenance hangars.

d) Besides, there are more positive reasons for the development to the north, as follows:

- It is necessary to remove the international cargo building, which penetrates the transitional boundary as an obstruction.
- It is required to renew the domestic PTB to deal with the traffic demand not only in the future but also at present. As there is no space there, it will have to be removed.
- It is requested to re-arrange hangars to cope with the new situation at TIA; introduction of larger aircraft by RNAC and the emergence of private airline companies.

In order to adopt these requests into the planning, these facilities must first be removed to new sites, and then this area will be re-developed for the future modernization.

e) Through the above considerations, there are three (3) alternative cases of terminal area development. (Refer to Figure 7.2.1)

Case 1 Developing the present terminal mainly to the north in order to accommodate large types of aircraft.
In this case, the international terminal will be sited at the northern part with the domestic terminal at the southern part.
This case gives a compact terminal which will bring many advantages.

However, it is necessary to relocate the existing airport maintenance area and hangars as a requisite condition.

Case 2 Developing the present terminal mainly to the south.

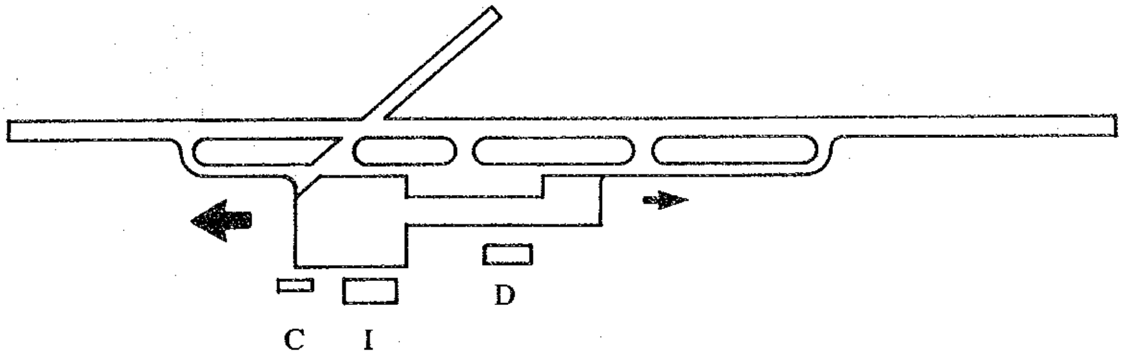
In this case, the international terminal will be located at the southern part and domestic terminal at the northern part.

This case requires the relocation of the Ring Road and houses and additional land acquisition to expand the airport boundary.

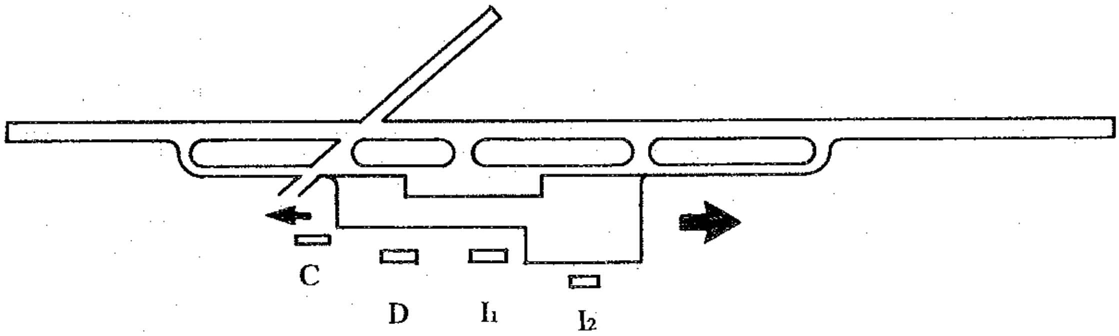
Case 3 Expanding the present international terminal for international use and constructing a new remote terminal for domestic use.

This imposes many disadvantages, but this is the easiest case of development as it will not require the relocation of the existing facilities.

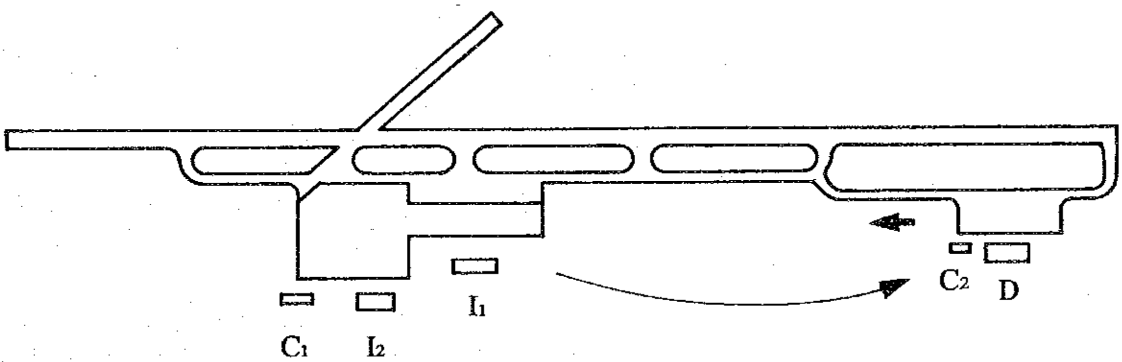
The pros and cons are compared in Table 7.2.1.



Case 1 Northern Development



Case 2 Southern Development



Case 3 Remote Terminal

I : International Passenger Terminal
D : Domestic Passenger Terminal
C : Cargo Terminal

Figure 7.2.1 Alternatives for Terminal Area Development

Table 7.2.1 Comparison of Terminal Area Development

Evaluation item \ Alternative case		Case 1 Northern Development of Present Terminal		Case 2 Southern Development of Present Terminal		Case 3 Present Terminal + New Remote Terminal (Dom PTB or CTB)
A. Convenience for Airport Users						
1. Passenger & Cargo						
1) Transfer between Int'l and Dom	-	Good	-	Good	X	Poor
2) Easy identification of PTB	-	Good	-	Easy	X	Not easy
3) Vehicle circulation on landside	-	Simple	X	Not simple	-	Simple
2. Airport Operation						
1) Vehicle circulation on airside	-	Good	-	Good	X	Poor
2) Flexibility of spot assignment	-	Good & Easy	-	Good & Easy	X	Poor & Complicated
3) Cargo handling & conveying	-	Easy	-	Easy	X	Not easy
4) Airport administration & security	-	Easy	-	Easy	X	Not easy
B. Expandability of terminal	-	Easy and Compact	X	Not difficult but more land aquisition needed	X	Easy but inconvenience not improved
C. Cost consideration	-	Small volume of earth work	X	Medium volume of earth work	X	Large volume of earth work
Total Evaluation	0	1	3	2	8	3

(2) Terminal Area Layout Planning

1) Layout planning

a. As a result of the comparison of the terminal development above, the development to the north (Case-1) is selected. Therefore the basic configuration of aprons is defined as follows.

- The northern portion of aprons will be for the international use, because of its long depth

- The southern apron will be for the domestic use

b. There are three alternative terminal layout plans as shown in Figure 7.2.2, taking into account the full usage of the existing international terminal building.

- CASE-A : In this case the present international PTB will be expanded to accommodate the needs in the design year, with the domestic PTB sited north of the Int'l PTB. Therefore the use of PTBs and aprons for international and domestic will cross each other. Work for land fill will be necessary to construct a flat area for the expansion.

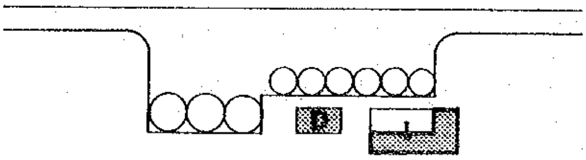
- CASE-B : In this case the present international PTB will be converted to a domestic PTB. A new international PTB will be constructed north of the Dom PTB.

- CASE-C : In this case a second international PTB will be constructed to accommodate the excess demand which the present international PTB cannot handle. Therefore a domestic PTB will be sited between the two international PTBs.

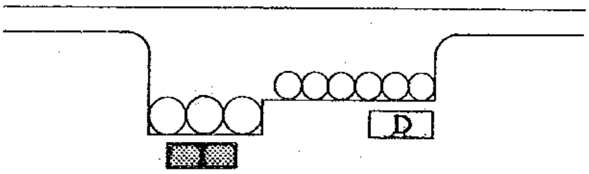
c. Features of each alternative above are compared in Table 7.2.2.

As the result of the comparison, CASE-B is selected as the best concept of the layout plan.

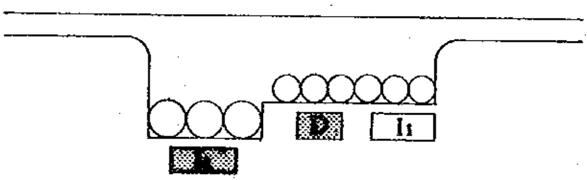
Case - A



Case - B



Case - C



Legend

I : International PTB — : Existing Portion

D : Domestic PTB — : New and/or Extended Portion

Figure 7.2.2 Alternatives of Terminal Area Layout

Table 7.2.2 Comparison of Terminal Area Layout Alternatives

Alternative		CASE A		CASE B		CASE C
A. Convenience for Airport Users						
1 Passengers						
1) Transfer between Int'l and Dom	-	Good	-	Good	X	Poor
2) Easy Identification of PTB	-	Good	-	Easy	X	Not easy
3) Vehicle Traffic Flow in Land side	-	Simple	-	Simple	X	Complicated
4) Possibility of Installing Boarding Bridge to Int PTB	X	Difficult	-	Possible	-	Partly Possible
2 Airport Operation						
1) Spot Assignment and PTB siting	X	Poor	-	Good	X	Poor & Complicated
2) Flexibility of Spot Assignment	-	Good & Easy	-	Good & Easy	X	Poor & Complicated
3) Vehicle Traffic Flow in Air side	X	Complicated	-	Simple	X	Complicated
4) CIQ Staff and Facilities	-	Good	-	Good	X	Duplicate
5) Ground Support Equipment & Staff	-	Good	-	Good	X	Duplicate
B. Expandability of Terminal						
1) Pax Terminal Buildings	-	Possible, but increasing inconvenience of terminal operations due to the opposite direction of Int'l apron	-	Good	X	Difficult for Dom PTB
C. Cost Consideration						
1) Construction Cost	X	1.1 times of CASE-C	X	1.1 times of CASE-C	-	(1.0)
2) Operating cost	-	Low	-	Low	-	High
Total Evaluation	5	2	1	1	10	3

2) Phased Development Planning

a. As the airport is requested to operate without interruption all day, the execution of the development plan should be practicable with a view to practical airport operations.

Hence, development planning is studied hereunder.

b. The development will be implemented by relocating the existing aircraft maintenance area and hangars. The maintenance area and hangars have the following functions.

- aircraft maintenance

- aircraft parking

It will therefore be required to construct alternative facilities before hand to maintain their functions.

c. The new aircraft maintenance area and hangars are planned at the eastern space of the airport. (The planning concept is described in 7.3.1)

   The frontal apron of the area will provide some parking spots, but it will not be sufficient to serve for all of the aircraft parking.

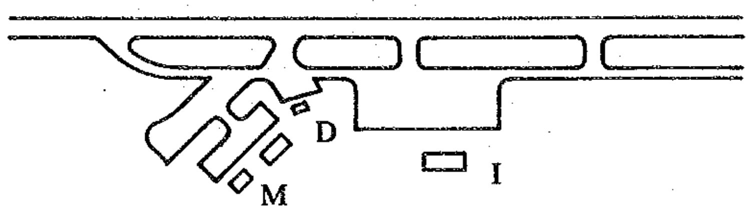
   Therefore a new parking apron, particularly for domestic aircraft, is required to be provided at the northern site of the existing aircraft maintenance area.

d. The development will be carried out step by step, following the continuous stages described in Figure 7.2.3 and Table 7.2.3.

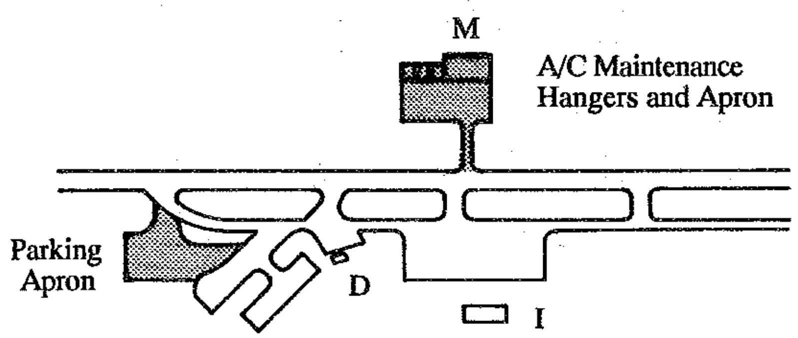
Table 7.2.3 Process of the Terminal Development

Stage & Construction Works / Airport Function	Int'l PTB	Dom PTB	Int'l CTB	Aircraft Parking Spots
1. (Present Condition)	Existing Int'l PTB	Existing Dom PTB	Existing Int'l CTB	Existing Aircraft Maintenance Area and Hangars
2. Construction of New Aircraft Maintenance Hangars and Apron and New Parking Apron	ditto	ditto	ditto	ditto
3. Demolition of Existing Aircraft Maintenance Area and Hangars	ditto	ditto	ditto	New Maintenance Apron and New Parking Apron
4. Construction of New Int'l PTB and New Int'l CTB, Expansion of Int'l Aprom	ditto	ditto	ditto	ditto
5. Demolition of Existing Dom PTB, Expansion of Int'l Apron	New Int'l PTB	New Int'l PTB (temporary use)	New Int'l CTB	ditto
6. Conversion of Existing Int'l PTB to Dom PTB Expansion of Dom Loading Apron	ditto	ditto	ditto	ditto
7. (Completion of the Development)	ditto	New Dom PTB	ditto	ditto

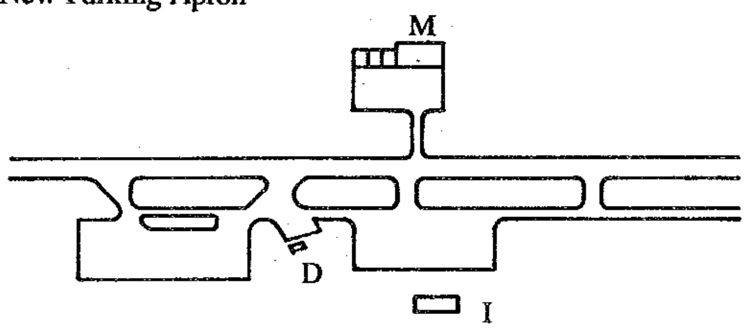
Stage 1. Present Condition



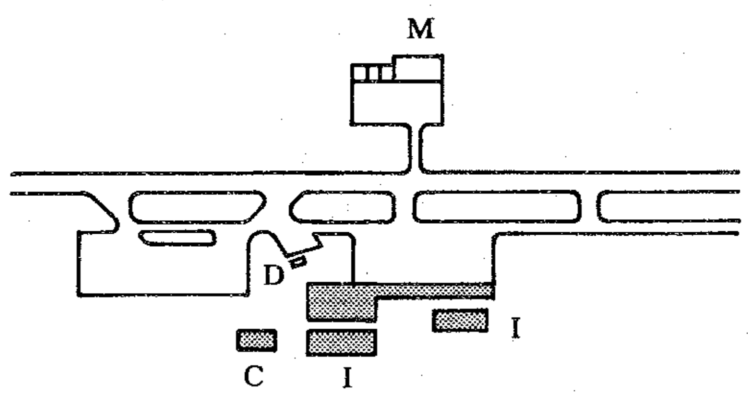
Stage 2. Construction of New Aircraft Maintenance Hangers and Apron, and New Parking Apron



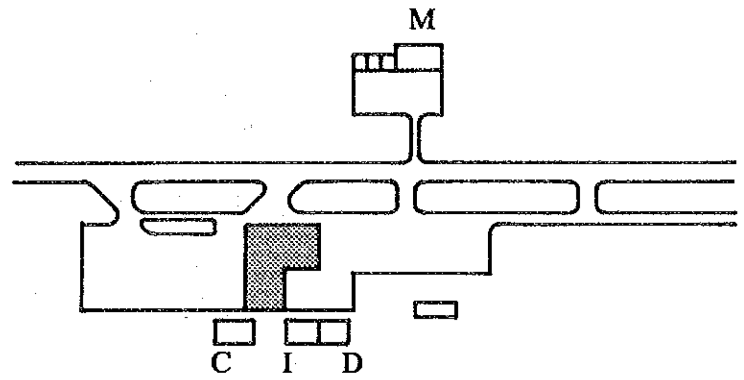
Stage 3. Demolition of Existing Aircraft Maintenance Area and Hangers, Expansion of New Parking Apron



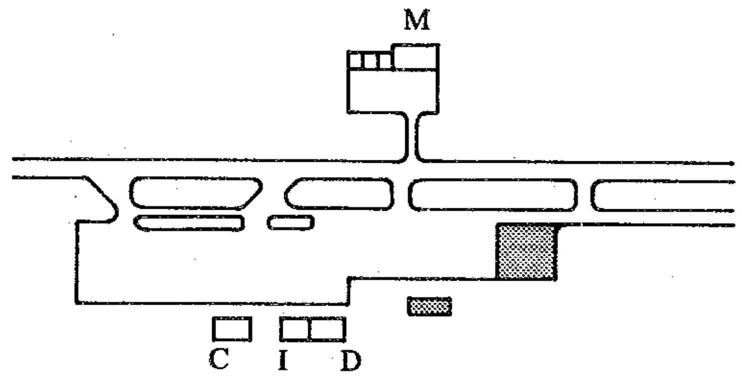
Stage 4. Construction of New Int'l PTB and New CTB, Expansion of Int'l Apron



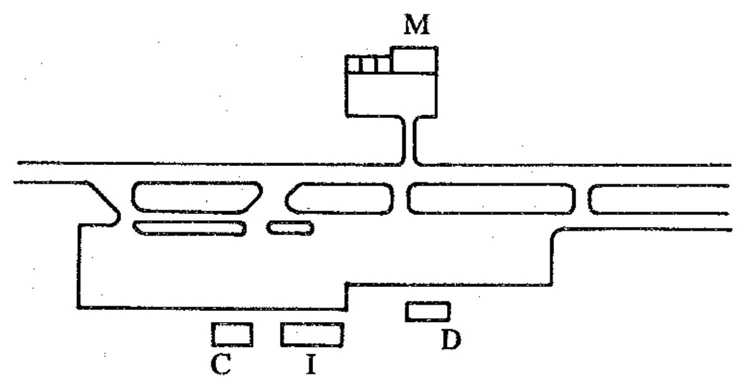
Stage 5. Demolition of Existing Dom PTB, Expansion of Int'l Apron



Stage 6. Conversion of Existing Int'l PTB to Dom PTB, Expansion of Dom Loading Apron



Stage 7. Completion of the Development



Note:

D : Domestic Passenger Terminal Building
I : International Passenger Terminal Building
C : Cargo Terminal Building
M : Aircraft Maintenance Hangers

Figure 7.2.3 Process of the Terminal Development

(3) Terminal Area Layout

1) International Terminal

a. The international apron is planned to handle large type aircraft. Taking into account this requirement and the following conditions of the planning; the 300 meter-width runway strip and the separation distance of 182.5 meters between the runway center line and the parallel taxiway center line, this requires a deeper depth of apron than at present. There is a land limitation within the present airport property. "NOSE-IN and PUSH-OUT" aircraft configurations will be adopted for the aircraft handling system on the apron.

b. The existing international passenger terminal building is limited for its expansion due to the surrounding facilities. Beside a large design unit for floor areas is planned to improve the level of service.

Therefore a new international terminal building is planned to accommodate the demand.

2) Domestic Terminal

a. A domestic passenger terminal is planned to be located at the southern site of the international terminal.

The existing international passenger terminal building is planned to be converted to a domestic one with adequate rehabilitation for domestic use.

b. As the aircraft fleet for the domestic flight consists of small aircraft such as HS-748 and or DHC-6; an "ANGLED SELF-MANEUVERING" parking configuration will be planned.

The apron is planned to accommodate 3 HS-748 and 3 DHC-6 for loading and 3 helicopters.

3) Cargo Terminal

a. Cargo terminals are planned to be located beside aprons for easy cargo-handling, smooth vehicle flows and better airport operations.

b. A new international cargo terminal is planned at the northern site of the new international PTB and in front of loading spots for large aircraft.

7.3 Configuration of Other Facilities

7.3.1 Aircraft Maintenance Area and Hangars

a) The present civil aircraft maintenance area consists of two (2) hangars for medium and small aircraft and the front apron. The maintenance work here will be limited to only regular and light maintenance checks.

There are requests from airline companies for hangers to accommodate the newly-introduced aircraft such as B-767 and other types.

As the present site is in use, the new site should be at a site ready to construct easily and at anytime. Therefore, it is planned for the eastern terrace on the opposite side of the terminal across the runway.

b) The hangars will be built by the private sector based on the new policy of HMG/Nepal. Therefore in the master plan, the new area for aircraft maintenance and hangars is planned to be reserved for future development. In response to the requests of airlines, one (1) hangar for B-767 class aircraft and one (1) hanger for small aircraft plus a frontal apron are planned.

For the development and the integration for aircraft maintenance, ATSC workshop and an apron (DHC-6) will be joined into this area in the future.

c) There are some points to be considered in the planning, as follows:

- Height of buildings : they should be clear of the transitional boundary which begins at the future runway strip edge of 300 m wide, and also they should not exceed 25 meters, the height of the radar tower, so as not to obstruct the radar function.

- The separation from the receiver site to keep stable signals

Therefore, the hangars for large aircraft will be placed parallel to the runway to obtain the clearances mentioned above.

7.3.2 Rescue and Fire Fighting Station

The rescue and fire fighting station is planned to be relocated to a site for short and direct access to the main runway in order to improve the facilities and the access time of the present condition. The eastern terrace is situated almost at the center of the runway, which gives an appropriate distance to both runway ends. Also siting here will not hinder future expansion of the terminal.

A direct access road to the runway is also planned.

7.3.3 Isolated Aircraft Parking Position

An isolated aircraft parking position is planned for aircraft to prevent unlawful interference or their isolation from normal aerodrome activities for other reasons. For this purpose, the east side of RWY 20 was selected to keep a certain separation from airport activities and facilities. One apron for B-747 aircraft is planned.

7.3.4 Fuel Farm

The existing fuel farm will have to be removed due to the parallel shifting of the taxiway and the expansion of the terminal area in the future. A new fuel farm is planned at the site south of the existing one along the Ring Road, taking account of the following:

- Access to the main road

- Traffic separation of fuel vehicles from other facilities

- Maintenance of separation distance from other airport facilities and residences in the case of emergencies

- Landscaping around the terminal area

The time of removal is expected to be as quick as possible to provide an airport perimeter road and a service road.

7.3.5 Security Fencing

Chain-link fencing for security is planned around the operational areas and along the perimeter of the airport in order to prevent intrusion by unauthorized persons into the non-public areas.

7.3.6 Perimeter Road and Airport Service Road

In order to facilitate various kinds of airport activities, a perimeter road and service road with paved surfaces are planned.

7.3.7 Utilities

1) A sewage treatment facility is planned to be located at the south site near the junction of the Ring Road, for convenience of the discharge directly to the outlet to Bagmati River and also making use of the topography.

2) Solid waste disposal is planned next to the sewage treatment plant, for its accessibility to the main road and for the separation from the terminal facilities.

3) The necessity of a new well should be studied in order to supplement the insufficient volume of water supply.

4) For electricity, it is also necessary to study the installation of additional generators beside the emergency generator in order to supplement shortages from the public electric power supply.

7.3.8 Landscaping

Landscaping of the terminal and its surroundings should be taken into account as well as the whole of the airport site, not only for aesthetic reasons but also for moderation of environmental impact to the areas concerned.

As the present landscaping at the terminal gives a better atmosphere and impression of Nepal, this should be considered in the future plan.

7.3.9 Military Area

a) At present, there are Nepalese military facilities of hangars and apron mixed with the civil aircraft maintenance area, next to the domestic terminal.
Generally it is better to separate civil and military activities for securing airport operations, as much as possible.

As TIA is a civil airport and the activity of civil air activities have priority over the military facilities, it is natural in airport planning to put stress on the development of the civil activities.

b) As the present area of aircraft maintenance is the best site for expansion of the terminal in the future, the military area is planned to be moved.
The north-eastern terrace was selected for the relocation.

7.3.10 Ground Facilities Improvement Plan

a) The Ground Facilities Improvement Plan, which is described in the previous paragraph, is summarized in Table 7.3.1, with a comparison with the existing facilities and the requirement for the year 2010.

b) Airport Improvement Works and Phasing

(a) The scope of works of Ground Facilities Improvement Plan is phased into three (3) stages in order to implement the project effectively and efficiently. The phasing is based on the urgency for enhancing the level of safety, service and cost-effectiveness.

(b) The completion of security fencing around operational areas and the service road/perimeter road is quite urgent so as to secure the safety of the airport. Due to the insufficient and inconvenient service to airport users, particularly to passengers, at present and in the future, terminal facilities for both passengers and cargo should be improved to that which is necessary for the national gateway and hub of Nepal. These works are categorized in the short-term modernization plan.

(c) Parallel taxiway shifting and runway strip widening are phased into the Ultimate Plan.

(d) The priority of airport improvements to the main facilities, which are phased into three stages, are shown in Table 7.3.2.

(e) In the Ground Facilities Improvement Plan, the works of both the international and domestic passenger terminal complex, cargo terminal complex, service and inner perimeter road and security fencing around operational areas will be identified as urgent because of their high necessity and contribution to the modernization and improvement of TIA.

Table 7.3.1 Ground Facilities Improvement Plan of Tribhuvan International Airport

A. Traffic Demand

Item	Unit	1992	2010
Annual Passengers			
International		780,000	1,940,000
Domestic		292,000	550,000
Total		1,072,000	2,490,000
Annual Cargo			
International	ton	15,833	51,600
Domestic	ton	680	1,940
Total	ton	16,513	53,540
Annual Aircraft Movements			
International		7,597	11,800
Domestic		16,991	17,500
Total		24,588	29,300
Peak Hour Passengers			
International		580	1,320
Domestic		210	390
Total		790	1,710
Peak Hour Aircraft Movements			
International		5	8.0
Domestic		11	11.8
Total		18	19.8

B. Facilities

Item	Unit	1993	2010 (Requirement)	2010 (Plan)
Aerodrome Reference Code		4D	4E	4E
Runway Classification		Non-precision approach	Non-precision approach	Non-precision approach
Runway				
Length	m	3,050	3,050	3,050
Width	m	45	45	45

Table 7.3.1 Ground Facilities Improvement Plan of Tribhuvan International Airport (Cont'd)

Item	Unit	1993	2010 (Requirement)	2010 (Plan)
Runway Strip				
Length	m	3,140	3,140	3,140
Width	m	150	150	150
Parallel Taxiway				
Length	m	1,945	1,945	1,945
Overall Width	m	23	23	23
Separation Distance				
Between runway	m	109	109*	109*
center line			(partially 182.5)	(partially 182.5)
to objects	m	30	47.5	47.5
Apron (Number of aircraft stands)				
Passenger Terminal Apron				
International				
B747-400 class		-	2	2
MD11 class		1	2	2
B767/A300 class		2	2	2
B757/B737 class		3	5	5
Sub Total		6	11	11
Domestic				
HS748 class		2	3	3
DHC6 class		3	3	3
Sub Total		5	6	6
Helicopter		-	3	3
Aircraft Parking Apron				
HS748 class		5	3	3
Passenger Terminal Building				
International Floor Area	m^2	10,750	33,000	33,000
Domestic Floor Area	m^2	700	7,100	10,750 (Conversion of existing Int'l terminal building
Cargo Terminal Building				
International Floor Area	m^2	Int'l+Dom=	10,300	10,300
Domestic Floor Area	m^2	3,500	400	400
Car Park				
International	m^2	-	27,700	27,700
Domestic	m^2	-	8,100	8,100
Total	m^2	17,000	35,800	35,800
	lot	141	1,020	1,020
Rescue & Fire Fighting				
Category		5	8	8
Vehicles		4	4	4
Capacity	L		18,200	18,200
Aircraft Maintenance Hangars		2	2	2

Table 7.3.2 Phasing of Ground Facilities Improvement Plan

Phase	Improvement of Safety	Improvement of Services
SHORT TERM MODERNIZATION PLAN (2003)	1. Security fencing (operational areas) 2. Service road/perimeter road 3. Isolated aircraft parking position 4. Relocation of aircraft maintenance area & hangars	1. New International passenger terminal complex 2. New International cargo terminal complex 3. Conversion of existing International passenger terminal building to domestic terminal
LONG TERM MODERNIZATION PLAN (2010)	5. Relocation of fire fighting station 6. Perimeter road 7. Perimeter security fencing	4. Expansion of international terminal complex 5. Expansion of cargo terminal complex
ULTIMATE MODERNIZATION PLAN (BEYOND 2010)	8. Parallel taxiway shifting (completion) plus Shoulder improvement 9. Runway strip widening	6. Expansion of facilities in accordance with demand increase

Note : Complex means the combined system of buildings, aprons, car parks and other facilities concerned.

7.4 Supplementary Consideration

According to the results of the calculations, the capacity of the runway was estimated to be sufficient even beyond the year 2010.

But the present and future congestion is and will be caused by the increasing small aircraft for domestic air operations.

As the calculated demand forecast and runway capacity was based on some assumptions of the socio-economic conditions and also airport operations, it will be generally required to review them before the target year by confirming the future trend of small aircraft activities.

If it is recognized that the runway will reach its maximum capacity in the near future, it will be the time to study a new airport for small aircraft for separation and/or relocation of TIA, which will overcome the deficiency.

7.5 Environmental Consideration

7.5.1 Social Environment

As a future plan, it is necessary to prepare a land use plan so that problems due to aviation noise will not be encountered.

7.5.2 Natural Environment

a) Meteorologically, no big problem is considered to occur since the project is a partial expansion of the present airport.

b) Since this region is mainly comprised of agricultural paddy land, there is no impact on rare animals and vegetation.

c) Topographically, it is anticipated that a significant slope face will be available with the expansion of the airport. Without any slope protection, during the period of heavy rain, sediment flows may occur.

d) As regards the color adjustment of airport structures in the plan, it will be expected to maintain harmony with the existing airport and the surrounding conditions.

7.5.3 Pollution

a) Once the construction works commence, the traffic volume of construction vehicles may increase on account of materials transportation, but it is not expected to be so high. It is anticipated that aircraft operations will not be so high that it will cause problems of high atmospheric pollution. However, periodic investigations are expected to be carried out to check the air quality which will enhance pollution control.

b) As regards the problem of aircraft noise, it is certain that the magnitude of aircraft noise will increase on account of the demand growth. Therefore, it is expected to be necessary to investigate noise periodically for future treatment of problems.

7.5.4 Land Use

In the region around TIA, there are no protected zones such as the national parks, wildlife parks, natural forest etc.. The region under reference mainly practices agricultural and commercial activities, and is inhabited by significant number of people. Therefore, the planning of land use control after the airport's expansion will have to be treated seriously.

7.6 Project Cost Estimation

Rough project cost for Ground Facilities Improvement Plan for the long-term development is estimated as follows:

Civil facilities :	31	(Million US Dollars)
Architectural facilities :	110	
Utilities and Equipment :	17	
Physical contingency :	16	
Engineering service :	17	
Total :	191	

PART B-2 AIR SAFETY IMPROVEMENT PLAN

CHAPTER 8

PRESENT CONDITION OF AIR SAFETY

CHAPTER 8 PRESENT CONDITION OF AIR SAFETY

8.1 Present Condition of Airspace Use

8.1.1 Flight Information Region (FIR)

The airspace above the area bounded by the national boundary of Nepal is designated as Kathmandu Flight Information Region (FIR) as shown in Figure 8.1.1.

Kathmandu FIR(VNSM) has been divided at 83 degrees of east longitude into two sectors.

Kathmandu Sector

Kathmandu Sector includes all KTM FIR airspace to the East of 83E from ground level to an unlimited height. This sector is further sub divided into two areas (east and west) by the line joining 28°17'00" N, 085°21'00" E , KTM VOR and 26°49'00", 085°43'25" E.

i) Area east includes that area of Kathmandu sector to the east of the sub dividing line.

ii) Area west includes that area of Kathmandu sector to the west of the sub dividing line.

Nepalgunj Sector

Nepalgunj sector includes all the area of Kathmandu FIR airspace to the West of 83E from ground level to an unlimited height (Ref. chart 1, attached)

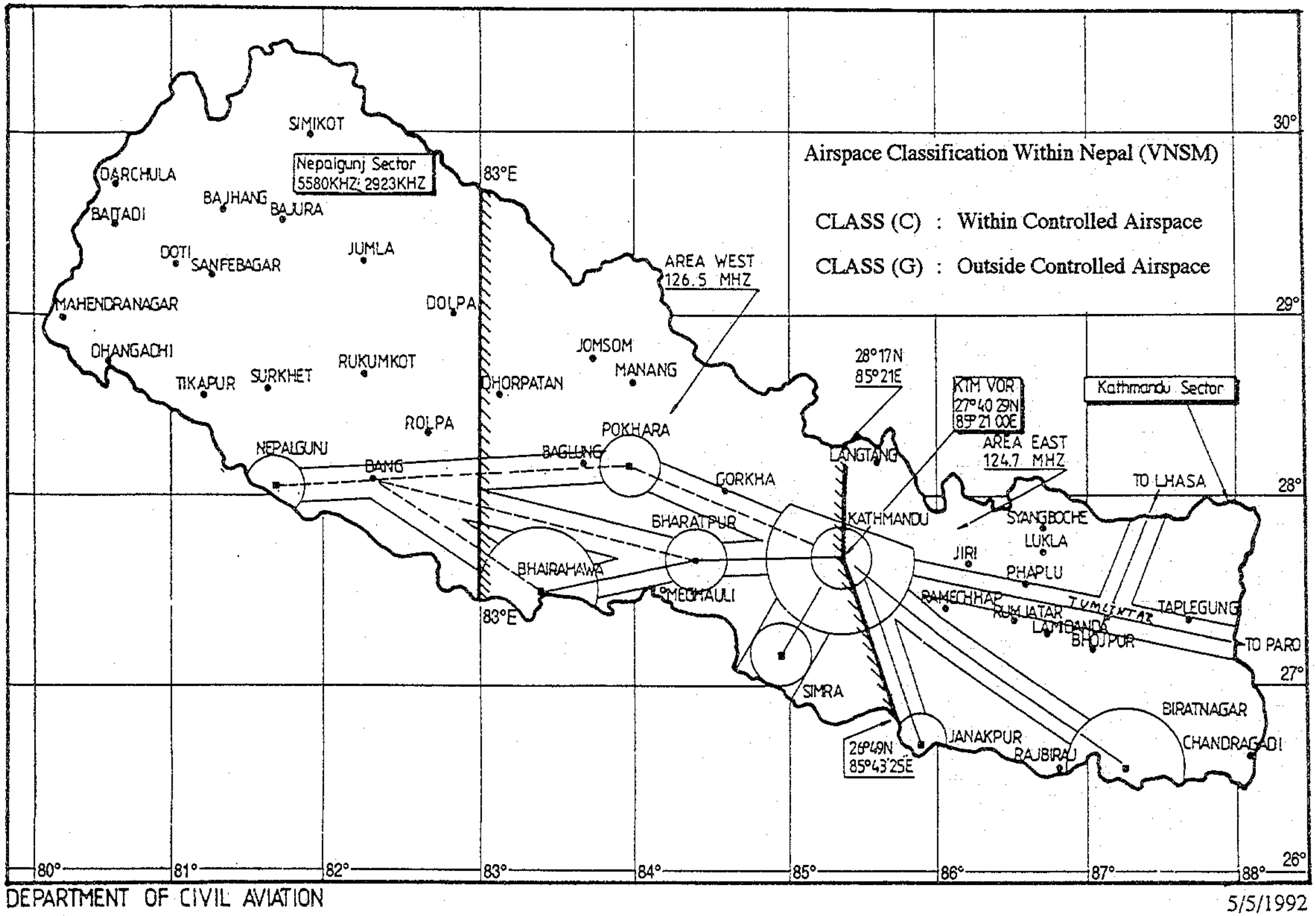


Figure 8.1.1 Flight Information Region and ATS Route Structure

8.1.2 Controlled Airspace

The following controlled airspaces such as aerodrome traffic zone, control zone and terminal control area have been established for Tribhuvan International Airport (TIA).

(1) Aerodrome Traffic Zone

The dimensions of the aerodrome traffic zone at TIA are shown in the following Table 8.1.1.

Table 8.1.1 Dimensions of the Aerodrome Traffic Zone at TIA

Aerodrome	Dimensions of Aerodrome Traffic Zone	
	Lateral Limits	Vertical Limits
Tribhuvan International Airport	Area of a circle of 5 NM radius centered at the aerodrome reference point.	From ground level up to 2000 feet.

(2) Control Zone

The dimensions of the control zone which were revised on 15th March in 1993 to promote air safety and expeditious air traffic flow are as shown in Table 8.1.2 and Figure 8.1.2.

Table 8.1.2 Dimensions of the Control Zone at TIA

Tower	Hours of Operation	Lateral Limits	Upper limits / Lower limits	Language
Kathmandu Tower	HJ (Sunrise to sunset)	1) 10 NM radius centered at KTM VOR/DME (27°40'29"N/ 85°21'00"E) from ground up to 8,500'. 2) The area enclosed by the following sectors up to 15 NM from ground up to 8,500' - East Sector between R070-R130 - South Sector between R190-R230 - West Sector between R265-R310	8,500' AMSL / ground	English

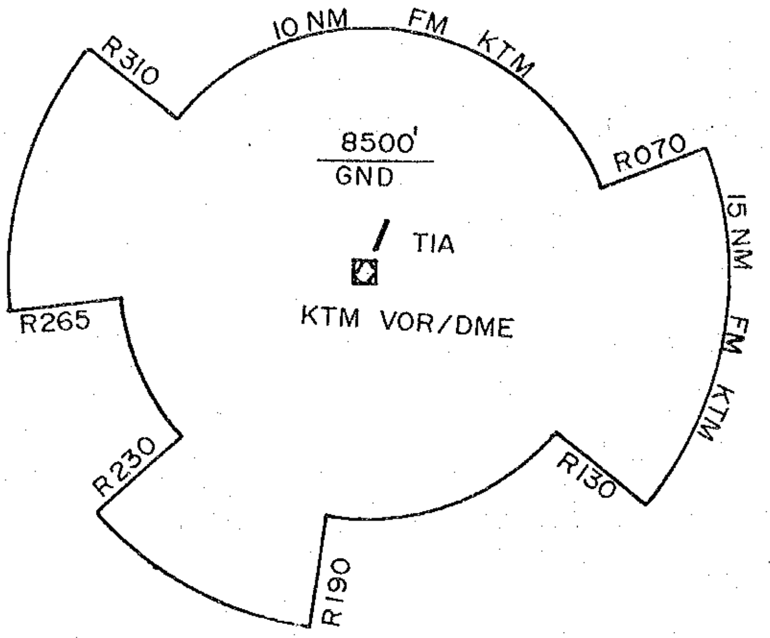


Figure 8.1.2 Revised Control Zone at TIA

(3) Terminal Control Area

The dimensions of airspace for the terminal control at TIA are as shown in Table 8.1.3 and Figure 8.1.3.

The expansion of the terminal control area to 30-35 NM radius is now being studied by DCA to cope with the increase of traffic volume and expeditious air traffic flow at TIA.

Table 8.1.3 Dimensions of Terminal Control Area at TIA

Authority	Hours of operation	Controlled Airspace and Lateral Limits	Upper Limits / Lower Limits	Language
Kathmandu ACC/Tower	HJ (Sunrise to Sunset)	An area enclosed by a circle of radius of 25 NM centered on KTM VOR/DME (27°40'29"N/ 85°21'00"E) except airspace outside the line joining 27° 57'45"N/ 85°00'00"E to 27°46'00"N/85°48'30"E	FL 460 / 7,500'	English

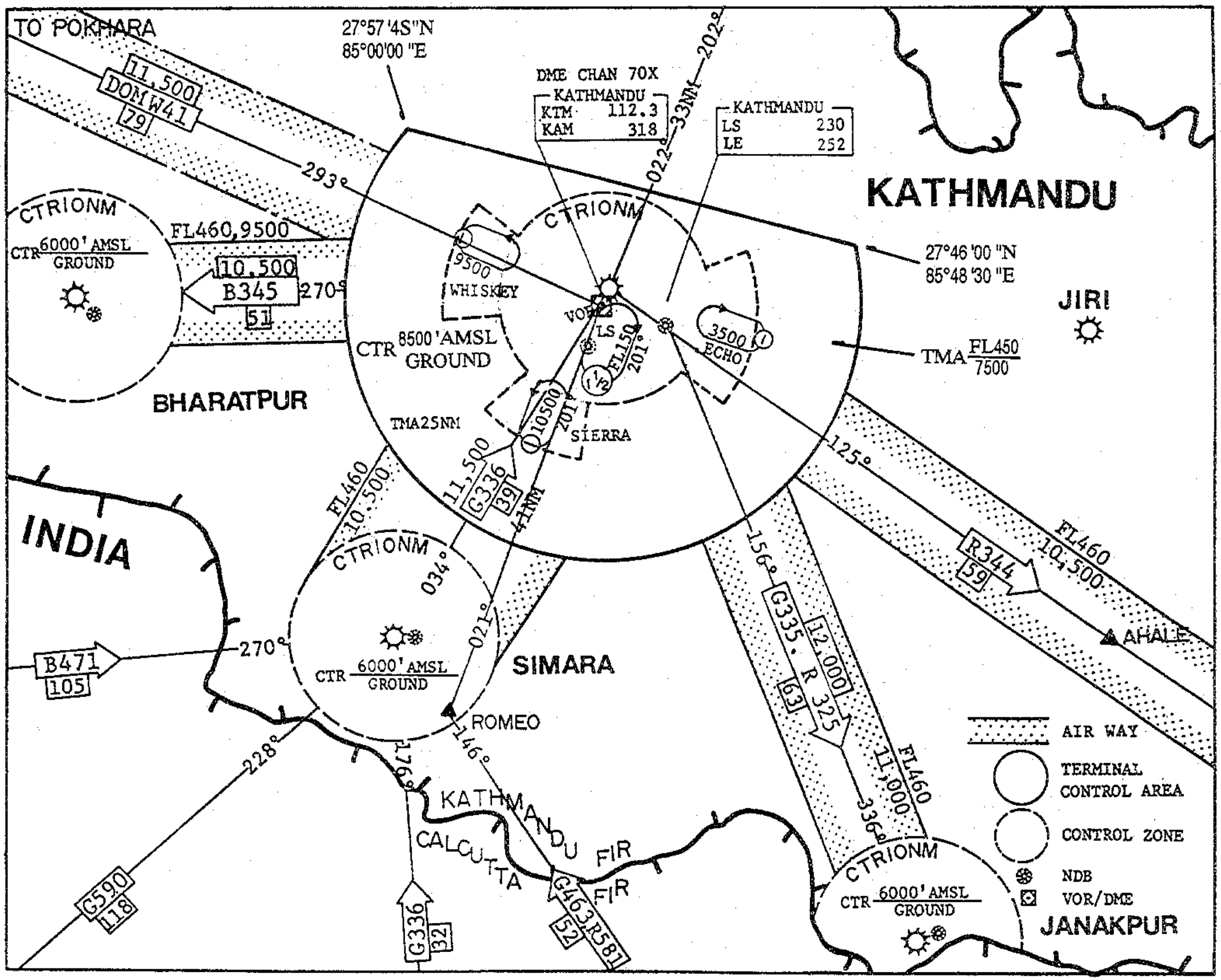


Figure 8.1.3 Dimension of Terminal Control Area at TIA

8.1.3 ATS Route Structure around TIA

ATS routes which are established around TIA are classified into inbound and outbound routes respectively.

ATS routes B345, G335, R325 and R344 are designated as outbound routes and B471, G336, G463 and R581 are designated as inbound routes as shown in Figure 8.1.3.

However, ATS routes which are designated as inbound traffic mentioned above converge over the Simara NDB which is located approximately 40 NM SW of Kathmandu VOR/DME.

The recent increase of air traffic volume has often caused confusion over Simara NDB by the following reasons:

i) Most of inbound international flights which come from New Delhi, Calcutta, Patna, Dhaka, Bangkok, Hong Kong, etc. to TIA along the designated inbound routes often converge over the Simara NDB at the same flight level (FL) and at the same time.

ii) The controllers of Kathmandu ACC are faced with the difficulty of the establishing separation between each inbound aircraft due to critical condition mentioned above.

iii) On the other hand, since most of the inbound aircraft approach over the Simara NDB with a high FL (cruising level), they are confronted with a difficult descent to a suitable altitude for landing at TIA due to the short distance between Simara NDB and TIA. To solve these matters, DCA has studied a change in the ATS route structure around TIA including the abolition of the convergence of inbound ATS routes over Simara NDB. These matters are under negotiation with the ACCs concerned at present.

8.1.4 Approach and Departure Procedures

At present two (2) instrument approach procedures and six (6) instrument departure procedures have been established at Tribhuvan International Airport as shown in Figures 8.1.4 through 11.

Tribhuvan International Airport is located in the Kathmandu Valley which is surrounded by high mountains of approximately 2500 m ~ 3000 m AMSL. Aircraft approaching to and departing from TIA are strictly required to make a steep descent or climb due to these topographical conditions. The main navigational aid for aircraft use at TIA at present is the Kathmandu VOR/DME, identification KTM, co-ordinates 27°40'29"N/85°21'00"E, frequency 112.3 MHz/CH 70X, approximately 0.6 NM south of Runway 02 threshold.

However, taking into consideration that VOR/DME is the only useful landing aid for TIA and to secure the safe air traffic flow, it is strongly requested to install additionally a NAVAID system for aircraft operations at TIA, especially for aircraft approaching to Runway 02.

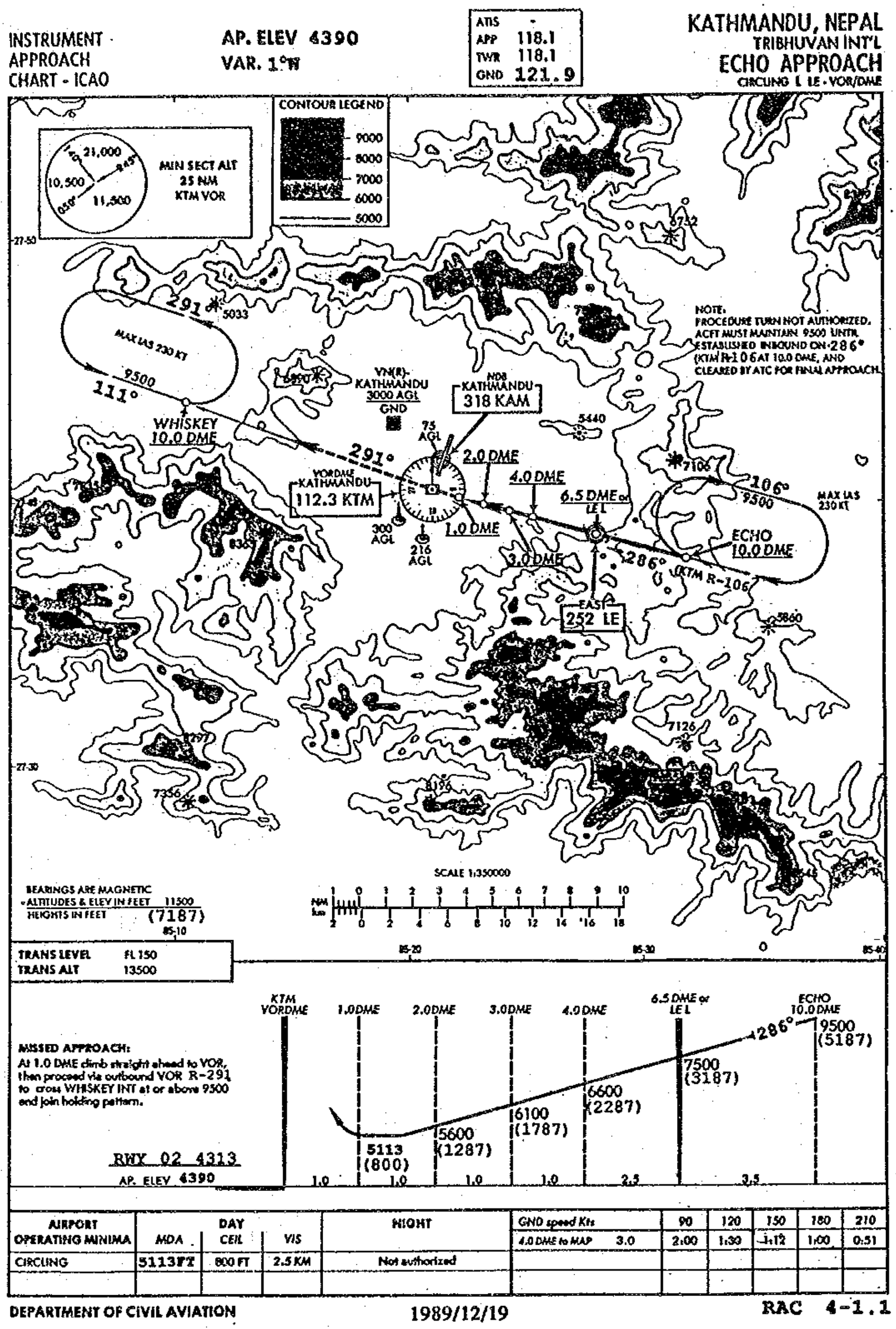


Figure 8.1.4 Instrument Approach Procedure - 1

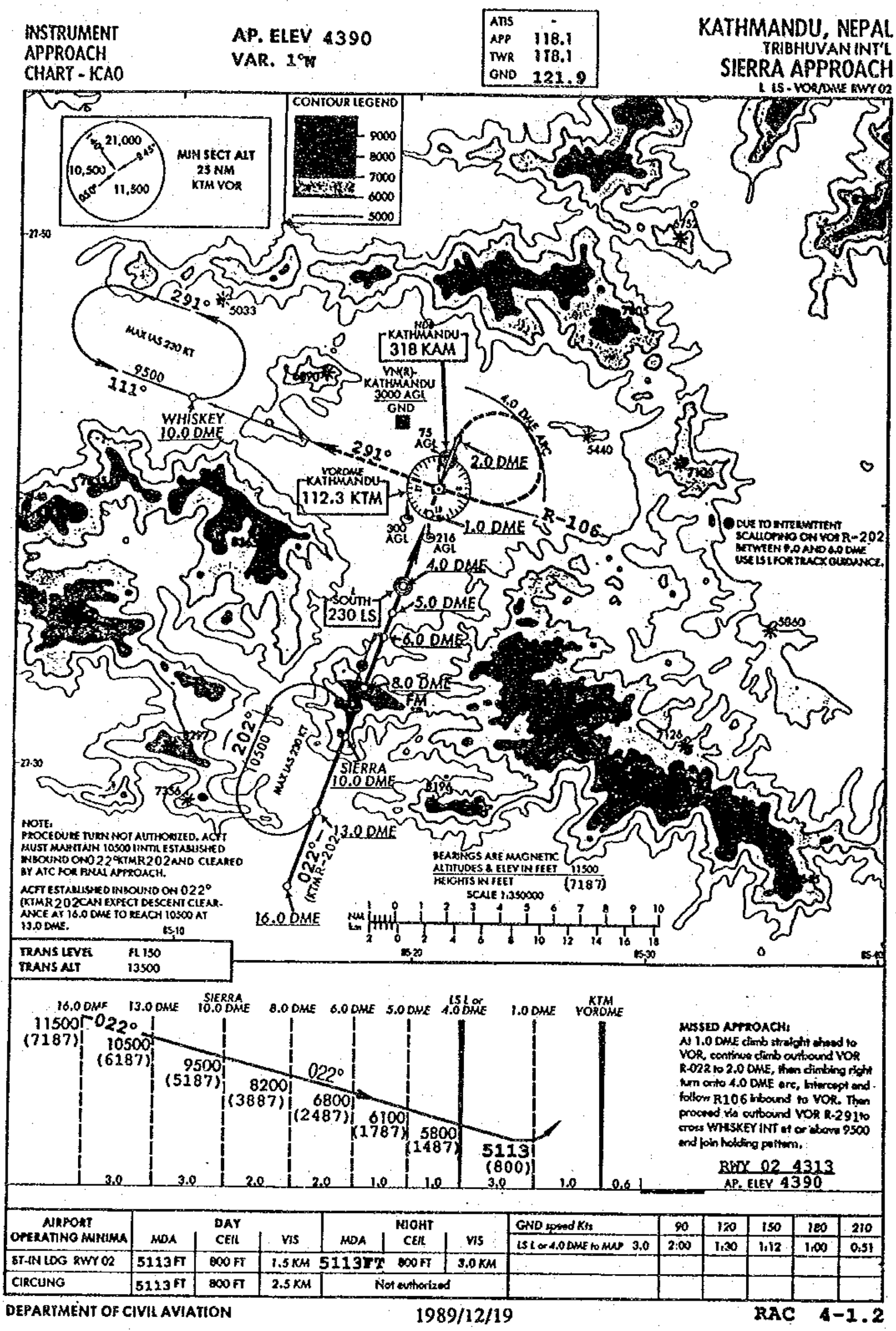
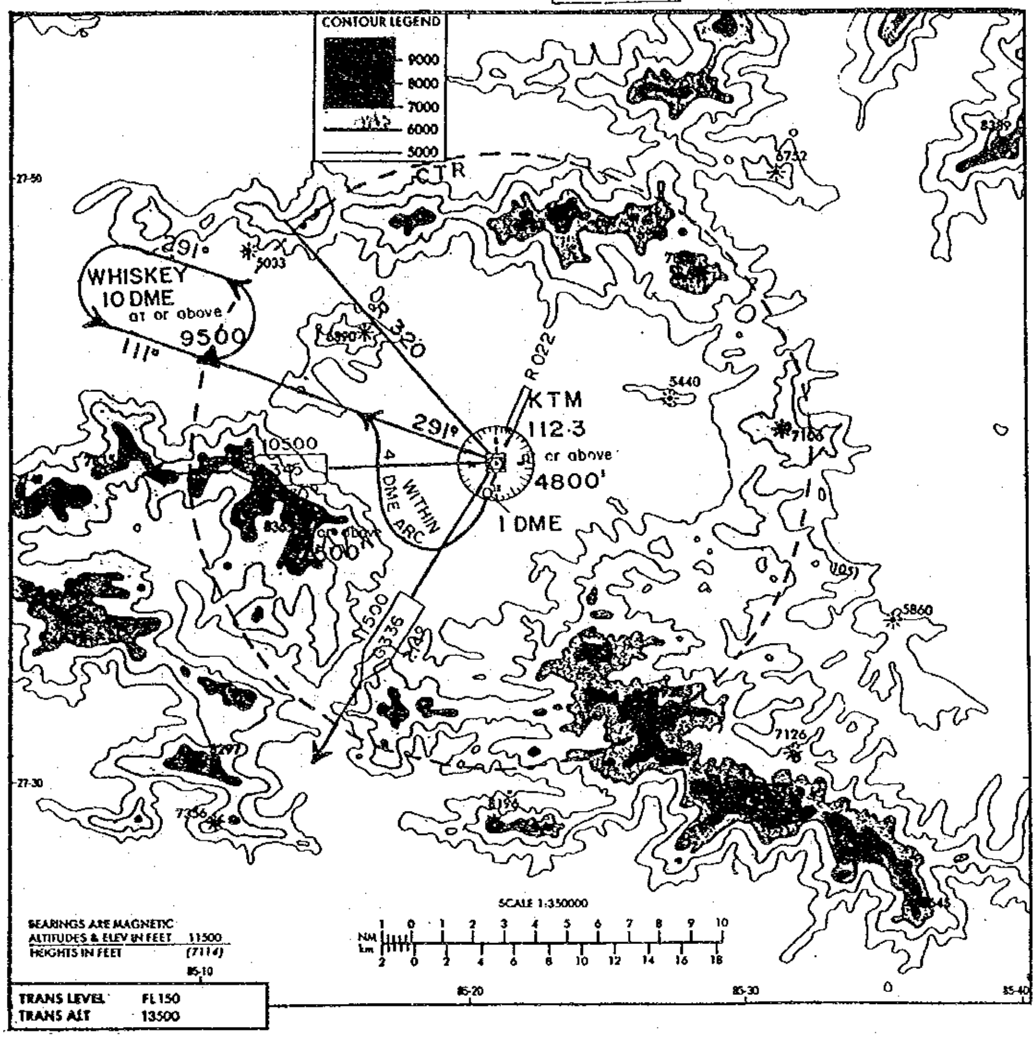


Figure 8.1.5 Instrument Approach Procedure -2

STANDARD INSTRUMENT DEPARTURES | AP. ELEV. 4390 TRANS LEVEL FL150 TRANS ALT: 13500 | ATIS APP 118.1 TWR 118.1 GND 121.9 | KATHMANDU/ TRIBHUVAN INT'L



SID WHISKEY ONE

1. RWY 20/WEST, SOUTH - WEST BOUND.

Departure turn limited to 180 KIAS maximum, Minimum climb gradient of 5% required. Climb straight ahead inbound R 022 to cross VOR "KTM" 112.3 MHZ at or above 4800 ft. At 1 DME south of KTM turn right remaining within 4 DME arc. When crossing R 270 "KTM" at 7500 ft or above turn left to intercept and follow outbound R 291 "KTM" to WHISKEY INT (10 DME). Climb to and maintain 9500 ft. till 5 DME. Continue climb inbound WHISKEY to MEA.

Remark:- If below 7500 ft at R 270 KTM. Mintain 4 DME arc to reach 7500 ft or above before intercepting R 320 outbound.
Then continue via 7 DME arc to WHISKEY INT (10 DME).

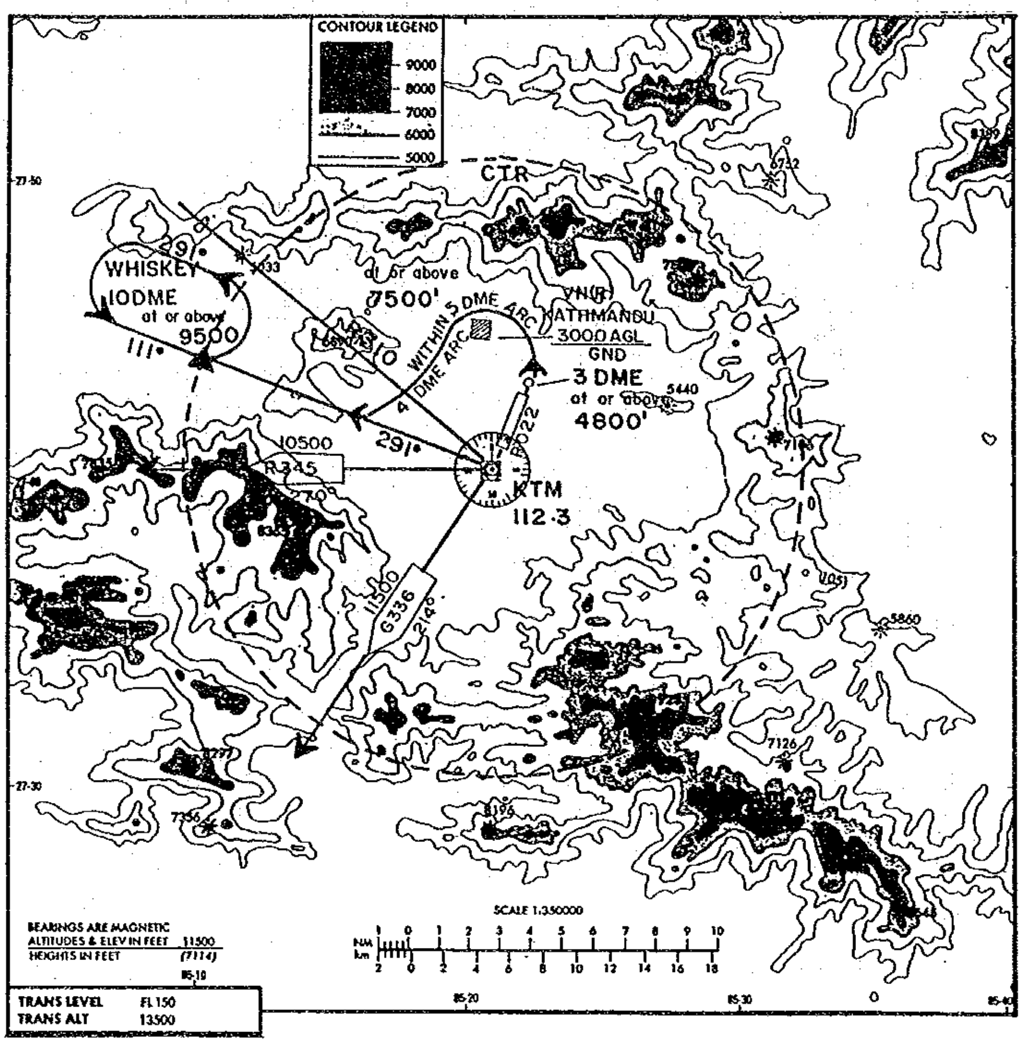
DEPARTMENT OF CIVIL AVIATION 1989/12/19 RAC 4-1.3

Figure 8.1.6 Instrument Departure Procedure - 1

STANDARD INSTRUMENT DEPARTURES | AP. ELEV 4390 | TRANS LEVEL FL 150 | TRANS ALT: 13500

ATIS	
APP	118·1
TWR	118·1
GND	121·9

KATHMANDU/
TRIBHUVAN INT'L



SID WHISKEY TWO

2. RWY 02/WEST, SOUTH - WEST BOUND.

Departure turn limited to 180 KIAS maximum. Minimum climb gradient of 5% required. Climb straight ahead outbound R 022 VOR "KTM" 112.3 MHZ to cross 3 DME at or above 4800 ft. At 3 DME turn left (remaining within 5 DME arc) to intercept 4 DME arc. When crossing R 310 "KTM" at 7500 ft. or above turn right to intercept R 291 "KTM" to WHISKEY INT (10 DME). Climb to 9500 ft. and maintain till 5 DME. Continue climb inbound WHISKEY to MEA.

Remark:- If below 7500 ft. at R 310 "KTM" stay within 4 DME arc and intercept R 291 "KTM" within this arc.

DEPARTMENT OF CIVIL AVIATION 1989/12/19 RAC 4-1.4

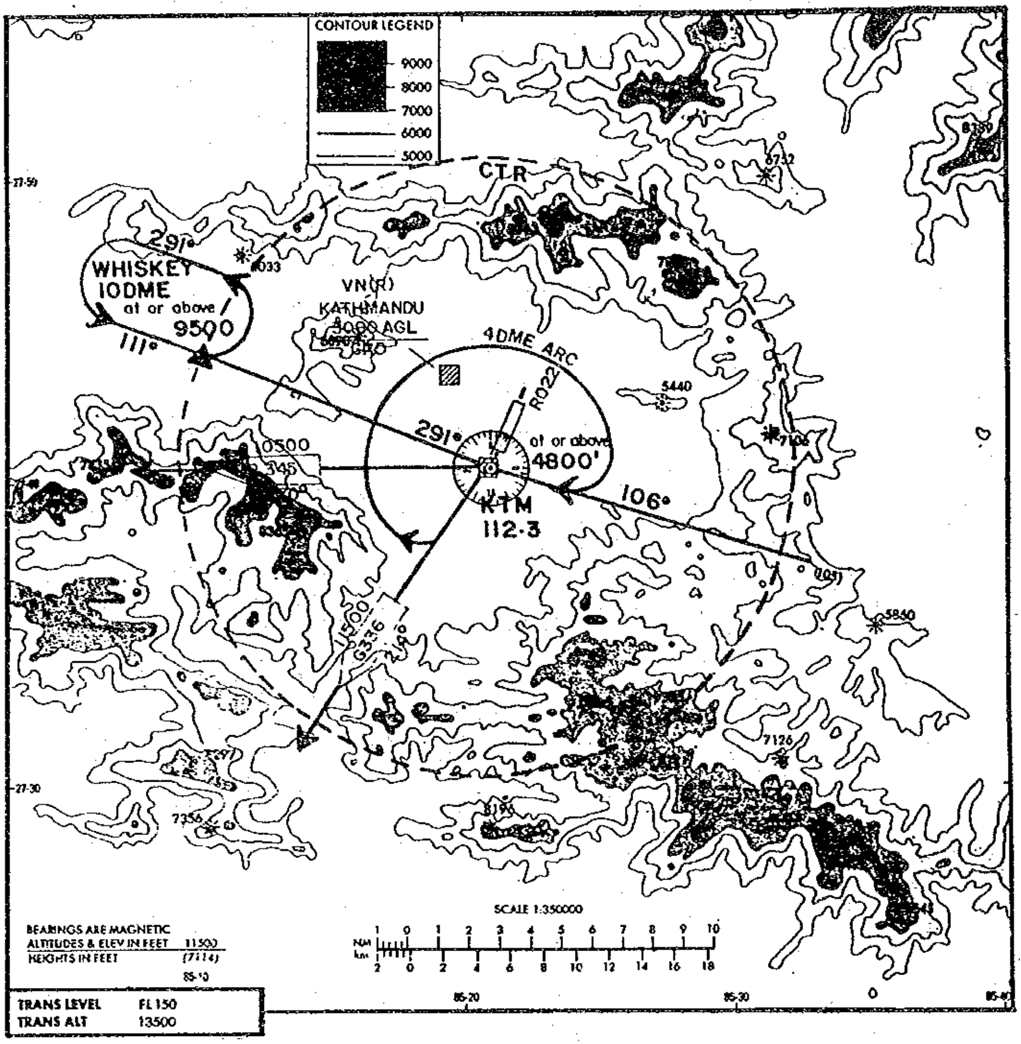
Figure 8.1.7 Instrument Departure Procedure - 2

STANDARD INSTRUMENT DEPARTURES

AP. ELEV. 4390
TRANS LEVEL: FL 150
TRANS ALT: 13500

ATIS	
APP	118.1
TWR	118.1
GND	121.9

KATHMANDU/
TRIBHUVAN INT'L



SID WHISKEY THREE

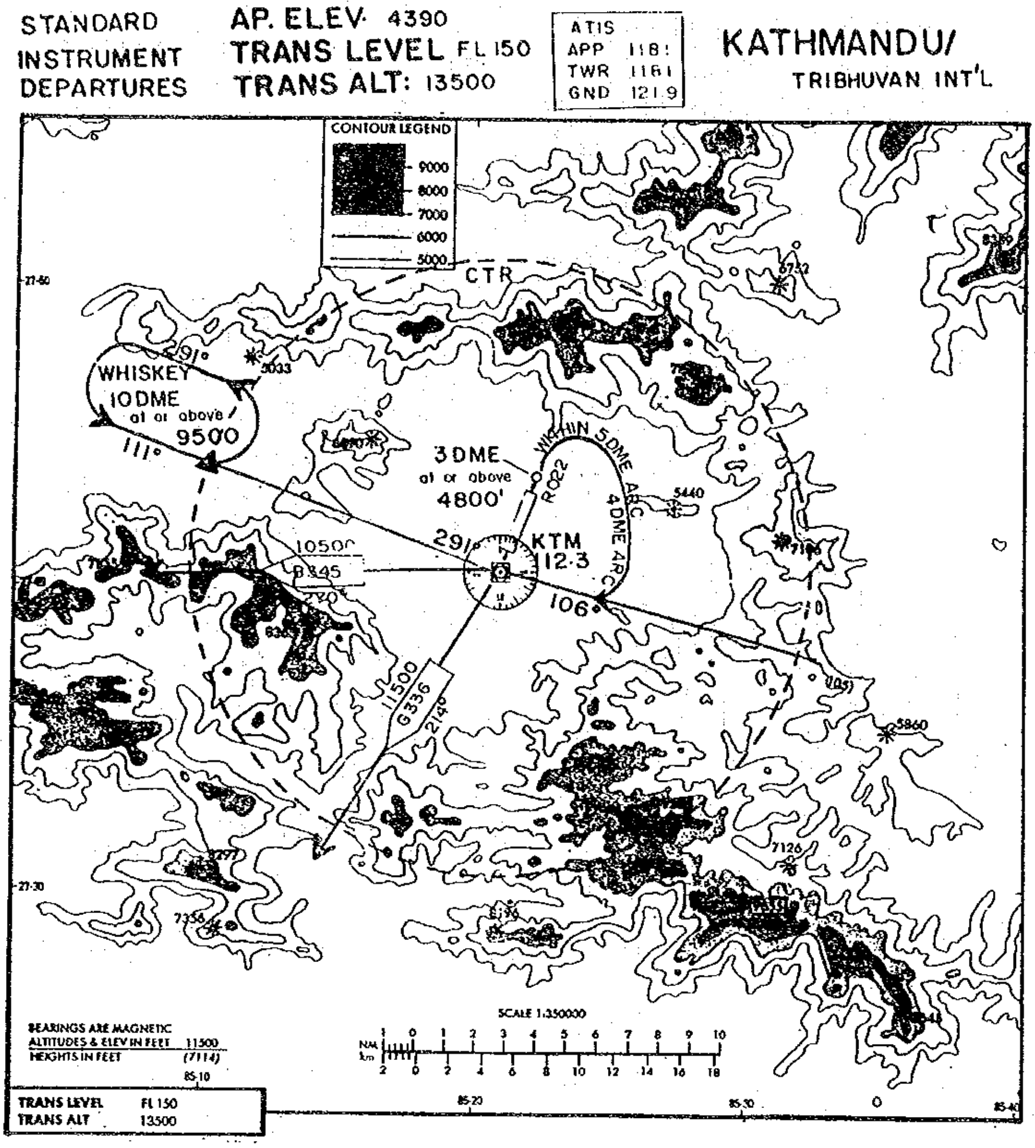
3. <u>RWY 20/WEST, SOUTH - WEST BOUND.</u>

Departure turn limited to 180 KIAS maximum.

Climb straight ahead inbound R 022 to cross VOR "KTM" 112.3 MHZ at or above 4800 ft. Then turn right to intercept and maintain 4 DME arc. Intercept and follow inbound on R 106 to "KTM" then proceed via outbound R 291 to WHISKEY INT. (10 DME). Climb to 9500 ft and maintain till 5 DME. Continue climb inbound WHISKEY to MEA.

DEPARTMENT OF CIVIL AVIATION 1959/12/19 RAC 4-1.5

Figure 8.1.8 Instrument Departure Procedure - 3



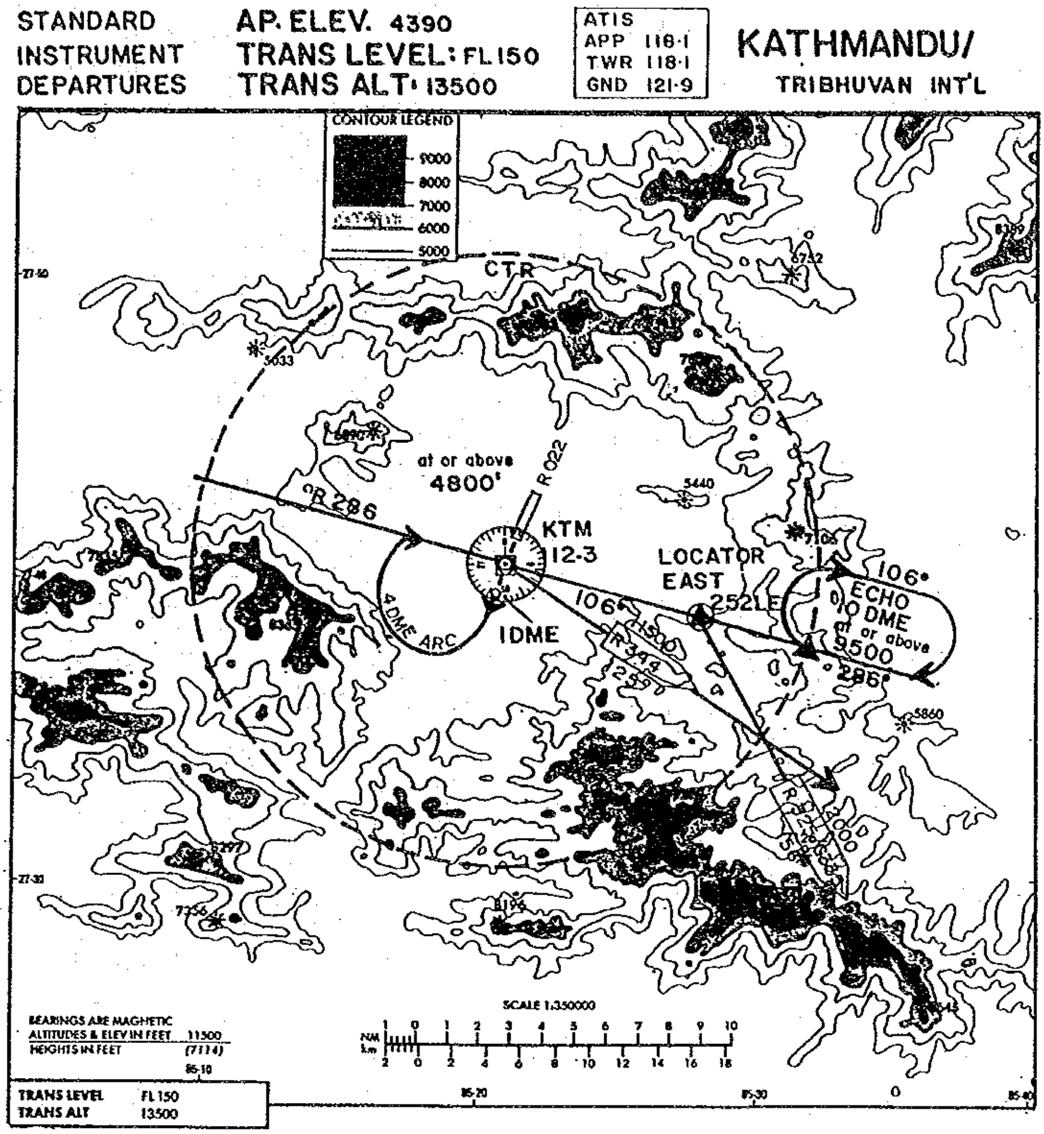
SID WHISKEY FOUR

4. RWY 02/WEST, SOUTH - WEST BOUND.

Departure turn limited to 180 KIAS maximum. Minimum climb gradient of 5% required. Climb straight ahead outbound R 022 VOR "KTM" 112.3 MHZ to cross 3 DME "KTM" at or above 4800 ft. At 3 DME turn right.(remaining within 5 DME arc) to intercept 4 DME arc to proceed to "KTM" via intercepting R 106 inbound. Then proceed outbound R 291 "KTM" to WHISKEY INT (10 DME). Climb to 9500 ft and maintain till 5 DME. Continue climb inbound WHISKEY to MEA.

DEPARTMENT OF CIVIL AVIATION   VTION   1989/12/19   RAC 4-1.6

Figure 8.1.9   Instrument Departure Procedure - 4



SID ECHO ONE

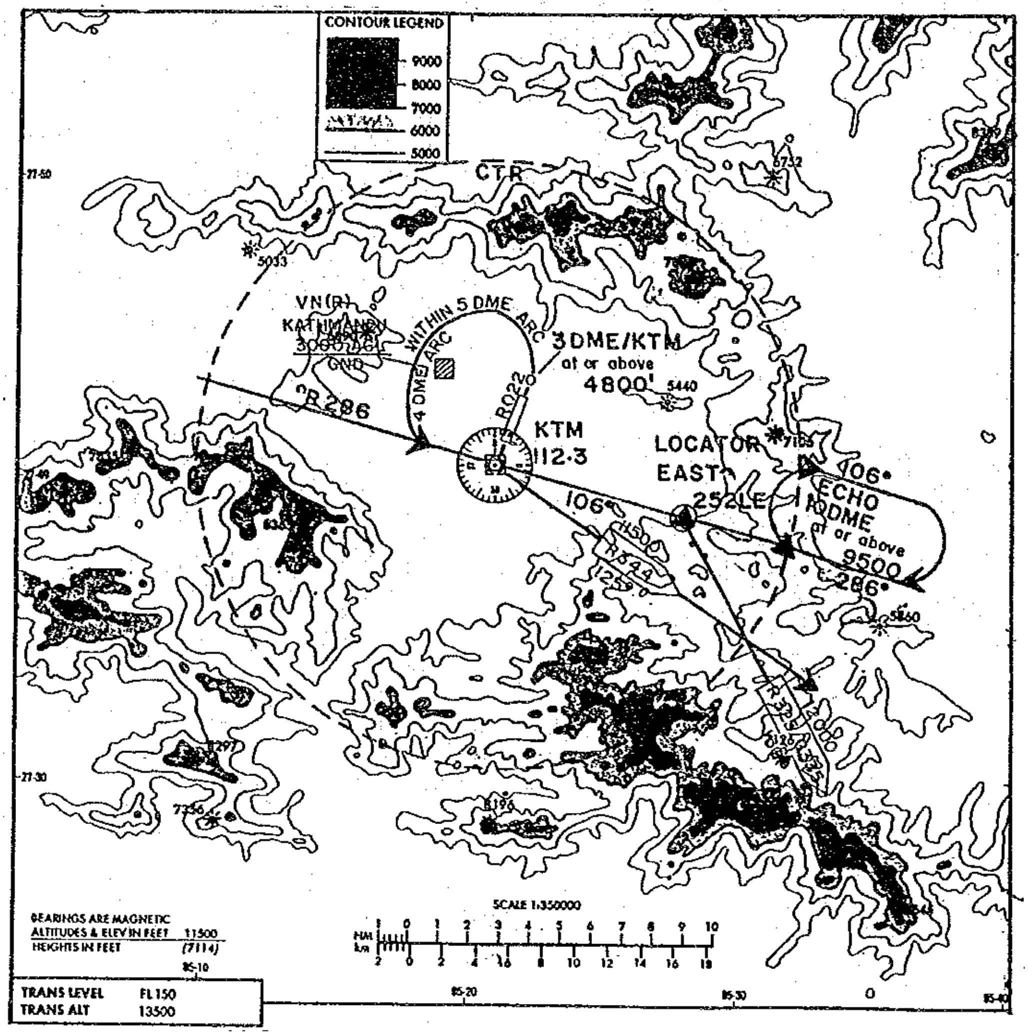
5. RWY 20/EAST - BOUND.

Departure turn limited to 180 KIAS maximum. Minimum climb gradient of 5% required. Climb straight ahead inbound on R 022 VOR "KTM" 112.3 MHZ to cross "KTM" at or above 4800 ft. At 1 DME south of "KTM" turn right remaining within 4 DME arc. Then intercept R 286 inbound "KTM". Thence proceed outbound R 106 "KTM" to ECHO INT (10 DME). Climb to 9500 ft and maintain till 5 DME. Continue climb inbound ECHO to MEA.

DEPARTMENT OF CIVIL AVIATION 1989/12/19 RAC 4-1.7

Figure 8.1.10 Instrument Departure Procedure - 5

STANDARD INSTRUMENT DEPARTURES | AP. ELEV. 4390 | TRANS LEVEL FL150 | TRANS ALT: 13500 | ATIS | APP 118·1 | TWR 118·1 | GND 121·9 | KATHMANDU/ TRIBHUVAN INT'L



SID ECHO TWO

6. RWY 02/EAST - BOUND.

Departure turn limited to 180 KIAS maximum. Minimum climb gradient of 5% required. Climb straight ahead outbound R 022 VOR "KTM" 112.3 MHZ to cross 3 DME "KTM" at or above 4800 ft. At 3 DME turn left (remaining within 5 DME arc) to intercept and maintain 4 DME arc. Intercept and follow R 286 inbound to "KTM". Then proceed via outbound R 106 "KTM" to ECHO INT (10 DME). Climb to 9500 ft and maintain till 5 DME. Continue climb inbound ECHO to MEA.

DEPARTMENT OF CIVIL AVIATION 1989/12/19 RAC 4-1.8

Figure 8.1.11 Instrument Departure Procedure - 6

8.2 Obstacle Limitation Surfaces

8.2.1 The requirements for obstacle limitation surfaces

The requirements for obstacle limitation surfaces for runways with a non-precision approach which are described in ANNEX 14 Aerodromes, ICAO, are as summarized in Figure 8.2.1 and Tables 8.2.1 ~ 8.2.2.

8.2.2 Obstacle Limitation surfaces at TIA

Figure 8.2.2 shows the obstacle limitation surfaces at TIA in accordance with the ANNEX 14, Aerodromes, ICAO. The dimensions are based on a non-precision approach runway, code number 4E.

(1) Approach Surface for Runway 02

There are many obstacles on the horizontal section of the extended approach surface for Runway 02.

To maintain sufficient clearance between the extended approach surface and these obstacles, the length of a second section of extended approach surface was tried to extend to 7700m instead of 3600m in accordance with 4.2.9 and 4.2.17 of Chapter 4 of ANNEX 14, Aerodromes, ICAO. However, obstacles still project above the horizontal section of the extended approach surface as shown in Figure 8.2.2.

The VOR/DME approach procedure for Runway 02 at TIA is obliged to establish a steep descent after passing these obstacles.

(2) Approach Surface for Runway 20

The first section of the Approach surface for Runway 20 is clear from obstacles.

Beyond the first section of the approach surface, mountains block the extended approach surface for Runway 20 as shown in Figure 8.2.2.

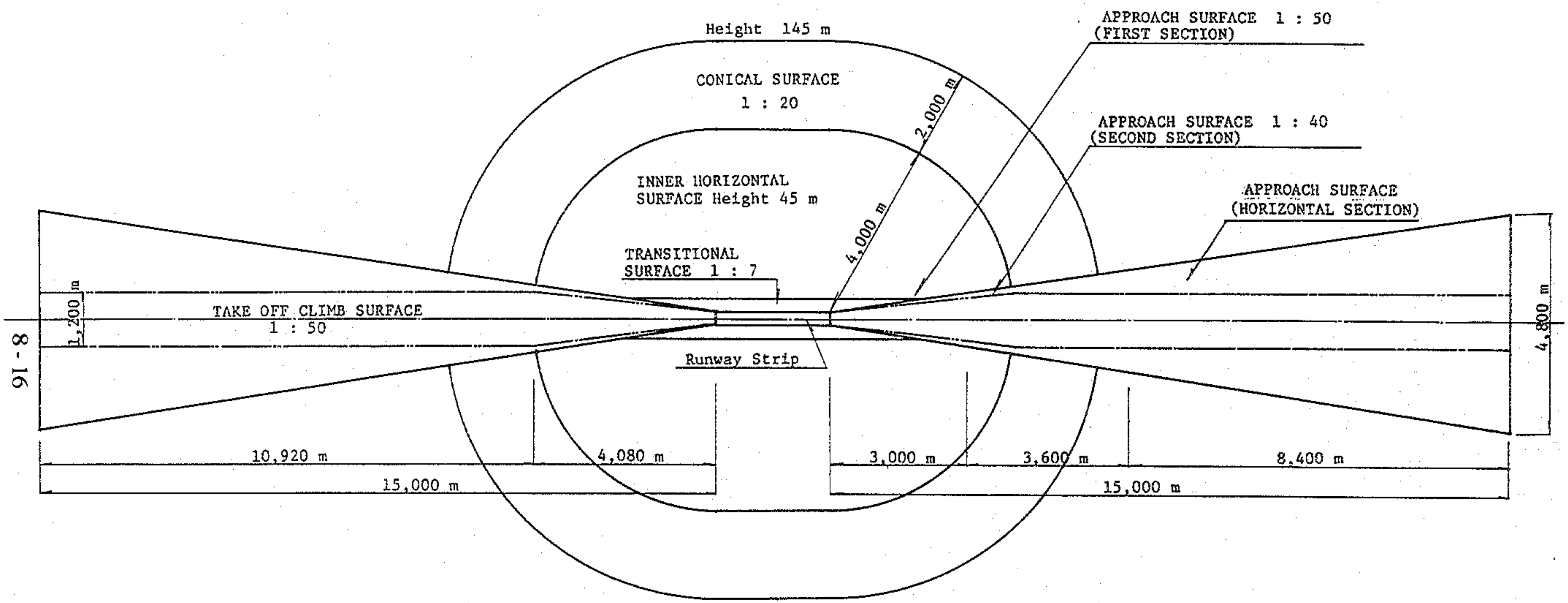
Since the severe conditions exist on both approach areas, the establishment of aircraft operations is strictly limited due to these obstacles. Particularly, take-offs from both ends of the runway are specified to comply with the turning departure procedures with strict limitations for turning areas.

(3) Inner horizontal Surface

When the height of this surface is 4537 feet (airport elevation 4390 feet +147 feet), no obstacle projects above the inner horizontal surface except for some mountains projecting above the north corner of this surface.

(4) Conical Surface

Most of the conical surface is clear from obstacles except for a mountain, 5,000 feet AMSL, which is located at 6 km E of Runway 20 threshold, projects above this surface.



Note : Height above aerodrome elevation

Figure 8.2.1 Obstacle Limitation Surfaces in accordance with Annex 14, Aerodromes, ICAO

Table 8.2.1 Dimensions and Slopes of Obstacle Limitation Surfaces for Approach Runways

	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision approach category I		II or III
Surface and dimensions[a]	Code number 1	2	3	4	Code number 1,2	3	4	Code number 1,2	3,4	Code number 3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	–	–	–	–	–	–	–	90 m	120 m	120 m
Distance from threshold	–	–	–	–	–	–	–	60 m	60 m	60 m
Length	–	–	–	–	–	–	–	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	150 m	300 m	300 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	–	–	–	–	–	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	–	–	–	–	–	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	–	–	–	–	–	8 400 m[b]	8 400 m[b]	–	8 400 m[b]	8 400 m[b]
Total length	–	–	–	–	–	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	–	–	–	–	–	–	–	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	–	–	–	–	–	–	–	90 m	120 m	120 m
Distance from threshold	–	–	–	–	–	–	–	c	1 800 m[d]	1 800 m[d]
Divergence (each side)	–	–	–	–	–	–	–	10%	10%	10%
Slope	–	–	–	–	–	–	–	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.

Table 8.2.2 Dimensions and Slopes of Obstacle Limitation Surfaces for Take-off Runways

Surface and dimensions[a]	Code number 1	Code number 2	Code number 3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

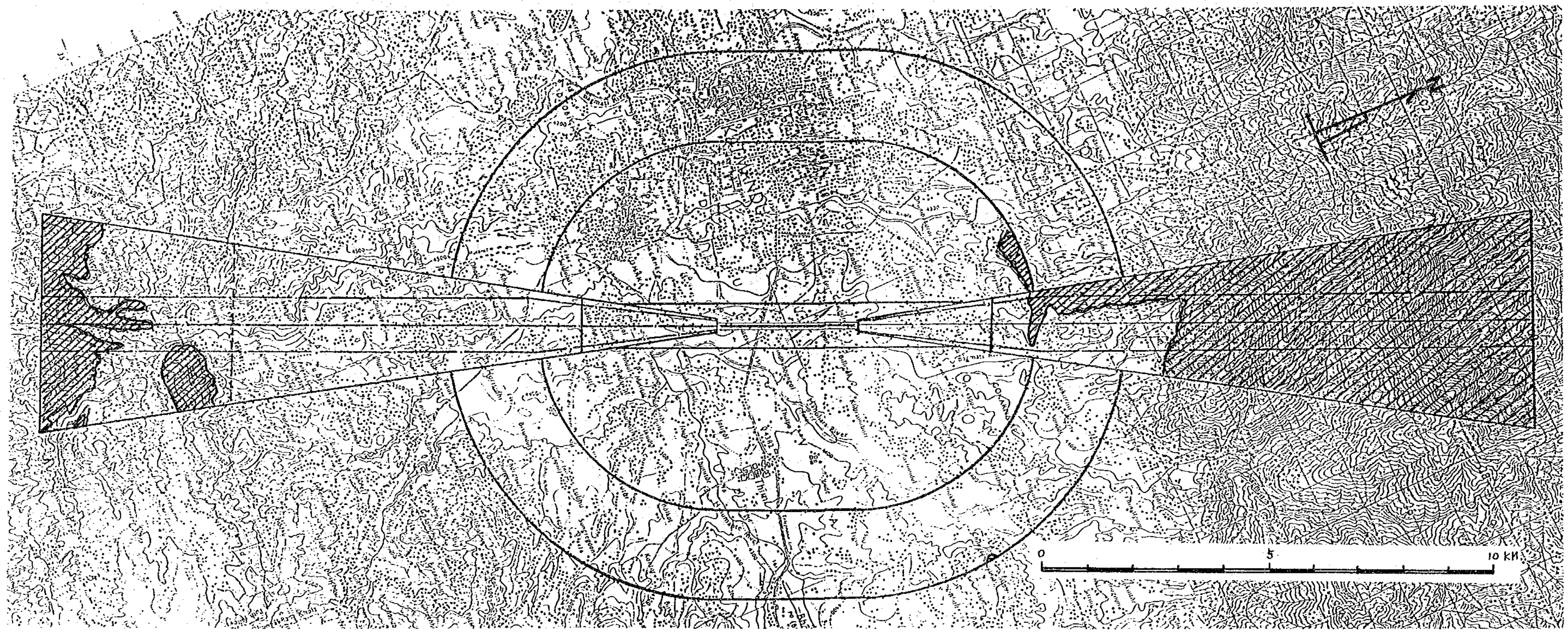


Figure 8.2.2 Obstacle Limitation Surfaces at Tribhuvan International Airport

8.3 Air Navigation System

8.3.1 Air Navigation System being operated currently in Tribhuvan International Airport

- Radio Navigation Aids
- Air Traffic Control System
- Aeronautical Telecommunication System
- Visual Aids for Navigation
- Meteorological Observation System

The location of the facilities, conceptual diagram of the Air Navigation System and Inventory List are shown in Figure 8.3.1, 8.3.2 and Table 8.3.1 respectively.

8.3.2 Radio Navigation Aids

Radio Navigation Aids are provided at preferable sites complying with the instrument approach procedures and the standard instrument departure procedures of the airport.

Replacement of DVOR/DME, which has been providing the major navigation service at TIA, is in progress by the Navigation Aids Project offered by the Australian Government.

NDB, Locators and Fan Marker beacon are also provided. The status of the DVOR /DME and the Marker beacon are monitored and controlled at both the Control Tower and the Equipment room by means of a VHF radio link.

8.3.3 Air Traffic Control System

Air traffic control facilities at TIA are specified into two major functions, ACC and Control Tower.

ACC has the responsibility to provide an air traffic control and information service within the KTM FIR. The service area of ACC is divided into two sub sectors, East and West.

ATC tower is in charge of approach control, aerodrome control and surface movement control in TIA.

Air traffic control consoles are provided at each control position which can access various communication circuits with push switching button down. The main control unit for the consoles is installed in the Equipment room which provides the circuit distribution, audio monitoring and power supply.

The VHF DF (Direction Finder) antenna and direction indicator are installed beside the runway, and in the tower console respectively. Monitoring of the equipment is done in the control tower.

The VHF emergency frequency (121.5 MHz) monitoring facilities are installed in the RCC room. However, it is monitored from the Control Tower by a receiver at present.

Air field Lighting is controlled and indicated on the console. The status of the central power substation is also indicated.

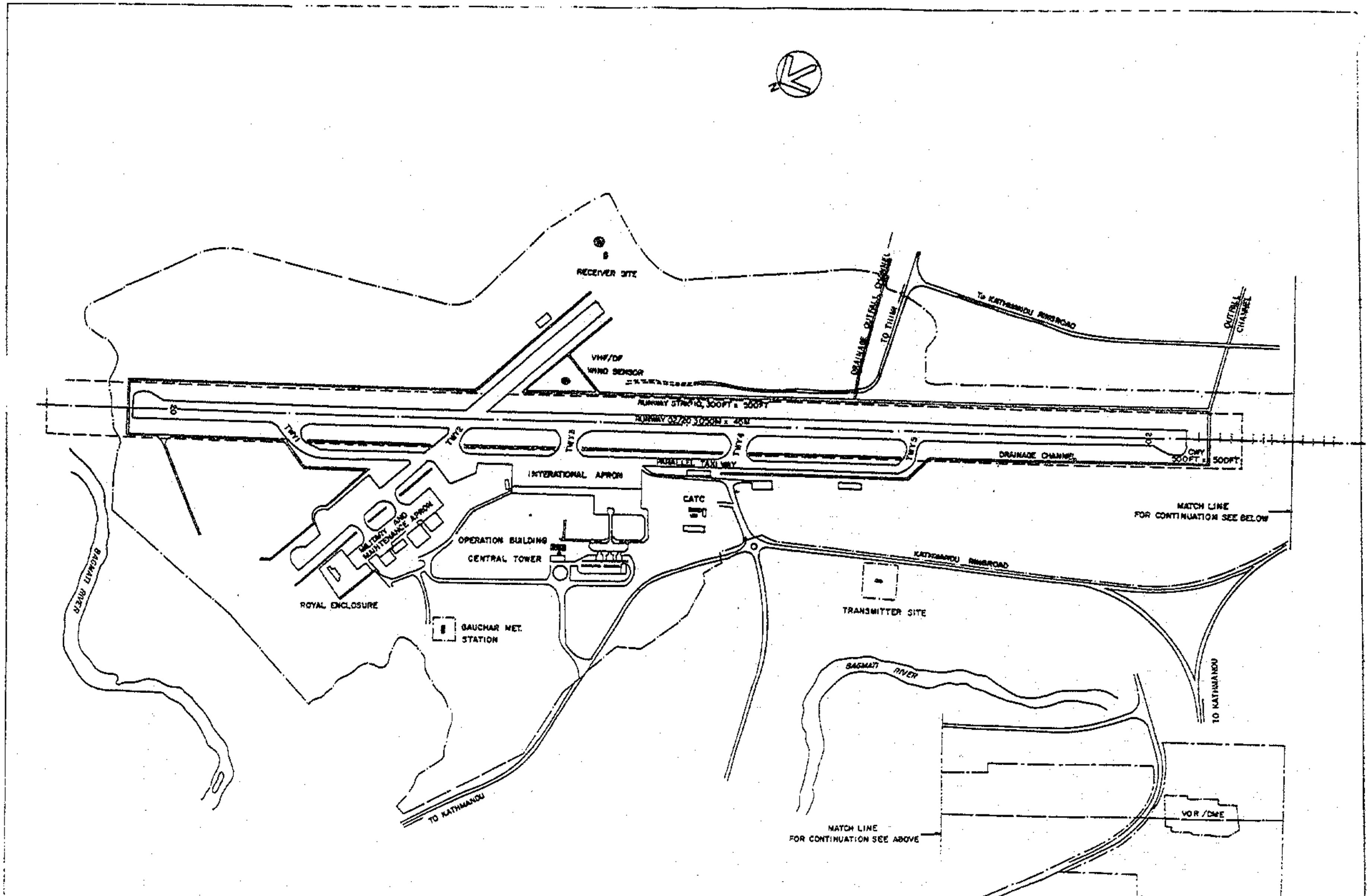


Figure 8.3.1 Location of the facilities

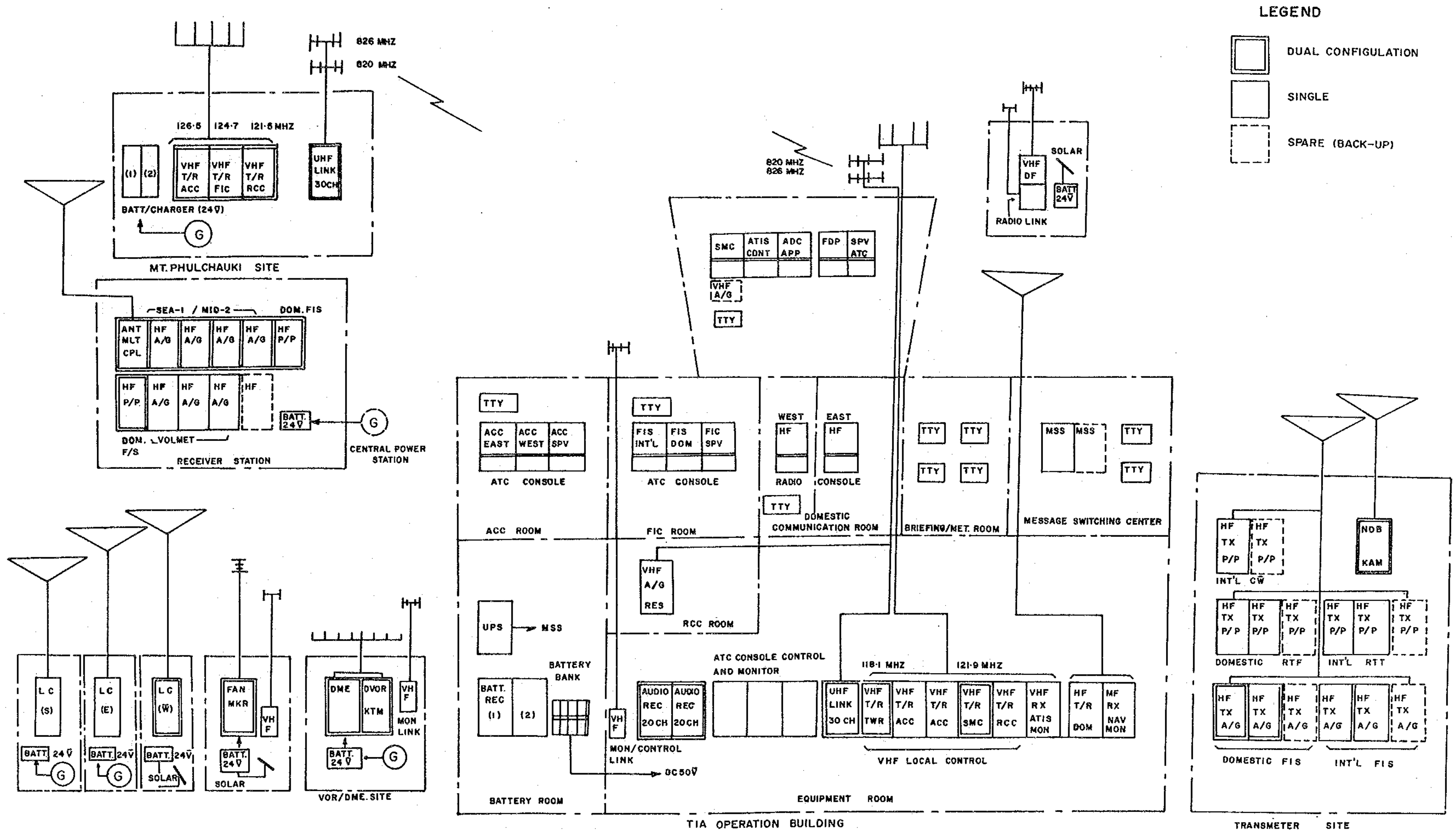


Figure 8.3.2 Conceptual diagram of Air Navigation System

Table 8.3.1 Inventory List

FACILITIES	PERFORMANCE	NET WORK CODE	OPERATING FREQUENCY	PURPOSE	INSTAL-LATION	MFR,Mfd D	No.	REMARKS
RADIO NAVAIDS								
DVOR	50w	KTM	112 .3MHz		1975	AWA	1	
DME	1000w		CH 70X		1975	WILCOX	1	
NDB	400w	KAM	318 KHz		1991	Telerad	1	
LOCATOR (South)	35w/100w	L/S	230 KHz		1970	APP	1	
(East)	35w/100w	L/E	252 KHz		1970	APP	1	
LACATOR (West)	25w	L/W	358 KHz		1988	Telerad	1	
Fan marker	2w		75 MHz		1991	Thomson CSF	1	
NAV AIDS MONITOR HF MF RECEIVER				NDB/LT Monitor	1988 1975	JRC RACAL IAL	1 1 3	
Fan Marker Monitor Radio Link			156 .15 MHz		1989	Thomson CSF	2	Sola Battery Supply
AERONAUTICAL COMMUNICATION								
MOBILE SERVICE								
VHF Transmitter / Receiver	10w/30w	TWR	118 .1MHz	A/G		Park Air Electronics	1	Local Radio(TIAO)
VHF Transmitter / Receiver	10w/30w	SMC	121 .9MHz	G/G		Park Air Electronics	1	Local Radio(TIAO)
VHF Transmitter / Receiver	10w/30w	ACC/WEST	126 .5MHz	A/G	1988	Park Air Electronics	1	Local Radio(TIAO)
VHF Transmitter / Receiver	10w/30w	ACC/EAST	124 .7MHz	A/G	1988	Park Air Electronics	1	"
VHF Transmitter / Receiver	10w/30w	RCC	121 .5MHz	A/G	1988	Park Air Electronics	1	"
VHF Receiver		ATIS	112 .3MHz	A/G	1991	Codan	2	VOR/Monitor
VHF Transmitter / Receiver	50w	ACC/WEST	126 .5Mhz	A/G	1988	Jotron	2	Phulchouki
VHF Transmitter / Receiver	50w	ACC/EAST	124 .7Mhz	A/G	1988	Jotron	2	Phulchouki
VHF Transmitter / Receiver	50w	RCC	121 .5MHz	A/G	1988	Jotron	2	Phulchouki
HF HF Transmitter	1 kw Preset 6CH	SEA-1 SEA-1 MID-2 MID-2	10,066 KHz 6,556 KHz 10,018 KHz 5,658 KHz	A/G A/G A/G A/G	1984	Codan	3	
HF Transmitter	1 kw Dual Channel	DOM FIS	2,923 KHz 5,580 KHz	A/G A/G	1971	CE, Electronics	4	
HF Receiver		SEA-1 SEA-1 MID-2 MID-2	10,066 KHz 6,556 KHz 10,018 KHz 5,658 KHz	A/G	1993	Nardoux	2 2 2 2	
HF Receiver		FIS	5,580 KHz 2,923 KHz	A/G	1993	Nardoux	2 2	
UHF Radio Link	50w PCM 30CH	TIAO Phulchouki	8,700/ 8,695 8,760/ 8,757	Radio Remote Control	1988	AWA	1	
VHF Radio Link		VOR/DME TWR					1	
AERONAUTICAL FIXED SERVICE								
Semi Automatic Message Switching System	16 terminal			AFTN MSS	1988	AWA	1	
HF Transmitter	1kw	International CW	5,442 .5KHz	AFTN		Aerocom	2	Patna, Varanasi Lhasa
HF Transmitter	1kw	International RTT	5,022 KHz 10,486 KHz 7,320 .5KHz	AFTN	1975	Aerocom	1 1 1	 Bombay Calcutta
HF Transmitter	400w Preset 6 CH	Domestic RTF	5,858 KHz 3,380 .5KHz 5,805 .5KHz 3,280 .25KHz 5,858 KHz 3,280 .25KHz	Domestic RTF	1989	Nardoux	1 1 1 1 1 1	 West East Back-Up
HF Receiver		Domestic RTF (E) Domestic RTF (W)	5,805 .5KHz 3,280 .2KHz 5,858 .0KHz 3,380 .5KHz	P/P	1993	Nardoux	2 2 2 2	
HF Receiver HF Receiver		Volmet	6,676 .0KHz 3,467 .0KHz 11,387 .0KHz	P/P	1993	Nardoux	1 1 2	
Multi Coupler Antenna					1993	Nardoux	1	
Modem	FSK 1200BPS 16 Signal/CH			Radio Control	1989	SEEE	10	Transmitter 6CH Phulchokki 4CH
Modem	40 / 20 ma DC	LTT		AFTN			2	Calcutter Bombay
AIR TRAFFIC CONTROL								
ATC System				ATS Console	1988	Email	1	
MET. Data Indicator	Wind Direction Wind Speed Pressure Temp.			Met. Observation	1988	METCH/ AMPS	1	
VHF DF			118 .1KHz		1984	Telead	1	Solar/ Batt
POWER SUPPLY								See note
Battery Bank	400A/10AH				1988		2	
UPS	2.5 KVA			MSS			1	

Note: All equipment installed at TIAO equipment room acceptable only DC 48 V

8.3.4 Aeronautical Telecommunications

1. Aeronautical Fixed Service

A point to point aeronautical telecommunication network and circuit are established at TIA by means of radio links, land line and HF radio.

(1) International Teletype Network (AFTN) and domestic teletype network

A semiautomatic teletype message switching system (MSS), processing with 70 MB memory capacity, has been operated at the message switching center. A total of 16 lines, which is capable of handling messages from/to 13 input /output terminals and 3 receiving only terminals, are provided at ATS sections, the meteorological office, the briefing room and the airlines office and CAL.

Kathmandu - Calcutta and Kathmandu - Bombay AFTN circuits are operational by means of NTC leased lines.

Additionally, provision of one intra-regional circuit for Kunming/Lhasa was agreed at the last ICAO RAN- 3 meeting.

Domestic teletype messages are provided by one of the MSS terminals, which installed at the Domestic Communication Center. This will be mentioned later.

(2) ATS Direct Speech

Since 1990, the Kathmandu/Calcutta, and Kathmandu/Varanasi ATS voice communication circuits have been upgraded from HF voice communication to leased common carrier lines. However, reliability of the line is low due to the poor local line quality.

Some of the problems will be improved after establishing a UHF radio link between TIA and Nepal Telecommunication Corporation (NTC) station coordinated by the Australian Project.

Provisions for new ATS direct speech circuits between Kathmandu-Delhi and Kathmandu-Kunming/Lhasa are taken into consideration by means of a satellite or land line.

(3) Domestic Radio Telecommunication

An HF radio telephone communication network is established between the Kathmandu Communication Center and thirty - two domestic airports. Only Nepalgunj airport is connected by an NTC microwave line.

Two domestic HF communication centers controlling the eastern and western networks are located at the operation building. All domestic aeronautical information is handled here and relayed to the centers.

Information is convertible to teletype messages for the MSS at the center.

Network Charts are shown in Figure 8.3.3 and Figure 8.3.4.

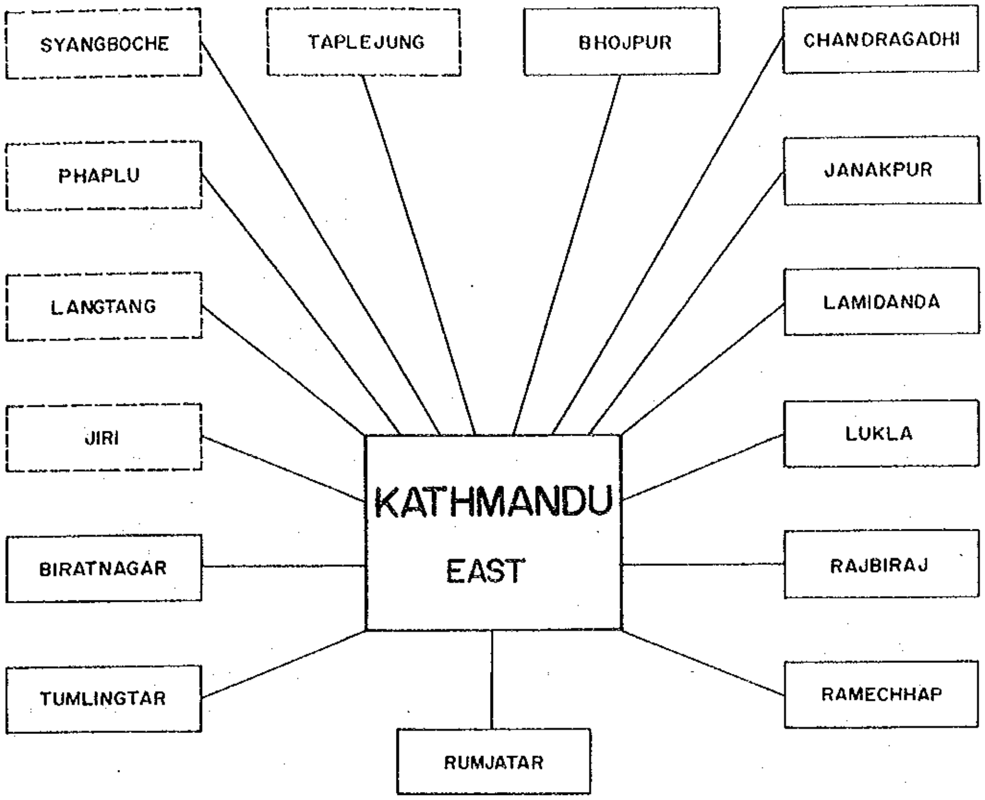


Figure 8.3.3 Domestic HF Network (East)

Manned Station

Unmanned Station

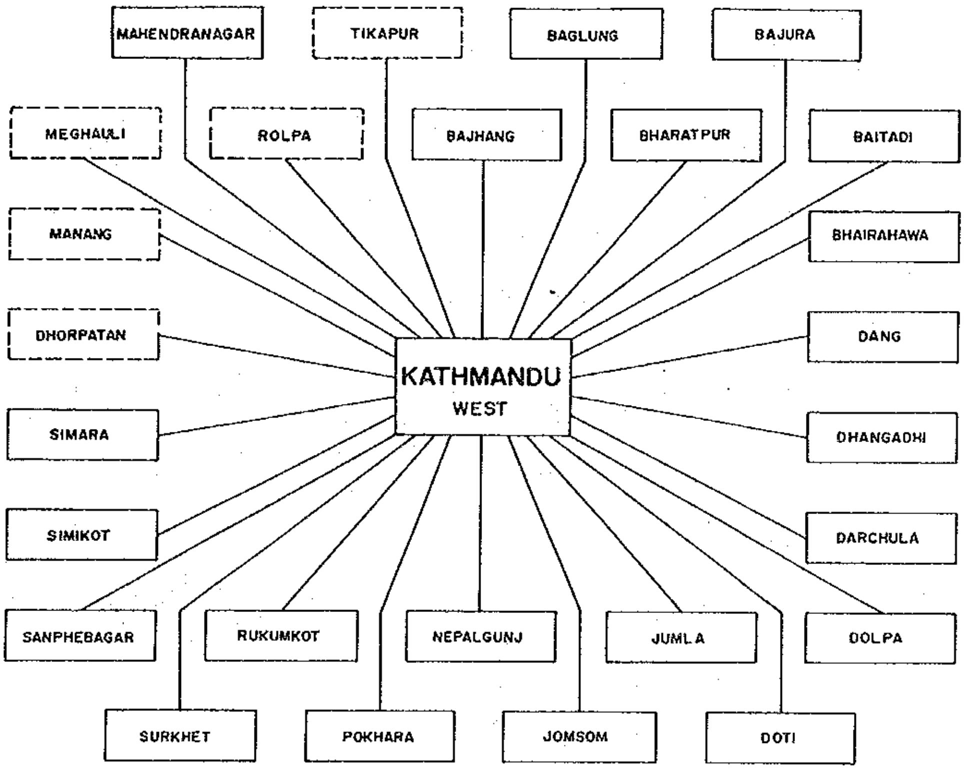


Figure 8.3.4 Domestic HF Network (West)

2. Aeronautical Mobile Service

(1) International HF Mobile Service

SEA-1 (1A) and MID-2 flight information services are provided.

However, communication difficulties at night time are reported due to no optimum frequency assignment.

(2) HF Domestic Aeronautical Mobile Service

A flight information service is provided to domestic en-route flights with two HF frequencies.

Communication difficulties at night and at twilight are reported due to in-adequate frequency assignment.

(3) VHF Aeronautical Mobile Service

A radio relay station is located at the top of the Phulchouki mountain so as to establish satisfactory coverage for the VHF communications, required for ACC and RCC.

The status of the equipment at the relay station is monitored and controlled in the equipment room by means of a UHF link.

Other VHF radio sets in the Equipment room are controlled from the tower console for approach control, aerodrome control and surface movement control.

A handy receiver is provided in the control tower to monitor emergency frequencies.

8.3.5 Meteorological Observation System

The Department of Hydrology and Meteorology has the authority and responsibility for meteorological observations over the airport and its surroundings. Gautchar meteorological observation station, located near the airport, performs observation activities.

The meteorological office, located in the operations building of TIA, also carries out observation activities.

The meteorological observation data is reported on an MSS display at intervals of one to three hours.

Air temperature, pressure and surface wind at the airport are measured and reported by two different sensors which are controlled by the Meteorological Authority and TIA.

A few differences are reported in the data due to the different sensors in different locations.

Only authorized data is provided to MSS.

Although weather satellite and FAX information is received at the Gautcher station, no information is provided to the briefing room.

Locations and instruments are shown in Table 8.3.2.

Table 8.3.2 Location of meteorological observation instrument

Instrument	Gautchar Station	Met. Office	TIAO
Temperature	*		*
Atmospheric Pressure	*	*	*
Wind Speed / Direction	*		*
Precipitation	*		
Humidity / Dew point	*		
Weather, Satellite Receiver	*		
Weather FAX	*		

8.3.6 On-going relevant project

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

- Replacement of the Kathmandu DVOR / DME
- UHF radio link between TIA and NTC (Nepal Telecommunication Corporation)
- RVR
- Ceilometer
- Maintenance Center for the DVOR / DME, including a training facility
- Installation of DVOR / DME in Simara and Bhairawa, and DME only in Pokhara

8.4 Aeronautical Ground Light Systems

8.4.1 Types of lighting systems installed

The following aeronautical ground lighting systems completed in 1991 are installed and operated in the airport.

a. Precision Approach Light System (CAT -I) (RWY - 02)

b. PAPI (RWY - 02 and 20)
c. Sequenced Flash Light System (RWY - 02)
d. Runway Edge Light System (RWY -02 and 20)
e. Runway Threshold Light System (RWY - 02 and 20)
f. Runway End Light System (RWY -02 and 20)
g. Runway End Identification Light System (RWY - 20)
h. Taxiway Edge Light System
i. Taxing Guidance Light System
j. Illuminated Wind Direction Indicator
k. Apron Flood Light System
l. Aerodrome Beacon

All lighting systems are adapted to the requirements of ICAO Annex 14.

These lighting systems are supplied with power and controlled by three substations for aeronautical ground lighting system located in the main substation and at the both ends of the runway.

8.4.2 Power supply

There are three substations for lighting systems. The first one is located in the main substation named P0. The second one is located at the south end of the runway named P1 and the third is at the north end of the runway named P2 as shown in Figure 8.4.1.

The two main transformers specified as 380V/ 5.5 KV, 3-phase, 250 KVA, are installed in the substation P0 and the power supply to each substation is distributed by a 5,500V link distribution system.

Each lighting system is connected to distribution boards in these substations.

8.4.3 Control system

All aeronautical lighting systems are remotely controlled by a control console installed in the control tower.

Remote control relay panels are installed in each substation and connected to the console by control cables.

8.4.4 Cables

All cables such as high tension, low tension, control and aeronautical lighting cables, are installed in cable trenches along the runway, taxiway or apron in a manner of direct burial.

These trenches are classified into three types;

a. AFL cable trench : Width : 400 mm, Depth : 600 mm
b. LT and Control cable trench : 400 mm 800 mm
c. HT cable trench : 400 mm 900 mm

These trenches are separated by at least 2 m from each other.

At present, part of these cable routes, passing under a construction area of the apron expansion, will be removed temporarily and returned back to the normal condition when the expansion construction is completed.

8.4.5 Composition of circuits

Composition of the lighting system circuits is as follows;

CIRCUIT	SYSTEM	LOAD (W)	CCR (KVA)
A	RWY EDGE LIGHT (02)	12, 900	25
B	RWY EDGE LIGHT (20)	12, 900	25
C	THRESHOLD LIGHT (02)	2, 400	4
D	THRESHOLD LIGHT (02)	2, 400	4
E	THRESHOLD LIGHT (20)	800	2.5
F	THRESHOLD LIGHT (20)	800	2.5
G	PAPI (02)	800	2.5
H	PAPI (02)	800	2.5
I	PAPI (02)	800	2.5
J	PAPI (02)	800	2.5
K	APPROACH LIGHT(02)	16, 600	25
L	APPROACH LIGHT (02)	15, 600	25
M	TAXIWAY LIGHT (02)	3, 150	4
N	TAXIWAY AND APRON LIGHT	1, 890	2.5
O	TAXIWAY LIGHT (20)	2, 880	2.5
P	NORTH APRON LIGHT	3, 375	4
Q	REILS		
R	FLASH LIGHT		

8.4.6 Apron flood lights

Six apron flood lighting poles are installed in the existing international apron.

Each pole is provided with six 500 W sodium lamp lighting units (a unit consisting of 2-250 W) and three 1000 W halogen lamp flood lights.

The lighting intensity of the apron is enough for ground servicing and parking.

8.4.7 Control

These lighting systems are controlled by the control console in tower or the control panels in substations P0, P1 and P2.

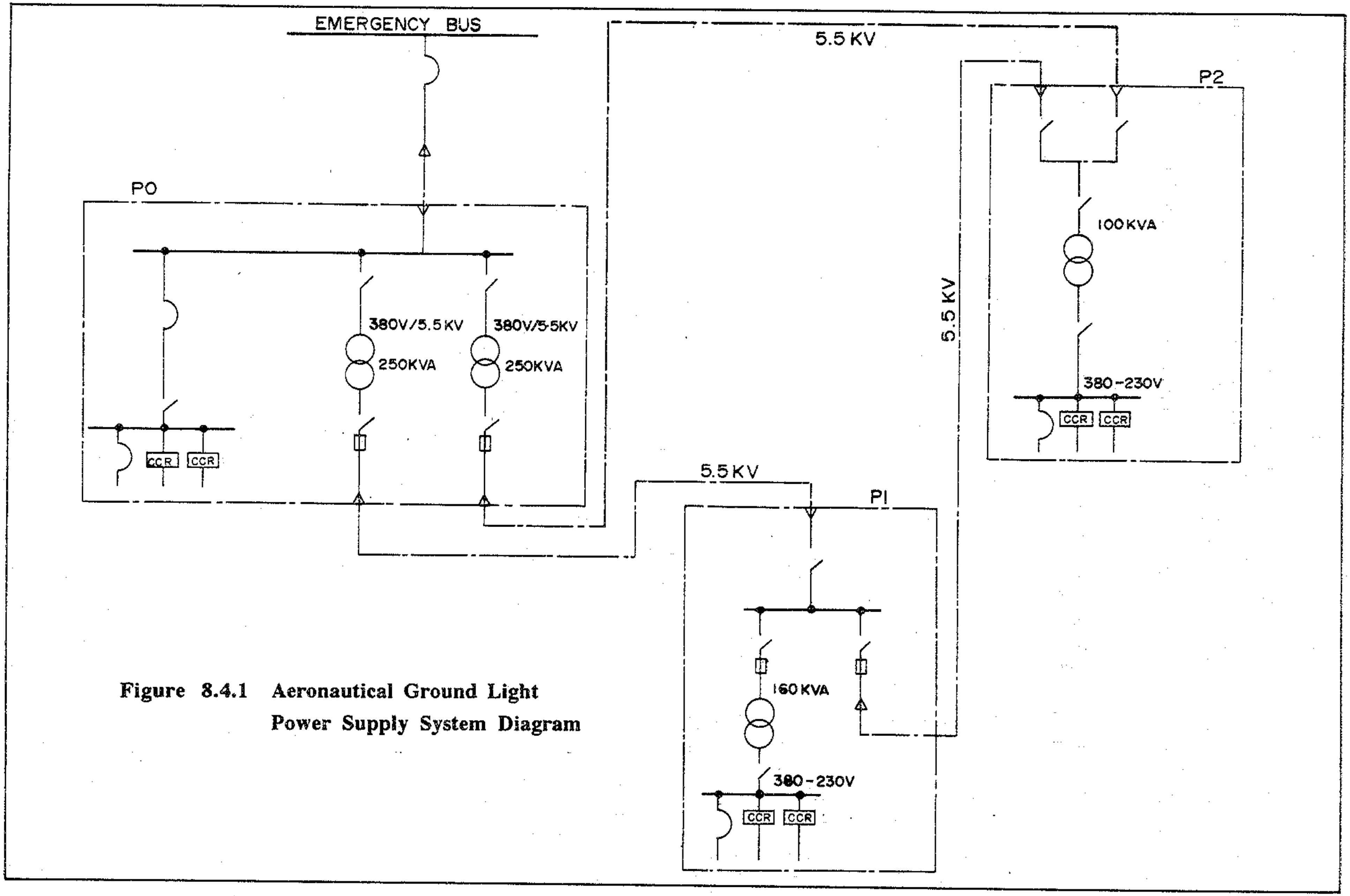


Figure 8.4.1 Aeronautical Ground Light Power Supply System Diagram

8.5 Organization of the ATC and Radio Engineering

The working time of the ATC controllers and radio maintenance engineers/technicians is based on a two shift working schedule.

The morning time team (shift morning) is on duty from 06:00 to 12:30 and the following day time team (shift day) from 12:00 to 18:00.

The shift working times are sometimes changed with regard to the season or air traffic conditions.

The organization chart of TIA is shown in Figure 3.3.3.

8.5.1 Working schedule of ATC controllers

Twelve (12) ATC controllers are assigned to each shift team and are in charge of ATC services at the Control Tower. Some of twelve controllers, on duty for day time work, are appointed overtime work by the end of the last flight usually.

The working schedule, therefore is changing a three shift system by the end of this year so as to improve inveterate overtime work. This third team probably will be on duty at night instead of the overtime work.

8.5.2 Working schedule of radio engineers/technicians

Systems to be maintained by radio engineers and technicians consist of two different fields, one is radio facilities maintenance such as radio navigation aids and communication systems, and the another is facilitation maintenance such as airport security systems, information systems, public announce systems and telephone systems.

Three (3) technical teams consists of one ordinary day time team in charge of the management of the maintenance section and maintenance work for the required high level technology and another two teams in charge of morning time and day time shift work.

The technical skill of the team members is as follows:

Ordinary day time work team

Chief of radio engineers	1
Supervisors	3
General Maintenance Officers	4

Shift work team

General Maintenance Officers	5
General Maintenance Non-Officers	4
Line Technicians	1
Non skilled workers	2

A duty officer is also assigned. Some of the half day shift team are in charge of overtime work. The third shift work team also will be assigned for the improvement of overtime work by the end of the year 1993.

8.5.3 Improvement Program for Operators and Technical Staff

The Department of Civil Aviation (DCA) has an improvement program for ATC controllers and technical staff at TIA.

8.6 Human Resources Development

8.6.1 General

The Civil Aviation Training Center (CATC) has given aviation training to over 600 persons since 1974. Various training courses are prepared for Air Traffic Control, Air Traffic Information Services, Aeronautical Radio Communication, Electronics, Rescue and Fire-fighting, Security and so on.

Training is prepared for both of fundamental and refresher courses.

8.6.2 Outline of current training courses

The following training is provided :

Courses	Training Period
Work shop seminar	3 to 4 days
Aviation security for junior police	16 days
Aviation security for senior officers	4 weeks
Air Traffic Control officer refresher course	7 weeks
Technical officer refresher course	6 weeks
Conversion from communication officer to ATC officer	23 weeks
Basic ATC officer	16 months

8.6.3 Training facilities

One ATC laboratory with mock-up, one communication laboratory with a Message Switching System, one fundamental electronics laboratory, and one HF maintenance practical laboratory are provided. There are also four class rooms for theoretical training and five instructors rooms including one administration room. The building and facilities are old and not well maintained enough for training and human development.

The technical laboratory and the class rooms have limited floor sizes and the building is in a poor condition due to the state of disrepair. Laboratory equipment for theoretical and practical training is also outdated and does not comply with practical operations in the airport.

A new VOR/DME laboratory has been provided recently. However, the facility does not belong to CATC.

The CATC has the sole responsibility for civil aviation training in Nepal. Therefore it is reasonable that all training systems be managed under the CATC's authority and responsibility.

8.6.4 Study for Improvement

In spite of the contribution to human resources development in the field of civil aviation in the past, there is and will be much more necessity for CATC to improve the organization, the curriculum, and the training facilities to meet the new requirements.

In order to cope with the increased training requirements created by the recent expansion of TIA, an improvement program has been prepared by UNDP/ICAO called "Modernization and Upgrading of the Civil Aviation Training Center" (UNDP/ICAO project NEP/85/028) in 1992.

This program involves a comprehensive action plan to improve the human resources development of DCA. The objectives and requirements for CATC were specified as follows:

- To replace the existing obsolete Civil Aviation Training Center (CATC) with a new facility;

- To equip the center with qualified trainers and equipment relevant to current needs.

CHAPTER 9

EVALUATION OF AIR SAFETY

CHAPTER 9 EVALUATION OF AIR SAFETY

9.1 Effective Air Navigation Systems

It is well known that the stages of landing and taking off to and from an airport are the most critical for an aircraft through the flight.

In order to secure approaching and departing aircrafts, air navigation aids are generally installed at airports on the main approach/departure routes to ensure they are flying on course.

When evaluating the effectiveness of air navigation systems, the requirement of the systems such as facility type, performance and location are considered in general.

Besides, particularly in TIA, it is required to consider the coverage boundary of radio navigation aids due to the restriction of distance of line-of-sight by the surrounding mountains around the airport.

9.1.1 Air Traffic Control System

VHF air to ground communication, VHF Direction Finder (VHF/DF), and Aeronautical Terminal Information System (ATIS) have been installed at the airport.

A communication relay station is provided at Mt. Phulchouki so as to extend the VHF coverage boundary.

The necessary improvement for the air traffic control system is as follows:

(1) Introduction of an approach radar control service in Kathmandu TMA

An aircraft flying by instrument flight rules (IFR) in the Kathmandu control air space is controlled based on a procedural control method. In this method, the flying position of the aircraft can be verified only by the controller's vision or position reports from the aircraft by means of radio communication.

Generally, the procedural control method mostly depends upon the pilot's ability and the quality of the service of the navigation aids provided around the airport and/or air traffic control system.

If a pilot loses his position or altitude due to the poor visibility of navigation aids, this may cause a dangerous situation for the aircraft in a mountainous area like Kathmandu TCA. In order to ensure safe operations even in poor weather conditions, visual verification of the aircraft's position for controllers by use of radar would be beneficial. Because of the severe geographical conditions and poor visibility in the rainy season at TIA, a terminal radar system should be introduced as soon as possible.

(2) Expansion of radio service coverage

The service coverage for ATIS, which provides the airport information VOR transmitter, is extremely limited because of the mountainous features around the airport and the VOR location. The aircraft intending to approach to land can not receive information until across the ATIS coverage boundary and this distance is too close to the airport to acknowledge information for the aircraft's operations. A transmitter should be provided for the exclusive use of ATIS at a suitable site such as the Mt. Phulchouki relay station.

Although the coverage of the VHF direction finder is lacking in TMA, the system will be decommissioned after the introduction of the approach radar.

9.1.2 Radio Navigation Systems

Radio Navigation Aids are provided at preferable sites complying with the instrument approach procedure and the standard instrument departure procedure of the airport.

However, the following facilities should be improved in order to enhance the reliability of the system:

(1) Only a VOR/DME is installed at TIA for guidance of instrument approach. This system provides the information of direction and distance between a station and aircraft automatically to aircraft. However, the accuracy of the system is not sufficient for final approach guidance to the runway.

Besides, the VOR/DME approach procedure requires a pilot to read and check gauges of the control panel continuously on the approach. This increases the workload of pilots who are at their most busy and nervous at the stage of the final approach and landing.

The most accurate and easily-handled equipment at present is the Instrument Landing System (ILS). Therefore, it would be desirable to install ILS at TIA in order to enhance the reliability of the system and to ease pilots' workload.

An ILS consists of two components, a glide path and a localizer, which provides both positive information of glide path angle and azimuth to aircraft automatically. This enables a pilot to easily maneuver the aircraft in order to follow the designated guidance by ILS.

One of the components (GP) may not be applicable to TIA, because the mountains lying under the approach course may intrude upon the recommended glide slope angle of three (3) degrees by ICAO.

Nevertheless, another component of LLZ is established to be quite helpful to enhance the safety of approach aircraft to TIA.

Therefore, both guidance systems, not only LLZ/DME but also the current VOR/DME, are recommended, to keep and improve the reliability.

(2) Locators, East and South, are still operational, however they have already reached the end of their useful lifetime.

9.1.3 Aeronautical Telecommunication Systems

Aeronautical Telecommunication Systems are specified into two categories by system function as an aeronautical fixed communication service and a mobile service.

The system which provides the aeronautical fixed communication service has been established by means of an HF, VHF telecommunication and radio link or land line cable.

The following systems should be improved to provide sufficient services and ensure reliability:

(1) HF communication, that is maintained as the major communication system in Kathmandu, should be replaced with another communication system due to the poor reliability of the system.

The existing HF system will be retained only as a back-up system for aeronautical communications.

(2) The Message Switching System (MSS) which is providing the teletype message switching service for AFTN and the domestic teletype service, does not have enough capacity in the system memory, and the function of the system is limited due to its semi-automatic nature.

The implementation of the improved system is required to meet the completion of the fixed communication system development .

(3) A multiple network is required to ensure communication reliability.

9.1.4 Aeronautical Ground Light System

The following aeronautical ground lighting systems completed in 1991 are installed and operated in the airport.

a. Precision Approach light system (CAT-1)(RWY-02)
b. Precision Approach Path Indicator (PAPI) (RWY 02 and 20)
c. Sequenced Flash light system (RWY-02)
d. Runway edge light system (RWY-02 and 20)
e. Runway threshold light system (RWY-02 and 20)
f. Runway End light system (RWY-02 and 20)
g. Runway End Identification light system (RWY-20)
h. Taxiway edge light system
i. Taxing Guidance light system
j. Illuminated Wind Direction Indicator
k. Aerodrome Beacon
l. Flood Light system

All lighting systems follow the recommendations of ICAO Annex 14.

However, guidance lighting systems for approach and departure to and from runway 20 are not installed, which would be important and useful systems to ensure a circling approach course set up close to the mountains.

9.1.5 Meteorological Observation Systems

Meteorological observations and information activities are carried out by the Department of Hydrology and Meteorology, with observation instruments installed at a station near the airport.

Besides DHM, some observation instruments are provided in the airport and maintained by TIAO.

All of these instruments should be maintained and controlled by the one authority of DHM with full responsibility. Locations of the sensors should conform to the ICAO recommendations.

9.2 Air Traffic Control Service

9.2.1 Organization and Structure

Kathmandu ACC/FIS previously provided the service to all of the areas of the Kathmandu FIR before, the service was recently divided into two sectors, Kathmandu and Napalgunj. The work load of Kathmandu ACC, therefore, may have eased due to its decentralized function and responsibility.

Therefore, shift work members in the service should be released from regular overtime work.

9.2.2 Airspace Use and Management

(1) ATS Routes System around TIA

The one-way route system has been introduced on the ATS routes structure in the vicinity of TIA as stated in Chapter 8.

Generally, the existing ATS routes system which is clearly classified for each ATS route into inbound or outbound is very easy and clear for the control of aircraft when the volume of air traffic is not so large.

However, due to the recent increase of aircraft operations to and from TIA, problems have arisen on this ATS route system especially on the inbound routes due to the following reasons.

a) The inbound ATS routes which come from the neighboring FIR converge over the Simara NDB which is located approximately 40 nm SW of the Kathmandu VOR/DME.

b) Accordingly, most of inbound international flights which come from New Delhi, Calcutta, Patna, Dhaka, Bangkok, Hog Kong, etc. to TIA along the designed inbound routes often converge over the Simara NDB at the same flight level (FL) and at the same time.

c) The controllers of Kathmandu ACC are faced with the difficulty of establishing separation between each inbound aircraft due to the critical condition mentioned above.

d) On the other hand, since most of the inbound aircraft approach over the Simara NDB with a high FL (Flight Level), they are confronted with a difficulty descent to a suitable altitude for landing at TIA due to the short distance between Simara NDB and TIA.

To solve these matters, DCA has studied a change in the ATS routes structure around TIA including the abolition of the convergence of inbound ATS routes over Simara NDB and these matters are under negotiation with the ACCs concerned at present.

In 1993, from April to May, the Third ASIA/PACIFIC Regional Air Navigation Meeting of ICAO was held in Bangkok.

In this meeting, recommendations for the revision of the one-way route system in the vicinity of major aerodromes, and the establishment of arrival and departure routes instead of the one-way routes system were adopted as shown in the appendix to this section. In the RAN Meeting Report, ATS routes B345, G335, G336, G463, R325, R344 and R581 which have been established in Kathmandu FIR were pointed out as the subject of these recommendations.

These ATS routes mentioned above are all international ATS routes, and the modification of the ATS route system from a one-way route system to a two-way route system with close coordination between neighboring countries will bring about safer and a more expeditious flow of air traffic.

Considering the background stated above, the existing one-way route system in the vicinity of TIA should be modified to a two-way routes system urgently.

Appendix

AIR TRAFFIC SERVICES ROUTE NETWORK

5.6 The meeting reviewed the principles on which the changes required to the network of ATS routes and the related provision of air traffic services would be based. It took due account of the Table of Aircraft Operations and the Statement of Basic Operational Requirements and Planning Criteria, as well as the need for integration of the ATS route network with those of adjacent regions. It was noted that the route network should take into account the need to keep to a minimum the need for co-ordination between ATS units and for position reporting and frequency changes by aircraft, also bearing in mind the need for fuel conservation and economy of operations.

5.6.1 With respect to long-haul flights, such as inter-regional and inter-continental operations without intermediate stops, it was agreed that ATS routes should be established so as to enable such flights to operate along, or as near as possible to, preferred routes from the point of departure to the point of landing. In addition, the meeting took into account the capabilities of modern commercial aircraft to fly between two points along an ATS route or track with a high degree of navigational accuracy.

5.6.2 The meeting agreed that ATS route designators applicable to the area under consideration should be established in accordance with Appendix 1 to Annex 11 and with the ICAO system of regional distribution of designators. The meeting further agreed that the old designators should be removed from their respective tables in the Air Navigation Plan Publications (ANPPs) during the review of these tables by the meeting.

5.6.3 The meeting considered the current format of Table ATS 1 as contained in the *Air Navigation Plan - Middle East and Asia Regions* (Doc 8700) and the *Air Navigation Plan - North Atlantic, North American and Pacific Regions* (Doc 8755). It was agreed that the current practice of including cruising levels within Table ATS 1 (ASIA/PAC RAN Meeting [1973] Recommendation 7/16 refers) was no longer required within the Asia and Pacific Regions.

5.6.4 The meeting reviewed the plan of ATS route networks for the Middle East, Asia, Pacific and European Regions, as covered by the area under consideration by the meeting. In addition, amendments to the ATS route network as proposed by the States were also considered. Route designators for new ATS routes as detailed in Appendix C (European ATS Route Network) would be allocated at a later time by the ICAO European and North Atlantic Regional Office. During discussion on ATS routes A210 and B345, it was noted that India was not able to agree to the significant points contained within the route description. In addition, China did not support the need for ATS route R216 at this time, but did agree to the inclusion of the requirement in the ANP, with a note being added indicating that the route was subject to further study. With regard to proposed ATS route B330 (Appendix A to the Report on Agenda Item 5, page 5A-8 and Appendix C to the Report on Agenda Item 5, page 5C-3), the meeting was unable to reach a unanimous agreement on a requirement for a segment of this route between Altai and Yabrai, due to communications difficulties at the time in the area which would have an adverse impact on safety.

Recommendation 5/19 - Plan of ATS routes

That:

a) the plan of air traffic services (ATS) routes as shown at Appendices A, B and C to the Report on Agenda Item 5 form the ATS route network for the area under consideration; and

b) States co-ordinate the requirements for proposed additions, deletions and changes to ATS routes through the ICAO Regional Office.

5.6.5 The meeting recognized that there may be a future requirement for an ATS route linking Shanghai with Seoul. When this requirement would be more clearly defined, China and the Republic of Korea agreed to meet to jointly develop a proposal for inclusion of this requirement in the ANP.

5.6.6 The meeting recognized that, from an operational point of view, an ATS route network based on area navigation (RNAV) and providing for optimal routing, which would facilitate fuel conservation and reduce pilot workload, was the preferred system. The meeting, therefore, examined the need for such routes and agreed that RNAV routes should be included in the plan for ATS routes to offer improved routing to aircraft with RNAV capability.

5.6.7 The meeting noted that, in some parts of the area under consideration, ATS routes were implemented as one-way routes, especially in the vicinity of major aerodromes. The purpose of this type of route configuration was to segregate the flows of arriving and departing traffic at the aerodrome and to facilitate the provision of air traffic control. The meeting agreed that there was a need to establish arrival and departure routes and consequently developed the following recommendation:

Recommendation 5/20 - Establishment of standard arrival and departure routes

> That States, which have not already done so, establish standard departure and arrival routes wherever necessary, taking into account relevant ICAO provisions of Annex 11, Appendix 3 and guidance material in the *Air Traffic Services Planning Manual* (Doc 9426).

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(2) Approach and Departure Procedures

Tribhuvan International Airport is located in the Kathmandu Valley which is surrounded by the mountains of approximately 2,500 m ~ 3,000 m AMSL. Aircraft approaching to and departing from TIA are strictly required to make a steep descent or climb due to these topographical conditions. The main navigational aid, Kathmandu VOR/DME, identification KTM, co-ordinates 27°40'29"N/85°21'00"E, frequency 112.3 MHz/ch 70X, approximately 0.6 nm south of Runway 02 threshold, is the only installed aid for the use of aircraft operations at TIA at present.

However, taking into consideration that VOR/DME is the only useful landing aid at TIA to secure safe air traffic flow, it is strongly requested to install an additional NAVAID system for aircraft operations at TIA, especially for aircraft approaching Runway 02.

(3) Obstacle Limitation Surfaces

The obstacle limitation surfaces for TIA were studied in Chapter 8. In this study, it was found that many mountains project above these surfaces especially in the second and horizontal sections of the approach surfaces for Runway 02 and 20 of this airport. The mountains mentioned above obstruct the establishment of precision approach procedures for both runways.

Due to the geographical conditions surrounding the airport, it is considered that limitations on aircraft operations should be added to overcome there obstacles.

(4) Management

At present, combined approach control and aerodrome control is provided by the Tower Controller only. As a result of this procedure, the Tower VHF communications are kept busy. So as to solve this matters, separate units which back-up procedural control should be provided for both of approach and aerodrome control.

9.3 Human Resources Development

9.3.1 General

Aviation technology, particularly, in the field of electronic devices, has been developed rapidly and the requirement for Air Traffic Services to cope with traffic increases and enhance air safety have also been raised.

As CATC is the only authority institute to develop human resources for civil aviation in Nepal, CATC should be strengthened to be responsible for this role.

In spite of these situations, CATC still faces the difficulty of developing it's structure and facilities due to the surrounding restraints.

Basic training and refresher training have been carried out. Various courses for training are prepared but not enough for the requirements. Training facilities, such as class rooms, laboratories, and training equipment are insufficient to teach recent technology and principles of operation.

The courses are handled by a limited staff of CATC training specialists and extra instructors from DCA's staff.

The purpose of human resources development is to raise individual ability and responsibility in the workplace. Therefore the final stage of training should be practical. On-the-Job-Training (OJT) is expected to be involved, in parallel with, training at CATC. However, the current OJT system is not well arranged in terms of training quality and evaluation.

The Recommendations of the report prepared by UNDP/ICAO project NEP/85/028 are quite helpful and should be realized as soon as possible so as to modernized and upgrade to meet the current and future requirements.

9.3.2 Requirements for immediate improvement

The following items can be specified to be improved immediately in viewpoint of aviation training methodology by the ICAO Training manual (DOC. 7192-AN/857).

(1) Instructors

All instructors should have excellent experience in their technical field and a knowledge of the whole field of aviation.

To ensure this requirement, fellowship training abroad should be considered. Technical assistance by international experts also will be required to review and develop the training curriculum and syllabus.

Note: Training Curriculum : Definition of detailed knowledge, skill and experience required for a specific occupation in aviation, which should be contained in a course of training, resulting in the required Manpower Standards.

Training Syllabus : Detailed content of a course of training derived from a Training Curriculum, presented in an order corresponding to a teaching sequence of topics, required to reach the desired Manpower Standard.

(2) Facilities

An adequate floor space for class rooms, modern laboratory equipment and others should be provided. Modern training aids, e.g. video recorders, reproducers, overhead projector and CCTVs, will be required to meet the modern training curriculum.

9.4 Recommendations for Improvement

(1) Air Traffic Control System

The installation and operation of ASR and SSRs, that can perform radar surveillance and control aircraft within Kathmandu TCA, are highly required. Recruitment and training of radar controllers and technical staff necessary for the operation and maintenance of a radar system should also be considered. The existing VHF/DF will be decommissioned after the commencement of radar.

(2) Radio Navigation Aids

In addition to the existing VOR/DME facilities, Localizer type Direction Aids (LDA) or Localizer/DME facilities, that may provide a more accurate guidance for instrument approach, should be installed. Related instrument approach procedures and navigation charts should be developed.

(3) Aeronautical Telecommunication System

A reliable Fixed Aeronautical Telecommunication System by means of communication satellite and/or microwave radio link should be installed instead of the existing HF communication.

Improvement of the existing semi-automatic message switching system should also be performed prior to the commencement of the improvement communication network.

(4) Aeronautical Ground Light System

Two systems for guidance lighting; Runway Lead-in Lighting and Circling Guidance Lighting (CGL) are required to enhance approach and departure to/from RWY20.

(5) Meteorological Observation System

Observation sensors should be installed at preferable locations recommended by ICAO Annex 3. Reporting weather data should be recorded and managed.

An Automatic Meteorological Observation System (AMOS) is required so as to achieve data collection, analysis and automatic recording.

(6) Manpower of ATS

The number of shift working crews should be increased to three in order to solve chronic overwork.

(7) Human Resources Development

CATC should be strengthened in terms of structure and equipment to develop the necessary training of DCA personnel. Improvement of the training environment should be promoted by relocation and construction of a training building with the necessary modern training facilities.

Instructors with required technical levels should be maintained in sufficient numbers for CATC courses.

Personal records of OJT should be maintained so as to be utilized for their rating and technical ability evaluation.

CHAPTER 10

AIR SAFETY IMPROVEMENT PLAN

CHAPTER 10 AIR SAFETY IMPROVEMENT PLAN

10.1 General

(1) This chapter describes the air safety improvement plan as a master plan of air safety improvement at TIA. This plan is prepared for the long-term development aiming at the year 2010 and is based on the evaluations of air safety in Chapter 9, the study in Chapter 10 and also the following study and report as far as concerned.

- ICAO Action Plan of the Civil Aviation Development Cooperation 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

(2) This chapter consists of two parts. One part is the study of air safety improvements to estimate the adaptability and effectiveness of systems which are being considered to be introduced. The other part is the plan itself.

(3) Recent aviation technology has developed rapidly especially in the field of electronics with the development of ground navigation aids and their relation with airborne equipment. The air safety improvement plan, therefore, is expected to be reviewed from time to time to meet technological changes as well as the airport modernization plan.

10.2 Air Safety Improvement Study

10.2.1 Airspace Use Study - realignment of ATS routes in and around TIA -

At present, TIA is faced with various problems. The main problems are;

- Realignment of the ATS route system including the revision of the one-way route system established in the vicinity of the airport in accordance with the recommendations of the ICAO RAN Meeting in 1993
- The establishment of arrival routes and new approach procedures to meet the increasing traffic volumes at this airport

The management of these problems mentioned above is an urgent matter to ensure the safety of aircraft operations.

Furthermore, it is strongly required that ASR (Airport Surveillance Radar) and SSR (Secondary Surveillance Radar) is installed to help management of the problems mentioned above successfully.

In this section, airspace use and instrument approach procedures at TIA are studied considering the evaluations of the existing conditions at TIA studied in Chapter 9.

(1) The Study of Line of Sight from KTM VOR/DME

Kathmandu VOR/DME (KTM 112.3 MHz, CHN 70X, 27°40'29"N/85°21'00"E) located at approximately 0.6 nm south of the Runway 02 threshold occupies the most important point for the existing ATS routes system which is established in the vicinity of this airport. Accordingly, in advance of the study of arrivals and ATS routes for TIA, the lines of sight from KTM VOR/DME were studied based upon the geographical map.

The check lines for line of sight from KTM VOR/DME were drawn between 111° and 315° true bearings at irregular intervals on the geographical map as shown in Figure 10.2.1 taking into account of the surrounding mountains located near KTM VOR/DME which will become obstacles against the lines of sight from KTM VOR/DME.

Two or three obstacles along each check line which will influence the line of sight were selected as shown in Figure 10.2.1.

The obstacle which makes the steepest slope of line of sight on each check line was chosen from Table 10.2.1, then the attitude of the line of sight along each check line was calculated at points between 15 nm and 25 nm as shown in Table 10.2.2.

The calculations for the attitudes of the slope of the line of sight were performed with following conditions:

1. Elevation of KTM VOR/DME : 4300 feet
2. Earth curvature : $0.024D^2$ (D = Distance(feet) / 1000)
3. Using Map : Geographical map prepared by US Army Map Service (RMBM) Corps of Engineers US Army, Washington, D.C. with scale of 1/250000.

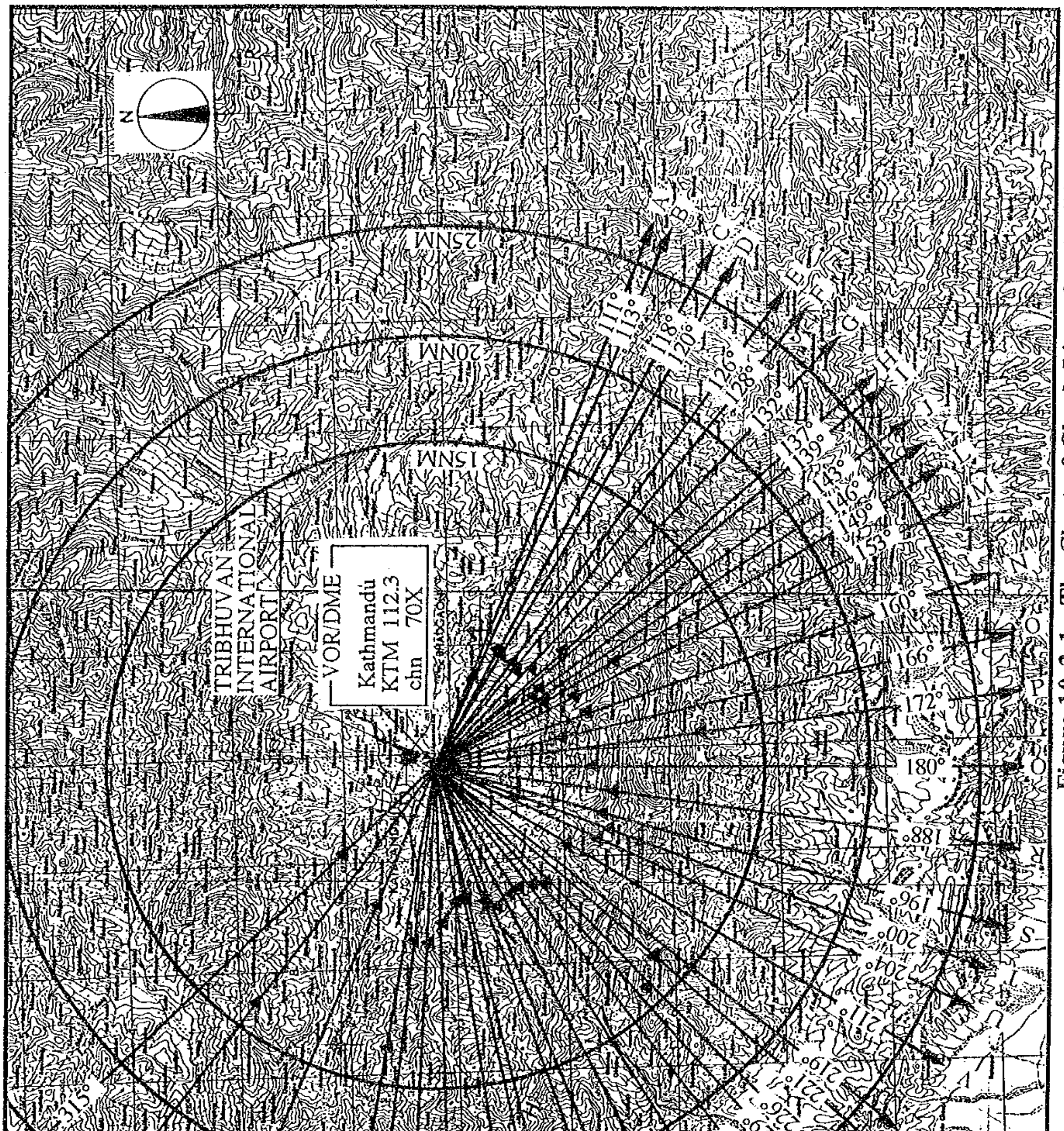

Figure 10.2.1 The Chart of Check Lines for the Line of Sight from KTM VOR/DME

Table 10.2.1 Inspection Sheet for the Line of Sight of KTM VOR/DME from SE through NW Direction

Line	Obstacles				
	Distance from KTM VOR/DME (m/nm)	Height above MSL (ft)	Height above KTM VOR/DME site (ft/m)	Direction from KTM VOR/DME (degrees true)	Slope from KTM VOR/DME (%)
A	8300/4.5	5000	700/213	111	2.566
	16500/8.9	6036	1736/529		3.206
B	8300/4.5	5000	700/213	113	2.566
	40000/21.6	6750	2450/747		1.868
	8300/4.5	5000	700/213	118	2.566
C	11000/5.9	6500	2200/671		6.1
	30000/16.2	5797	1497/456		1.52
D	6500/3.5	5000	700/213	120	3.277
	11000/5.9	6587	2287/697		6.336
E	7500/4.0	5000	700/213	126	2.84
	11000/5.9	6500	2200/671		6.1
F	6500/3.5	5000	700/213	128	3.277
	10500/5.7	6500	2200/671		6.39
	41250/22.3	7500	3200/975		2.364
G	7750/4.2	5000	700/213	132	2.748
	11500/6.2	6500	2200/671		5.835
	35000/18.9	7000	2700/823		2.351
H	6500/3.5	5000	700/213	137	3.277
	10000/5.4	6000	1700/518		5.18
	14500/7.8	7000	2700/823		5.676
	31750/17.1	9000	4700/1433		4.513
	36000/19.4	8744	4444/1355		3.764
I	7000/3.8	5000	700/213	139	3.043
	10000/5.4	6500	2200/671		6.71
	14000/7.6	7000	2700/823		5.879
	20000/10.8	8500	4200/1280		6.4
	31500/17.0	9500	5200/1585		5.032
J	6000/3.2	5000	700/213	143	3.55
	10000/5.4	7000	2700/823		8.23
	18500/10.0	8000	3700/1128		6.097
	20000/10.8	8500	4200/1280		6.4
	27000/14.6	9500	5200/1585		5.87
K	6000/3.2	5000	700/213	146	3.55
	10000/5.4	7000	2700/823		8.23
	18500/10.0	8500	4200/1280		6.919
	25000/13.5	9710	5410/1649		6.596
L	6000/3.2	5000	700/213	149	3.55
	10000/5.4	7000	2700/823		8.23
	13000/7.0	8000	3700/1128		8.677
	17500/9.4	9500	5200/1585		9.057
M	6000/3.2	5000	700/213	153	3.55
	10500/5.7	7000	2700/823		7.838
	13000/7.0	9050	4750/1448		11.138
N	10000/5.4	5000	700/213	160	2.13
	13500/7.3	8500	4200/1280		9.481

Table 10.2.1 Inspection Sheet for the Line of Sight of KTM VOR/DME from SE through NW Direction (Con't.)

Line	Distance from KTM VOR/DME (m/nm)	Height above MSL (ft)	Height above KTM VOR/DME site (ft/m)	Direction from KTM VOR/DME (degrees true)	Slope from KTM VOR/DME (%)
O	9000/4.9	5000	700/213	166	2.366
	10500/5.7	7500	3200/975		9.286
P	9000/4.9	5000	700/213	172	2.366
	10000/5.4	6000	1700/518		5.18
	17000/9.2	7000	2700/823		4.841
	22500/12.1	8274	3974/1211		5.382
Q	9500/5.1	5000	700/213	180	2.242
	13000/7.0	6000	1700/518		3.985
	22000/11.9	7500	3200/975		4.432
R	10000/5.4	5000	700/213	188	2.13
	15000/8.1	7000	2700/823		5.487
S	9500/5.1	5000	700/213	196	2.242
	14500/7.8	7500	3200/975		6.724
T	11500/6.2	5000	700/213	200	1.852
	15500/8.4	7500	3200/975		6.29
U	13000/7.0	5000	700/213	204	1.638
	15000/8.1	7000	2700/823		5.487
V	12500/6.7	5000	700/213	211	1.704
W	18500/10.0	5000	700/213	219	1.151
	24000/13.0	6000	1700/518		2.158
	27500/14.8	7392	3092/942		3.425
X	13500/7.3	5000	700/213	221	1.578
	15000/8.1	6000	1700/518		3.453
	24500/13.2	7500	3200/975		3.98
Y	9000/4.9	5000	700/213	226	2.367
	14000/7.6	6000	1700/518		3.7
	25500/13.8	8297	3997/1218		4.776
Z	8000/4.3	5000	700/213	229	2.663
	13500/7.3	6500	2200/671		4.97
	21000/11.3	7500	3200/975		4.643
AA	8000/4.3	5000	700/213	233	2.663
	13500/7.3	6000	1700/518		3.837
	21500/11.6	7000	2700/823		3.828
BB	7500/4.0	5000	700/213	238	2.84
	11500/6.2	6000	1700/518		4.504
	12500/6.7	7000	2700/823		6.584
CC	7750/4.2	5000	700/213	243	2.748
	12500/6.7	6500	2200/671		5.368
	13000/7.0	7000	2700/823		6.331
DD	8000/4.3	5000	700/213	248	2.663
	12000/6.5	7000	2700/823		6.858
	12500/6.7	8000	3700/1128		9.024
EE	8000/4.3	5000	700/213	251	2.663
	12000/6.5	8000	3700/1128		9.4
	26500/14.3	8500	4200/1280		4.83
FF	8500/4.6	5000	700/213	256	2.506
	11250/6.1	8289	3989/1216		10.809